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RIM 2021

ELECTRONIC PROCEEDINGS

13th International Scientific Conference on Manufacturing Engineering

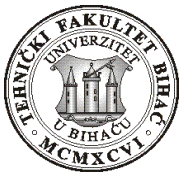
DEVELOPMENT AND MODERNIZATION OF THE MANUFACTURING

UNIVERSITY OF BIHAĆ

FACULTY OF TECHNICAL ENGINEERING

Sarajevo, September 29th - October 1st 2021

UNIVERZITET U BIHAĆU
TEHNIČKI FAKULTET



UNIVERSITY OF BIHAC
FACULTY OF TECHNICAL ENGINEERING

13th International Scientific Conference on Manufacturing Engineering
DEVELOPMENT AND MODERNIZATION OF THE MANUFACTURING

13. međunarodna naučna konferencija o proizvodnom inženjerstvu
RAZVOJ I MODERNIZACIJA PROIZVODNJE

RIM 2021

ELECTRONIC PROCEEDINGS

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PREDGOVOR

Opći trend razvoja i prestrukturiranja proizvodnje u tehnološki razvijenom svijetu sve se više zasniva na modernizaciji i reinženjeringu, čiji je temelj primjena novih tehnologija, fleksibilne automatizacije i organizacije, kompjuterski integrirane proizvodnje s osnovnim ciljem da se proizvodi kvalitetnije, jeftinije i brže. Na tragu tih spoznaja Naučno nastavno vijeće Mašinskog fakulteta Univerziteta u Bihaću odlučilo je da svake druge godine organizira međunarodni skup pod nazivom ***" Revitalizacija i modernizacija proizvodnje"***. Prvi skup RIM '97 organiziran je s ciljem sagledavanja i analize stanja u industriji nakon rata i stvaranja osnovnih pretpostavki za širu primjenu revitalizacije i modernizacije proizvodnje.

Međunarodni skupovi RIM održavaju se pod motom:

- Industrijska proizvodnja se realizira uz stalne i intenzivne promjene koje se sastoje u prilagođavanju novim okolnostima i zahtjevima tržišta.
- Konkurentnost i promjena strukture proizvodnje, orijentacija prema tržištu, reinžinjering i revitalizacija poslovnih i proizvodnih procesa i sistema su imperativ opstanka poduzeća.
- Revitalizacija i reinženjering proizvodnje su procesi neprekidnog inoviranja i unapređenja postojećih proizvoda, tehnologija, proizvodnih procesa i sistema od čije efikasnosti primjene ovisi opstanak proizvodno-poslovnih sistema.
- Usvajanje koncepta industrije 4.0.

Ovogodišnja trinaesta konferencija RIM 2021 održava se pod nazivom "Razvoj i modernizacija proizvodnje" sa tematskim područjima:

A. Mašinsko inženjerstvo
B. Dizajn i tehnologija drveta
C. Elektrotehnika i računarstvo
D. Tehnologije i konstrukcije u građevinarstvu
E. Dizajn i tehnologije tekstila
F. Pravno-ekonomska regulativa i standardizacija
G. Osiguranje kvaliteta, zaštita okoliša i održivi razvoj

Na konferenciji sudjeluje 236 autora i koautora iz zemlje i inozemstva sa 136 radova. Očekuje se da će ovaj skup i prikazani radovi biti novi konkretni podsticaj i doprinos u transferu znanja i tehnologija i razvoju moderne proizvodnje, te da će ponuditi odgovore na niz pitanja kako usavršiti proizvodnju i poslovne sisteme učiniti profitabilnijim i efikasnijim na turbulentnom međunarodnom tržištu.

Svim autorima radova, suorganizatorima, pokroviteljima, institucijama i svim drugima koji su pridonijeli održavanju ove Konferencije, organizator najtoplije zahvaljuje.

Dekan Tehničkog fakulteta

Prof. dr. Atif Hodžić

Predsjednik Organizacionog odbora

Prof. dr. Fadil Islamović

PREFACE

The general trend of development and restructuring of the manufacturing in the technologically developed world is increasingly based on modernization and reengineering, based on the application of new technologies, flexible automation and organization, computer-integrated manufacturing with the basic goal of producing better, cheaper and faster. Following these findings, the Scientific Teaching Council of the Faculty of Mechanical Engineering, University of Bihac decided to organize an international conference every second year called "Revitalization and modernization of the manufacturing". The first conference of RIM '97 was organized with the aim of reviewing and analyzing the situation in industry after the war and creating the basic preconditions for the wider application of revitalization and modernization of the manufacturing.

RIM International Conferences have been held with the motto:

- Industrial manufacturing has been realized with constant and intensive changes that consist of adapting to new circumstances and market requirements.
- Competitiveness and change of the manufacturing structure, market orientation, reengineering and revitalization of business and manufacturing processes and systems are imperative for the survival of the company.
- Revitalization and reengineering of the manufacturing are processes of continuous innovation and improvement of existing products, technologies, manufacturing processes and systems on the efficiency of which the survival of the manufacturing and business systems depends.
- Application of the concept of industry 4.0.

This year's thirteenth conference RIM 2021 is held under the title "Development and modernization of the manufacturing" with the following thematic areas:

A. Mechanical Engineering
B. Wood Design and Technologies
C. Electrical Engineering and Computer Science
D. Technologies and Structures in Civil Engineering
E. Textile Design and Technologies
F. Law-Economics regulations and standardization
G. Quality Assurance, Environment Protection and Sustainable Development

The conference is attended by 236 authors and co-authors from the country and abroad with 136 papers. It is expected that this set and presented papers will be a new concrete stimulus and contribution in the transfer of knowledge and technologies, development of the modern manufacturing and that it will offer answers to questions on how to improve the manufacturing making business systems more profitable and efficient in turbulent international market.

The organizer would like to thank all the authors, co-organizers, sponsors, institutions and all others who contributed to the organization of the Conference.

Dean of the Faculty of Technical Engineering

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Generalni pokrovitelj konferencije RIM 2021

Medijski pokrovitelj

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I

HOW TO CHOOSE THE BEST WOOD FOR DECKING AND CLADDING?

Miha Humar[1], Boštjan Lesar[2], Davor Kržišnik[3]
1. University of Ljubljana, Biotechnical faculty; miha.humar@bf.uni-lj.si
2. University of Ljubljana, Biotechnical faculty; bostjan.lesar@bf.uni-lj.si
3. University of Ljubljana, Biotechnical faculty; davor.krzisnik@bf.uni-lj.si

ABSTRACT:

The importance of wood in the building sector is increasing. Predominantly wooden facades and cladding are exposed to a variety of degradation factors. To prevent wood decay, we need to select the appropriate wood species, protection or modification method. In order to assess the durability of different wood species, a model house was constructed in Ljubljana in October 2013. The wooden facade on the object has a protective and aesthetic function. It consists of 19 materials used for this and similar applications in this region. In addition to untreated wood (spruce, larch, beech, English oak, sweet chestnut, pine sapwood and heartwood, linden, ash), the materials were given four different treatments: Cu-ethanolamine (Silvanolin®), montan wax (Silvacera®), acrylic surface coating (Silvanol® Lazura B) and thermal modification (Silvapro®). The terrace boards were made of the same materials. Wood moisture sensors from Scanntronik (Germany) were installed on 120 positions in the model objects. The decay and moisture content of decking boards and cladding elements were regularly monitored. In addition, the positive effect of thermal modifications and water repellent treatments on the outdoor behaviour of the materials studied was revealed, as well as the synergistic effects between moisture performance and fungal durability. In the second year, the first signs of decay developed in the sapwood of spruce, beech and pine. After seven years of exposure, there was no decay on the cladding, while the decking boards were severely affected. This shows how important the construction details are. Spruce wood was completely degraded, followed by beech and Scots pine sapwood. At least minor decay occurred in all of the wood species except thermally modified wood, which was also treated with copper-based wood preservatives or wax. The results indicate that the best durability is found in wood species with good water exclusion efficiency and natural durability.

Keywords: decay, durability, model house, moisture content, service life prediction, wood

1. INTRODUCTION

Wood is one of the most important constructions and building materials. Wood and derived materials are often used outdoors. Low maintenance costs, broad accessibility and relatively simple production and mounting contribute to the increasing popularity of wooden façades and decking. Furthermore, [22] showed that a wooden façade and decking are favourable in terms of greenhouse gas emissions, compared to other materials such as brick, fibre cement and steel. Similarly, as with other materials, wood in outdoor applications is exposed to weathering and a variety of degradation organisms. In the temperate climate zones, wood-inhabiting fungi are the predominant reason for replacement [1]. Various approaches are applied to prevent fungal decay: impregnation of wood with biocides, wood

modification, protection by design, selection of naturally durable wood species and use of hydrophobic treatments [13,20]. Wooden façades and decking can be made of untreated wood, wood treated with biocides or modified wood [12].

There is rather a vast number of materials available for decking and cladding applications. Despite that, the selection of the most appropriate materials is still a challenging task. Selection mainly depends on the expected service life and price of the materials. Service life prediction of wood is challenging because the time during which a particular wooden structure will fulfil its function depends on a variety of factors, including the wood material used, the protection applied, and various climate-related parameters [14]. In addition to the material-inherent durability, the moisture and temperature conditions inside the wood, i.e., the material climate, are the most critical factors influencing the ability of fungi to decompose wood [1,4]. These factors are influenced by the design of the construction, the exposure conditions and local climatic conditions (microclimate). Therefore it is of great interest to monitor moisture content during exposure.

Building information modelling (BIM) software packages nowadays require information about service life and maintenance intervals for materials used in the planning phase [18]. This information is required by the European Construction Products Regulations [8] and is needed for performance-based design [17]. The Eurocode [10] provides indicative design working lives of 10 years for temporary structures, 50 years for building structures and 100 years for monumental building structures and bridges. These values are set for objects regardless of the materials used. The expected service life of wooden structures under the given exposure conditions is a crucial parameter in selecting materials for construction.

To determine the technical and aesthetic service life of wood, a model house in Ljubljana was constructed. The decking and façade of the model house were made of various wood species, modified wood, wood treated with hydrophobic treatments and biocides. Within this contribution, we aimed to describe wood's aesthetic and technical service life after eight years of exposure.

2. MATERIAL AND METHODS

The field trial is based on the testing of the façade and the decking of the wooden model house unit at the Department of Wood Science and Technology in Ljubljana, Slovenia (Figure 1). The average temperature in Ljubljana is 10.4 °C, the annual precipitation is 1290 mm, and the Scheffer Climate Index is 55.3. The model house was finished in October 2013. The materials listed in Table 1 were exposed on the façade and decking applications. The cross-section of the elements was 2.5 × 5.0 cm. The preparation of all the materials is described by Kržišnik et al. [16].

Figure 1: Visual appearance of model house in Ljubljana in November 2013.

The in-service testing started in October 2013, and the prime objective was to monitor the occurrence and development of decay (functional service life) and moisture performance. Decay was visually evaluated annually and rated (0—no attack; 1—slight attack; 2—moderate attack; 3—severe attack; 4—failure) as prescribed by EN 252 [6]. Only the decay on decking specimens were considered within this study, as there was no decay on the cladding.

At the house, a variety of continuous and non-continuous measurement techniques was performed. For moisture measurements, resistance sensors are applied to 150 positions and linked to Material Moisture

Gigamodule Universal Sensor (Scanntronik Mugrauer GmbH, Germany), enabling wood MC measurements between 6% and 60%. To transform electrical resistance determined by Material Moisture Gigamodule to moisture content, the methodology described by Brischke and Lampen [2] was used. For colour measurements, several times a year, the portable measuring device Colour Measuring Device EasyCo 566 (Erichsen, Germany) was used. Values of measured colours were expressed according to the CIE Lab system, the method created by the Commission International de l'Eclairage.

Table 1: Nineteen different investigated wood species and wood-based materials.

	Wood species								Treatment			
	Norway spruce (*Picea abies*)	**Scots pine – sapwood (*Pinus sylvestris*)**	**Scots pine – heartwood (*Pinus sylvestris*)**	**European larch (*Larix decidua*)**	**European ash (*Fraxinus excelsior*)**	**European beech (*Fagus sylvatica*)**	**Sweet chestnut (*Castanea sativa*)**	**English oak (*Quercus* sp.)**	thermal modification	impregnation with natural wax	copper–ethanolamine impregnation	water borne acrylic surface coating
Abbreviation	PA	PS	PH	LD	FE	FS	CS	Q	TM	NW	CE	AC
PA	**PA**											
PA–NW	**PA**									**NW**		
PA–AC	**PA**											**AC**
PA–CE	**PA**										**CE**	
PA–CE–NW	**PA**									**NW**	**CE**	
PA–TM	**PA**								**TM**			
PA–TM–NW	**PA**								**TM**	**NW**		
PA–TM–CE	**PA**								**TM**		**CE**	
PS		**PS**										
PH			**PH**									
LD				**LD**								
LD–TM				**LD**					**TM**			
FE					**FE**							
FE–TM					**FE**				**TM**			
FS						**FS**						
FS–TM						**FS**			**TM**			
FS–TM–NW						**FS**			**TM**	**NW**		
CS							**CS**					
Q								**Q**				

3. RESULTS AND DISCUSSION

3.1. Colour changes

In-service testing provided the most accurate information regarding the colour changes during weathering. The most important reason for seasonal fluctuations was related to fungal melanin, with its formation, on the one hand, being countered by bleaching on the other. Blue stain fungi grew on the surface during the wet autumn and winter months (Figure 2). In the summer months, melanin was at least partially bleached [21], which resulted in fluctuations of lightness (in the autumn and winter, the wood gets darker, and in summer, it turns back to lighter colours) (Figure 3). The extent of discolouration depended on microclimate conditions, the susceptibility of the material, UV radiation, etc.

Figure 2: Development of the blue stain fungi on the surface of Norway spruce wood after 12 weeks of exposure as determined by Laser Scanning Confocal Microscopy.

After seven years of weathering, the total colour difference was the highest on decking and lowest on the south-facing façade. Colour changes on the other three exposures (north, east, and west) were comparable. Furthermore, seasonal fluctuation in ΔE could be observed on all façades and decking, but mainly on the north-facing façade and on the deck. The horizontal position is the most exposed to sun radiation, as well as to precipitation, which assured conditions for colour changes in abiotic and biotic ways, in particular the formation of a grey colour, as well as the sequential formation of UV-induced free radicals, the degradation of lignin into quinones, the leaching of quinones [11], and the development of staining fungi [16].

In general, the most prominent colour difference was observed on the decking, with one exception, the thermally modified European larch (LD-TM), for which the ΔE was lowest on decking compared to other exposures. In addition, the colour changes of thermally modified Norway spruce (PA-TM) on decking were not the most prominent; on the east and west façade; the colour difference was more notable. Generally, there was no correlation between which orientation of the façade resulted in lower or higher colour changes. The prime reason for this was that the micro-positions of each material on respective façades differed, hence introducing an additional level of uncertainty. If individual materials were compared, it could be concluded that the lowest ΔE was observed on PA-TM-CE (copper-treated thermally-modified Norway spruce), followed by LD-TM (thermally-modified European larch) and PA-CE (copper-treated Norway spruce). On the other side, the highest ΔE was measured on Norway spruce (PA), followed by wax treated Norway spruce (PA-NW) and European larch (LD). The modifications in wood structure occurring at high temperature were accompanied by several favourable changes in physical structure, i.e., enhanced weather resistance and a decorative, dark colour [23]. Colour changes indicated that the course of the colour changes was pretty similar for all the exposure directions. One of the reasons for these observed differences originated in the initial colour. Norway

spruce (PA), wax-treated Norway spruce (PA-NW), and European larch (LD) were lightly-coloured materials, so the development of the dark pigmented blue stain fungi was the most notable. On the other hand, the presence of fungicides (copper-based wood preservatives) prevented the development of the blue-stain fungi, whilst the presence of copper slowed down UV-induced degradation to a certain extent [7], which resulted in less noticeable colour differences (PA-CE and PA-TM-CE)(Figure 3).

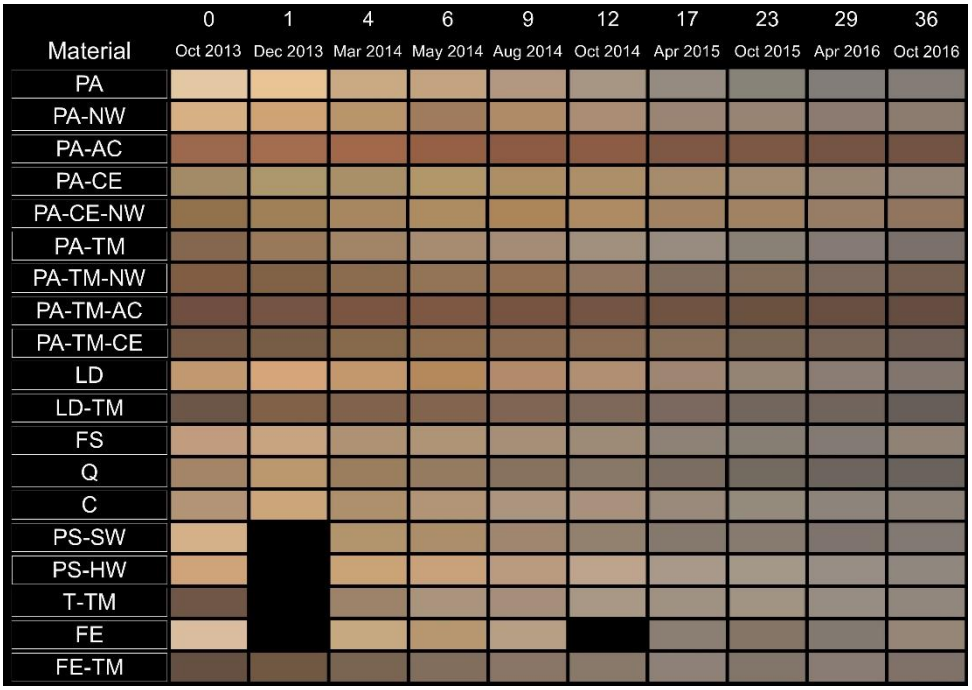

Figure 3: Representation of averaged colour changes from east and west façade on wooden model house unit over three year period. Afterwards, the colour was pretty constant, so only the first three years are plotted.

3.2 Moisture content monitoring

Moisture dynamics are an essential parameter for the overall outdoor performance of wood and its inherent durability. To present the data more clearly, we have decided to summarise the data and present them in Table 2. In addition to average and extreme data, the percentage of wet days was found to be an important parameter as well. The term "wet day" refers to days when the wood MC exceeds the predefined threshold of 25% while the temperature stays between 4°C and 40°C. Respective wood moisture measurements were performed in the centre of the wood samples, approximately 10 mm below the surface. It should be considered that the MC on the surface of the wood might have been even higher, as the surface is directly exposed to weathering. In addition, the authors are aware that different thresholds could be taken into account, depending on the wood sorption properties. For example, the threshold for thermally modified wood might be lower than that for beech. In general, the 25% wood moisture threshold is considered the minimum MC required for fungal decay on most untreated woods from temperate regions. This value represents a conservative fibre saturation (FSP) value. However, it should be considered that lower threshold values are possible if fungi can transport water from a neighbouring moisture source to the wood [19]. In addition, it is generally accepted that fibre saturation is a range rather than a fixed threshold and varies between 22% and 36%, depending on the wood species. In modified wood, these values can be considerably lower.

Median values are more indicative than average values since resistance-based measurements are fairly inaccurate at higher MC, above 50% to 60%, depending on the wood species. We will focus on the median values below. The highest median value was reported for Scots pine sapwood. The median MC was 54,6%, with 83% of the measurements being above the threshold of 25%. The low moisture performance of Scots pine sapwood was expected and has been reported, for instance, by Žlahtič-Zupanc et al.[24]. The second-highest median MC was for beech wood decking elements. This coincides with its good permeability. Surprisingly, thermally modified wood did not exhibit a good moisture performance. However, the moisture performance of freshly modified wood was fairly good. The excellent moisture performance of freshly thermally modified wood has often been reported [9]. However, as can be seen from the data presented in Table 2, exposure to above-ground conditions apparently led to an increased water uptake [1]. The drop in moisture performance can be ascribed to microcrack formation, bacterial degradation of pit membranes and blue staining [15]. The combination of thermal modification and wax treatment considerably improved the moisture performance of decking elements (Table 2). Wax formed a hydrophobic layer on the surface that limited the penetration of liquid water into the wood. Wax-treated, thermally modified Norway spruce wood thus exhibited the lowest median MC, 12.2%. A similar but less prominent effect was also observed for wood coated with acrylic coatings. Due to their anatomical features (tyloses, aspirated pits, etc.), heartwoods (PH, Q, and CS) revealed a fairly good moisture performance (Table 2).

Table 2: Measurements of moisture content (MC) of wood decking at the wooden model house unit. Calculated median and average values of all measurements, and the number and percentages of the measurements with MC equal to or higher than 25% are shown. Measurements were performed in the period between 11.4.2014 and 1.4.2021 (n = 5106).

Material	**Average MC (%)**	**Median MC (%)**	**No. of meas. MC > 25%**	**% of meas. MC > 25%**
PA	32.5	22.5	1871	39%
PA–NW	20.0	17.5	1175	25%
PA–AC	18.3	16.7	925	19%
PA–CE	16.5	15.4	316	7%
PA–CE–NW	19.8	19.0	326	8%
PA–TM	25.5	25.6	2397	50%
PA–TM–NW	16.0	12.2	906	19%
PA–TM–CE	19.5	14.2	1308	27%
PS	47.8	54.6	3593	83%
PH	19.1	15.1	1090	25%
LD	18.7	17.2	893	21%
LD–TM	13.7	12.6	8	0%
FE	14.3	13.6	123	3%
FE–TM	16.6	15.9	943	22%
FS	27.8	26.3	2360	55%
FS–TM	17.6	17.8	944	20%
FS–TM–NW	17.1	13.5	1013	21%
CS	16.5	14.3	817	17%
Q	16.1	15.2	501	10%

The high moisture performance of wax-treated, thermally modified wood (PA–TM–NW; FS–TM–NW) is evident from Figure 3. At almost any time, the MC of the thermally modified and wax-treated wood was significantly below that of the untreated reference. This is further evidence of the synergistic effect of wax and thermal modification. However, the moisture performance of untreated spruce wood and untreated beechwood decreased after a certain period of exposure. We assume that the decreased moisture performance may be associated with fungal decay. Fungi open up new voids in the cell-matrix, which results in better permeability [25]. One possible explanation for increased electrical conductivity

(hence, increased MC) could be the consequence of fungal colonisation due to the presence of electrolytes excreted by the fungi. However, recent results indicate that the high moisture content of decayed wood cannot be ascribed to the changed relationship between electrical resistance and MC, as reported by Brischke and coworkers [5].

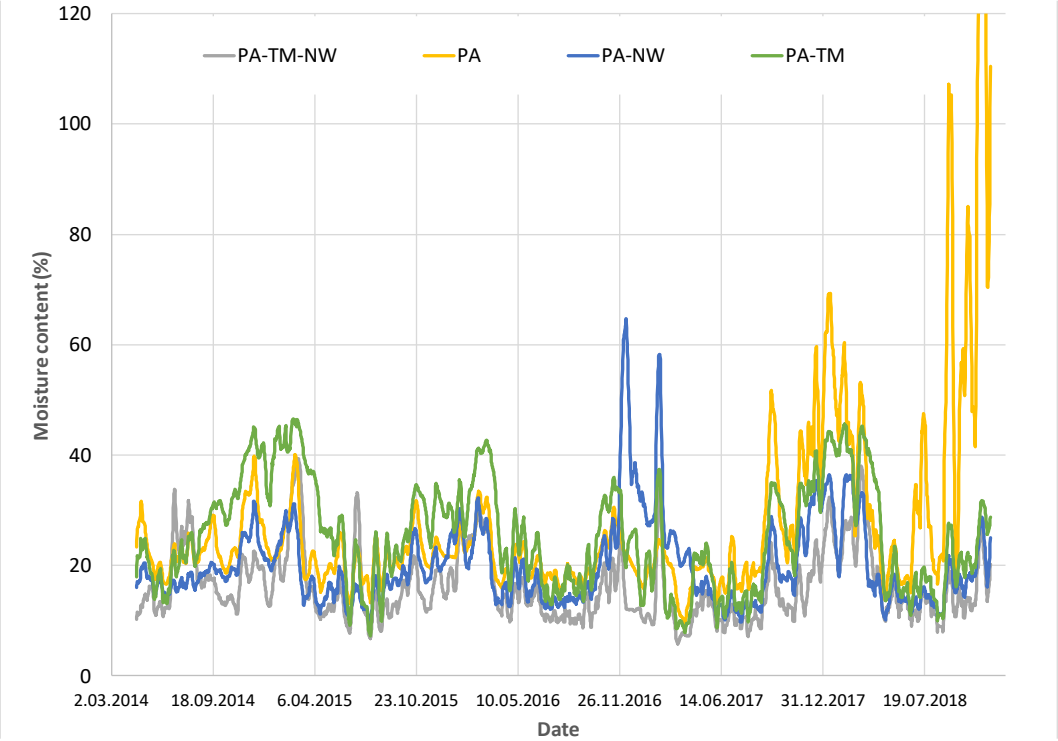

Figure 4: MC of spruce (PA), thermally modified spruce (PA–TM), wax-treated spruce (PA–NW) and wax-treated thermally modified spruce (PA–TM–NW) decking of model house in Ljubljana in the period between 11 April 2014 and 26 November 2018. Plots displayed are moving averages of 20 measurements.

3.3. Wood decay

During the first year of exposure, there was no decay to the decking of the model house in Ljubljana. In the second year, the first signs of decay developed on Norway spruce (PA), beech (FS) and Scots pine sapwood (PS). This is in line with findings from previous studies [3]. One of the possible reasons for the lesser decay of Scots pine sapwood could be associated with pinosylvin. This extract in pine sapwood causes a delay in spore germination. Decay occurred in the third year. In addition, decay developed on coated Norway spruce (PA–AC), Scots pine heartwood (PH), Ash (FE), wax-treated Norway spruce (PA–NW) and larch (LD). In the fourth year, the first signs of decay also appeared on oak (Q). After four years of exposure, only sweet chestnut (CS), copper-treated spruce (PA–CE; PA–CE–NW) and thermally modified wood remained without visible signs of decay (Table 3). After five years of exposure, Norway spruce wood was degraded entirely, followed by beech and Scots pine sapwood. Fairly prominent decay was noted on Norway spruce coated with acrylic coatings. It must be

noted that the acrylic coating was not maintained, so its initially positive effect turned negative. Coating limited liquid penetration in the first stages, but later on, when cracks form coatings, limit the drying of the wood, which enables fungal development below the acrylic coating. First, cracks formed; later, flakes of coating appeared as well (Figure 5). Brown rot fungi caused most of the decay on softwood species, e.g., fruiting bodies of *Gloeophyllum sp*. were found. On hardwoods, white rot was more dominant. Fruiting bodies of *Trametes versicolor* were frequently found.

Table 3: Decay rating of the decking elements determined according to EN 252 [24].

Material	Average decay rating of the decking elements						
	2014	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
PA	0.0	1.0	2.4	3.7	4.0	4.0	4.0
PA–NW	0.0	0.0	0.2	1.1	1.9	2.7	3.1
PA–AC	0.0	0.0	0.8	1.6	2.8	3.6	3.9
PA–CE	0.0	0.0	0.0	0.0	0.0	0.0	1.4
PA–CE–NW	0.0	0.0	0.0	0.0	0.0	0.0	0.4
PA–TM	0.0	0.0	0.0	0.0	0.0	0.4	0.6
PA–TM–NW	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PA–TM–CE	0.0	0.0	0.0	0.0	0.2	0.0	0.0
PS	0.0	0.6	1.2	2.2	3.1	3.6	3.9
PH	0.0	0.0	0.6	1.5	2.3	2.6	3.2
LD	0.0	0.0	0.6	1.3	1.6	2.2	2.4
LD–TM	0.0	0.0	0.0	0.0	0.1	0.1	0.3
FE	0.0	0.0	1.0	1.4	2.1	3.3	3.8
FE–TM	0.0	0.0	0.0	0.0	0.0	0.0	0.1
FS	0.0	1.0	2.2	3.1	3.7	3.9	4.0
FS–TM	0.0	0.0	0.0	0.0	0.0	0.6	1.6
FS–TM–NW	0.0	0.0	0.0	0.0	0.0	0.0	1.2
CS	0.0	0.0	0.0	0.0	0.0	0.0	1.1
Q	0.0	0.0	0.0	0.5	0.9	1.4	1.9

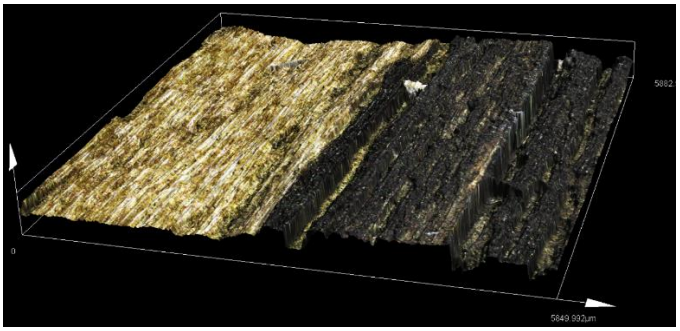

Figure 5: Laser confocal image of the surface of the spruce wood coated with an acrylic coating after five years of exposure. The remaining coating on the decking element is brown, while parts where the coating was removed, remain lighter. The surface was severely damaged. Field of view 5850 × 5882 µm.

4. CONCLUSION

The visual appearance of wood on the façade and decking changed relatively fast. All wood, regardless of the treatment, turned into greyish tones. After three years of exposure, it became almost impossible to distinguish between various wood species. The only exception was wood, treated with brown acrylic coating. Therefore the visual appearance of wood should not be the decisive factor for the selection of wood, as the majority of the wood-based materials will look the same after few years.
Moisture monitoring revealed a good correlation between wood performance and decay. Wood that remained dryer performs better. Low water performance was predominately evident at spruce, Scots pine sapwood and beech wood on decking.
Severe decay developed on wood on the decking. The first signs of decay were formed at spruce, Scots pine sapwood and beech wood after the second year of exposure. Spruce wood was decayed entirely after five years, and beech wood after seven years. The best performance was determined at sweet chestnut; copper treated wood and thermally modified wood. These results clearly indicate that even non-durable wood species can be used for outdoor application if wood preservation and/or wood modification is applied correctly.

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6. REFERENCES

[1] Van Acker, J., Van den Bulcke, J., De Windt, I., Colpaert, S., Li, W. (2015) Moisture dynamics of modified wood and the relevance towards decay resistance. 8th European Conference on Wood Modification (ECWM8), Helsinki, Finland, pp. 44–55.

[2] Brischke, C., Lampen, S.C. (2014) Resistance based moisture content measurements on native, modified and preservative treated wood. European Journal of Wood and Wood Products 72(2), 289–92, Doi: 10.1007/s00107-013-0775-3.

[3] Brischke, C., Meyer, L., Alfredsen, G., Humar, M., Francis, L., Flæte, P.O., Larsson-Brelid, P. (2013) Prirodna trajnost drva izloženoga iznad zemlje - Pregled istraživanja. Drvna Industrija 64(2), 113–29, Doi: 10.5552/drind.2013.1221.

[4] Brischke, C., Rapp, A.O., Bayerbach, R., Morsing, N., Fynholm, P., Welzbacher, C.R. (2008) Monitoring the “material climate” of wood to predict the potential for decay: Results from in situ measurements on buildings. Building and Environment 43(10), 1575–82, Doi: 10.1016/j.buildenv.2007.10.001.

[5] Brischke, C., Stricker, S., Meyer-Veltrup, L., Emmerich, L. (2019) Changes in sorption and electrical properties of wood caused by fungal decay. Holzforschung 73(5), 445–55, Doi: 10.1515/hf-2018-0171.

[6] CEN. (2015) European Standard EN 252 - Field test method for determining the relative protective effectiveness of a wood preservative in ground contact.

[7] Deka, M., Humar, M., Rep, G., Kričej, B., Šentjurc, M., Petrič, M. (2008) Effects of UV light irradiation on colour stability of thermally modified, copper ethanolamine treated and non-modified wood: EPR and DRIFT spectroscopic studies. Wood Science and Technology 42(1), Doi: 10.1007/s00226-007-0147-4.

[8] EC. (2011) Regulation (EU) No 305/2011 of the European Parliament and of the Council of 9 March 2011 laying down harmonised conditions for the marketing of construction products

and repealing Council Directive 89/106/EEC. OFFICIAL JOURNAL- EUROPEAN UNION LEGISLATION L 54(88), 5–43.
[9] Esteves, B.M., Pereira, H.M. (2009) Wood modification by heat treatment: A review. BioResources 4(1), 370–404.
[10] European Committee for Standardization. (2010) Eurocode - : basis of structural design.
[11] Hon, D.N.S., Shiraishi, N. (2020) Weathering and Photochemistry of Wood. Wood and Cellulosic Chemistry, Revised, and Expanded, pp. 523–56.
[12] Humar, M., Kržišnik, D., Lesar, B., Brischke, C. (2019) The performance of wood decking after five years of exposure: Verification of the combined effect of wetting ability and durability. Forests 10(10), Doi: 10.3390/f10100903.
[13] Humar, M., Lesar, B., Kržišnik, D. (2020) Technical and aesthetic service life of wood. Acta Silvae et Ligni 121, 33–48, Doi: 10.20315/asetl.121.3.
[14] Isaksson, T., Thelandersson, S. (2013) Experimental investigation on the effect of detail design on wood moisture content in outdoor above ground applications. Building and Environment 59, 239–49, Doi: 10.1016/j.buildenv.2012.08.023.
[15] Keržič, E., Humar, M. (2021) Studies on the material resistance and moisture dynamics of wood after artificial and natural weathering. Wood Material Science and Engineering, Doi: 10.1080/17480272.2021.1902388.
[16] Kržišnik, D., Lesar, B., Thaler, N., Humar, M. (2018) Influence of natural and artificial weathering on the colour change of different wood and wood-based materials. Forests 9(8), 1–22, Doi: 10.3390/f9080488.
[17] Kutnik, M., Suttie, E., Brischke, C. (2014) European standards on durability and performance of wood and wood-based products - Trends and challenges. Wood Material Science and Engineering 9(3), 122–33, Doi: 10.1080/17480272.2014.894574.
[18] Marzouk, M., Azab, S., Metawie, M. (2018) BIM-based approach for optimizing life cycle costs of sustainable buildings. Journal of Cleaner Production 188, 217–26, Doi: 10.1016/j.jclepro.2018.03.280.
[19] Meyer, L., Brischke, C. (2015) Fungal decay at different moisture levels of selected European-grown wood species. International Biodeterioration and Biodegradation 103, 23–9, Doi: 10.1016/j.ibiod.2015.04.009.
[20] Reinprecht, L. (2016) Wood Deterioration, Protection and Maintenance. JohnWiley & Sons, Ltd, Oxford,.
[21] Rüther, P., Time, B. (2015) External wood claddings – performance criteria, driving rain and large-scale water penetration methods. Wood Material Science and Engineering 10(3), 287–99, Doi: 10.1080/17480272.2015.1063688.
[22] Tellnes, L.G.F., Gobakken, L.R., FlÆte, P.O., Alfredsen, G. (2014) Carbon footprint including effect of carbon storage for selected wooden facade materials. Wood Material Science and Engineering, Doi: 10.1080/17480272.2014.904432.
[23] Yildiz, S., Yildiz, U.C., Tomak, E.D. (2011) The effects of natural weathering on the properties of heat-treated alder wood. BioResources 6(3), 2504–21, Doi: 10.15376/biores.6.3.2504-2521.
[24] Žlahtič, M., Humar, M. (2016) Influence of artificial and natural weathering on the hydrophobicity and surface properties of wood. BioResources 11(2), 4964–89, Doi: 10.15376/biores.11.2.4964-4989.
[25] Žlahtič, M., Humar, M. (2016) Influence of Artificial and Natural Weathering on the Moisture Dynamic of Wood. BioResources 11(1), 4964–89, Doi: 10.15376/biores.12.1.117-142.

RECENT TRENDS AND DEVELOPMENT OF PROTECTIVE CLOTHING, FOOTWEAR AND EQUIPMENT FOR FIREFIGHTERS

Anica Hursa Šajatović
University of Zagreb Faculty of Textile Technology, Department of Clothing Technology, Prilaz baruna Filipovića 28a, HR-10 000 Zagreb, Croatia, anica.hursa@ttf.unizg.hr

ABSTRACT:

In extreme working conditions, such as firefighters exposed to high temperatures, a flash fire, fog, water and dust, as protection protective clothing, footwear and equipment are used. All type of clothing, footwear and equipment are functionally designed, taking into account the safety and protection of users, as well as comfort, compatibility with all parts of the protective equipment, simple use and maintenance. Paper describes recent trends and new development of protective clothing, footwear and equipment as well as smart and intelligent protective clothing which applying innovation and integrating new technologies in textiles. Innovation and new technologies applied in textiles will give great opportunities in the future for developing and applying protective clothing and footwear for various uses, including protective personal equipment for firefighters.

Keywords: protective clothing, footwear and equipment, firefighters, development of PPE for firefighters

1. INTRODUCTION

In everyday situations at their workplaces, workers are consciously or unconsciously exposed to life-threatening dangers. Workers at risk need to be equipped with personal protective equipment (PPE), which will protect their health and protect them from the dangers to which they are exposed [1].
For selection the appropriate protective clothing, footwear and equipment that will be suitable for the purpose and specifics of the workplace, it is necessary to make a risk analysis as well as analysis of ergonomic requirements of the workplace, working environment conditions, study the impact of ergonomics on work and study the activities of workers in the workplace [2]. For protective clothing, footwear and equipment intended for protection against heat, flame, explosive fire, water and mechanical influences, which are used in firefighting, it is necessary to pay attention to extreme working conditions (high temperatures, fire, water, etc.) as well as usually postures (standing, squatting or sitting) and normal and anticipated extreme movements that are most commonly used when wearing the garment and performing work task [3]. Firefighters are exposed a range of hazards during structural and wild-land firefighting. The hazards can cause minor injuries to fatal accidents leading to end of career or even death of firefighters. Personal protective equipment (PPE) and personal protective

clothing (PPC) are the materials which create a barrier between the hazardous environment and the firefighter for protection [4]. Although, good fire protection equipment is relatively easy to design, special attention should be paid to the fact that the wearing time of such protective clothing systems is sometimes long (more than one working day), and the user have to perform his work tasks efficiently and should feel safe and comfortable [5].

Appropriate material selection, clothing design and final evaluation of the results play a critical role in predicting the clothing performance and comfort. The clothing design and different materials used to achieve a balance between performance and comfort and various test standards are used for determine characteristics of different materials of which the equipment, clothing and footwear are made [6]. In addition, some test and very expensive measuring equipment can be used for determination of comfort of protective clothing and footwear (thermal manikin) or for determination of grade protection (flame manikin).

2. REQUIREMENTS FOR PERSONAL PROTECTIVE EQUIPMENT (PPE)

In according to the Regulation (EU) 2016/425 of the European Parliament and of the Council of 9 March 2016 in Annex II, essential health and safety requirements on Personal Protective Equipment (PPE) are defined. According to the Annex II, PPE must provide adequate protection against the risks against which it is intended to protect. Thereby, it should be taken into account design principles (ergonomics, levels and classes of protection), innocuousness of PPE, comfort and effectiveness (adaptation of PPE to user morphology, lightness and strength, compatibility of different types of PPE intended for simultaneous use, protective clothing containing removable protectors) as well as manufacturer's instructions and information (for example instructions for storage, use, cleaning, maintenance, servicing and disinfection) [7].

In addition, Annex II for PPE for protection against heat and/or fire give obligation that PPE must be designed to protect all or a part of the body against the effects of heat and/or fire must possess thermal insulation capacity and mechanical strength appropriate to the foreseeable conditions of use. Constituent materials and other components of PPE intended for protection against radiant and convective heat must possess an appropriate coefficient of transmission of incident heat flux and be sufficiently incombustible to preclude any risk of spontaneous ignition under the foreseeable conditions of use.

Materials and other components of equipment intended for brief use in high-temperature environments and of PPE, which may be splashed by hot products such as molten material, must also possess sufficient thermal capacity to retain most of the stored heat until after the user has left the danger area and removed the PPE. PPE materials and other components, which may be splashed by hot products, must also possess sufficient mechanical-impact absorbency.

PPE materials and other components which may accidentally come into contact with flame and those used in the manufacture of industrial or fire-fighting equipment must also possess a degree of non-flammability and thermal or arc heat protection corresponding to the risk class associated with the foreseeable conditions of use. They must not melt when exposed to flames nor contribute to flame propagation [7].

2.1. Functional design of products

Today, in each new product development, considerable efforts should be put in designing process from rightful selection of materials, construction, and technological concept to prototyping and consumer desires (Figure 1) [8]. Only in that case new product will be designed and functionalized according to the end user needs and requirements.

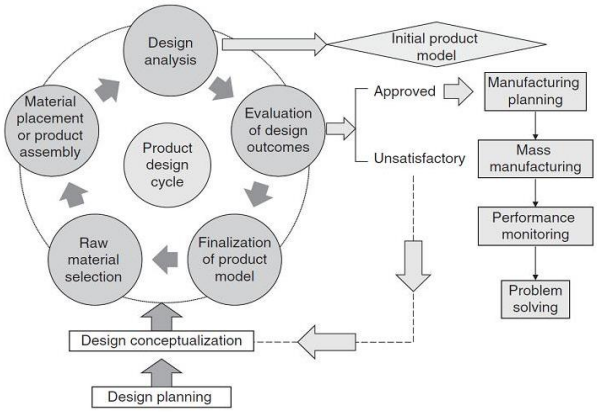

Figure 1: Product design concept [8]

The process of designing of specific products (for example protective clothing, footwear or equipment) includes the entire design activity for the development of new products with high technological content from the initial idea and first project concept to the feasibility analysis, considering new materials and researchers during designing, prototyping and manufacturing. Designing of specific products means balancing between design requirements and function, performance, protection and comfort [9].
Already in the design of protective clothing should take into account a number of factors that affect the fulfilment of the basic requirements (appearance, cut, shape, color, surface materials, flexibility and comfort when worn, resistance to creasing, stains, wear, etc.), starting from functional design, ergonomics, selection of suitable materials for production, comfort and efficiency, manufacturing technology, method of maintenance during use, as well as disposal (recycling) after use (Figure 2).
In addition, it is important to note that in the design process of protective clothing, footwear and equipment an important role is played by end users who in accordance with their experience and testing prototypes in real conditions can give an objective assessment of protection and comfort of clothing, footwear and equipment [2].

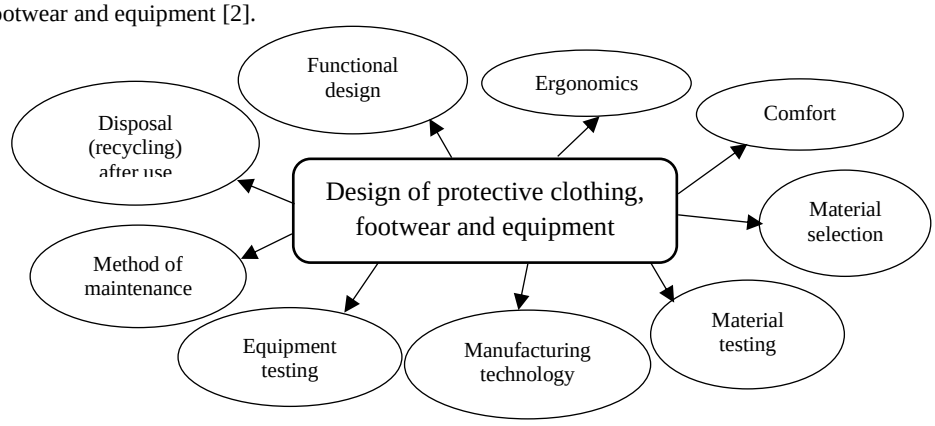

Figure 2: Important factors in the design of protective clothing, footwear and equipment [2]

The process of functional design and engineering of protective clothing, footwear or equipment is very important and is based on the outcomes of an objective assessment of many requirements of the user. According to requirements of end users from functional clothing, requirements can be classified into

physiological, biomechanical, ergonomic and psychological classes. Physiological requirements are relate to the physiology and anatomy: shape, size, mass, strength and metabolic activities of the body or the need of the human body to feel comfortable in a clothing system. Biomechanical requirements are connected with mechanical structure, strength, and mobility of humans for engineering purposes – unusual postures and movements of the users, such as crawling, crouching, firefighting, flood relief, climbing, zero gravity and manipulating objects. Ergonomic requirements dictate mechanical characteristics of clothing match the motion, degree of freedom, range of motion and force, and moment of human joints. The working postures, materials handling, movements, workplace layout, safety and health considerations should be given due consideration while developing the style, cut and features of a functional clothing [10].

In addition, today is very important functional design of smart and intelligent protective clothing or footwear, because the integration of technology with textiles creates enormous possibilities for dress. The combination of technology and fashion will in turn establish a multidisciplinary workforce where engineers, fashion designers and scientists will work together in order to adapt to their environment. Be that of heat sensors that display a range of colours in a garment or a garment that protects a fire fighter from the threat of flames and smoke inhalation, fashion is evolving to suit the needs of the people of this century and to aid them in their professional or private lives [11].

2.2. Materials and construction of clothing

The variables for final design include the number and combination of layers, material types (Table 1) for each layer and total weight of the clothing, footwear and equipment. As individual firefighters body dimensions are different, designing customised clothing is essential to achieve the desired result. Furthermore, correct sizing, appropriate fit and ergonomically designed clothing are essential, as lack of these factors can lead to burn injuries or restrict the movement [12].

Table 1: The most commonly used materials for making firefighting clothing

Layer	Material types	Mass per unit area [g/m^2]
1st layer "outer shell"	Nomex® Delta TA	195
	Nomex® Static Control	260
	Nomex® III	265
	Nomex® Comfort	220
	Nomex® Tough	195
	Fabrics made from meta- and para-aramid fibres	210
	Kermel HTA	210
	PBI fabrics	205
	Aramid Nomex®	225
	Lenzing FR®	250
2nd layer	PU (poliuretan) membranes	~ 125
	Comfortex C membranes	~ 125
	Sympatex® membranes	~ 125
	Gore-Tex® membranes	~ 125
3rd layer	Fabrics made from aramid fibres	
4th layer	Fabrics made from Nomex®	160-270
	Fabrics made from aramid fibres	160-270
	Fabrics made of mixtures of aramid and viscose fibers	160-270
	Fabrics made from cotton fibres (additionally processed and flame resistant)	330

Protective clothing for firefighters is usually multi-layered and is usually made of four basic layers of material assembled in one combination / system [13]:

- the outer material, also called the "outer shell", is very strong, has high resistance to heat and flame, resistance to mechanical influences, most solvents and acids, must not burn, melt, crack or decompose even after burning . Materials must be water-resistant, windproof and must 'breathe' or allow heat to pass from the body to the environment.
- waterproof / permeable membrane, the purpose of which is to reduce the amount of water that could penetrate from the environment into the interior of the garment
- thermal interlining, a material intended to slow the passage of heat from the outside to the inside of the garment, and
- inner lining, which provides comfort and an additional protective layer for user.

Easy donning and doffing, collar design and the closure systems, pockets, designing of elbow, underarm, knee area and the crotch are some of the important design aspects to be taken care. The underarm and elbow area can be fitted with bellows and gussets to enhance the mobility. The design should not hinder the use of other equipment such as helmet, gloves, fire hood, footwear and breathing apparatus.

Careful selection of materials and appropriate design can facilitate the heat and mass transfer from the body. The type of the fibres in various layers, the weight and thickness of fabrics and the final design of the PPC are the crucial factors determining the performance and comfort. In addition, the appropriate fit by using the customized measurements for individual firefighters can help in this matter [6].

2.3. Smart and intelligent protective clothing system

Every year many firefighters die around the globe during firefighting. Therefore, the design of smart or intelligent protective clothing system is vital to be able to record physiological data, health and safety such as heart rate or location of the firefighters. A number of studies investigated the application of wearable sensors under protective clothing. However, the enhancement is required to monitor all the vital parameters for firefighters. For example in fire situation, the sensor will alert the workers regarding the heat exhaustion, hence improve the safety of the firefighters. As soon as the heart rate and skin temperature increase above the safety threshold, the warning signal will alert the worker, either by vibration, visual or audible signals. Wearable Advanced Sensor Platform is another wearable tracking device, which can track firefighters' location and physical activity [6]. All sensors for recording vital human functions should be integrated in protective clothing without changing its characteristics of flexibility and comfort.

The next generation of protective clothing will be smart protective clothing which interact with the human and environment. This new generation of protective clothing can sense and react to environmental conditions and be active in many fields.

Many research are done in the field of textile technology and smart sensors which are usually used to monitor physiological parameters, such as heart rate, temperature and blood pressure, are incorporated into textile. One of the project in this area is ConText. In frame of this project a system where different types of sensors are incorporated into textiles to be used in continuous monitoring of individuals are created [14]. ProeTEX [15] is project in frame which research has been conducted to rescue firefighters by using wireless monitoring of heart rate and temperature measurements. PROFITEX is the project to increase work safety and efficiency of firefighting interventions through advanced protective clothing equipment. Viking industries [16] produced smart protective jackets which sense the temperature and assist firefighters in recognizing dangerous elevated temperatures and in some cases telemetry to transmit this information to others, outside the hazardous environment, based on visual or tactile indicators. In the design and construction of protective jackets for firefighters they are integrated Thermal Sensor Technology (TST) directly into the fabric (Figure 3).

a. b. c.

Figure 3: Protective jacket with integrated thermal sensors: a. on the shoulder, b. on the sleeve, c. jacket with integrated thermal sensors [17]

Well Globe Manufacturing, USA designed the so-called WASP™ (Wearable Advanced Sensor Platform) T-shirt (Figure 4), which is made of knitwear, absorbs moisture well and dries quickly, and is resistant to burning. The T-shirt has a built-in wireless monitoring system that collects data on the user's location, and monitors and controls the physiological parameters of the human body (heart rate, respiration, activity level, etc.).

Figure 4: WASP™ T-shirt and WASP™ configuration with Andrioid cell phone and Motorola APX radios [18]

The use of electronic textiles can monitor the physiological conditions of the wearer and the environmental conditions. Different sections of application can include physiological monitoring, locating firefighters, predicting the stress, communication and environmental monitoring. A combination of human body sensing, environmental sensing (gases, moisture and temperature) and motion sensing is needed for monitoring firefighters at risk. The sensing systems should be designed to monitor record and transmit the information to a central room monitoring the firefighters physical

conditions for safety reasons. The development in communication systems can help to receive data on the temperature and other hazards they are entering, including the air pressure, heat stress level, ambient temperature and other potential hazards. This will help in the improved firefighting conditions and reduce the risk of injuries. Various challenges in designing sensors, connectors, power storage devices, data transfer and storage devices need to be overcome in the successful design of the firefighters PPC. Table 2 describes the application of various electronic textiles in the future firefighters PPC to improve the functionality [6].

Table 2: Application of electronic textiles in firefighting [6]

Types of application	Effect	Mechanisms
Monitoring health	Physiological process of human body	Electrocardiography (ECG), electromyography (EMG) and electroencephalography (EEG), sweat and temperature measurement
Detecting the location of firefighters	Location identification	Wireless devices
Communication	Exchange of information	Wireless and wired devices
High environmental temperature	Heat stress	Active (e-textiles) or passive (PCM) thermal management

Many researchers in their studies are obtained good results of uses smart and electronic textile in protective clothing and equipment for firefighters. The future in research of protective clothing, footwear and equipment for firefighters are in new materials – nano-materials (lighter, better protection, better comfort), new technology – nanotechnology (for production fibres, fabric, new sensors, new technology for manufacturing protective clothing, footwear and equipment, new technology for integration fibre or fabric sensors into protective clothing, footwear and equipment).

3. CONCLUSION

In burning buildings, firefighters risk their lives not only in contact with open flames, but also because of great fatigue or overheating, especially in smoke-filled rooms with a significantly reduced field of view. The protective clothing, footwear and equipment used for firefighting is required to shield the firefighters from all possible hazards that may be faced during the work and should provide thermo-physiological comfort. The protective clothing is usually heavy, thick with multiple layers, which reduces water vapour permeability and heat exchange across layers from body to the environment. The protective footwear (boots) are heavy, made from thick fire-resistant leather, and other personal protective equipment such as fire helmet, breathing apparatus, ropes, etc., are heavy and all equipment which have to bring firefighter can be more than 25 kg. All hazards during the work of firefighters, heavy clothing and equipment as well as very difficult environmental conditions (fire, high temperature, smoke, etc.) are results the wearer to face heat stress due to the high physical activity and excessive exposure to heat which overloads his metabolic system. Therefore, it is extremely important to research and make smart and intelligent clothing for firefighters, to monitor the physiological parameters of the human body (heart rate, respiration, activity and stress levels, etc.), and thus reduce the chances of injury to firefighters.

4. REFERENCES

[1] Horvat, J., Regent, A. (2009). Osobna zaštitna oprema. Rijeka: Veleučilište u Rijeci.

[2] Hursa Šajatović, A., Dragčević, Z., Zavec Pavlinić, D. (2017). Oblikovanje zaštitne odjeće, obuće i opreme s ergonomskog stajališta. Sigurnost, 59, 227-236.
[3] Hursa Šajatović, A., Bogović, S. (2011). Design and construction of functional protective clothing for firefighters. In Young scientists in the protective textile research. Zagreb: University of Zagreb, Faculty of Textile Technology & FP7-REGPOT-2008-1-229801: T-Pot.
[4] Scott, R.A. (2005). Textiles for Protection. Cambridge: Woodhead Publishing.
[5] Zavec Pavlinić, D., House, J. R., Mekjavić, I. B. (2010). Protupožarni odjevni sustavi i njihovo vrednovanje. Sigurnost 52, 251-262.
[6] Nayak, R., Houshyar, S., Padhye, R. (2014). Recent trends and future scope in the protection and comfort of fire-fighters' personal protective clothing. Fire Science Reviews 3, No. 4.
[7] Regulation (EU) 2016/425 of the European Parliament and of the Council of 9 March 2016 on Personal Protective Equipment and repealing Council Directive 89/686/EEC, (2016).
[8] El Mogahzy, Y.E. (2009). Engineering textiles. Cambridge: Woodhead Publishing Limited.
[9] Dammaco, G., Turco, E., Glogar, M.I. (2012) Design of Protective Clothing. In Scientific Book Functional Protective Textiles. Zagreb: University of Zagreb Faculty of Textile Technology.
[10] Gupta, D. (2011). Design and Engineering of Functional Clothing. Indian Journal of Fibre & Textile Research 36, 327-335.
[11] Fallen Bailey, D.R. (2012). The role of the Fashion Designer with regard the emergence of Smart textiles and Wearable technology. www.gzespace.com.
[12] Hsiao, H., Whitestone, J., Kau, T-Y., Whisler, R., Routley, J.G., Wilbur, M. (2014). Sizing firefighters method and implications. Human Factors 56, 873–910.
[13] Hursa Šajatović, A., Zavec Pavlinić, D., Dragčević, Z. (2013). Vatrogasni odjevni sustavi za zaštitu od topline i plamena. Tekstil 62, 160-173.
[14] *Available from* http://www.hitech-projects.com/euprojects/context/, *Accessed:* 2021-06-05
[15] *Available from* http://www.proetex.org/, *Accessed:* 2021-06-15
[16] *Available from* http://cfbt-us.com/wordpress/?m=200908, *Accessed:* 2021-06-05
[17] *Available from* http://www.crunchwear.com/viking-turnout-gear-high-tech-firefighter-safety-clothing/, *Accessed:* 2021-06-15
[18] WASP™ Wearable Advanced Sensor Platform, *Available from* http://globeturnoutgear.com/innovation/wasp, *Accessed:* 2021-06-05

SECTION/SEKCIJA
A

INFLUENCE OF WORKING TIME ON MECHANICAL AND EXPLOITATION PROPERTIES OF HIGH ALLOYED STEEL

Zijah Burzić[1], Dženana Gačo[2], Meri Burzić[3], Srđa Perković[1]
[1]Military Technical Institute, Ratka Resanovića 1, Belgrade, Serbia,
e-mail: zijah.burzic@vti.vs.rs
[2]Technical faculty, University of Bihać, Dr Irfana Ljubijankića b.b., Bihać, Bosnia and Herzegovina.
e-mail: dzgaco@bih.net.ba
[3]IC Faculty of Mechanical Engineering, Kraljice Marije 16, Belgrade, Serbia,
e-mail: mburzic@mas.bg.ac.rs

ABSTRACT:

In the present paper, experimental investigations have included the effect of operating conditions (time and temperature of operation) on mechanical and exploitation properties of base metal, steel X20 CrMoV 12-1 (X20). The effect of operating conditions was analysed by testing new material and material that had already been in service for 116000 hours. The investigations have included critical stress intensity factor, K_{Ic}, fatigue strength and parameters of fatigue-crack growth rate at room and operating temperature. The results obtained and their analysis represent a practical contribution to the assessment of base metal X20 quality, aimed at revitalisation and prolongation of service life of thermal power plants components, made of high alloy steels operating at elevated temperatures.

Keywords: High alloyed steel X20 CrMoV 12-1, tensile properties, impact energy, fracture toughness, high cycle fatigue, fatigue strength, fatigue crack growth rate, fatigue threshold

1. INTRODUCTION

The usual service life of processing equipment in thermal power plants operating at elevated temperatures is 30 years, i.e. 150000 operating hours. Economic interests induced extension of designed period, as service life of a large number of the components in power stations is often longer than the designed, indicating the conservatism in design. Therefore, it becomes more and more important to extend service life and to tetrofit the components in thermal power plants, as well as to find the methods to keep the old power stations in operation for 40-50 years, and even longer [1].

Observation of variations in structural materials under service conditions is practically performed during the entire service life, through regular maintenance and emergency overhauls in case that a thermal power plant should be reconstructed and revitalised after failure caused by damage. Observation and inspection of the properties of structural materials of high-temperature loaded components exposed to high pressure, too, in corrosive media are main indicator of their reliability.

Therefore, the assessment of remaining life of the components and of the plants is important. As defined, life of a component expires when there is no safety reserve for further use, or when its further use is not economically justifiable [1].

One of most frequently used steels for operation at elevated temperatures and under high pressure, at the same time corrosion-resistant, is steel designated as X20 CrMoV 12-1 (hereinafter referred to as X20), mainly designed for steam lines and pipelines in thermal power plants because of its good strength and ductility at elevated temperatures. Tendency to minimise the wall thickness of the steam lines for required steam pressure can be accomplished only with steel of adequate properties [2].

For service safety of structures in processing equipment for operation in thermal power plants, very important properties are those describing the phenomenon of crack initiation and growth under variable loading. Fatigue crack initiation at structurally smooth and homogeneous forms still cannot be described by some simple functions of loading, stress, material properties and cross-section; therefore, empirically derived functions are used, as a rule induced by thorough experimental and laboratory testing. Generally accepted property for that case is fatigue strength that determines the level of loading at which no crack occurs on smooth specimens. Initiation and growth of a crack induced by variable loading, i.e. Paris law of crack growth that establishes the dependence of acting variable loading, of corresponding range of stress intensity factor, and crack growth per cycle is nowadays widely accepted as it generally describes micromechanical behaviour of a growing crack [2].

The effect of operating conditions (operating time and temperature) on mechanical and exploitation properties of base metal, steel X20, designed for vital components of thermal power plant - steam lines has been analysed by testing new material and material after service of 116000 hours. Performed investigation at room and operating temperatures of new and used high alloy steel X20 included testing of [2]:

- tensile properties,
- impact properties, using instrumented Charpy machine (Charpy V-notch test),
- critical stress-intensity factor, K_{Ic}, as an important parameter of fracture mechanics,
- permanent fatigue strength and design of Veler's curve, and
- parameters of fatigue crack growth rate.

The results obtained by testing and their analysis should provide a practical contribution to assessment of quality of X20 steel, aimed at revitalisation and extension of service life of vital components in thermal power plants made of high alloy steel for elevated temperatures.

2. MATERIAL

For assessment of the effect of service temperature and life on fatigue properties of steel X20 designed for manufacture of vital components in thermal power plants, samples of new pipe (*N*) and a pipe that had been in service for approx. 116000 hours (*S*) were available. Both samples were the pipes ∅450 x 50 mm. Chemical composition of tested pipes is given in Tab. 1 [2,3].

Table 1: Chemical composition of tested pipe samples

Charge No.	Chemical composition, mass %								
	C	Si	Mn	P	S	Cr	Mo	Ni	V
N	0,21	0,27	0,563	0,017	0,006	11,70	1,019	0,601	0,310
S	0,22	0,31	0,539	0.019	0,005	11,36	1,033	0,551	0,314

The specimens were sampled from the longitudinal direction. The notches on the specimens for determination of impact properties were directed width upward, while the notches on the specimens for fracture mechanics were longitudinal to the pipe longitudinal direction.

3. TEST RESULTS

3.1. Testing of mechanical properties

Testing of mechanical properties was conducted at room temperature (20°C), operating temperature (545°C) and peak operating temperature (570°C) according standards EN ISO 6892-1 [4] and EN ISO 6892-2 [5]. Graphic presentation of the effect of testing temperature on the values of yield stress and tensile strength is given in Fig. 1 for new material and in Fig. 2 for used material, steel X20, respectively [2].

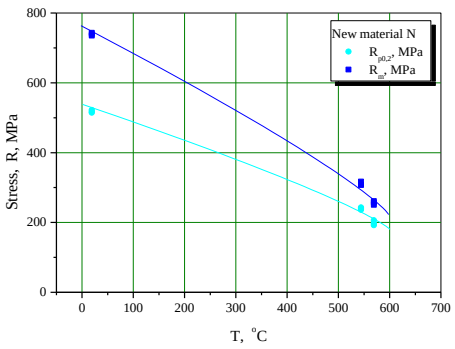

Fig. 1: Variation of yield strength $R_{p0.2}$ and ultimate tensile strength R_m with temperature for new steel

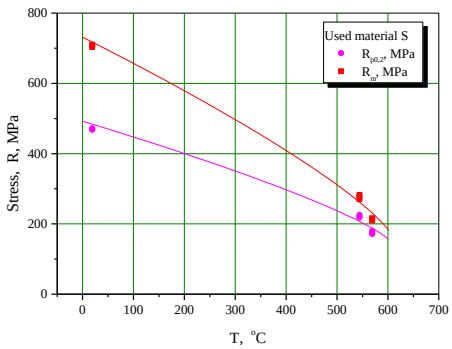

Fig. 2: Variation of yield strength $R_{p0.2}$ and ultimate tensile strength R_m with temperature for used steel

Impact testing of the base-metal (BM) specimens was conducted according to the standards EN ISO 148-1 [6] and EN ISO 14556 [7], using the Charpy machine instrumented with oscilloscope. Two types of diagrams were obtained, load vs. time and energy vs. time, with the values of crack-initiation energy, A_I, and crack-propagation energy, A_p, as integral components of total impact energy, and the deflection, *s*, as the indicator of the material toughness.

Typical diagrams force vs. time and energy vs. time obtained by Charpy testing of specimens taken from new pipe for different testing temperatures are given in Figs. 3-5 for illustration. The dependence of impact energy, A_t, of new and used pipes steel X20, on testing temperature is given in Fig. 6, and of the deflection, *s*, in Fig. 7 [2].

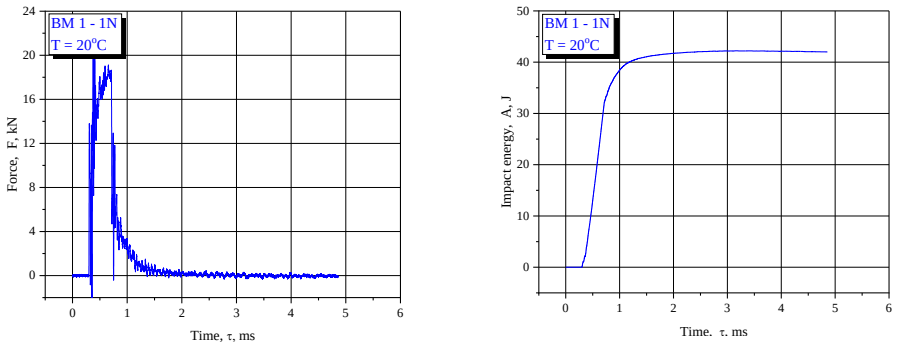

Fig. 3: Diagrams obtained by Charpy impact testing at room temperature

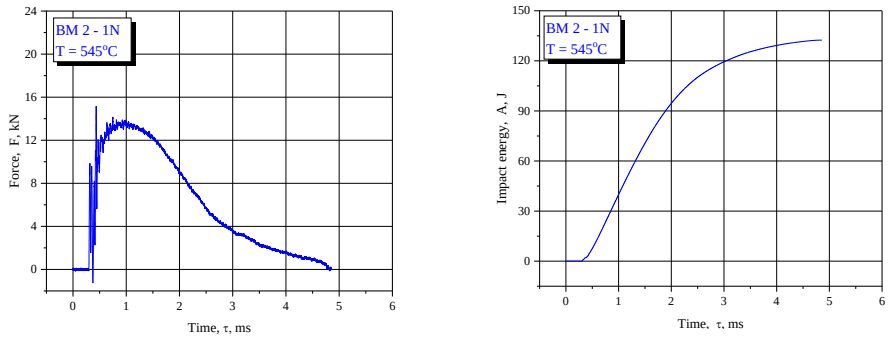

Fig. 4: Diagrams obtained by Charpy impact testing at 545°C

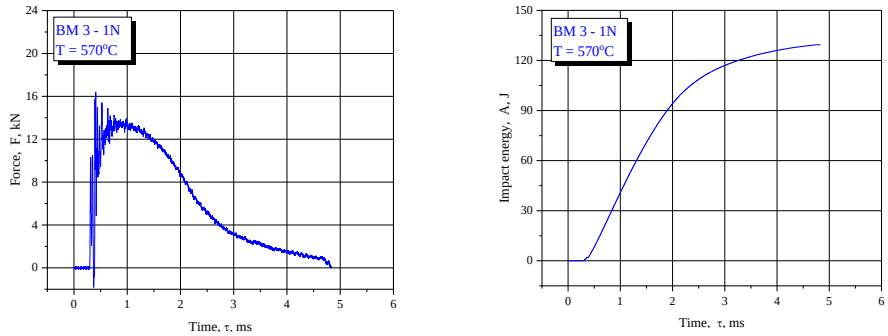

Fig. 5: Diagrams obtained by Charpy impact testing at 570°C

Total impact energy is divided into crack-initiation energy, A_I, and crack-propagation energy, A_p, and presented for new pipe (*N*) in Fig. 8, and for used pipe (*S*) in Fig. 9.

3.2. Fracture toughness test

Critical value of stress-intensity factor, K_{Ic}, was obtained by applying the single-specimen compliance method, by successive loading-unloading cycles. Modified CT specimens were used, standards ASTM E1820. From the relations force, *F*, – crack mouth opening displacement (*CMOD*), δ, the diagrams *J* integral vs. crack extension Δa were constructed and presented for the specimen tested at room temperature in Fig. 10, at 545°C in Fig. 11 and at 570°C in Fig. 12 [2].

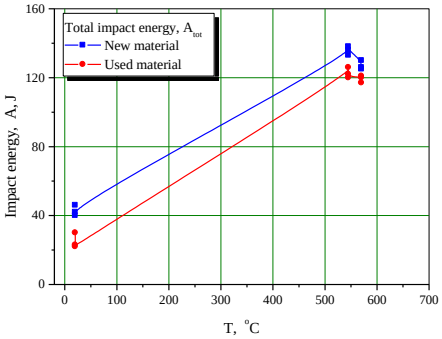

Fig. 6: Dependence of impact energy, A_t, of new and used pipes steel X20, on testing temperature

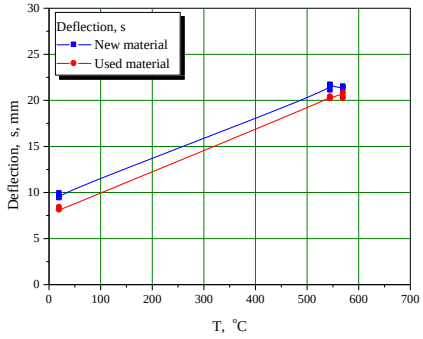

Fig. 7: Dependence of deflection, s, of new and used pipes steel X20, on testing temperature

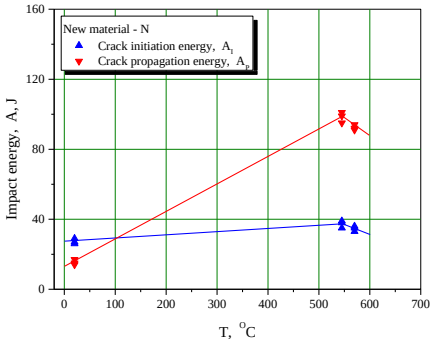

Fig. 8: Fraction of crack-initiation energy, A_I, and crack-propagation energy, A_p, for new steel(N)

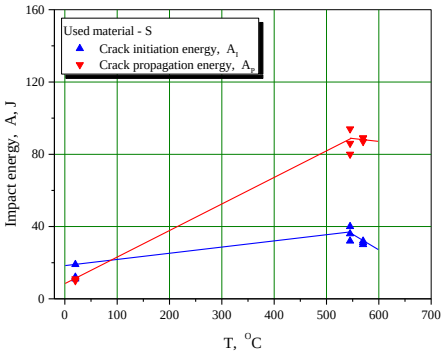

Fig. 9: Fraction of crack-initiation energy, A_I, and crack-propagation energy, A_p, for used steel (S)

The dependence of critical stress-intensity factor, K_{Ic}, obtained via J_{Ic} integral testing on temperature is given in Fig. 13. It should be mentioned that in calculation of plane-strain fracture toughness, K_{Ic}, one value of Young modulus was used at room temperature (210 GPa), and another at elevated temperatures (175 GPa at 545°C and 570°C) [2].

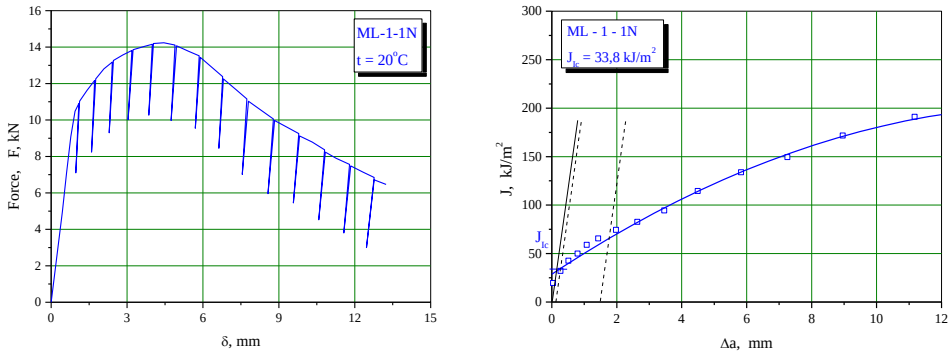

Fig. 10: Diagrams F-δ and J-Δa at room temperaturs

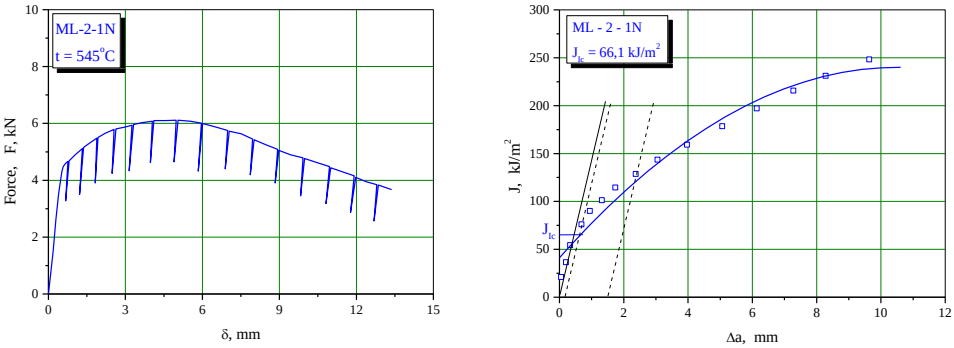

Fig. 11: Diagrams F-δ and J-Δa at 545°C

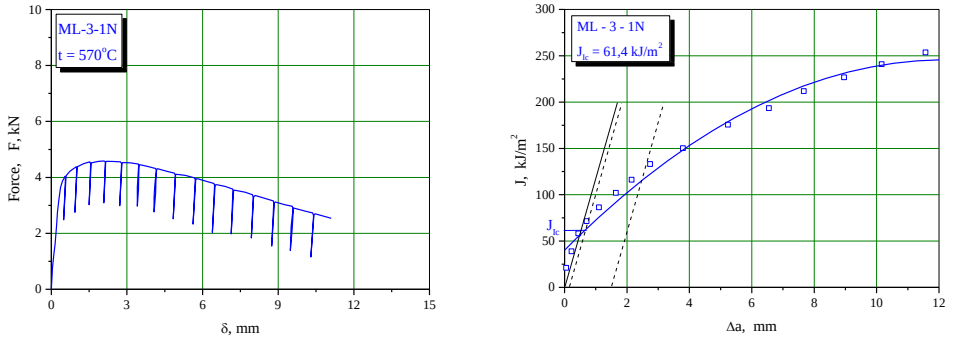

Fig. 12: Diagrams F-δ and J-Δa at 570°C

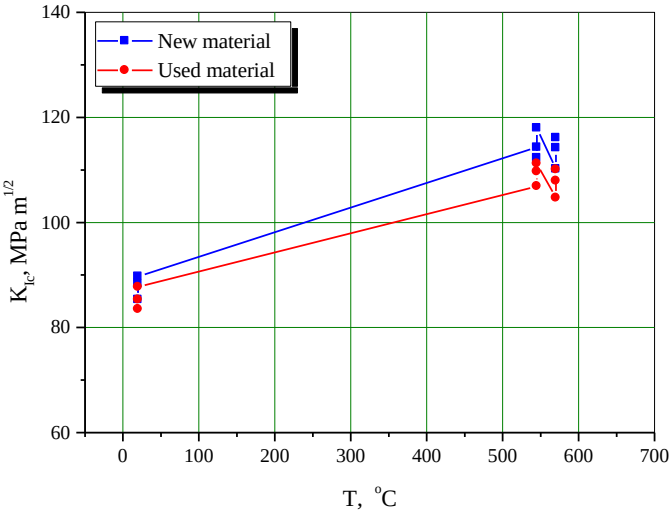

Fig. 13: Variation of K_{Ic} value depending on testing temperature for new and used steel X20

3.3. Testing of variable loading

Testing of the effect of service conditions on behaviour of steel X20 under variable loading was performed on the sample of new steel and steel after service of 116000 hours. These tests were performed in order to determine the spot in *S-N* diagram (design of Veler's curve) and determination of permanent fatigue strength, S_f. The specimens were shaped and sized according to ASTM E466 [8].

High-frequency pulsator can induce sinusoidal alternating load ranging from -100 kN to + 100 kN. Mean loading and loading amplitude were registered with an accuracy of ±50 kN. Achieved frequency varied from 110 to 174 Hz, depending on loading value and test temperature. In order to make an assessment of steel behaviour under variable loading completely, and having in mind the size of specimens, the most critical case of variable loading was treated, i.e. alternating variable loading tension-compression (R = -1). The results of testing under variable loading are presented in a form of *S-N* (Veler's) curve in Fig. 14 for new and in Fig. 15 for used steel.

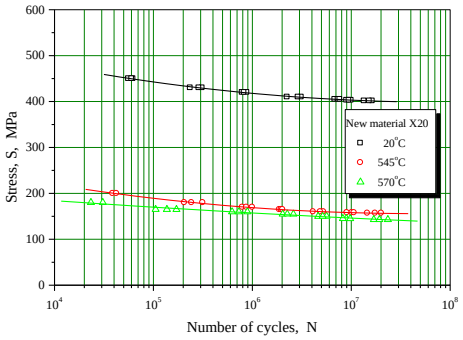

Fig. 14: S-N diagram of the specimens taken from the sample of new pipe made of steel X20

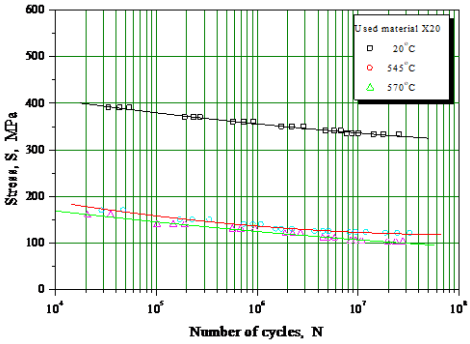

Fig. 15: S-N diagram of the specimens taken from the samples of used pipe made of steel X20

In this test, as a rule, only the number of load variations until fracture is determined at constant-range loading, and the standard requires only a datum on stress level at which fracture does not occur after certain number of cycles (usually between 10^6 and 10^8 cycles). For steel materials, ASTM E468 defines permanent fatigue strength, S_f, after 10^7 cycles [9]. Therefore, this test is extremely expensive and justifiable only when the data are necessary for design, mainly from the point of view of fatigue and fracture mechanics, i.e. when the components exposed to long-term variable loading within total designed life of structure.

3.4. Application of fracture mechanics in study of fatigue

Main progress in fracture mechanics related to material fatigue is analytical division of the phenomenon of fatigue fracture into period of initiation, during which a fatigue crack nucleates, and period of growth and propagation that follows, during which the nucleated crack grows up to critical size at which rapid fracture occurs. In that way, total number of cycles, N_t, after which fracture occurs, is divided into number of cycles required for fatigue crack initiation, N_i, and number of cycles necessary for it to propagate up to the size critical for fracture, N_p.

$$N_t = N_i + N_p \tag{1}$$

The development in study of material behaviour under variable loading enables parallel introduction of experimental and theoretical approach, as theoretical approach itself cannot completely explain fatigue

crack initiation and propagation. The analysis of stress and strain state at the tip of growing fatigue crack using the procedures of linear elastic fracture mechanics (*LEFM*) has lead to formulation of Paris equation [10] for all structural materials, metals and alloys in the first place, that relates fatigue crack growth rate to the range of stress intensity factor at the crack tip:

$$\frac{da}{dN} = C \cdot (\Delta K)^m \tag{2}$$

Although Paris equation for crack growth is not applicable in the whole region, between low rates near the fatigue threshold (ΔK_{th}) and high rates (K_{Ic}) a large linear central part of the curve covered by the Paris relation has, from the practical point of view, proven to be far most important, as at the same time it allows to make difference between fatigue crack initiation and fatigue crack growth.

3.4.1. Testing of Fatigue Crack Growth Parameters

Test performed in order to determine fatigue crack growth rate *da/dN* and fatigue threshold, ΔK_{th}, was performed with standard Charpy specimens, using the method of TPB (three-point bending) on resonant, high-frequency pulsator. The test itself was performed as force-controlled. On machined specimens, measuring tape RUMUL RMF A-5 of 5 mm measuring length were attached for monitoring of crack growth using the FRACTOMAT device. As fatigue crack grew under the measuring foil, the later tore following the tip of fatigue crack, thus causing electric resistance of foil to vary proportionally with variation of the crack length. Fatigue crack growth rate was determined based on the obtained functions of crack length, *a* – number of cycles, *N* [11]. Namely, during experiment the number of cycles was automatically registered for every 0.05 mm of crack growth. Obtained curves of dependence *a-N* were used as a base for determination of fatigue crack growth rate, *da/dN*.

To make comparison of the results obtained by testing easier, in Tab. 2 the values of fatigue threshold, ΔK_{th}, coefficient *C* and exponent *m* for fatigue crack growth are given for all tested samples.

Table 2: Results of determination of fatigue crack growth parameters

Sample mark	Testing temperature, °C	Fatigue threshold ΔK_{th}, MPa $m^{1/2}$	Koeficient *C*	Eksponent *m*	*da/dN*, with $\Delta K=20$ MPa $m^{1/2}$
New–1	20	8,1	$1.13 \cdot 10^{-15}$	4.689	$1.42 \cdot 10^{-09}$
New–2	545	6,9	$1.15 \cdot 10^{-13}$	2.933	$7.52 \cdot 10^{-10}$
New–3	570	6,8	$5.72 \cdot 10^{-15}$	3.828	$5.47 \cdot 10^{-10}$
Old–1	20	7,2	$5.84 \cdot 10^{-15}$	4.852	$1.35 \cdot 10^{-08}$
Old–2	545	5,8	$3.09 \cdot 10^{-13}$	3.065	$3.51 \cdot 10^{-09}$
Old–3	570	5,7	$1.80 \cdot 10^{-13}$	3.286	$3.39 \cdot 10^{-09}$

Determination of the dependence of fatigue crack growth rate per cycle, *da/dN*, and range of stress intensity factor, ΔK, is reduced to determination of coefficient *C* and exponent *m* in Paris equation. The range of stress intensity factor, ΔK, depending on specimen geometry and crack length and on variable force range, $\Delta P = P_g - P_d$, should be attributed to fatigue crack growth rate for effective crack length, *a*. Based on the development of testing, *log da/dN – log* ΔK dependences were calculated and plotted. Typical diagrams of dependence of *da/dN* on ΔK are given in Fig. 16 for the specimens taken from new steel X20, and in Fig. 17 for used steel X20.

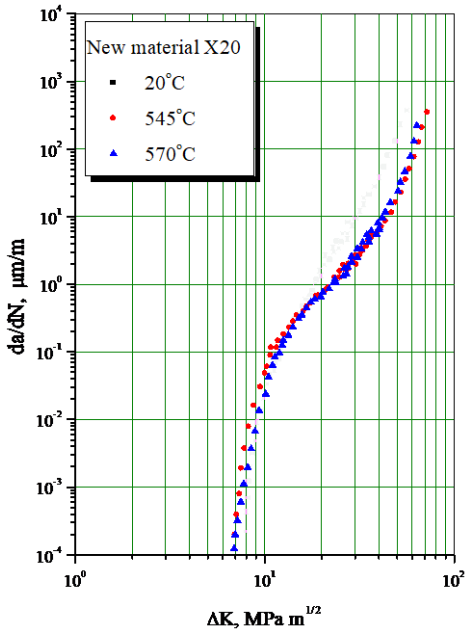

Fig. 16: Diagram of dependence da/dN-ΔK for the specimens taken from new pipes made of steel X20

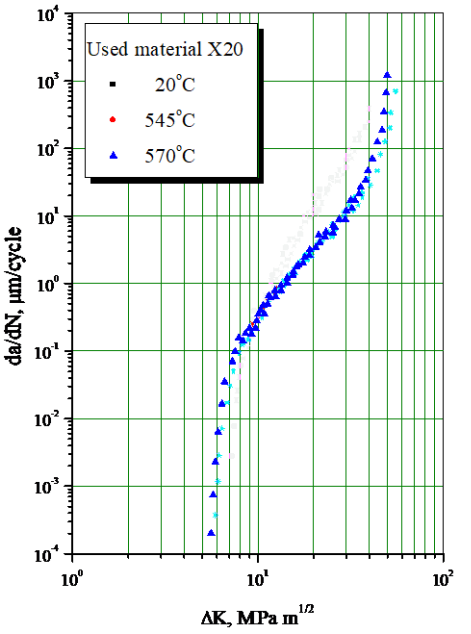

Fig. 17: Diagram of dependence da/dN-ΔK for the specimens taken from used pipe made of steel X20

4. ANALYSIS OF RESULTS

It is clear that strength, yield stress and tensile strength decrease with temperature increase. Mechanical properties of used material are a little bit lower than those of new steel, and the difference diminishes with the increase of testing temperature. According to Ref. [9], the effect of operating time is stronger on tensile strength than on yield stress.

Total impact energy, A_t, increases with the increase of temperature and reaches the peak value at operating temperature of 545°C, slightly decreasing with further increase to 570°C, Fig. 7. The values of crack-initiation A_I, and crack-propagation, A_p, energy, depend strongly on temperature, Figs. 8 and 9. At elevated temperatures their ratio varies, and the fraction of crack-propagation energy is about 2.5 times greater than that of crack-initiation energy, exhibiting typical ductile behaviour.

Similar behaviour compared to impact energy, A_t, was found in regard the deflection, *s*, Fig. 7. The values of critical stress-intensity factor, K_{Ic}, increase with temperature increase, reaching the peak value at operating temperature of 545°C, Fig. 14, and slightly decrease at 570°C. The service time of 116000 hours affected decreasing the values of K_{Ic}.

Analysing the results obtained by fatigue testing of smooth specimens in order to design Veler's curve and to determine permanent fatigue strength, one can see that service life and testing temperature affect the values obtained for permanent fatigue strength. At room temperature, obtained value of fatigue strength is 79% of yield stress for new steel, and 71% for used steel. At operating temperature of 545°C, obtained value of yield stress is 65% for new steel, and 55% for used steel. At peak operating temperature, the value of permanent fatigue strength is 64% of yield stress for new steel, and 53% for

used steel. If consider the effect of the loading type, one can see that the effect of service life is much stronger in fatigue testing than in static testing.

As one can see from the results presented in Tab. 2, service time and testing temperature significantly affect the values of fatigue threshold, ΔK_{th}, and parameters of fatigue crack growth. New steel X20 has higher values of fatigue threshold, ΔK_{th}, i.e. better resistance of an already existing crack to propagation. Namely, if new material contains a crack of same length as that in used material, its propagation in new material requires higher loading (range of stress intensity factor, ΔK) for re-growth of the crack.

The samples tested at room temperature have highest fatigue crack growth rate, i.e. the lowest resistance of crack to propagation. Crack propagation resistance increases in the samples tested at operating temperature of 545°C, and the highest crack propagation resistance is encountered in the samples tested at peak operating temperature of 570°C. Under same variable loading (range of stress intensity factor, ΔK), new material X20 has higher value of fatigue threshold and lower fatigue crack growth rate than used material.

One can calculate fatigue crack growth rate for different values of the stress intensity factor range, ΔK. For the analysis, the value of ΔK =20 MPam$^{1/2}$ is taken This value of the stress intensity factor range is located in the part of the curve where Paris law applies. Fatigue crack growth rate, *da/dN*, ranges from 1.42 10^{-9} for the sample of new steel X20 tested at room temperature to 5.47 10^{-10} μm/cycle for the sample tested at peak operating temperature of 570°C. Same tendency toward variation of fatigue crack growth rate applies for used steel.

5. CONCLUSIONS

Obtained test results are a practical contribution to assessment of quality of new and used material, steel X20, regarding possible operating life extension. Following conclusions can be derived:

- The increase of testing temperature leads to the decrease of strength slight increase of deformation (elongation). The effect of operating time on mechanical properties is stronger at room temperature than at temperatures of 545°C and 570°C. Mechanical properties of used steel are only slightly lower than that of new steel.
- Total impact energy, A_t, increases with temperature increase and reach the peak value at operating temperature of 545°C, slightly decreasing at 570°C. The same effect is found for energy components, for crack-initiation and for crack-propagation, as well as for deflection. Operating time affects only slightly total impact energy.
- Critical stress-intensity factor, K_{Ic}, increases with temperature increase, reaching the peak value at operating temperature of 545°C, and slightly decreases at 570°C. The service period of 116000 hours caused only slight decrease of K_{Ic}, but this is not of prime importance for next service.
- Period of service (new and used steel) affects the values of permanent fatigue strength so that new material has higher resistance to crack initiation in smooth structural components.
- Testing temperature also affects the values of permanent fatigue strength: it decreases with increase of testing temperature. The specimens tested at room temperature have the highest fatigue crack growth rate and the lowest resistance to crack propagation. Crack propagation resistance increases with increase of testing temperature.

Maximum crack growth rate may be expected for the stress intensity factor range approaching to plane-strain fracture toughness K_{Ic}, as at that level brittle fracture occurs. It means that crack growth rates at which fatigue process shall be replaced by development of brittle fracture at various levels of loading can be assessed introducing these values into obtained *da/dN*-ΔK diagrams.

6. REFERENCES

[1] Sedmak, S., Petrovski, B., (1988) Obezbeđenje kvalitetnih zavarenih spojeva i njihovog pouzdanog rada na parovodima termoelektrana ZEP-a", Studija za potrebe Združene elektrorivrede Beograd, Ugovor br. 1093, TMF.
[2] Gačo, Dž., (2007) Istraživanje uticaja promjenljivog opterećenja i temperature na ponašanje zavarenih spojeva visokolegiranih čelika, Doktorska disertacija, Mašinski fakultet Univerziteta u Beogradu.
[3] Burzić, D., (2006), Promene osobina i mukrostrukture čelika X20 CrMoV 12-1 nakon eksploatacije, Diplomski rad, TMF.
[4] EN ISO 6892-1, (2019) Metallic materials-Tensile testing-Part 1: Method of test at room temperature.
[5] EN ISO 6892-2, :(2018) Metallic materials-Tensile testing-Part 2: Method of test at elevated temperature.
[6] ISO 148-1, (2018), Metallic materials-Charpy pendulum impact test-Part 1: Test method.
[7] EN ISO 14556, (2015) Metallic materials-Charpy V-notch pendulum impact test-Instrumented test method.
[8] ASTM E466, (2005), Standard Practice for Conducting Force Controlled Constant Amplitude Axial Fatigue Tests of Metallic Materials, Book of Standards Volume 03.01.
[9] ASTM E468, (2008), Standard Practice for Presentation of Constant Amplitude Fatigue Test Results for Metallic Materials, Book of Standards Volume 03.01.
[10] Paris P. C., and Erdogan F., (1989), A Critical Analysis of Crack Propagation Laws″, Trans. ASME, Journal Basic Eng., Vol. 85, No. 4, p. 528.
[11] ASTM E647, (2005), Standard Test Method for Measurement of Fatigue Crack Growth Rates, Book of Standards Volume 03.01.

THE RELIABILITY OF GEOMETRICAL SHAPE

Sanel Gredelj, Milan Jurković
Tehnički fakultet Bihać, ul. dr I. Ljubijankića, tfb@bih.net.ba,
sanel.gredelj@unbi.ba , mi.jurkovic@gmail.com

ABSTRACT:

The reliability of the workpiece characteristics is the basis for determining the reliability of the technological process or machining process. The geometrical shape is one of the characteristics of the workpiece. The reliability of the geometrical shape depends on the prescribed tolerance for the accuracy of the shape in the shape of the tolerance space. The simplest tolerance space is the shape of a hollow cylinder. In general, a tolerance space can be represented by two irregular surfaces. The reliability of the geometrical shape is generally calculated as twice the value of the Laplace integral of the quotient of tolerance and twice the value of the standard deviation. The standard deviation is obtained on the basis of the measured residuals, ie. maximum deviations in as many sections as possible. Higher values of geometrical shape reliability require high tolerance, so specifying tolerances for shape accuracy should be avoided. This increases the overall reliability of the workpiece and reduces production costs.

Keywords: Reliability, Geometrical Shape, Tolerance Space, Residual

1. INTRODUCTION

Reliability is the probability that a system will perform its intended function without failure as a function of time [8]. Other sizes that have a random character are used to determine the reliability at a precisely defined and relatively short time. Reliability as a function of time can be expressed on the basis of a certain at least two instantaneous reliability at different time moments. Determining the instantaneous reliability of machining systems is very complicated if the machining system is viewed primarily as a structure. It is easier to determine the reliability of the machining system from the aspect of production and machining process, which is related to the correctness of the workpiece. The workpiece is the output product of the machining process, and is relevant for determining the reliability of the machining process, ie the system and quantitative measures of process stochasticity. [2, 3, 4]

2. THE RELIABILITY OF WORKPIECE CHARACTERISTICS

Failure of the technological process or machining process is determined by the fault of the workpiece. Tolerance characteristics of the workpiece are important for determining the reliability of the workpiece. Other quantities have a reliability of approximately 1. In order to determine the instantaneous reliability of the technological process based on the workpiece, it is necessary to determine the reliability for each tolerated characteristic of the workpiece. The instantaneous reliability f the technological process is the lowest reliability of any of the workpiece characteristics. The characteristics of the workpiece are [5]: dimensions (length measures), geometrical shape, mutual position, surface roughness, mechanical, chemical, physical and other properties. The reliability of a characteristic of a workpiece is considered to be the probability that the actual value of the characteristic is within the tolerance field at a specific time, or a very short time interval, which can be represented by the equation [2, 4]:

$$R_i(t_1) = P(x \in T), \tag{1}$$

where are: x - random variable, T - prescribed tolerance, i - mark of the characteristic to be measured and t_1 - mark that the reliability refers to a specific time.
The reliability of the characteristics of the workpiece is the basis for determining other quantitative measures of stochasticity of the process: dynamical and instantaneous reliability and the time until which the process is in a state of statistical control [3].

3. THE RELIABILITY OF GEOMETRICAL SHAPE

The macrogeometry of the workpiece, in addition to the length measures, includes the mutual position of two or more axes or surfaces of the workpiece and the geometrical shape [1].
As it is impossible to achieve completely accurate length measures and mutual position, it is even more difficult to achieve the prescribed tolerance geometrical shape. Prescribing tolerances for shape accuracy should be avoided, as they are generally difficult to achieve, and increase production costs and reduce workpiece reliability [5].
The geometric shape is a spatial dimension, so the tolerance space is relevant, not the tolerance field. The simplest tolerance space is a hollow cylinder with the smallest allowable diameter d_{min} and the largest allowable diameter d_{max}, figure 1. [6].
Deviations from the shape of an ideal cylinder may be ovality, conicity, inflexion, concavity, convexity and wavy [5].
The reliability of the geometric shape where the tolerance space is a hollow cylinder is easy to determine. It is first necessary to measure more than 30 (application of the Central Limit Theorem) real diameters of the observed cylinder d_{si} ($i = 1,\ 2, ..., n$) (Figure 2.), eg diameter ∅ 15 of workpiece shown in Figure 1.
The average of the real cylinder diameters is:

$$\bar{d}_s = \frac{\sum_{i=1}^{n} d_{si}}{n}. \tag{2}$$

The standard deviation is calculated by equation:

$$\sigma_d = \sqrt{\frac{\sum_{i=1}^{n}\left(d_{si} - \bar{d}_{si}\right)^2}{n-1}}\ . \tag{3}$$

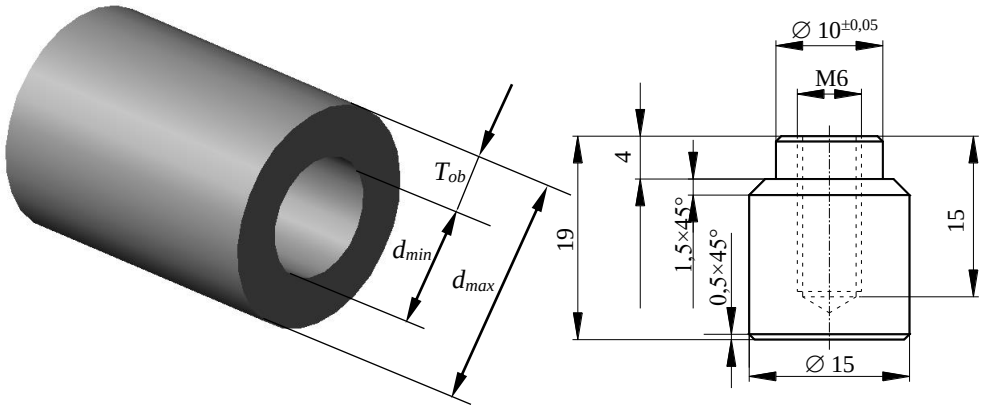

Figure 1: Tolerance space in the form of a hollow cylinder and workpiece

The reliability of the cylinder shape, that is, the probability that the diameter d_s is within the tolerance space bounded by the diameters $d_{\min}$ and $d_{\min}$ is determined by solving the integral [7]:

$$\hat{R}_{obc} = P\left(d_{\min} < d_s < d_{\max}\right) = \int_{d_{\min}}^{d_{\max}} \frac{1}{\sigma_d\sqrt{2\pi}} \exp\left(-\frac{\left(d_s - \bar{d}_s\right)^2}{2\sigma_d^2}\right). \tag{4}$$

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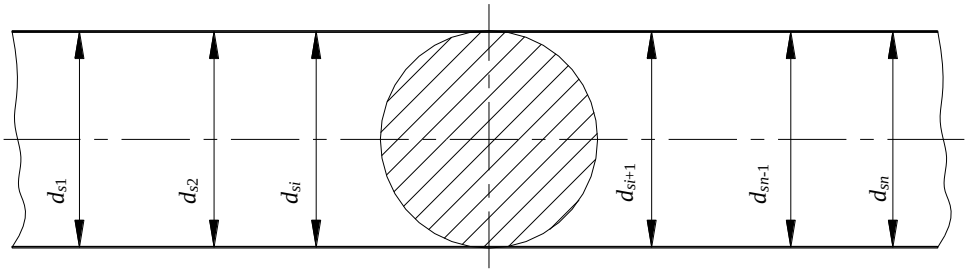


Figure 2: Measurement of cylinder diameter

The previous procedure is a special case and is applicable to the case of the shape of an ideal cylinder, while in the general case it cannot be applied.
Let, as the most general case, the tolerance space be determined by two irregular surfaces, as shown in Figure 3. [2, 4]

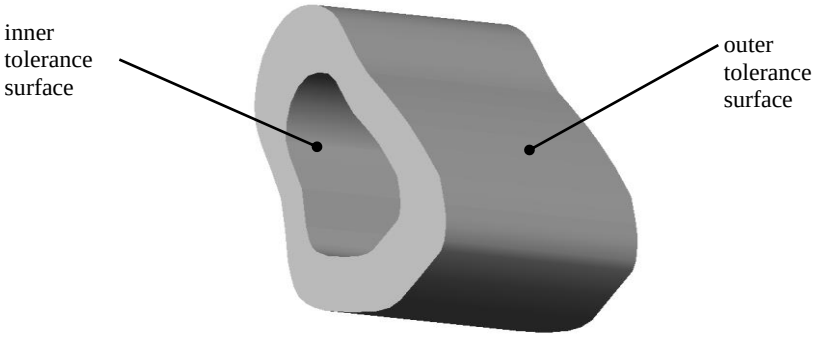


Figure 3: Tolerance space defined by two irregular surfaces

To calculate the reliability of an irregular shape, it is first necessary to determine the ideal shape. The ideal shape is usually the central surface in the middle of the tolerance space between the outer and inner tolerance surface, Figure 4.

Further, it is necessary to measure the maximum deviation, i.e., the residual ε_{obi} ($i = 1,\ 2,..., n$) for as many sections of the irregularly shaped body as possible, as shown in Figure 4, where n is the number of sections. Thus, the residual is calculated directly and not using coordinates or dimensions, as is usual.

The standard deviation is obtained by including the residual ε_{obi} ($i = 1,\ 2,..., n$) in the equation:

$$\sigma_{ob} = \sqrt{\frac{\sum_{i=1}^{n} \varepsilon_{obi}^{\ 2}}{n}}\ ,\ i = 1,\ 2,..., n\ . \tag{5}$$

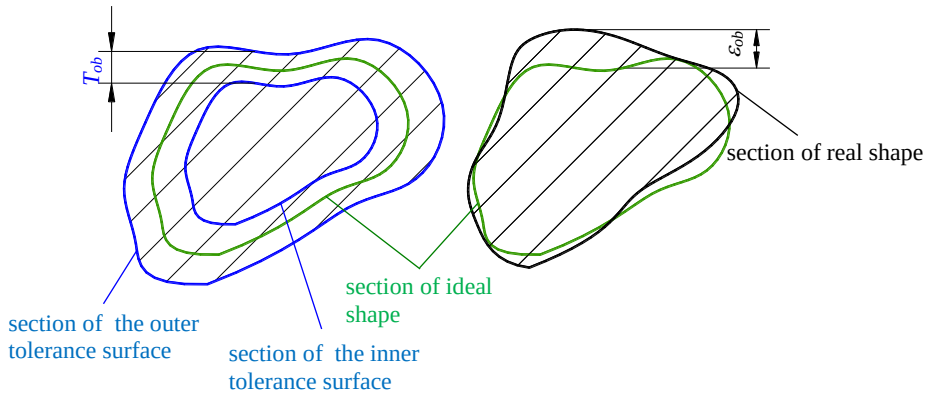


Figure 4: Section of an irregularly shaped body

Since prescribed shape tolerance T_{ob} is known, the reliability of the geometric shape is calculated using the equation:

$$\hat{R}_{ob} = 2\Phi\left(\frac{T_{ob}}{2\cdot\sigma_{ob}}\right). \tag{6}$$

In equation (6) Φ is the Laplace integral, ie the cumulative distribution function (CDF) of the standard normal distribution, where the mean is equal to 0 and the standard deviation is 1, with the known upper limit of the integral [7]:

$$\Phi(t) = \frac{1}{\sqrt{2\pi}}\int_0^t e^{-\frac{u^2}{2}}du\,. \tag{7}$$

Therefore, the methodology for determining the reliability of the geometric shape is generalized. In special cases this can be simplified.

For example, let it be necessary to determine the minimum tolerance space with the diameters of the ideal cylinder for the workpiece shown in Figure 1. for which the shape reliability is at least $\hat{R}_{ob} = 0{,}999$. For this purpose, the nominal workpiece diameters ∅ 15 [mm] were measured on a coordinate measuring machine. All diameters were measured with 49 points per circumference. There are a total of 31 of these diameters, in order to achieve a normal distribution of the measured values. The frequencies of the measured values are shown in Table 1.

Table 1: Frequency of measured diameters d_{si} (nominal diameter ∅ 15)

d_{si}	14,990-15,009	15,010-15,029	15,030-15,049	15,050-15,069
Frequency	21	4	3	3

The arithmetic mean and standard deviation of measured values are obtained by including the measured cylinder diameters in equations (1) and (2): $\bar{d}_s = 15{,}01$ [mm], $\sigma_d = 0{,}022$ [mm]. The measured diameter values and reliability $\hat{R}_{ob} = 0{,}999$ require a minimum tolerance of the shape $T_{ob} = 0{,}15$ [mm] symmetrically distributed around the arithmetic mean [mm]. That is a high tolerance value. For example, if the prescribed tolerance is $\varnothing\, 15^{\pm 0{,}05}$, then the reliability is $\hat{R}_{ob} = 0{,}962$. For ∅ $15^{\pm 0{,}025}$ is $\hat{R}_{ob} = 0{,}696$. This means that considering the tolerance and reliability of the shape, the workpiece is not manufactured to a requirement specification.

4. CONCLUSION

The reliability of the technological process is defined as the probability that the product will complete the conditions of the design documentation. The reliability is a dynamic size, having a tendency of a decrease in time. In this regard, a methodology has been developed to determine the time until which the process is capable, ie in a state of statistical control. For this purpose, it is necessary to determine the instantaneous reliability as the minimum reliability of the workpiece characteristics. The reliability of the workpiece characteristic is the probability that the value of a characteristic is within a specified tolerance field. The geometrical shape is one of the characteristics of the workpiece. The

reliability of the geometrical shape depends on the prescribed tolerance for the accuracy of the shape in the shape of the tolerance space. Prescribing tolerances for shape accuracy should be avoided, as they are generally difficult to achieve, and increase production costs and reduce workpiece reliability.
The reliability of the geometrical shape is generally calculated as twice the value of the Laplace integral of the quotient of tolerance and twice the value of the standard deviation. The standard deviation is obtained on the basis of the measured residuals.
The example shows that a high tolerance is required for satisfactory geometric shape reliability values. That is, if a lower tolerance is obtained, an extremely high-quality and capable technological procedure is required for greater reliability.

5. REFERENCES

[1] Ekinović, S. (2001). Obrada rezanjem, Mašinski fakultet, Zenica
[2] Gredelj, S. (2011). Pouzdanost i sposobnost tehnoloških sistema i procesa, magistarski rad, Tehnički fakultet, Bihać
[3] Gredelj, S. (2017). Istraživanje utjecaja vibracija obradnih sistema na stohastično i haotično ponašanje procesa obrade, doktorska disertacija, Tehnički fakultet, Bihać
[4] Gredelj, S., Halilagić R. (2021). Pouzdanost konstrukcija i procesa, Tehnički fakultet, Bihać
[5] Jurković, M., Tufekčić, Dž. (2000). Tehnološki procesi, projektiranje i modeliranje, Mašinski fakultet, Tuzla
[6] Jurković, M. (1980). Tehnološki procesi u proizvodnom i konstrukcionom mašinstvu, Mašinski fakultet, Banja Luka
[7] Pauše, Ž. (2003). Vjerojatnost, V izdanje, Školska knjiga, Zagreb
[8] Vujanović, N. (1990). Teorija pouzdanosti tehničkih sistema, II izdanje, Vojnoizdavački i novinski centar, Beograd

THE APPLICATION OF CENTRAL LIMIT THEOREM IN DETERMINING STRUCTURAL RELIABILITY

Sanel Gredelj, Ramo Halilagić
Tehnički fakultet Bihać, ul. dr I. Ljubijankića, tfb@bih.net.ba,
sanel.gredelj@unbi.ba , halilagic.r@gmail.com

ABSTRACT:

The load and capacity of structure (construction) are relevant for determining instantaneous structural reliability. In most of the literature, the analytical method of calculating instantaneous structural reliability usually assumes that both the load and capacity of structure *as random variables have a normal distributions. Empirical results, and rarely mathematical theory, are cited as the basis for this assumption, which can be confusing. The purpose of this paper is to emphasize the importance of mathematical theory, in the form of Central Limit Theorem (CLT), as a basis for the stated assumptions. The CLT is a group of theorems that establish the conditions under which the limit distribution is a normal distribution. In our case, the two theorems, listed in Chapter 2, are important for the analytical determination of structural reliability. In Chapter 3, both the load and capacity of structure are defined as a normally distributed random variables. The distribution that represents the difference between the load and capacity of structure is also normally distributed, which is a direct consequence of the CLT. The result is a simple analytical determination of reliability, Chapter 4. Disadvantages of applying the normal distribution have no practical significance and can be ignored. If this is not possible and in order to eliminate the errors of the analytical model, the simulation Monte-Carlo method can also be used to determine instantaneous structural reliability. Chapter 6 provides the conclusions.*

Keywords: Reliability, Structure, Load of Construction, Capacity of Construction, Normal Distribution, Central Limit Theorem

1. INTRODUCTION

A structure is an assemblage of components which are connected in such a way that the structure can withstand the action of loads that are applied to it. These loads may be due to gravity, inertia, wind, ground shaking, impact, temperature, or other environmental sources. Examples of structures employed in civil infrastructure are buildings, bridges, dams, tunnels, storage tanks, and transmission line towers. Mechanical engineering applications include aerospace structures such as airplane fuselages, missiles; naval structures such as ships, offshore platforms; and automotive structures such as cars and trucks. Structural engineering is the discipline which is concerned with identifying the loads that a structure may experience over its expected life, determining a suitable arrangement of

structural members, selecting the material and dimensions of the members, defining the assembly process, determininig a structural reliability and lastly monitoring the structure. [2]
The subject of structural reliability provides a logical framework within which the uncertainties, that invariably exist in dealing with problems of structural analysis and design, could be systematically addressed. The uncertainties in structural and load characteristics are quantied using the mathematical theories of probability, random variables, random processes and statistics. Early studies in this field were carried out by Freudenthal (1945) who brought the methods of probability and statistics to bear on characterizing the nature of factor of safety. An illuminating account of the historical development of the subject is available in the book by Madsen, Krenk and Lind (1986). A resume of industrial applications of structural reliability has been given by Thoft-Christensen (1998). Bjerager (1990) presents a state-of-the-art review of structural reliability methods by classifying the problems into random variable problems, random process reliability models and random field reliability models. Rackwitz (2000) has presented a discussion on counter examples that reveals possible weaknesses of methods of reliability analysis. Huang, El Hami and Radi (2016) have published Overview of Structural Reliability Analysis Methods. [6, 10]
The CLT is a well-established mathematical theory and one has been elaborated and analyzed in many literature works [1, 11, 13, 15, 17]. But in the literature of structural and reliability engineering, the CLT is analyzed insufficiently. Due to the application of the CLT, especially in the analytical determination of instantaneous reliability, this is an obvious drawback. [5, 9, 10, 14, 16].

2. INSTANTANEOUS RELIABILITY

Reliability is the probability that a system will perform its intended function without failure as a function of time (dynamical reliability) [16]. Other sizes that have a random character are used to determine the *instantaneous reliability* at a precisely defined and relatively short time. These quantities in structures are [3, 4, 8, 10]: load of construction, capacity of construction, dimensions (length measures), geometric shape and mutual position, surface roughness, and other mechanical, chemical, physical and other properties. Reliability as a function of time can be expressed on the basis of a certain at least two instantaneous reliability at different time moments. The Exponential and Weibull distributions have priority by dynamic reliability [5, 12, 16]. The Gaussian (normal) distribution is primary in determining instantaneous reliability. The basis for such an approach is the CLT.

3. THE CENTRAL LIMIT THEOREM

The normal distribution is most commonly used to approximate empirical distributions. If the observed size of the phenomenon is affected by a large number of independent random factors and each of them has only a small influence on the occurrence, then the combined effect of these factors gives the result that the observed size tends to a normal probability distribution.
The CLT is a group of theorems, and two theorems are important for structural reliability. The first theorem proves that the sum (and difference) of independent random variables, each of which has a normal distribution, also has a normal distribution. The second theorem: if are X_1, X_2, ... random variables (samples drawn from a population) with overall mean μ and finite variance V, then the limiting form of the distribution $Z_n = \left(X_1 + X_2 + ... + X_n - n\mu\right)/\sqrt{V \cdot n}$, is a standard normal distribution, when n tends to infinity [11, 13, 15, 17]:

$$\lim_{n \to +\infty} P\left(Z_n \le x\right) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{x} e^{\frac{-t^2}{2}} dt \,. \tag{1}$$

The CLT can be practically used even when the number of single variables is small. When it comes to the sum of independent random variables that can be compared according to their deviations, with a larger number of summands, the distribution of the sum is approximately a standard normal distribution. There is a significant application of the approximate replacement of one probability distribution with another. According to previous research, when the number of summands of independent variables is at least 10, then the distribution of sums can be approximated by a normal distribution. A better result is obtained if each the distributions of single independent random variables are analyzed. Thus, if the single distributions are approximately symmetric it can be assumed that it is $n \geq 10$. Otherwise $n \geq 30$, which is the usual lower limit, if it is necessary to be sure that it is a normal population. [17]

4. THE LOAD AND CAPACITY OF STRUCTURE AS A RANDOM VARIABLES

Both the load and capacity (tension) of structure (construction) are relevant for determining instantaneous structural reliability. The load of the structure can be estimated with appropriate deviations. Therefore, the load of the structure can be expressed by its mean and deviation [7]:

$$\sigma_r = \overline{\sigma}_r \pm \Delta\sigma_r , \tag{2}$$

where are:

$\overline{\sigma}_r$ – mean or nominal value;

$\Delta\sigma_r$ – deviation from the mean.

Thus, the load of the structure is a random variable. The capacity of the structure (similar to load) can be expressed by:

$$\sigma_k = \overline{\sigma}_k \pm \Delta\sigma_k , \tag{3}$$

where are:

$\overline{\sigma}_k$ – mean or nominal value;

$\pm\Delta\sigma_k$ – deviation from the mean $\overline{\sigma}_k$, which the constructor evaluates based on experience or literature.

In Figure 1, the load and capacity of structure are represented by a normal distribution curve. Assuming that the weaker parts of the structure are aided by the stronger parts surrounding them, then the critical stress distribution is related to the mean value of the samples. This means that the correct assumption is that the distribution of load of structure corresponds to the normal distribution.

It has been proven by experimental research that the ultimate strength, yield strength and fatigue strength of steel have a normal distribution. In this case, there are also certain limitations to the application of the normal distribution. The first limitation is that the domain of the normal distribution is a set of real numbers ($\pm\infty$), which does not correspond to the real values samples drawn from a population. Second limitation is the symmetric shape of the normal distribution, and the samples (random value) are often asymmetrically distributed.

Experimental research has confirmed that metal alloys often have a log-normal distribution. Also certain metals and alloys have a Webull distribution. [9, 16] However, if the coefficients of variation of the distribution are less than 0.3, the probability of negative and extreme values is negligible. Log-normal distribution in many cases tends to normal distribution.

The Weibull distribution is a multiparameter distribution, which incorporates several different distributions. Depending on the shape parameter, the Weibull distribution can be hyperexponential, exponential distribution, and (for values greater than 1) normal distribution. In most cases, the Weibull distribution tends to a normal distribution. [12, 14]

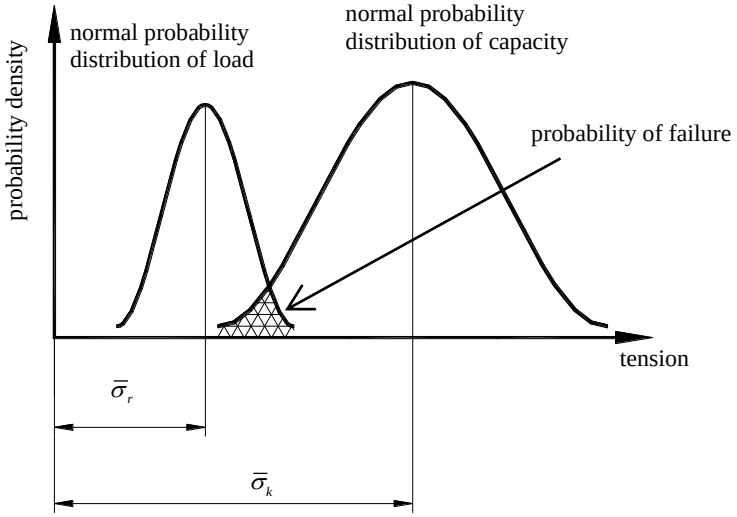


Figure 1: Mutual position the curves of normal distribution

Although it should not be generalized, primarily with respect to the CLT, and the above remarks, it is most accurate to represent the load and capacity of structure as the normal distribution curve, as shown in Figure 1.
Therefore, probability densities of the load and capacity of structure are [5]:

$$f(\sigma_r) = \frac{1}{D_r \cdot \sqrt{2 \cdot \pi}} \cdot \exp\left(- \frac{(\sigma_r - \overline{\sigma}_r)^2}{2 \cdot D_r^2} \right), \tag{4}$$

$$f(\sigma_k) = \frac{1}{D_k \cdot \sqrt{2 \cdot \pi}} \cdot \exp\left(- \frac{(\sigma_k - \overline{\sigma}_k)^2}{2 \cdot D_k^2} \right), \tag{5}$$

where are: D_r and D_k the standard deviations of the load and capacity of structure.

5. DETERMINATION OF INSTANTANEOUS STRUCTURAL RELIABILITY

The distribution that represents the difference between the load and capacity of structure ($\sigma_k - \sigma_r$), is important for determining reliability, Figure 2. The first theorem, given in Chapter 2, proves that the difference of independent random variables, each of which is normally distributed, also has a normal distribution. Thus, the difference between the load and capacity of structure ($\sigma_k - \sigma_r$) is normally distributed.
The standard deviation of a random variable $\sigma = \sigma_k - \sigma_r$ is:

$$D_\sigma = \sqrt{D_r^2 + D_k^2} \ . \tag{6}$$

The structural instantaneous reliability R is the probability that the capacity is higher than the load of structure, $\sigma_k - \sigma_r > 0 \ \Rightarrow \ \sigma > 0$:

$$R = P(\sigma > 0) = 1 - \int_{-\infty}^{0} \frac{1}{D_\sigma \cdot \sqrt{2 \cdot \pi}} \cdot \exp\left(- \frac{(\sigma - \overline{\sigma})^2}{2 \cdot D_\sigma^2} \right) d\sigma \,. \tag{7}$$

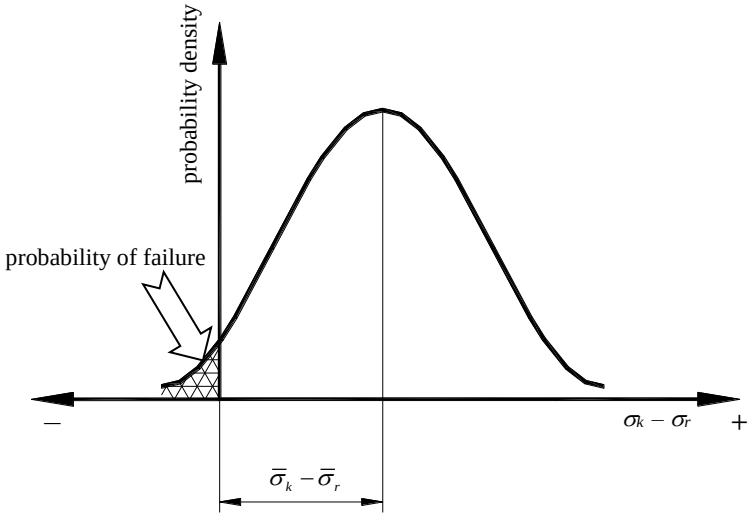


Figure 2: Normal distribution curve of $\sigma_k - \sigma_r$

We substitute $z = \dfrac{\sigma - \overline{\sigma}}{D_\sigma} \Rightarrow dz = \dfrac{d\sigma}{D_\sigma}$ in equation (7), and change limits of integration:

- za $\sigma = 0 \Rightarrow z_0 = \dfrac{0 - \overline{\sigma}}{D_\sigma} = -\dfrac{\overline{\sigma}_k - \overline{\sigma}_r}{\sqrt{D_r^2 + D_k^2}}$,
- za $\sigma \to -\infty \Rightarrow z \to -\infty$.

Equation (6) become:

$$R = 1 - \frac{1}{\sqrt{2 \cdot \pi}} \cdot \int_{-\infty}^{z_0} e^{-\frac{z^2}{2}} dz \,, \tag{8}$$

where is:

$$\Phi_1(z_0) = \frac{1}{\sqrt{2 \cdot \pi}} \int_{-\infty}^{z_0} \cdot e^{-\frac{z^2}{2}} dz \,, \tag{9}$$

the cumulative distribution function (CDF) of the standard normal distribution.
For $z_0 < -4{,}5$, the reliability has value of $R > 0{,}999997$. If is $z_0 = 0 \Rightarrow R = 0{,}5$; and for $z_0 > 0{,}5 \Rightarrow R < 0{,}3$. Generally, if $z_0 \to -\infty \Rightarrow R \to 1$; and for $z_0 \to +\infty \Rightarrow R \to 0$.
For a practical example, $\overline{\sigma}_k = 200$ [N/mm^2], $\overline{\sigma}_r = 100$ [N/mm^2], $D_k = 25$ [N/mm^2] and $D_r = 20$ [N/mm^2]:

$$z_0 = -\frac{\overline{\sigma}_k - \overline{\sigma}_r}{\sqrt{D_r^2 + D_k^2}} = -\frac{200 - 100}{\sqrt{25^2 + 20^2}} = -3{,}878 \Rightarrow R = 0{,}99947,$$

which means that the construction has a high instantaneous reliability *R*.

6. CONCLUSION

Structural reliability has significant applications in civil engineering, mechanical engineering, shipbuilding, aerospace engineering, etc. Structural reliability has been investigated in detail theoretically and experimentally. The analytical method of reliability calculation, as shown in this paper, can be easily found in the available literatures. It is most often assumed that the load and capacity of structure as random variables have a normal (Gaussian) distribution. In addition to empirical reasons, the mathematical basis for this assumption is the CLT, the most important theorem of Probability Theory. In this paper is to emphasize the importance of the CLT in structural and reliability engineering. Other theorems: The Moivre-Laplace theorem, the Lyapunov theorem, the Berry-Essén theorem; elaborate and supplement the basic premise of the CLT on the importance of the normal (Gaussian) distribution as the most applicable distributions. The application of CLT has disadvantages, which are mentioned in Chapter 4 of this paper. To eliminate these disadvantages and errors of the analytical model, the Monte-Carlo simulation method can also be used for determination a structural instantaneous reliability.

7. REFERENCES

[1] Adnroić, V. et. al. (2006). Inženjerstvo pouzdanosti, IA Projektiranje Zagreb, RH
[2] Connor, J., J., Faraji, S. (2012). Fundamentals of Structural Engineering, Springer, New York, USA
[3] Gredelj, S. (2011). Pouzdanost i sposobnost tehnoloških sistema i procesa, magistarski rad, Tehnički fakultet, Bihać, BiH
[4] Gredelj, S. (2017). Istraživanje utjecaja vibracija obradnih sistema na stohastično i haotično ponašanje procesa obrade, doktorska disertacija, Tehnički fakultet, Bihać, BiH
[5] Gredelj, S., Halilagić R. (2021). Pouzdanost konstrukcija i procesa, Tehnički fakultet, Bihać, BiH
[6] Huang, W., C., El Hami, A., Radi, B. (2016). Overview of Structural Reliability Analysis, Part I, II, III, ISTE Ltd. London, UK
[7] Jovičić, S. (1990). Osnovi pouzdanosti mašinskih konstrukcija, Naučna knjiga, Beograd, RS
[8] Jurković, M., Tufekčić, Dž. (2000). Tehnološki procesi, projektiranje i modeliranje, Mašinski fakultet, Tuzla, BiH
[9] Kailash, C, K., Pecht, T. (2014). Reliability Engineering, John Wiley & Sons, Inc., Hoboken, New Jersey, USA
[10] Manohar, S., C., Gupta, S. (2001). Modeling and evaluation of structural reliability: current status and future directions, Indian Institute of Science, Bangalore, India
[11] Merkle, M. (2002). Verovatnoća i statistika, Akademska misao, Beograd, RS
[12] Milčić, D. (2005). Pouzdanost mašinskih sistema, Mašinski fakultet, Niš, RS
[13] Pauše, Ž. (2003). Vjerojatnost, V izdanje, Školska knjiga, Zagreb, RH
[14] Ramović M., R., (2005). Pouzdanost sistema, Elektrotehnički fakultet, Beograd, RS
[15] Riley, F., K., Hobson, P., M., Bence, J. S. (2006). Mathematical Methods for Physics and Engineering, Cambridge University Press, UK
[16] Vujanović, N. (1990). Teorija pouzdanosti tehničkih sistema, II izdanje, Vojnoizdavački i novinski centar, Beograd, RS
[17] Vukadinović, S. (1978). Elementi teorije vjerovatnoće i matematičke statistike, Privredni pregled, Beograd, RS

THE MEASUREMENT SYSTEM ANALYSIS (MSA) AS METHOD FROM MEASURE PHASE OF DMAIC LEAN SIX SIGMA APPLIED IN MAINTENANCE OF GAGE

Ismar Alagić
TRA Tešanj Development Agency / University of Zenica, Faculty of Mehanical of Engineering
Trg Alije Izetbegovića 11, BA-74260 Tešanj/ Fakultetska 3, BA-72000 Zenica
ismar.alagic@gmail.com ; alagicismar@yahoo.com

ABSTRACT:

Traditional methods such as "Six Sigma" are more focused on quality than on speed. Methods known as "Lean" are better to improve processes and speed, then quality. By combining these two types of methods is obtained method, Lean Six Sigma, which yields the best results in improving business organization. The most common and the most often used tools within the second phase of Lean Six Sigma projects are as follows: Process map; Ishikawa diagram; Cause-Effect matrix; FMEA (Failure Mode and Effect Analysis);Data Investigation Plan; MSA – Measure System Analysis; Visualization tools, and; Calculating process capacity (Cp, Cpk, Pp, Ppk, Sigma, PPM). This article provides proposal a set of approaches that are the basis for the development and application of the principles and MSA tool of Lean Six Sigma maintenance of gage. A special focus is given to the MSA method of applying Lean Six Sigma concepts in specific working conditions maunfacturing of ring bearing in domestic OEM company from automotive sector.

Keywords: Measurement system analysis (MSA), Lean six sigma (LSS), measure phase, gage, maintenance, ring bearing.

1. INTRODUCTION

Measurement data are used more often and in more ways than ever before. For instance, the decision to adjust a manufacturing process or not is now commonly based on measurement data. Measurement data, or some statistic calculated from them, are compared with statistical control limits for the process, and if the comparison indicates that the process is out of statistical control, then an adjustment of some kind is made. Otherwise, the process is allowed to run without adjustment. Another use of measurement data is to determine if a significant relationship exists between two or more variables. The quality of measurement data is defined by the statistical properties of multiple measurements obtained from a measurement system operating under stable conditions. The Measurement Systems Analysis defines the procedure for assessing the quality of a measurement system [6].

Six Sigma as a modern strategy management quality can help companies to achieve and maintain business success in the long period of time. This is one of the leading strategies that make the goals achievable through a structured and systematic project approach DMAIC (Define, Measure, Analyse, Improve, and Control). The main objective of Six Sigma strategy is oriented towards the improvement of the customer, in order to reach the company's business goals. Six Sigma is not just a method of improving the quality or process. This is the vision, philosophy, strategy and a set of tools, but the

greatest savings and the greatest revenue had companies that have implemented Six Sigma across the organization. Also, Six Sigma takes into account the aspects of the organizational structure, corporate culture and process implementation strategy, and for this reason brings a comprehensive concept and framework of business success [3]. At the operational level, Six Sigma uses a structured and systematic approach (DMAIC, DMADC cycle) to achieve operational excellence. The Six Sigma provides the tools to solve problems in various fields of business with statistical and non-statistical methods in a sustainable way. The goal of Six Sigma projects is to identify input factors that cause variations and deviations from the target in order to centre the process and minimize deviations. Lean Six Sigma combines the two most important trends of development and improvement of operating results: improve the work (with the help of Six Sigma) and increase the speed (through Lean principles). Lean Six Sigma is a business concept that focuses on increasing the zero point of profit and customer satisfaction. This article provides a set of approaches that are the basis for the development and application of the principles, methods and tools of Lean Six Sigma concepts. A special focus is given to the MSA method of applying Lean Six Sigma concepts in specific working conditions in BH companies, taking into account international experience in the study of this field [3].

2. MEASURE PHASE OF DMAIC

Measure phase is the second step within DMAIC cycle in which project team collects information and data about defined problem. In this step is important to measure current Lean Six Sigma process performance, and observe the problem in deeper level [4].

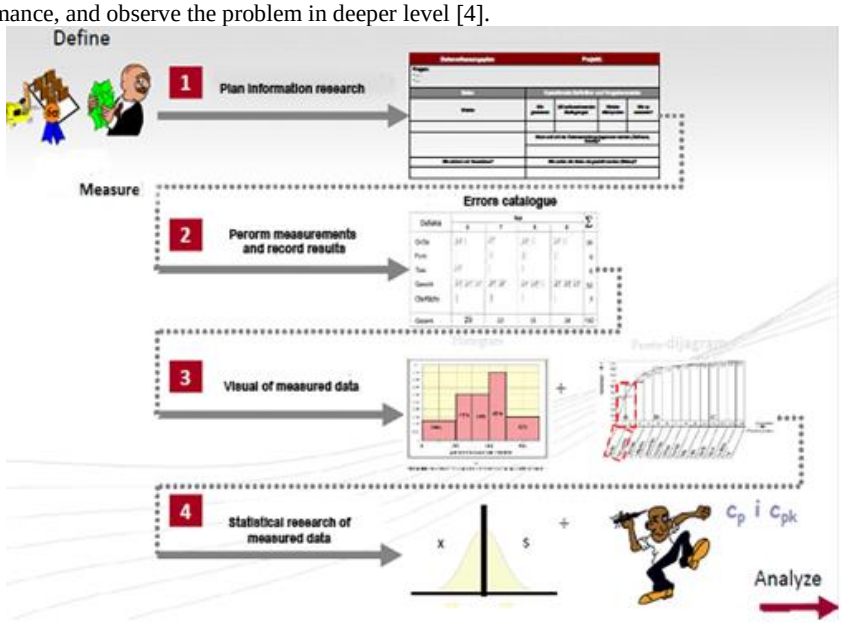


Figure 1: Process Flow "measure" within the DMAIC cycle.

It is important to emphasise that this is phase with no solution in sight, but where is necessary to learn more about the problem and collect as many information on dimension and kind of the problem. Namely, it is necessary to describe and quantify improvement possibility in this step, by describing current state. Likewise, after certain changes in the last phase of project were implemented, measure phase is for "baseline" study, by which before/after data can be compared, and in that way to get to the information about real process improvement, that is, product improvement. To analyse and measure

monitored process, product, it is needed to know basic statistical techniques as calculation of average arithmetic value, standards of deviations and other indicators, since it is the only way to understand process movements, i.e. variations inside the process. W. Edwards Deming said: "Variation is evil" keeping in mind that all process deviations origin from existence of too big and unacceptable variations. There is another statement of W.E. Deming that gives picture of measure phase importance. It says: "In God we trust-all others bring data"). From the above, we can say that measure phase is necessary for the following: To map the process; To identify critical measurement points necessary for meeting customers' requirements; To plan data research for quantifying the problem; To collect hypothesis on problem, as well as variations; To prove and, if necessary, to fix or develop reliability of measurement system; To provide with data for the later hypothesis testing, and; To quantify problem by reliable data. The most common and the most often used tools within the second phase of Lean Six Sigma projects are: Process map; Ishikawa diagram; Cause-Effect matrix; FMEA (Failure Mode and Effect Analysis); Data Investigation Plan; MSA – Measure System Analysis; Visualization tools; Calculating process capacity (Cp, Cpk, Pp, Ppk, Sigma, PPM).

PONOVLJIVOST IN PRIMERLJIVOST-REPRUDOKTIVNOST MERILA

številka poročila:

Podatki o merilcih:	Merilec A	Merilec B	Merilec C
naziv merila:		številka:	proizvaj.:	enote:
naziv merjenca:		koda:	mera:	tolerance: 10

št. merjenih kosov (n) = 10 (običajno 10) | št. poskusov / merilca (r) = 3 (3 ali 2) | št. merilcev = 3 (3 ali 2)

kos	merilec A 1.poskus	2.poskus	3.poskus	razpon	merilec B 1.poskus	2.poskus	3.poskus	razpon	merilec C 1.poskus	2.poskus	3.poskus	razpon
1	502	502	502	0	502	501,5	502	0,5	501,5	501,5	501,5	0
2	501	501	502	1	501	501	501	0	502	502	501,5	0,5
3	502,5	502,5	502	0,5	502,5	502,5	502,5	0	502,5	502,5	502,5	0
4	501,5	501,5	501,5	0	501,5	502	501,5	0,5	501,5	501,5	501,5	0
5	502	502	502	0	502	501,5	501,5	0,5	502	502	502	0
6	502	502	501,5	0,5	502	502	502	0	502	502	502	0
7	501,5	502	501,5	0,5	501,5	501,5	501,5	0	502	502	501,5	0,5
8	501	501	501,5	0,5	501	501	501	0	501	501	501	0
9	502	502	502	0	501,5	502	502	0,5	502	502	502	0
10	501,5	501,5	501,5	0	501,5	501,5	501,5	0	501,5	501,5	502	0,5
VSOTA	5017	5017,5	5017,5	0,3000 RpA	5016,5	5016,5	5016,5	0,2000 RpB	5018	5018	5017,5	0,1500 RpC

VSOTA A1÷Ar = 15052, XpA = 501,7333 | VSOTA B1÷Br = 15049,5, XpB = 501,65 | VSOTA C1÷Cr = 15053,5, XpC = 501,7833

VSOTA Rp = 0,65, Rpp = 0,216667

poskusi	D4
2	3,27
3	2,58

Max.Xp = 501,7833, Min.Xp = 501,65, XpDiff.= 0,133333, UCLR = 0,559

ANALIZA MERILA | **ANALIZA % TOLERANCE**

	poskusi	K1				
ponovljivost - variacija opreme (E.V.)	2	4,56	E.V. =	0,66083	**% E.V. =**	6,61%
	3	3,05				
	merilci	K2				
posnemljivost - variacija merilca (A.V.)	2	3,65	A.V. =	0,33918	**% A.V. =**	3,39%
	3	2,70				
ponovljivost in posnemljivost (R&R)			R&R =	0,74279	**% R&R =**	7,43%

OCENA :

0%	≤	10%	:	merilo je sposobno
10%	≤	30%	:	merilo je pogojno sposobno, potrebna izboljšava
	>	30%	:	merilo je neprimerno

MERILO JE SPOSOBNO

Datum : | Ime : | Podpis :

Figure 2: Calculation form for "Gage R&R".

3. MEASUREMENT SYSTEM ANALYSIS (MSA)

The discussion of the analysis of measurement system can become confusing and misleading without an established set of terms to refer to the common statistical properties and related elements of the measurement system[1]. In this article, the following term are used:

- Measurement is defined as "the assignment of values to material things to represent the relations among them with respect to particular properties". Above mentioned definition was first given by Eisenhart. The process of assigning the values is defined as measurement process, and the value assigned is defined as measurement value.
- Gage is any device used to obtain measurements. It frequently used to refer specifically to the devices used on the manufacturing stage, includes go/no-go devices.
- Measurement system is the collection of instruments or gages, standards, operations, methods, fixtures, software, personnel, environmenr and assumptions used to quantify a unit of measure or fix assessment to the feature characteristic being measured. The complete process used to obtain measurements.

For instance, suppose that a measurement system, operating under stable conditions, is used to obtain several measurements of a certain characteristic. If the measurements are all "close" tio the master value for the characteristic, then the quality of the data is said to be "high". Similarly, if some, or all, of the measurements are "far away" from the master value, then the quality of the data is said to be "low".

When explaining what a measurement system is we have to start form measuring devices or gages, continue with operational definitions and procedures and, finally, end with people, operators who measure. Types of measurement system analysis are:

- Gage R&R – is a measurement system analysis for continuous data that can be measured in scale and be compared against each other;
- Attributive analysis – is analysis used for discrete data that have specifically determined minimum and maximum and are expressed in integer numbers and are usually used for visual measuring, inspections and subjective opinion.

The statistical properties most commonly used to characterize the quality of data are the "bias" and "variance" of the measurement system. The property called bias refers to the location of the data relative to a reference (master) value, and the property called variance refers to the spread of the data. Figure 3 shows example of "bias" determination [3].

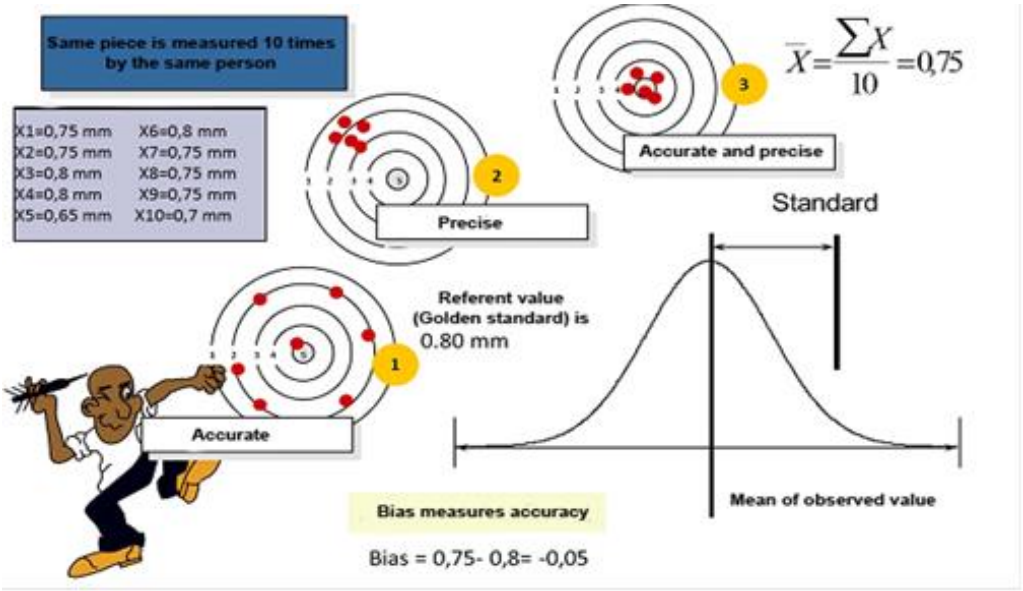


Figure 3: Example of determination of "bias".

A general rule is that a gage must be at least 10 times more precise than the subject of measurement. Cause of such imprecision can be process variation that occurs in two forms:

- The first form of process variation can be that gage is precise, measurement correct, but still incorrect because of the use of wrong standard, pattern for measurement comparison. This kind of process variation is mostly caused by deviations inside gage, and test of repeatability is used for this kind of check.
- Another type of process variation can be that gage is correct, but imprecise, because different measurements show different values, i.e. imprecise values. This kind of process variation is mostly caused by operator's deviation and is checked by the test of reproducibility.

One of the most common reasons for low-quality data is too much variation. Much of the variation in a set of measurements may be due to the interaction between the measurement system and its environment. If the interaction generates too much variation, then the quality of the data may be so low that the data are not useful. For example, a measurement system with a large amount of variation may not be appropriate for use in analyzing a manufacturing process because the measurement system's variation may mask the variation in the manufacturing process. Much of the work of managing a measurement system is directed at monitoring and controlling variation. Among other things, this means that emphasis needs to be placed on learning how the measurement system interacts with its environment so that only data of acceptable quality are generated.

Basic features of measurement system are accuracy and precision. When discussing accuracy it is important to know the term of "bias". Bias is methodological system error in measuring, in the analysed case it would be "average" difference between "evaluator" and the correct value. In order to calculate

bias, we need the "golden standard". Bias is equal to difference between average value of all measurements and "golden" standard which represents the reference value. In order to determine the bias, that is the "evaluator" accuracy, object of measurement is measured at least 10 times by the same "evaluator" [2].

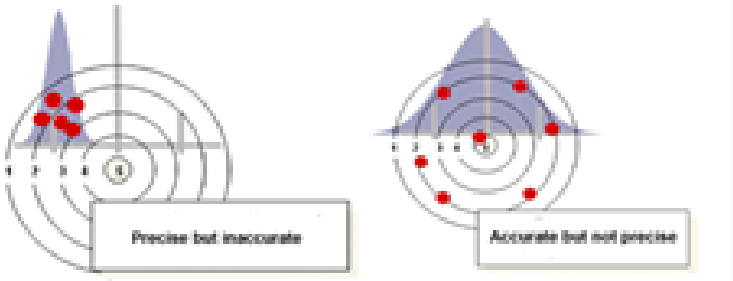


Figure 4: Interplay of (in)accuracy and (im)precision of measurement.

Another important term is precision and it represents "standard" deviation, declination, distribution of "evaluator" (the one performing measurement). Precision is checked by Gage R&R analysis, i.e. by the variation of measure device. Figure 3 shows review of interplay of (in)accuracy and (im)precision of measurement. Test of repeatability and test of reproducibility together are called "Gage R&R" (Gage Repeatability & Reproducibility) and serves as basic test in MSA analysis. Gage R&R test is a statistical method for variation evaluation inside measurement system by measuring variations caused by faulty measurement device calibration (repeatability) and variations caused by operator (reproducibility). While using this statistical tool, we usually use the rule "10x2x2", 10 pieces controlled by 2 operators in 2 measurement repetitions. Result of Gage R&R must be less than 20% to consider the system acceptable. Result of 5% means that our measurement system is very good, i.e. that just 5% of variations occur due to measure system and the rest of 95% occur due to process itself. This rule is valid for continuous data testing - Continuous Gage R&R. If data values are discrete then the result must be higher than 80% - Attributive Gage R&R. We can conclude from the above mentioned that repeatability requires the following procedure: the same work piece, the same evaluator, several measurements. The reproducibility requires the following procedures of measurements: the same work piece, different evaluator or inspector, several measurements. We choose samples randomly, as mentioned, mostly 10 work pieces by 2 or 3 different evaluators/controllers. Then every work piece is measures 2 or 3 times by each evaluator, and sample size is chosen by the following rule:

(number of pieces) x (number of evaluators) > 15 *...(1)*

Analysis of a certain measurement system, for example, lays down the following conditions for the measurement: 5 "products" (work pieces), 5 different settings of measure system, 3 inspectors/surveyors and 2 measurement repetitions. While interpreting the results of measurement, we follow value percentage of Gage R&R that offers the following conclusions for obtained results:

	% Gage R%R	Conclusions
❖	< 5%	Great measure system
❖	<= 10%	Measure system is satisfying (OK)
❖	10%-30%	Acceptable, depending on costs, or how important measures are
❖	> 30%	Measure system needs to be fixed, it requires corrective actions

Part No.& Name:	Gage Name:	Datum: 14.5.2017
Characteristic:	Gage No:	erstellt vom:
Specifications:	Gage Type:	

APPRAISER/ TRIAL #		Part 1	2	3	4	5	6	7	8	9	10	AVERAGE	
1. A	1	100,000	102,000	103,000	102,000	103,000	103,000	103,000	102,000	102,000	101,000		102,100
2.	2	100,000	102,000	103,000	102,000	103,000	103,000	103,000	102,000	102,000	101,000		102,100
3.	3	100,000	102,000	103,000	102,000	103,000	103,000	103,000	102,000	102,000	101,000		102,100
4.	Average	100,000	102,000	103,000	102,000	103,000	103,000	103,000	102,000	102,000	101,000	$\overline{X}_a$ =	102,100
5.	Range	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	$\overline{R}_a$ =	0,000
6. B	1	100,000	102,000	103,000	102,000	103,000	103,000	103,000	102,000	102,000	101,000		102,100
7.	2	100,000	102,000	103,000	102,000	103,000	103,000	103,000	102,000	102,000	101,000		102,100
8.	3	100,000	102,000	103,000	102,000	103,000	103,000	103,000	102,000	102,000	101,000		102,100
9.	Average	100,000	102,000	103,000	102,000	103,000	103,000	103,000	102,000	102,000	101,000	$\overline{X}_b$ =	102,100
10.	Range	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	$\overline{R}_b$ =	0,000
11. C	1	100,000	102,000	103,000	102,000	103,000	103,000	103,000	102,000	102,000	101,000		102,100
12.	2	100,000	102,000	103,000	102,000	103,000	106,000	106,000	106,000	106,000	106,000		104,000
13.	3	100,000	102,000	103,000	102,000	103,000	103,000	103,000	102,000	102,000	101,000		102,100
14.	Average	100,000	102,000	103,000	102,000	103,000	104,000	104,000	103,333	103,333	102,667	$\overline{X}_c$ =	102,733
15.	Range	0,000	0,000	0,000	0,000	0,000	3,000	3,000	4,000	4,000	5,000	$\overline{R}_c$ =	1,900
16.	Part	100,000	101,000	101,000	104,000	105,000	106,000	107,000	108,000	109,000	110,000	$\overline{\overline{X}}$ =	102,311
	Average ($\overline{X}_P$)	100,000	102,000	103,000	102,000	103,000	103,333	103,333	102,444	102,444	101,556	R_p =	3,333
17.	$\overline{R} = (\overline{R}_a + \overline{R}_b + \overline{R}_c)/$ # OF APPRAISERS											=	0,6333
18.	$\overline{X}_{DIFF} = \text{Max}\,\overline{X} - \text{Min}\,\overline{X}$											=	0,633
19.*	$UCL_R = \overline{R} * D_4$											=	2,071
20.*	$LCL_R = \overline{R} * D_3$											=	0,000

*D_4=3,27 for 2 trails and 2,58 for 3 trails; D_3=0 for up to 7 trails. UCL_R represents the limit of individual R's. Circle those that are beyond this limit. Identify the cause and correct. Repeat these readings using the same appraiser and unit as originally used or discard values and re-average and recompute R and the limiting value from the remaining observations.

Notes:

Figure 5: Form with input data for MSA analysis.

It is visible, from the presented results, that, if the measure system is inadequate, that is, if the value of "Gage R&R" is higher than 30%, we have to correct the system by taking the following actions: Analyse possible cause of the problem; Check what the problem is: Repeatability and/or reproducibility?; Whether the problem is people, equipment, environment, procedure... (Ishikawa diagram). Analysis of measurement system for attributive data is all about gaining data by the principle: "good - bad", "works – doesn't work" or "OK - NOK". Thereby, we need to test Repeatability and Reproducibility.

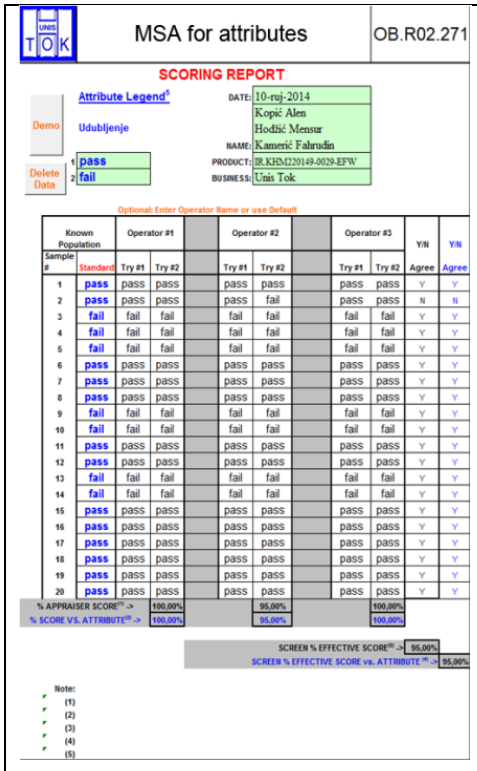


Figure 6: MSA report for attributive data.

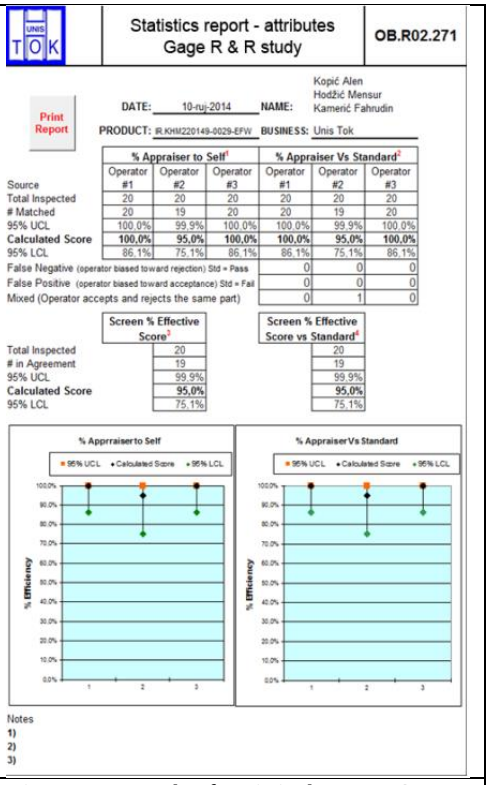


Figure 7: Example of statistical report "Gage R & R".

To establish it we need to check each "piece" minimum twice by the same inspector. Since the status, or the result, can have only two states (OK - NOK; good - bad; tall - short; etc.) the result is not as precise as the numerically expressed analysis. However, attributive controls are often the only way of control, so it is important to do this analysis. In order to make this analysis it is necessary to take approximately minimum of 25-30 pieces/products, and the sample has to contain both, "good" and "bad" pieces. The next activity is marking of work pieces. An expert, i.e. a customer, marks (gives the final evaluation) using the principle "OK-NOK". After that, 2-3 inspectors randomly control pieces at least 2-3 times. The important thing, both in Lean Six Sigma project, as well as in use of any statistical method, is the procedure of collecting samples. The procedure is a special methodology for itself, but members of Lean Six Sigma team must be familiar with the basics, which is: the sample must be representative of the whole population and there cannot be systematic difference among data, why we take or reject certain samples. Also, it is necessary to take into consideration "Hawthorne effect ". To be a successful Six Sigma team member it is necessary to know basic statistical terms. To lead Six

Sigma project and use MSA method it is necessary to have advanced knowledge of statistical methods [5].

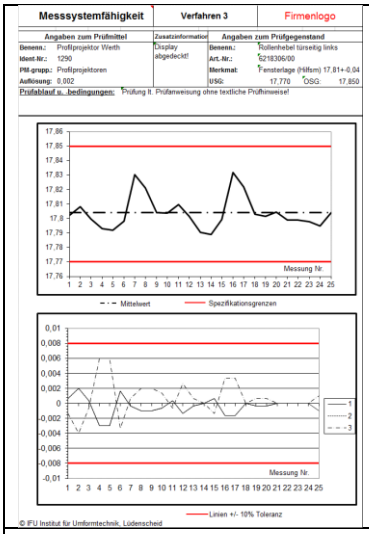


Figure 8: Example of SPC for MSA analysis of measurement of the profile of the product.

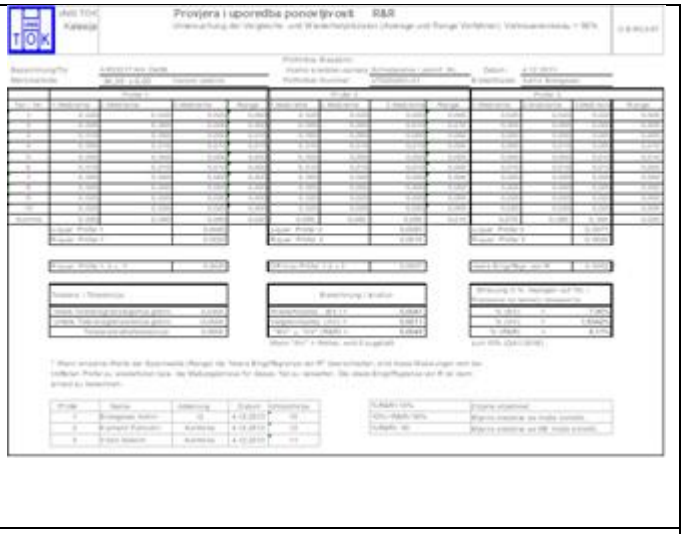


Figure 9: Comparability and reproducibility (R&D)-special gauge UT0202001.

4. MSA APPLICATION

Author of article has used the publication "Measurement Systems Analysis-MSA“, which is a binding frame for application of MSA method. Measuring systems treats numerical analysis and attribute data. When processing and calculations for MSA, as well as creating reports was used software application WinSTAT. All the presented graphical representations are made using applications WinSTAT. So below we will show patterns used for the application of the MSA in case of company Unis Tok from Kalesija. In this case, standard will yield the same results when applied by the supplier or customer, with the same meaning anytime. Effective resolution represents the sensitivity of a measurement system to process variation for particular application. At initial stage of MSA application, we will define accepted basis for comparation, follows criteria for acceptance, then known value within stated limits of uncertainty as a true value and finally to get reference value. Through this experiment we will understand to which measurements are traceable and how traceable they are. Traceability is an important issue in the automotive industry and even wider [2]. Measurements that are traceable to the same or similar standards will agree more closely than those that are not traceable. This helps reduce the need for re-test, rejection of good product and acceptance of bad product. Figure 6 gives an overview of examples of MSA reports for attribute data in the company Unis Tok, Kalesija. Figure 7 shows calculative form of "repeatability and reproducibility of the" measuring device (Gage R&R) from one company which is OEM supplier in automotive industry. Example of SPC for MSA analysis of measurement of the profile of the product-projector of bearings intended for the auto mobile industry The example of SPC for MSA

analysis of measurement of the profile of the product-projector of bearings intended for the auto mobile industry.shown in figure 8. Figure 9 shows R&R report to measure the outside diameter of 30.30 mm in the case of special gauge UT0202001. Documentation part is a very important part of the quality system and measurement system as part of the quality assurance system in the automotive industry. Example of report form on MSA analysis is given in Figure 10.

Figure 10: Application example of MSA and SPC analysis using WinSTAT® applications

5. CONCLUSION

The paper presents the application of MSA as a LSS tool in the concrete case study "Optimization of MSA analysis for ring bearing product in company Unis Tok Kalesija".
This article presents the application of MSA as a LSS DMAIC tool for ring bearing product in company Unis Tok from Kalesija. The results of R&R calculation in case of above mentioned MSA analysis for ring bearing are as follows:

- Repeatability–Equipment variation, EV=2,888; total variation %EV=41,9%;
- Reproducibility–Appraiser Variation, AV=1,526; total variation %AV=22,1%;
- Repeatability & Reproducibility,R&R=3,266;% ; total variation %R&R=47,4%.
- Part Variation, PV=6,067; total variation %PV=88,0%;
- Total Variation, TV=6,890.

The procedure of calculation of R&R for purposes of MSA analysis - ring bearing is shown on figure 11.

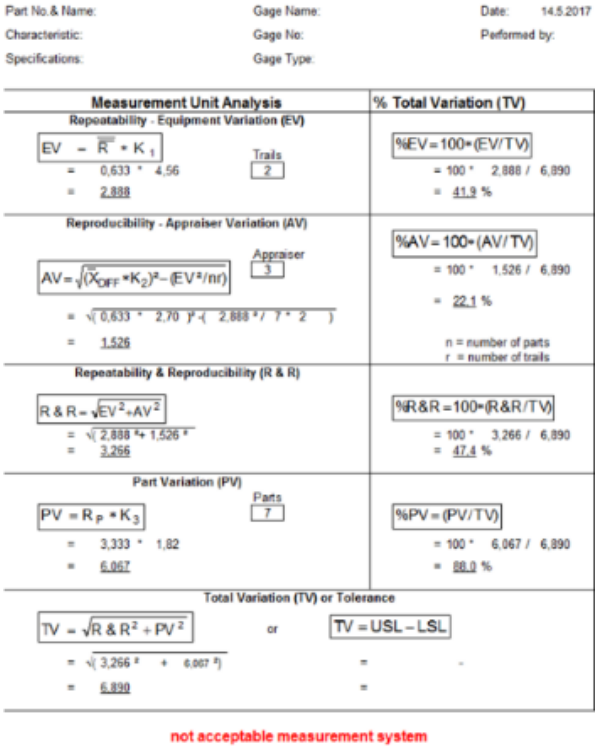


Figure 11: Calculation of R&R for purposes of MSA analysis - ring bearing.

All presented characterizations of the total variation of the analyzed measurement system assume that the system is stable and consistent. The above mentioned application of MSA method through LSS DMAIC concept is unthinkable without software support embodied in applications such as WinSTAT. All presented characterizations of the total variation of the analyzed measurement system assume that the system is stable and consistent.

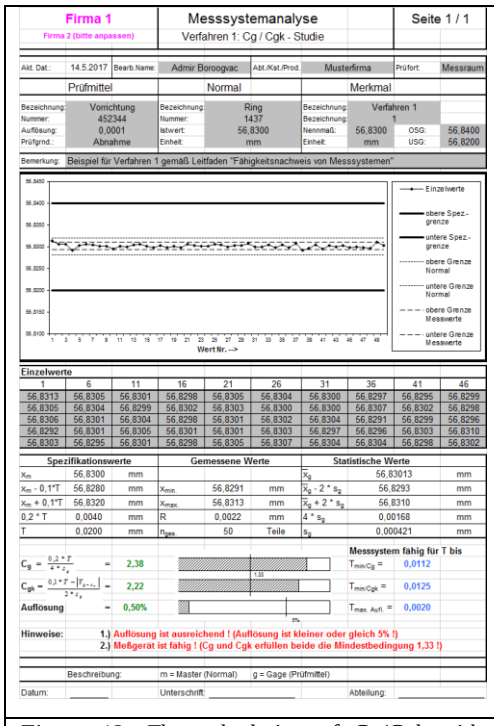


Figure 12: The calculation of Cg/Cgk with graphic representation of the bearings product.

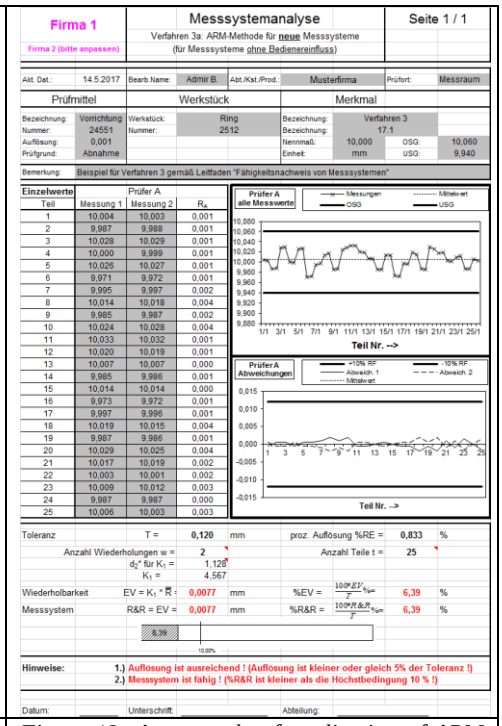


Figure 13: An example of application of ARM method for a new measuring device for the bearing ring of the product.

From all the above it can be seen that the application of statistical techniques, methods and tools through Lean Six Sigma concept is unthinkable without strong software support embodied in specialized applications such as WinSTAT® in the above case.

4. REFERENCES

[1] Alagić I., Tehnologija montaže i demontaže, ISBN 978-9958-617-53-9, COBISS.BH-ID 41739782, Univerzitet u Zenici, Mašinski fakultet, Zenica, 2020.

[2] Alagić I., Priručnik: Projekti i upravljanje proizvodnjom, ISBN 978-9958-31-473-5, COBISS.BH-ID 43378694, Off-set, Tuzla,2021.

[3] Alagić I. Industrial Engineering & Maintenance: Lean Production - Six Sigma with application of tools and methods in specific working conditions, ISBN 978-9958-074-09-7, COBISS.BH-ID 24232454, Štamparija-S, Tešanj, 2017.

[4] Alagić I., KAIZEN IN PRACTICE-CASE STUDY OF APPLICATION OF LEAN SIX SIGMA METHOD IN WORKING CONDITION OF WOOD-PROCESSING FIRM, New Technologies, Development and Application, ISSN 2367-3370, ISSN 2367-3389 (electronic) Springer International Publishing AG, part of Springer Nature 2019.

[5] Pyzdek, Keller, "The Six Sigma Handbook: A Complete Guide for Green Belts, Black Belts, and Managers at All Levels", 2010.

[6] Measurement Systems Analysis-MSA, Fourth Edition, ISBN: 978-1-60-534211-5, Chrysler Group LLC, Ford Motor Company, General Motors Corporation, 2010.

STRESS AND STRENGTH ANALYSIS OF STEAM PIPE TO HEATING CONDENSER

Nenad Lorković, Marina Tevčić
B. sc. M.E. N. Lorković, University of Applied Sciences, Trg J. J. Strossmayera 9, Karlovac, Hrvatska
M. sc. Math. M. Tevčić, University of Applied Sciences, Trg J. J. Strossmayera 9, Karlovac, Hrvatska

ABSTRACT:

This paper presents stress and strength analysis of steam pipe which supplies heating condenser with the steam. Main purpose of the analysis is to confirm that installation of new steam pipe and heating condenser will not influence operating conditions of existing piping and equipment. Analysis has been performed in three major steps. First, as a pipe stress calculation according to ANSI/ASME B31.1 standard. This includes steady-state analysis for piping highest possible operating conditions and static earthquake calculation considering seismic concept valid for power plant location.
Furthermore, calculated loads on steam inlet nozzle of heating condenser have been evaluated and verified in accordance with the requirements of the technical documentation. As final, additional FEM calculation is performed for piping steady-state operating conditions and results are evaluated with criteria of Von Mises theory.

Keywords: air preheating, steam pipe to heating condenser, stresses, strength

1. INTRODUCTION

This paper presents stress and strength analysis based on pipe stress calculation [1] performed for steam pipe to heating condenser.
Heating condenser is a heat exchanger where water/glycol fluid is heated by steam. Water/glycol is than used in air preheater to warm up the inlet air. Main purpose of this heat transfer inside air preheater is anti-icing operation in cold operating conditions of gas turbine. The air preheater, as a heat exchanger, is main part of air intake system, located in gas turbine's air intake housing between the weather hoods and filter.
Schematic overview of main components of air intake system is presented in *Figure 1*.
Steam pipe and heating condenser are completely newly designed and installed on site. Steam is deducted from existing Low pressure bypass pipe. The main requirement of this implementation was not to disturb the working conditions and support concept of the existing Low pressure bypass.

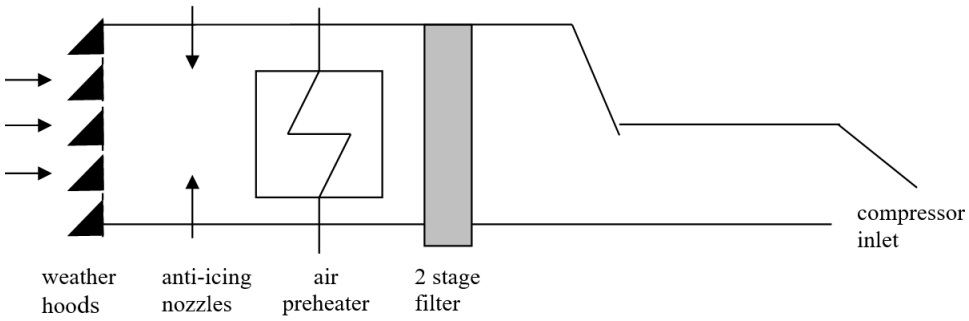


Figure 1: Schematic overview of air intake system [2]

2. CALCULATION MODEL AND REQUIREMENTS FOR PIPING DESIGN

Pipe stress analysis [1] is performed according to ANSI/ASME B31.1 standard [3] and using ROHR2 calculation program. ROHR2 is based on a finite element method and use beam finite elements for piping components.

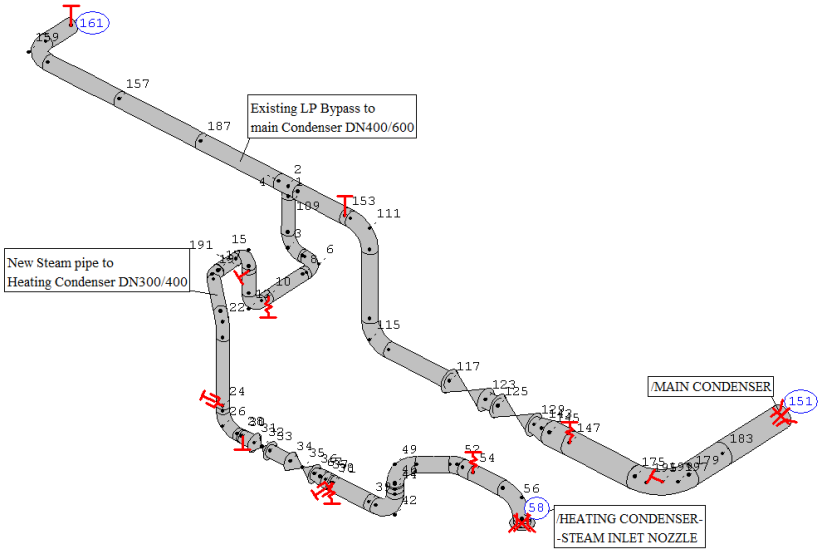


Figure 2: ROHR2 calculation model of new Steam to Heating condenser and existing LP Bypass

Calculation model, presented in *Figure 2*, is a result of several iterations that led to the fulfillment of the following requirements for piping design:

- New steam pipe and heating condenser are both installed inside power plant building in the area with other existing pipes and equipment. It was necessary to find out proper location of tie-in point to existing LP Bypass. New steam pipe is with LP Bypass connected with tee connection.

- Furthermore, location of Heating condenser was determined according to arrangement of existing steel structure which has to take over the weight of condenser.
- Working conditions and support concept of the existing Low pressure bypass must not be disturbed.
- Loads generated by thermal expansion of steam pipe must not be transferred to steam inlet nozzle of heating condenser. Allowable loads for steam inlet nozzle are specified by the manufacturer [4].
- All design documentation had to be submitted to Notified body for checking and approval.

3. STRESS ANALYSIS FOR OPERATING LOAD CASE

Operating load case is a superposition of two load cases, sustained load and thermal expansion. The highest pipe design parameters of 190 ^{0}C and 1.1 MPa are taken into account.
Existing LP Bypass is included in the calculation to check the influence of new steam pipe to existing pipes and vice versa. Calculation model for existing LP Bypass is created according to data from calculation of ‘’LP Steam & LP Bypass’’ system [5].

As it is presented in *Figure 3*, maximum stress utilization is 9.7 % at calculation node 2 which is located at the tee connection between new and existing pipe [1]. Value of 9.7 % is a ratio between the calculated and allowable stresses according to ASME B31.1 [3].

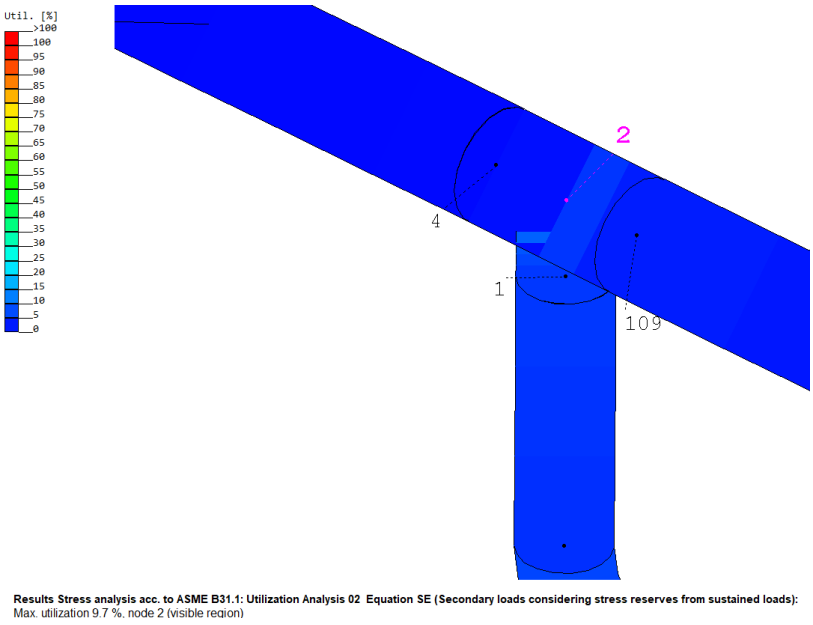


Figure 3: Stress utilization for ‘’Operating load case’’

Such low stress utilization proves that the new pipe is properly designed and does not influence operating conditions of existing system.

4. STRESS ANALYSIS FOR EARTHQUAKE LOAD CASE

Stress analysis of existing ''LP Steam & LP Bypass'' system [5] did not include calculation of stresses and loads due to earthquake. But, according to latest seismic concept valid for power plant location (country and region) [6], it is obligatory to comprise earthquake in the calculation of piping systems.

Values for the static earthquake acceleration, employed in calculation are [6]:

- 0.25 *g* (horizontal-directions X and Y)
- 0.18 *g* (vertical-direction Z),
  where *g* is acceleration of gravity (9.81 m/s^2).

Calculation is performed for the worst case when earthquake acts in all three directions simultaneously. It has to be noticed that the client did not allowed and accept any modifications on support concept of existing pipes. Despite the fact that calculation for LP bypass did not include earthquake loads.
This means that everything needed to prevent earthquake had to be done by support concept of new pipe.
As it is presented in *Figure 4*, maximum stress utilization for earthquake load case is 49% at calculation node 123 which is located on piping spool in between two valves on existing pipe [1].

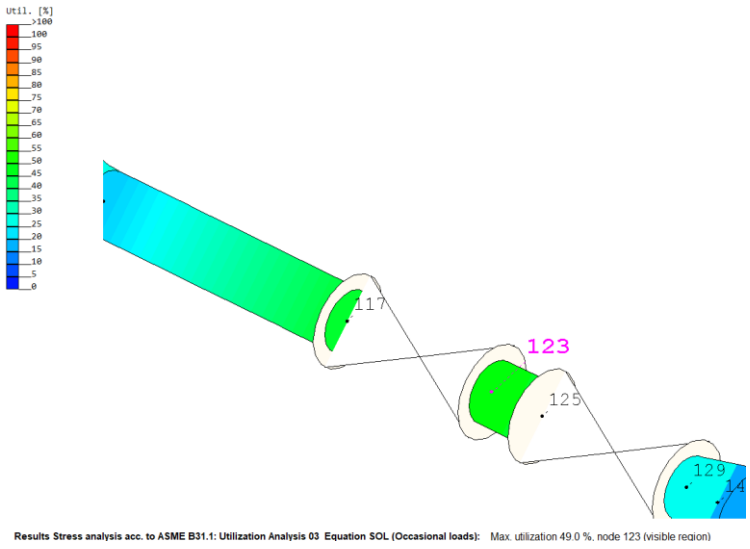


Figure 4: Stress utilization for ''Earthquake load case''

The conclusion is that the supports installed on the new pipe are sufficient to prevent earthquake on the new and existing pipes as well.

5. EVALUATION OF CALCULATED LOADS AT HEATING CONDENSER'S STEAM INLET NOZZLE

As it is already written in Chapter 2, one of requirement which had to be fulfilled, refers to calculated loads on steam inlet nozzle of heating condenser. Calculated forces and moments on steam inlet nozzle must not exceed allowable values specified in technical documentation for heating condenser [4]. Comparison of calculated and allowable loads is shown in Table 1.

Table 1: Comparison of calculated and allowable loads at heating condenser's steam inlet nozzle

	CALCULATED LOADS					
Load Cases	Fx (kN)	Fy (kN)	Fz (kN)	Mx (kNm)	My (kNm)	Mz (kNm)
Dead load	-0.386	0.115	-1.850	-0.669	-0.127	0.367
Operation	-7.483	-0.862	-0.292	0.463	-5.018	1.294
Earthquake X	0.765	-0.151	0.140	0.629	0.307	-0.345
Earthquake Y	1.437	0.549	-0.528	-1.040	1.246	-0.775
Earthquake Z	-0.621	0.010	1.485	0.634	-1.943	0.167
Extreme loads	-9.048	-1.411	-3.427	-1.887	-7.326	2.087
Hydrostatic test	-0.400	0.075	-2.128	-2.034	-0.212	-0.043
Allowable loads (kN)	**9.1**	**12.1**	**12.1**	**8**	**8**	**8**

All calculated loads, including extreme loads as the worst case, are below allowable limits.

6. STRENGTH VERIFICATION WITH FEM ANALYSIS

Stresses for operating load case, calculated according to ASME B31.1 standard, are presented in Chapter 2. Stress utilization of 9.7% shows that calculated stresses are much lower than allowable. Regardless of this very low stress utilization, additional FEM analysis [7] with Abaqus calculation program is performed for piping operating conditions. Under operating conditions is implied a superposition of two load cases, sustained load and thermal expansion. Calculation is performed as a steady-state analysis when piping system is exposed to highest possible design parameters of 190 ^{0}C and 1.1 MPa.

Equivalent stresses according to Von Mises theory are calculated and evaluated by comparing it with allowable stresses. Abaqus program is based on a finite element method and calculation model is created with 3D finite elements considering piping geometry, boundary conditions and support concept from Rohr2 calculation model. Nozzles of main and heating condensers are fixed points where all 6-DOF are blocked.

As it can be seen in *Figure 5*, maximum equivalent stress appears at tee connection between new steam pipe and existing LP Bypass pipe.

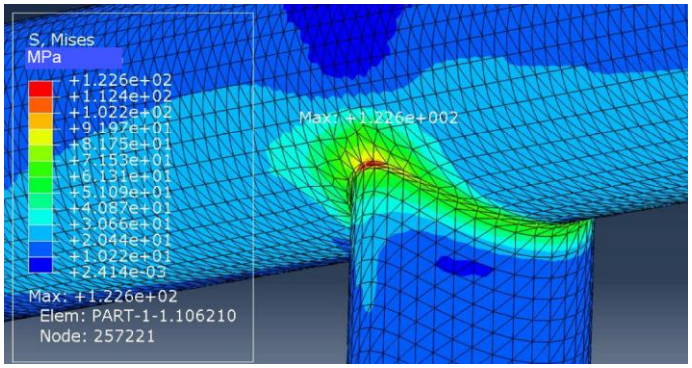


Figure 5: Maximum equivalent stresses according to Von Mises theory

Calculated Von Mises stress is evaluated as follows:

1.) Maximum calculated equivalent stresses using Von Mises theory [7]:

- $(\sigma_{eq})_{calc} = 122.6$ MPa - maximum equivalent calculated stresses at tee connection between new and existing pipes.

2.) Material properties for A106B at design temperature t = 190 ^{0}C [8]:

- $R_e = 208.1$ MPa - yield strength.

3.) Allowable stresses, safety factor, and comparison with calculated stresses [9]

- $\sigma_{all} = \frac{R_e}{S} = 138.7$ MPa,

where is: S=safety factor = 1.5.

The strength criterion is met because it is:

$$(\sigma_{eq})_{calc} = 122.6 \text{ MPa} < \sigma_{all} = 138.7 \text{ MPa}.$$

7. CONCLUSION

Steam pipe to Heating condenser, described in this article is a completely newly designed pipe with purpose for heating up water/glycol fluid inside heating condenser.
Stress and strength analysis is performed by applying two methods. First, as a pipe stress analysis in accordance with the criteria from ANSI/ASME B31.1 standard. Results for calculated stresses are significantly below allowable values specified in the standard. Second method was strength verification by calculating equivalent stresses according to Von Mises theory. Maximum equivalent calculated stress is lower than allowable value determined by the yield strength of piping material. Conclusion is that the results obtained for both methods are within permissible limits.
Furthermore, calculated forces and moments on heating condenser's steam inlet nozzle do not exceed allowable values specified in technical documentation.
With regard to all this facts, main goals and requirements for piping design have been achieved. New steam pipe is properly designed and working conditions, as well as support concept of the existing Low pressure bypass are not disturbed.

8. REFERENCES

[1] Lorković, N. (2013). Pipe Stress Analysis for Steam to Heating Condenser, Alstom Power, Karlovac, Croatia
[2] Air Intake Preheater (2008). Standard Operation Concept for Alstom's Gas Turbines, Alstom Power, Baden, Switzerland
[3] American Society of Mechanical Engineers (2014). ANSI/ASME Code for Pressure Piping B31.1
[4] Technical documentation for Heating condenser (2013). Calorifer company, Elgg, Switzerland
[5] Revesz, Z. (1997). Stress analysis for LP steam and LP Bypass, ABB Power Generation, Baden, Switzerland
[6] Norme Tecniche per le Construzioni-Normativa sismica (2008). Ministero delle Infrastrutture, Italy
[7] FEM analysis of Steam to Heating condenser (2013). Alstom Power, Baden, Switzerland
[8] American Society of Mechanical Engineers (2007). ASME Boiler & Pressure Vessel Code, Section II, Part D, Properties Materials
[9] EN 13480-3 (2012). Metallic industrial piping - Part 3: Design and calculation, European Committee for Standardization

COMPARISON BETWEEN CAD/CAM PROGRAMMING WITH ESPRIT AND MANUAL PROGRAMMING OF A SPECIFIC WORKPIECE WITH MILLING

Dženan Bajrić[1], Said Pašalić[2]
[1]University of Bihac, Faculty of Technical Engineering Bihac, dzenanbajric9@gmail.com
[2]University of Bihac, Faculty of Technical Engineering Bihac, said.pasalic@live.com

ABSTRACT:

The use of CAD/CAM software like Esprit makes it the processing of NC programme faster, easier and safer in comparison to the manual programming of CNC machines. This paper demonstrates a big difference between manual and semiautomatic (CAD/CAM in Esprit) programming through the processing of a same working part. Esprit is used in different types of industries due to its fast and easy programming and its very good process simulation. That simulation, although still virtual, shows the real movement of the tool and other moving elements; in case of collision it stops the process. Manual programming in its developed version also facilitates easier programming and enables simulation, but not in the same measure as Esprit.

Keywords: Milling, milling machine, contour, shift, number of turns, type of material, tool, programming, NC programme, G code, profile, corrections, working part

1. INTRODUCTION

CAD/CAM software enable a computer based construction of parts and assemblies or complex products respectively. CAD/CAM software find their use in almost all industrial branches. A computer based designed product (CAD) provides engineers with great possibilities during the designing of a product. Computer supported production (CAM) enables work organisation, technology development, and programmed definition of a specific product. The basis for the use of CAD/CAM software is the 3D model of products which development and construction along with all its characteristics is defined in CAD software. After the 3D model is created, it becomes the base for following steps in the process, which is the use of CAD software i.e the part's virtual processing from the initial parts material. After the completed process of programming of the working part the NC program is generated which is written in G code. This is all transferred to the computer of the CNC machine, that is into its controlling unit when the operator adjusts the machine, tool, and processing of the working part.

2. SOFTWARE FOR CAD/CAM PROGRAMMING

Nowadays, almost all more complex software packages like CATIA, SolidWorks, AutoDesk, PTC, Siemens and SolidEdge possess the environment which are intended for the virtual processing of

working parts. The most used softwares are Solid CAM and ESPRIT, because they enable the processing and simulation in the fastest and easiest way. By using any of those softwares [1] during the programming of working parts processing, it soul be followed by a programming algorithm which is universal for all processing types. The programming algorithm entails the following:

- It is necessary to analyze the technical documentation of the part, and the accompanying documentation if any,
- Modeling and construction of a part, if we do not already have a modeled part,
- Defining the processing technology (whether processing by milling, turning, laser cutting, bending, etc. is required.),
- Selection of tools and processing mode parameters,
- Development of processing technology, ie programming,
- Display of processing simulation and execution of necessary corrections and changes,
- G code generation and technological documentation of the part.

Regardless of which programming software is used, it is necessary to adhere to the specified algorithm when programming due to the speed, accuracy and quality of technology.

3. MANUAL PROGRAMMING

Classic manual programming can almost not be compared to CAD/CAM software programming. Manual programming is used in production processes with parts of simpler geometry. During manula programming it is important for the programmer to lead the tool along the characteristic dots of processing following the defined contour which is to be processed. It is also important for the programmer to control the processing modes, type of material, machine's stability, roughness of the treated surface, and the quality of the tools used. Some disadvantages of manual programming, which were observed in practice are as follows:

- The use of manual programming in production with parts of more complicated geometry and a large number of different CNC machines creates a bottleneck in production,
- Every machine requires a qualified programmer,
- The process of creating technology is several times longer than in computer programming,
- Errors are possible, especially with geometrically complicated parts.

In addition to classic manual programming, the development of technology also leads to advanced manual programming. A step further in this is when the programming menu system is installed on an external computer or on the computer control unit of a CNC machine. This makes the work easier for the programmer, and the operator can also perform programming directly on the CNC machine. Advanced manual programming [2] depends on the type of control unit used on the machine. Therefore, the method of programming is different for different machine manufacturers. With advanced manual programming, the programmer has the ability to simulate and review the process and detect possible errors. Advanced models such as SINUMERIK have the ability to insert STEP models into the control unit, thus bringing advanced manual programming to almost the same level as computer programming. The only disadvantage is that the machine stands still while the programming process is being performed. Therefore, for more complicated pieces, an NC program should be created on an external computer and entered into the computer of the CNC machine. Then there is no waiting and standing machine.

4. PROGRAMMING ON THE COMPUTER BY USING THE SOFTWARE ESPRIT

Computer programming involves the automatic creation of NC programs in G code based on defined contours, operations, tools and parameters selected by the programmer in relation to the shape of the part, the dimensions of the starting piece and the type of material. Thus, in computer programming, the NC program in G code is automatically generated in relation to the 3D geometry of the product model. Figure 1 shows a drawing of a workpiece selected for comparison of manual and CAD/CAM programming (ESPRIT software) through its fabrication on a CNC milling machine.

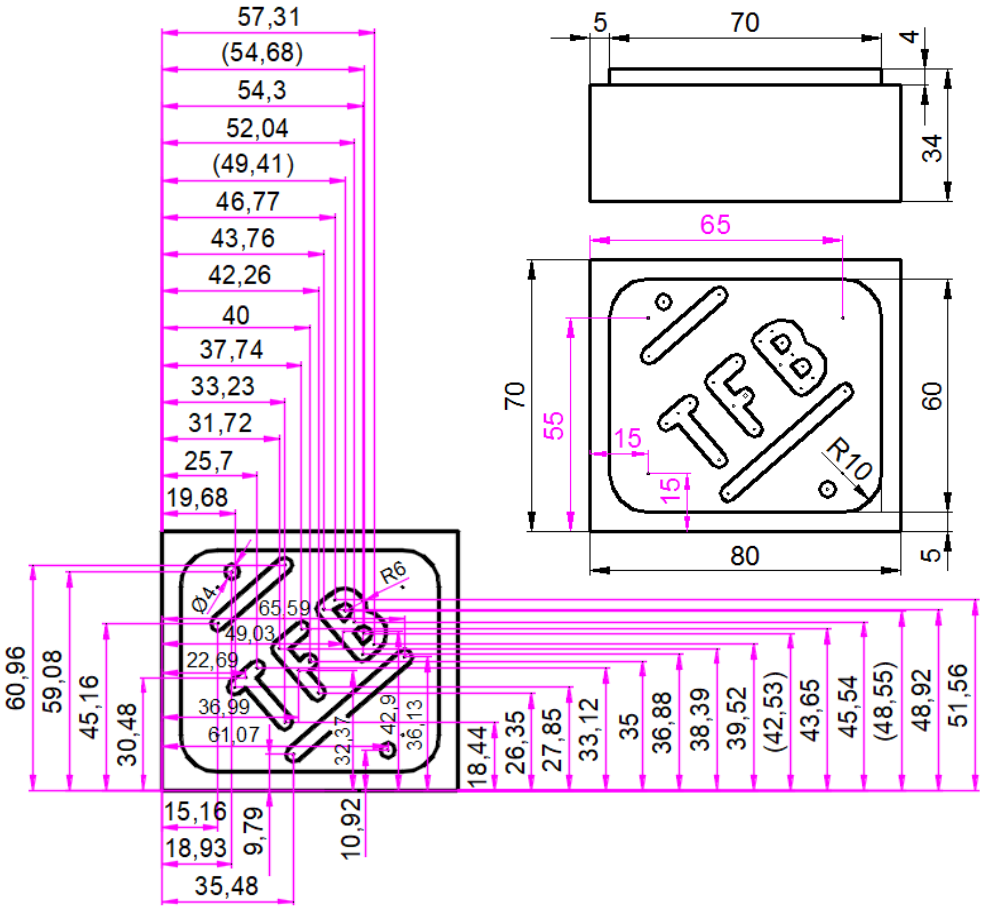


Figure 1: Drawing of a workpiece

After the drawing is defined, it is necessary to start modeling, ie making a 3D model of the workpiece or part. SolidWorks software was used to model the part. In addition to the fact that the geometry of the shown part is relatively simple, manual programming of its production is very complicated and time consuming.Modeling the part itself in SolidWorks takes a very short time with very little possibility of error and the possibility of control and repair after modeling. The 3D model of the part is shown in Figure 2.It is necessary, following the algorithm shown earlier, to study the available drawing of the part, after which the SolidWorks modeling software should be started. First it is needed to select the drawing plane of the Top plane in the FeatureManager Design Tree window, run the Sketch menu and draw a sketch that follows the contours of the part of the displayed dimensions. After this, in the Features menu, the Extruded Boss/Base command is used to add a third dimension to a part, i.e. 30 mm thick. After this, it is necessary to make a sketch in the shape of a rectangle 70x60 mm with rounded corners with a radius of 10 mm on the upper surface and extrude it 4 mm. Thus, the border of the part was formed, as well as the surface on which the inscription TFB, holes and pockets are placed.The last step in modeling this part is to define a sketch on the mentioned upper surface with the inscription TFB, holes and pockets. Since we use the Hole Wizard option for holes, it is not necessary to create a sketch, because we use this option as one feature on the workpiece (Feature) with all the possibilities for

defining a hole.After the holes are defined and modeled by the mentioned command, it is necessary to define a sketch with the inscription TFB, for which the TEXT option is used, which can define the font, font size, space between letters due to production, and the position of the inscription. In this case, it is necessary to draw a line parallel to the left diagonal that will follow the inscription. In addition to the inscription, pockets are also defined in the same sketch, because they are the same depth of 4 mm as the inscription. What is very important to do is to round the edges of the letters.

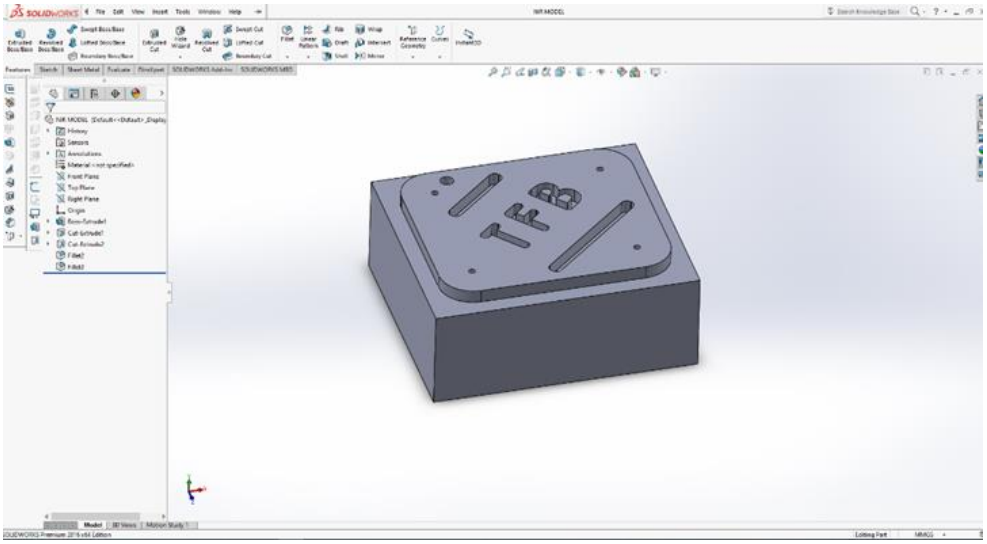


Figure 2: Created 3D model of a workpeice in SolidWorks

Once the part is modeled, it is necessary to select the appropriate technology to process it. Due to its specificity, the best and most cost-effective option for making this part is three-axis milling. Since the material is not defined, an aluminum alloy marked EN AW 5083 (AlMg4.5Mn0.7) is used due to its mechanical properties and easy machinability. After defining the material and selecting the CNC machine for work, it is necessary to start programming the production of the part. The ESPRIT software package with post-processors of the CNC machine HASS VF2 SS with its tool base was used for programming. Figure 3 shows the interface of ESPRIT software with the uploaded or introduced model. When initializing ESPRIT, it is necessary to select the appropriate postprocessor of the CNC machine on which the processing will be performed. In this case, a postprocessor is selected for three-axis milling with a work bench on which a creak is placed in which the workpiece preparation is attached. After the selected postprocessor, it is necessary to upload the modeled part and position it in relation to the zero point of the machine. It should also be noted that drawing and modeling a workpiece can also be done directly in ESPRIT, similar to drawing in AutoCAD or TOPS. Modeling in ESPRIT is slower than modeling in Solid Works. That is why the ready-made model is introduced-uploaded into ESPRIT.
When uploading the model into the ESPRIT environment, the zero piece is placed in its left front corner, which is not convenient for measurement. Therefore, the zero of the workpiece is placed in the middle of its upper surface along the x and y axes, and the z axis is vertical to that surface, Figure 3. After the positioning of the part is completed, it is necessary to define the preparation or initial material for making the part. In this case, the initial piece contour corresponds to the finished size of the piece 80x70x34. The next step is to select the appropriate tools from the database. Given the wide tool base, the necessary tools are selected, namely a fine spindle milling cutter with a diameter of 14 mm for

external contour edging, a fine spindle milling cutter with a diameter of 2 mm for processing inscriptions and longitudinal pockets and drills with a diameter of 3 and 4 mm for drilling holes.

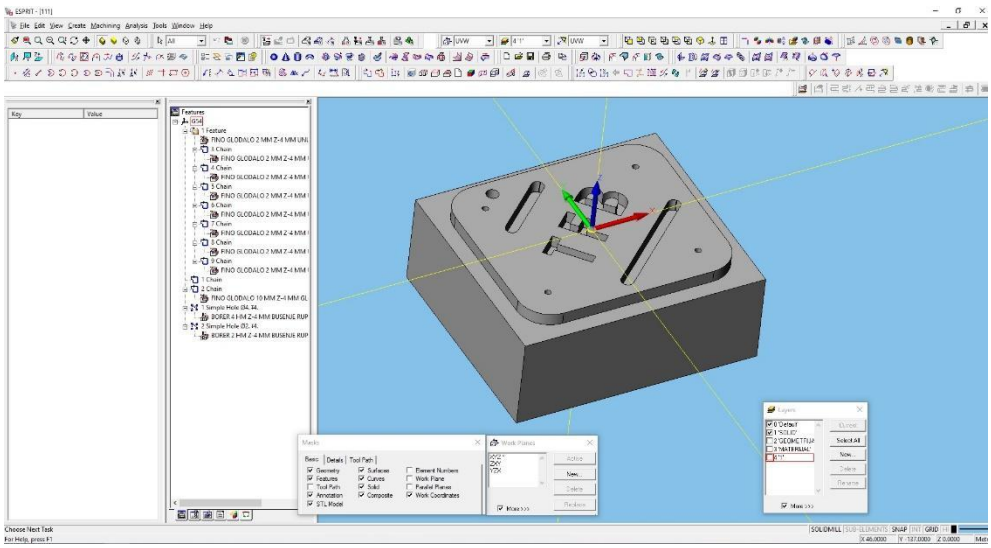


Figure 3: Model's interface in the ESPRIT software package

All these steps are only a preparation for programming, only afterwards the programming process starts in ESPRIT. First, in the Features [3] window, you need to define all toolpaths (chains) by characteristic parts of the workpiece (features). Defining tool paths (chain) avoids the tedious writing and calculation of tool movements, which is required for manual programming. When doing so, it is necessary to pay attention to the direction of the chain, the input and output of the tool, because this defines the movement of the tool.

In order to define the chains on which the tools will move easier, it is necessary to make a wired model from a solid model where chains are simply defined.

For machining the external gutter-balcony, it is best to use the Contouring operation in two passes due to the durability of the machining tool. The second operation is hole drilling, which is defined by the Holes option, and only with this option is it possible to apply the Drilling operation to drill holes. To process labels and pockets, it is also necessary to create chains and use the Contouring option, but with a spiral movement of the cutter which deepens with the Spiraling command. With this, the programming process in ESPRIT for this workpiece would be completed.

After the completed programming, it is necessary to run a processing simulation and notice any deficiencies and collisions and correct them. Figure 4 shows a simulated virtual model with indicated environments.

Figure 4 shows the different types of environments used in programming. The most important environment is the operation tree marked in black. The operations tree displays all operations systematically and, if additional corrections or corrections are required, is performed directly in it. The position tree is shown on the left, in red. When simulating the process, the position of the tip of the tool blade, i.e. the axis of the cutter or drill, is shown, and during programming, manipulation with chains is possible, which facilitates programming. Other auxiliary bars are used for easier and more accessible display during programming and rotation of the coordinate system in four-axis or five-axis milling.

In addition to the listed bars and options, without which it would not be possible to program and define creation operations, we must not forget the toolbar located in the lower right corner of the window,

which allows filtering features. Activating and deactivating individual options on that bar (SUB-ELEMENTS, SNAP, INT, GRID, HI, COLORS) enables coloring and individual selection of individual surfaces, activation of points when drawing object geometry, possibility of object translation, and the like.

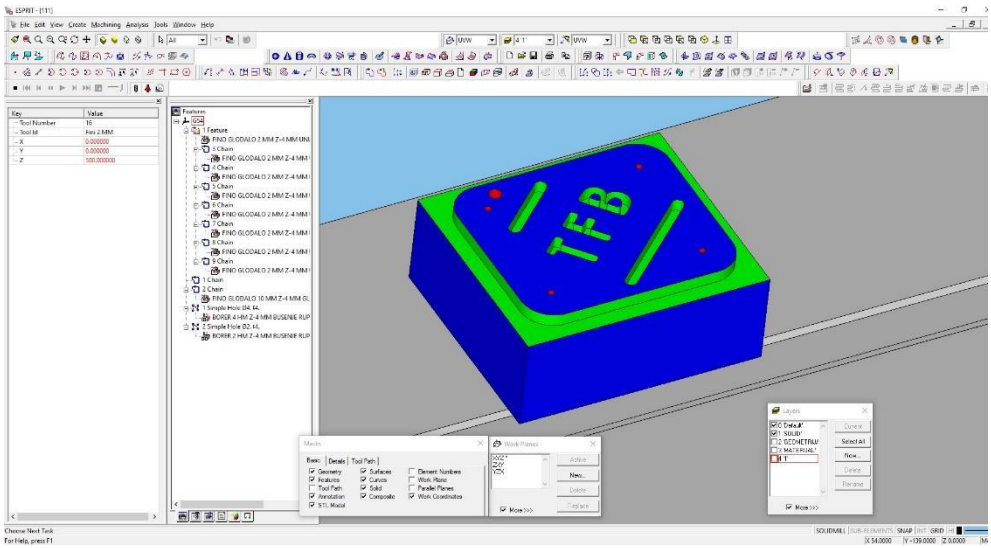


Figure 4: Display of a simulated model with the appropriate environment

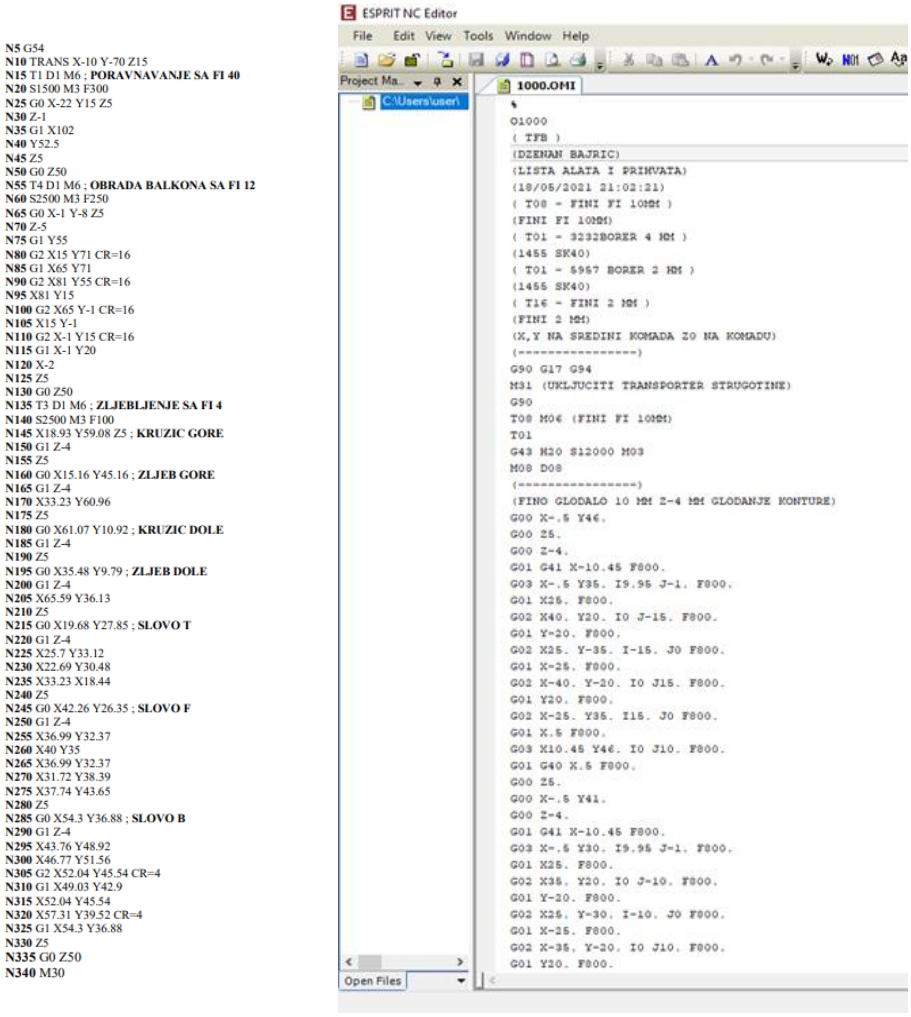
If everything is processed properly during the simulation, the NC program is printed in G code by pressing the F9 key on the keyboard or such as: Machining-Common Machining-NC Code or as: File-NC Code. Finally, with the help of USB or some other way of transferring data, the G is transferred to the computer of the CNC machine with the created NC program.

5. COMPARISON BETWEEN MANUAL AND CAD/CAM PROGRAMMING

Unlike CAD/CAM programming, manual programming requires a model drawing with exact coordinates due to the tool path. The NC program in G code is required to be written line by line (sentence by sentence) directly on the machine or on an external computer and then transfer it to the machine. For the part shown in Figure 1, the manual programming process is very demanding and laborious. The handwritten NC program in the G code shown in Figure 5 forms the contours like the program made in ESPRIT, but the tool stability and the quality of the machined surface is worse than in CAD/CAM programming. Thespirlaing tool's movement for processing texts and pockets is very difficult to write by hand. A handwritten NC program in G code dictates that the tool enters directly into the material and performs processing following the contour. This significantly reduces the durability of the tool and the quality of the machined surface, and greatly increases the possibility of tool breakage and the formation of scrap parts.

For modeling and programming the production of a part using CAD/CAM software, it takes 30-40 minutes of active work to start the production on a CNC machine, while manual programming takes 4-5 hours of active work. If advanced manual programming is performed, the programmer has the option of running the simulation before starting the machine, which represents a great advantage over classic manual programming. Newer models of CNC machines have a graphical representation of the tool's

movement, which somewhat facilitates the work of the programmer who writes the program manually. However, the graphics shown here are quite vague, especially for more complex products, and cannot be compared to the simulations shown in CAM software.



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N5 G54
N10 TRANS X-10 Y-70 Z15
N15 T1 D1 M6 ; PORAVNAVANJE SA FI 40
N20 S1500 M3 F300
N25 G0 X-22 Y15 Z5
N30 Z-1
N35 G1 X102
N40 Y52.5
N45 Z5
N50 G0 Z50
N55 T4 D1 M6 ; OBRADA BALKONA SA FI 12
N60 S2500 M3 F250
N65 G0 X-1 Y-8 Z5
N70 Z-5
N75 G1 Y55
N80 G2 X15 Y71 CR=16
N85 G1 X65 Y71
N90 G2 X81 Y55 CR=16
N95 X81 Y15
N100 G2 X65 Y-1 CR=16
N105 X15 Y-1
N110 G2 X-1 Y15 CR=16
N115 G1 X-1 Y20
N120 X-2
N125 Z5
N130 G0 Z50
N135 T3 D1 M6 ; ZLJEBLJENJE SA FI 4
N140 S2500 M3 F100
N145 X18.93 Y59.08 Z5 ; KRUZIC GORE
N150 G1 Z-4
N155 Z5
N160 G0 X15.16 Y45.16 ; ZLJEB GORE
N165 G1 Z-4
N170 X33.23 Y60.96
N175 Z5
N180 G0 X61.07 Y10.92 ; KRUZIC DOLE
N185 G1 Z-4
N190 Z5
N195 G0 X35.48 Y9.79 ; ZLJEB DOLE
N200 G1 Z-4
N205 X65.59 Y36.13
N210 Z5
N215 G0 X19.68 Y27.85 ; SLOVO T
N220 G1 Z-4
N225 X25.7 Y33.12
N230 X22.69 Y30.48
N235 X33.23 X18.44
N240 Z5
N245 G0 X42.26 Y26.35 ; SLOVO F
N250 G1 Z-4
N255 X36.99 Y32.37
N260 X40 Y35
N265 X36.99 Y32.37
N270 X31.72 Y38.39
N275 X37.74 Y43.65
N280 Z5
N285 G0 X54.3 Y36.88 ; SLOVO B
N290 G1 Z-4
N295 X43.76 Y48.92
N300 X46.77 Y51.56
N305 G2 X52.04 Y45.54 CR=4
N310 G1 X49.03 Y42.9
N315 X52.04 Y45.54
N320 X57.31 Y39.52 CR=4
N325 G1 X54.3 Y36.88
N330 Z5
N335 G0 Z50
N340 M30
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Figure 5. Comparison between manual (left) and ESPRIT's G code (right) [4]

The advantage of manual programming over CAD/CAM programming is the possibility of fast programming of simple objects where, for example, only face machining, hole drilling or longitudinal scraping is required. Another advantage of manual programming is the cost of equipment and software. By applying manual programming, it is enough to have an experienced programmer who can solve the required tasks, while with CAD/CAM programming, the price of software and operating license is very high. In addition, it is necessary to provide adequate work equipment that can produce the most demanding parts with its quality. And in this case, besides everything, it is necessary to have a quality programmer who is sufficiently familiar with CAD/CAM software. Figure 5 shows the NC programs

in G code written by manual-left and CAD/CAM-Esprit programming-right for the workpiece shown in Figure 1.

Figure 5 above shows that the manual G code has only 68 lines i.e. sentences (from N5 to N340) and the Esprit G code is only partially shown as it has 1498 lines. Using manual G code the programmer enters everything necessary according to the strict rules of program syntax and semantics, which means the coordinates of the geometry and all the paths of the cutting tool to the main G functions, auxiliary operations to additional M functions and technological data. In order to make the programmer's task easier, it is important to draw the floor plan of the piece in a precise way. For example, in AutoCAD with all the coordinates in the x and y axes. Figure 1 shows a multitude of these elevations and it is a great effort to manually enter all these numbers which are also decimal. Mistakes must not be made. The programmer must be well acquainted with technological processes as well as raw materials. Advanced manual programming frequently uses cycles and processing variants, but it additionally burdens the programmer, because the programmer needs to have a very deep understanding of the process which entails numerous rules. It stands true that this advanced manual programming is closer to semi-automatic CAD/CAM programming, but it will never reach it.Similarly, semi-automatic CAD /CAM programming will never reach automatic programming, ie computer-aided process design (CAPP). Nowadays, factories own many CNC machines that work on manual programming. That is why manual developers are still needed, because, among other things, they are the best technologists.

The CNC machine programmer in ESPRIT is not strained as a manual programmer. Once he has designed and modeled a workpiece well in SolidWorks, he no longer takes into account the coordinates of individual points in the object. Thanks to the Windows environment, this developer with a mouse click marks the path of the tool (Chain) within each "Features". He will then prescribe the necessary tools for machining, the type of machining, enter the raw materials for machining, and the choice of machining parameters (cutting speed and feed rate) can be left to the CNC machine itself. Based on all this, ESPRIT will do the NC program in G code with all the main and auxiliary functions and technological data without anyone's help, i.e. automatically. It is true that ESPRIT's NC program in G code is incomparably larger than manual, but that does not mean that programming in ESPRIT is more difficult than manual, because ESPRIT's G code is not written by a programmer.It can be seen that the ultimate goal of manual and semi-automatic programming is to create an NC program in symbolic G code, because it is easy to translate into a machine language that the CNC machine computer only understands.Figure 5 shows that the G code written in ESPRIT is more extensive and detailed than the G code written by hand. In addition to the classic G code, the program automatically throws out a list of tools along with the name of the piece and the name of the programmer. In addition, before the start of each operation, the operator sees a comment describing the method of creation and any warnings if necessary. The truth is, even in handwritten G code, something can be written, highlighted, noted, but all this must be entered directly into the G code by the programmer, and not automatically. During corrections, which are almost always necessary when setting up the machine, the possibility of correction is provided to do directly in the program with the addition of comments where it is much easier for operators to copy a part of the G code and thus introduce additional passages due to production quality and tool's durability. The software-printed G code enables better visibility to the operator and easier detection of possible programming errors, thus preventing collisions or tool breakage. The software programming mode achieves the highest cost-effectiveness in small series and individual production where the conventional programming mode cannot be competitive due to the long programming process and the large number of defective parts that occur when setting up the machine.

In classical manual programming, it is very difficult to write cycles such as spiral tool movement, table rotation, simultaneous milling or 3D milling where it is necessary to introduce I and J parameters that can only be calculated by a computer. Some of these operations can be performed with advanced manual programming, because the tool's movement, like everything else, is controlled by the control unit, i.e. the computer of the CNC machine. However, this is easier done in ESPRIT.

6. CONCLUSION

In this paper, a comparison is made on the example of making a workpiece on a CNC milling machine using manual and semi-automatic programming. These two programming paths rest on different ones' basics, and their goal is the same: to create an NC program in G code, because that code is easy to recode in a binary machine language on which each computer bases its work.
Manual programming is the direct writing of NC programs according to strict rules, directly in G code. Nowadays, advanced manual programming has been developed, for example SINUMERIK, but everything is still entered manually in the computer control unit of the CNC machine. All this can be entered on an external computer that has the SINUMERIK program, but again manually, and then transferred in electronic form to a CNC machine. When the NC program in the manual G code is transferred to the CNC machine, then it has meaning and after it is activated, it commands the control unit what to do when and how. In doing so, the CNC machine calculates the paths for the tool's movement following the selected main functions (G0, G1, G2, G3) as well as other necessary things. A distinction should be made between the programming of NC machines with punched cards, which do not include a computer, from the manual programming of CNC machines that have a computer. In manual programming, everything is left to the programmer, so he must know the technological-processing processes, CNC machine, cutting parameters, machinability of raw materials, tools, good handling of the computer and control unit, and strict rules for writing NC programs in G code. It can be stated that these programmers are technologists in their truest sense of the word..
It is enough to look at the set of elevations of the workpiece in Figure 1, which elevation numbers should be entered without error in the G code, and understand that it is very challenging. That had to be somehow avoided. This was successfully solved by CAD/CAM programming. Semi-automatic programming of the so-called CAD/CAM programming, performed with ESPRIT software, is based on an electronic work piece created by one of the CADs, e.g. in SolidWorks or in ESPRIT itself. When CAM, i.e. programming, is started in ESPRIT, it takes into account the workpiece model as wired and not as solid. These conditional wires are in fact the edges of the contact surfaces of the workpiece. These edges can be straight and curved lines, circles, ellipses, arcs, squares, rectangles, etc.It is on these wires that paths (chains) are formed. There can be various holes, grooves, pockets, protrusions, threads, etc. per workpiece. These are the characteristic parts of the workpiece and are called Features. Each Feature has its own surfaces or edges, i.e. wires. There is the same amount of Features as chains. These chains are made by clicking the mouse on the path, i.e. the wire, which is very simple and not laborious. After this, the tools are defined. In the end, chains and tools are connected into one whole, i.e. the processing technology is prescribed. The type of raw material must also be entered, in order for the software to determine the processing modes itself. It can be difficult to fill in a multitude of tables, but any mistake can be corrected quickly. However, it is necessary to learn all of it and practice it. Finally, the NC program can be printed in G code, which includes everything that was written in the tables.
It can be stated that CAD/CAM programming is better than manual because it is faster, easier and safer. It frees the programmer of many things, which the programmer simply does not even have to know, because the software does all those things. Manual advanced programming is very close to CAD/CAM programming, but cannot achieve it in simplicity, speed and precision. However, there are still plenty of CNC machines that work on manual programming, so there must be manual programmers as well. It is not easy for one programmer to switch from manual to CAD/CAM programming, and it is even more difficult to switch in the opposite direction.

7. REFERENCES

[1] Korčij S. (2016): CAD/CAM, Zagreb
[2] Blažević Z. (2004): Programiranje CNC tokarilice i glodalice, Virovitica
[3] DP Technology Corp (2009): Get Started with ESPRIT 2009, Camarillo, California-USA
[4] Žapčević S., Pašalić S. (2015): Prilog, Tehnički fakultet Bihać

RISK ASSESSMENT IN COLLABORATIVE ROBOTICS

Samir Vojić
University of Bihać, samir.vojic@unbi.ba

ABSTRACT:

A new roboat has appeared in the industry, called a "collaborative robot". The advent of these robots is changing our perception of the idea of robots and people sharing a workspace. The application of a robot that works safely together with humans can improve the production flow, while at the same time enabling the automation of new processes. As this type of robot is becoming increasingly popular and is sold as safe on the market, it is important to recognize the significant safety issues that arise with the introduction of these types of robots.

Keywords: Collaborative robotics, cobots, risk assessment

1. INTRODUCTION

From the beginning of their application, robots are made to be powerful and durable. They are designed to perform difficult tasks and it is not good to find yourself in the path of a robot when it is moving or performing programmed tasks because human injuries can occur. Collaboration robots are now designed to work together with humans without any fence.
With all these new robots, technologies and different standards related to robotics, safety is very important when using robots. There is a certain very low level of risk when the robot is in the same environment with a human. This level is set by various parameters related to the severity and likelihood of injury to a person. The robotic system and its environment must meet certain levels of security, before it can be considered safe enough to cooperate [1].
The literal definition of risk assessment is: Identification, assessment and assessing the levels of risk involved in the situation, comparing them with standards, and determining an acceptable level of risk.
In robotics, risk assessment is used to assess potential risks and mitigate them in order to achieve an acceptable level of the potential risk of harm to humans during the operation of a robotic system.
To comply with the ISO standard, all machines must pass a risk assessment to make sure it is safe to use. Some devices have already been approved by their manufacturers or a third party, which simplifies the risk assessment process because the safety level of certain parts, such as robot drives, does not have to be checked [8].
Even if the individual components and software of the robot are certified, this does not mean that the robot is safe in relation to the work environment. This is particularly the case in industrial applications where the use is so diverse that it is impossible for a parts manufacturer to approve any given procedure. This is where the risk assessment comes in. Another way to look at this is to evaluate each industrial application as a whole, not each device separately.

If we take the example of a sharp part or a knife manipulated by a certified robot, it does not mean that the application is safe, even if each part is safe in itself [2].

2. THE RISK ASSESSMENT PROCESS

Since most devices used in robotic stations already have a default level of performance, the risk assessment for the end user or integrator mainly relates to the application itself. An overview of the risk assessment process is given in the following diagram [6].

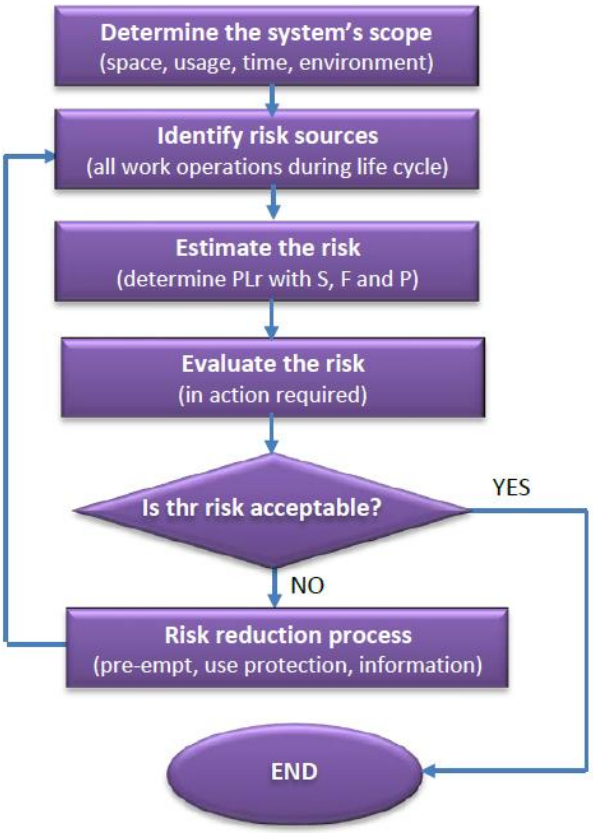


Figure 1: Following diagram of the risk assessment process

This part of the risk assessment describes the context of using the machine. Where will the robot be used? What tools will be used? What items will be part of the operation? Data such as the maximum speed and acceleration of the robot, the effective mass (load capacity of the robot), the mass of the parts, etc. must also be provided. This provides all the necessary information needed further in the risk assessment [9].

All operations involving any hazard should then be identified. These operations involve not only the operation of the robot but everything from the moment the robot is delivered from the truck to the moment it is turned off. This part of the analysis might seem a little exaggerated, but it can sometimes be underestimated. Thus, the risk assessment will analyze the different movements and actions of the robot during its lifetime and simply divide each operation for further analysis. This process is called task-based risk assessment [3].

From the observations seen during the risk assessment analysis, the risk of the given proposals should be ranked. There are different ways to monitor or assess risk.

The risk is assessed using the Rating Level Rating (PLr) nomenclature. In this analysis, they use three different parameters: the severity of the injury (S), the frequency of exposure to the hazard (F), and the possibility of avoiding the hazard (P).

The basic way of risk assessment would be to assess each parameter and go through the risk assessment tree to see the level of risk. In the risk assessment tree, the upper case represents the lowest risk and the lower the highest risk [6].

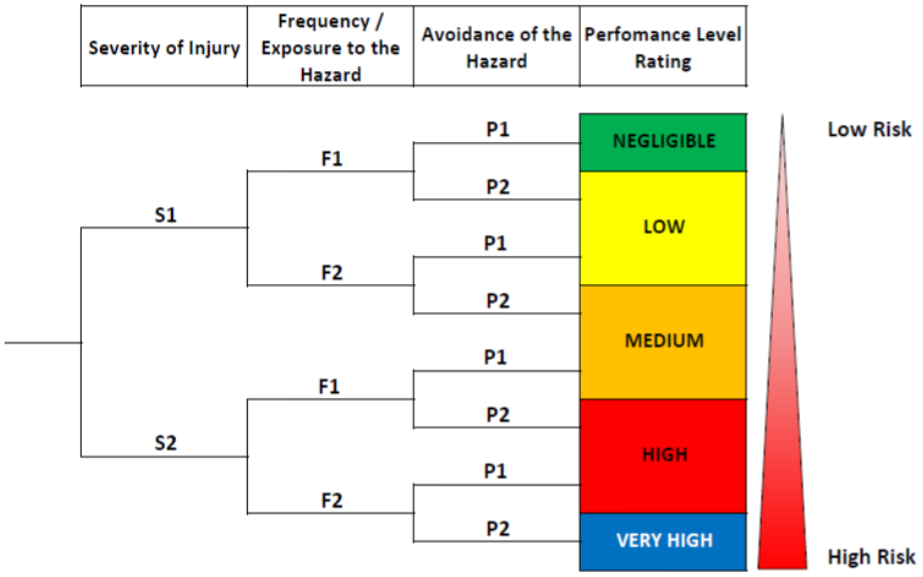


Figure 2: The risk evaluation tree

To quantify the PLr, the following parameters have to be evaluated.

S: Severity of injury
- S1: Slight (normal reversible injury)
- S2: Serious (normally irreversible injury or death)

F: Frequency and/or exposure to hazard
- F1: Seldom to less often and/or exposure time is short
- F2: Frequent to continuous and/or exposure time is long

P: Possibility of avoiding hazard or limiting harm
P1: Possible under specific conditions
P2: Scarcely possible

Let the nomenclature divide the parameters into three or more different intensities instead of two. This gives a more accurate risk assessment. In either case, the goal is to determine if the risk is too great for the robotic cell, leading to the next risk assessment step.
What actions are needed to reduce the risk?
If a station or application is judged to be at high risk (PLr = high), it must be ensured that the security features that will provide this application have a performance level equal to or greater than d (PL ≥ d). In this case d or e [6].

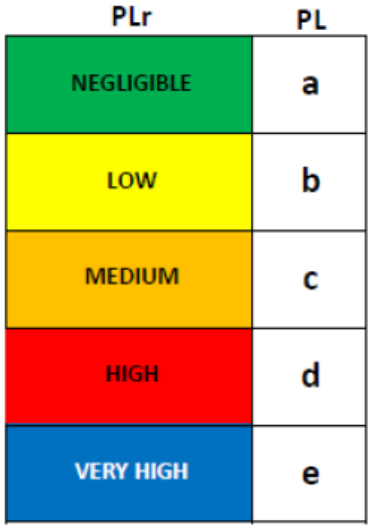


Figure 3: Evaluate risk

In most cases, you need to be in the category from lower to negligible to make sure employees are safe. If the assessment is in this category, then the assessment process is complete. If not, further steps are needed. If the risk assessment yields a potentially high risk, it is necessary to focus on those risks and reduce or eliminate them.
As the risks are reduced, it is necessary to go back to the risk identification chain and re-complete the whole process to make sure that the risk that has just been reduced does not create a new risk.
The risk reduction process is repetitive and should be performed very carefully considering and reviewing any potential risk as it returns down the chain [4].

3. ASPECTS OF HUMAN ROBOT COLLABORATION

ISO / TS 15066 defines safety standards for cobots emphasizing four different aspects of human-robot collaboration. The distance the robot will travel before a complete stopping, the allowable speed that translates directly into the force and pressure that can be applied to the human before he is inflicted with pain and/or injury [3].

Distance Before a Complete Stop
This parameter is used in speed and stop control for collaborative mode. TS provides a complete calculation of the distance (and time) required to stop the robot. This parameter must be set and approved to limit the speed of the robot if it works together with humans. The calculation includes different speeds (robot and human) and the distance that separates them, as well as several other parameters that allow the calculation of stop time, distance and speed required for application.

Speed Conditions
This part of the TS is typically used for safety-controlled stops. This part of the risk assessment lists the different conditions under which the robot can be started and at what speeds, as well as when it should be stopped. Under certain conditions, the robot can move at full speed, and in other situations, the robot should slow down or stop completely.

Force
Since the collaboration of humans and robots involves their contact, it is important to have information about the limit that a robot can reach without injuring humans. Industrial robots, even when used in the joint operation, should never come into contact with humans at normal speed.

Pressure
Pressure is the applied force divided by the surface of the part that exerts pressure. Since the robot can create certain forces on a human, the pressure area may need to be improved to ensure that the robot does not exceed acceptable pressure levels. It is also possible to improve or adjust the surface to ensure that no excessive pressure is applied.

4. CONCLUSION

The risk assessment process is designed to protect workers using industrial machinery. In robotics, it has been implemented to ensure that users of robotic cells are safe while performing tasks with the robot and its accessories. Risk assessments are also conducted to standardize robot integration and to ensure that the robot cell reaches a certain level of safety. The risk assessment process should also be carried out in accordance with the laws and regulations applicable where the robotic cell is integrated. Even if manufacturers of robots and robotic devices have established safety requirements (PL = d category 3) for their devices, there is still a large part of the risk assessment process that must be done taking into account the application and the environment itself. Risk assessments must be taken very seriously because there is direct or close contact between robots and humans.

5. REFERENCES

[1] ISO. ISO/TS 15066:2016 Robots and robotic devices – Collaborative robots. International Organization for Standardization, Geneva, Switzer- land, February 2016.
[2] S. Robla-Gomez, V. M. Becerra, J. R. LLata, E. Gonzlez-Sarabia,C. Torre-Ferrero, and J. Perez-Oria. Working together: A review on safe human-robot collaboration in industrial environments. IEEE Access, PP(99):1–1, 2017.
[3] ISO. ISO 10218-1 (2011): Robots and robotic devices - Safety require- ments for industrial robots - Part 1: Robots. International Organization for Standardization, Switzerland, July 2011.
[4] ISO. ISO 10218-2 (2011): Robots and robotic devices - Safety require- ments for industrial robots - Part 2: Robot systems and integration. International Organization for Standardization, Switzerland, July 2011.
[5] ISO. ISO 12100:2010 (2010) Safety of machinery: General principles for design. Risk assessment and risk reduction.
[6] Fanny Platbrood and Otto Gornemann. Safe robotics - safety in collaborative robot systems. In SICK AG WHITE PAPER, 2017.
[7] Matthias, Bjoern: Risk Assessment for Human-Robot Collaborative Applications, 2015
[8] Samir Vojić:Applications of collaborative industrial robots", International journal for science, technics and inovation for the industry, Year XIV, Issue 3/2020, pp. 96-100
[9] www. robotiq.com, april 2021.

EXPERIMENTAL INVESTIGATION OF CUTTING SURFACE ROUGHNESS IN LASER AND PLASMA CUTTING PROCESS

Edina Karabegović[1], Naila Demirović[1], Safet Rizvić[2], Amra Hajdarević[2]
[1]Faculty of Technical Engineering, University of Bihać, Dr. Irfana Ljubijankića bb, 77000 Bihać, BiH
edina-karabeg@hotmail.com, demi_naila@hotmail.com
[2] Company ''ZAH'' d.o.o., Bosanska Krupa, Dana nezavisnosti 25, 77240 Bosanska Krupa, BiH
safet-zah@hotmail.com, amra-zah@hotmail.com

ABSTRACT:

The application of laser and plasma energy in metal sheet cutting processes is justifiably present. The performance of these processes is based on the application of lasers and plasma, which achieve satisfactory technological and economic properties of processing. The influence of machining parameters on the quality of the cutting surface of the material is very large. The paper presents examples of cutting steel sheet (S235J2+N and S355J2+N) with different cutting thicknesses (for laser: 12 mm, 15 mm, 20 mm, and for plasma: 20 mm, 25 mm, 30 mm). The steel sheet was cut on the Trumpf Trulaser 3030 fiber laser cutting system and the Plasma CR Electronic plasma cutting system. The assessment of the cutting surface quality was performed by measuring the roughness of the cutting surface of the samples on a fixed measuring device for microscopic measurement MarSurf XR 1. In addition to the analysis of the obtained results, certain comparisons of these cutting processes are given, which refer to the justification of their application.

Keywords: Experiment, Roughness, Laser cutting, Plasma cutting, Sheet metal

1. INTRODUCTION

One of the constant requirements in the sheet metal cutting process is to increase the quality of the cutting surface in order to reduce the costs of post-processing. For this reason, special importance is given to the development of existing and the introduction of new cutting techniques. It is well-known that the reasons for the application of unconventional laser and plasma cutting technologies are multiple, which justifies their wide representation in all branches of industry. The application of laser and plasma energy is also important in other processes in the metal industry (welding, protection of metal surfaces, metal deformation processing). A common characteristic of the application of laser and plasma for all processes is the satisfactory quality, productivity and cost-effectiveness of the processing. The successful achievement of these characteristics is influenced by material parameters (type of material, thickness), selection of the appropriate cutting process (laser cutting or plasma cutting), as well as process parameters (laser power, cutting speed, nozzle diameter, nozzle distance from the work piece, gas for cutting, shielding gas, current, arc voltage, etc.). Samples obtained by the

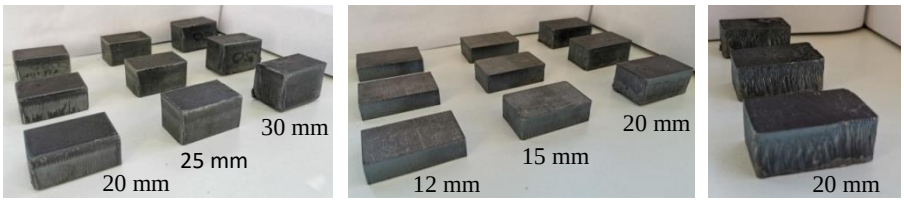
process of laser and plasma cutting of steel sheets S355J2+N and S235J2+N of different cutting thicknesses were used for the analysis of the cutting surface roughness. Roughness measurement was performed on a fixed measuring device for microscopic measurement [1-8].

2. LASER I PLASMA CUTTING

The application of laser energy in metal processing production has justifiably accelerated the development of laser systems of various types. Given the different physical states of the active surrounding and the operating modes for metal and alloy cutting, there are three different ways of laser cutting: laser cutting by melting, laser cutting by oxygen, and laser cutting by evaporation. The success of laser cutting is influenced by the parameters of the laser beam, process parameters and material parameters [1, 2, 6]. Plasma is considered to be the fourth physical state in nature. It is created by heating the gas conducted through an electric field, during which ionization occurs, thus forming an electrified ion jet-plasma, which is used at a satisfactory level to cut various types of metals. The developed temperature in the plasma classifies plasma cutting into thermal metal cutting processes. The introduction of plasma, as a new form of energy, enables the cutting of metals of relatively large cross-sections [3, 7, 8].

2.1. Roughness measurement samples

The process of cutting steel sheet samples was conducted on a plasma cutting system *"Plasma CR Electronic"* and a laser cutting system *"Trumpf Trulaser 3030 fiber"*. Samples for measuring the roughness of the cutting surface given in Figure 1 are made of structural steel S355J+N and S235J+N, with following dimensions: length 50 mm, width 30 mm and sheet thickness (30, 25, 20, 15, 12) mm.



Plasma cutting-S355J2+N Laser cutting-S355J2+N Laser cutting-S235J2+N

Figure 1: Examples of analysis samples

Chemical composition and mechanical characteristics of steel S355J2+N and S 235J2+N are given in Table 1.

Table 1: Chemical composition and mechanical characteristics of steel S355J2+N and S235J2+N

Chemical composition and mechanical characteristics of steelS355 J2+N						
Chemical composition	C (%)	Si (%)	Mn (%)	P (%)	S (%)	Cu (%)
	0,2	0,55	1,6	0.025	0,025	0,55
Mechanical characteristics	Re (N/mm^2)		Rm (N/mm^2)		Elongation (%)	
	315-355		490-630		max.22	
Chemical composition and mechanical characteristics of steel S235 J2+N						
Chemical composition	C (%)	Si (%)	Mn (%)	P (%)	S (%)	Cu (%)
	0,17	-	1,4	0,025	0,025	0,55
Mechanical characteristics	Re (N/mm^2)		Rm (N/mm^2)		Elongation (%)	
	225		360-510		max.26	

3. CUTTING SURFACE ROUGHNESS

The roughness on the work piece surface is determined by micro geometric deviations that occur on the surface texture of the material. Deviations occur as a result of the processing or some other cause. The quality of the cutting surface depends on: machining process parameters, rigidity of the cutting system, vibrations, damage to tools (nozzle), plastic deformations, errors in metal structure, etc. Measurement values important for determining roughness are given in expressions (1) and (2).
Mean arithmetic deviation:

$$R_a = \frac{1}{l}\int_0^l |y(x)|\,dx \tag{1}$$

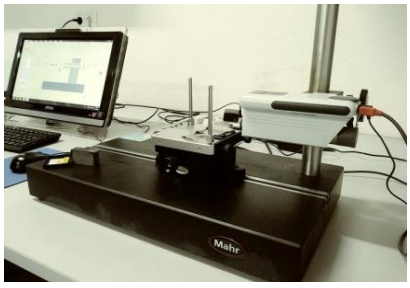
Value of mean height of roughness:

$$R_z = \frac{R_{i1} + R_{i2} + R_{i3} + R_{i4} + R_{i5}}{5} - \frac{R_{u1} + R_{u2} + R_{u3} + R_{u4} + R_{u5}}{5} \tag{2}$$

Explained as:
l –reference length of surface roughness, mm
$y\,(x)$ –the height of the roughness profile in regard to the mean reference line, μm
(R_{i1}-R_{i5}, R_{u1}-R_{u5}) –the five highest and five lowest points of the profile within the reference length.

Several methods can be used to determine roughness, which can be contact or non-contact [4, 5]. In this case, a fixed measuring device for microscopic measurement MarSurf XR 1 (Figure 2a) was used to measure the roughness. The determination of roughness is performed in accordance with the valid standard ISO 9013. The reference length at which the roughness was measured is determined by EN ISO 4287 and is 12.5 mm, as shown in Figure 2 b.

a)



b)

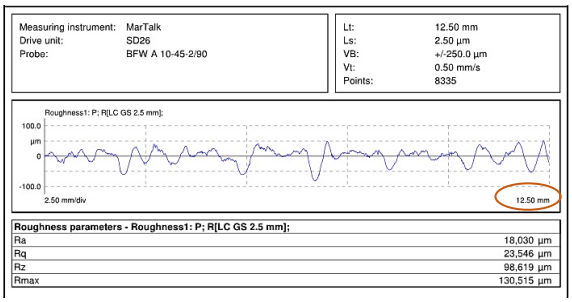


Figure 2: Measurement of cutting surface roughness of the sample
a) Measurement device, b) Measurement reference length

4. RESULTS AND ANALYSIS OF MEASUREMENT RESULTS

The results of measurement of cutting surface roughness parameters on samples cut by laser are given in Table 2.

Table 2: The results of measurement of roughness parameters on samples cut by laser

The results of measurement of roughness parameters for laser cutting process										
Cutting process	Type of material	Process input parameters							Measurement results	
		Sheet thickness (mm)	Number of samples (pieces)	Cutting speed (m/min)	Power (kW)	Nozzle diameter (mm)	Nozzle distance form sheet (mm)	Type of medium	Roughness parameters	
									Mean value Ra (μm)	Mean value Rz (μm)
Laser	S355J2+N	12	3	0,1	3,2	1,4	1	O_2	12,046	67,459
		15	3	0,1	3,2	2	1	O_2	9,874	54,451
		20	3	0,8	3,2	2,3	1	O_2	8,376	47,667

The results of measurement of roughness parameters on samples cut by plasma are given in Table 3.

Table 3: The results of measurement of roughness parameters on samples cut by plasma

The results of measurement of roughness parameters for plasma cutting process										
Cutting process	Type of material	Process input parameters							Measurement results	
		Sheet thickness (mm)	Number of samples (pieces)	Cutting speed (m/min)	Arc voltage (V)	Nozzle diameter (mm)	Nozzle distance form sheet (mm)	Type of medium	Roughness parameters	
									Mean value Ra (μm)	Mean value Rz (μm)
Plasma	S355J2+N	20	3	1,3	166	3,5	10	N_2O_2	2,091	14,128
		25	3	0,75	167	3,5	10	N_2O_2	1,546	14,922
		30	3	0,65	180	3,5	10	N_2O_2	2,295	19,909

Table 4 shows the results of measurement of roughness parameters for two types of materials (steel S235J2+N and S355J2+N), 20 mm thick, cut by laser under the same process input parameter conditions.

Table 4: Results of measurement of roughness parameter for different types of 20 mm thick steel

Results of roughness measurement for different types of 20 mm thick steel									
Sheet cutting process	Type of material	Process input parameters						Measurement results	
		Number of samples (pieces)	Cutting speed (m/min)	Power (kW)	Nozzle diameter (mm)	Nozzle distance (mm)	Type of medium	Mean value Ra (μm)	Mean value Rz (μm)
Laser	S235J2+N	3	0,8	3,2	2,3	1	O_2	3,026	17,550
	S355J2+N	3	0,8	3,2	2,3	1	O_2	8,376	47,667

The analysis of the obtained measurement results of the cutting surface roughness of sheet metal cut by laser and plasma was performed on the basis of the set criteria given in Table 5.

Table 5: Criteria for roughness analysis of laser and plasma cut samples

Criterion for the analysis and comparison of sample cutting surface				
Criterion (1, 2, 3)	Cutting process	Type of material	Material thickness, mm	Number of samples, pieces
1	laser	S355J2+N	12, 15, 20	3x3
	plasma	S355J2+N	20, 25, 30	3x3
2	laser	S355J2+N	20	3
	plasma	S355J2+N	20	3
3	laser	S235J2+N	20	3
	laser	S355J2+N	20	3

The first criterion implies the analysis of the obtained measurement results of the cutting surface roughness parameters of the samples (Figure 1), made of the same material S355J2+N, for laser cutting processes and plasma cutting process. For the stated input parameters of the laser cutting process (Table 2), deviations of the roughness parameter values of the cutting surfaces are evident in

all samples of the same thickness of 12 mm, 15 mm and 20 mm. The values of the roughness parameters are higher than expected. The analysis and comparison according to the other two criteria use the mean value of the measured roughness parameters. In the plasma cutting process (Table 3), the parameters of the cutting surface roughness for all three thicknesses (20, 25 and 30 mm) have shown small values of deviation per sample, for individual sheet thicknesses. The input parameters of cutting for both processes are determined by the conditions of real processing. According to the second criterion, the analysis of the obtained results refers to the comparison of the cutting surface roughness of 20 mm thick samples, made of the same material S355J2+N, and cut by laser and plasma. According to the obtained mean values of the roughness parameters, as shown in Table 2 and Table 3, the quality of the cutting surface of the plasma-cut sheet is better than the quality of the cutting surface of the laser-cut sheet. The cause of the poorer quality of the cutting surface of laser-cut samples may be due to damage to the nozzle diameter or insufficient experience of the operator, which was not the case with plasma cutting. According to the third criterion, a comparison was made of the cutting surface of samples made of steel S355J2+N and S235J2+N, 20 mm thick, and cut by the same laser cutting process. The process was performed with the same input parameters, as shown in Table 4. Based on the measured values of the roughness parameters, a better quality of the cutting surface was achieved with steel S235J2+N.

5. CONCLUSION

There may be several reasons for not achieving a satisfactory cutting surface quality of the laser-cut samples (e.g. selection of cutting power, cutting speed). Low or high speed during laser cutting can lead to an error on the surface of the cut, increased roughness (dents on the cutting surface), as well as the appearance of scratches at the bottom edge of the cut. In addition, the choice of nozzle diameter and the distance of the nozzle from the sheet surface can also affect the process, because often due to the appearance of earlier formation of molten metal droplets, deviations in the roughness parameters can occur. The values of the sample roughness parameters in plasma cutting were lower owing to the appropriate processing parameters and many years of experience of the operator. Also, the application of nitrogen in the protection of the plasma arc gives a better quality of the cutting surface. In order to achieve a better quality of the cutting surface, it is necessary to optimize the process input parameters in both cutting processes.

ACKNOWLEDGMENT

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6. REFERENCES

[1] Petring, D. (2001). Laser Cutting, LIA Handbook of Laser Materials Processing.
[2] Dahotre, N. B., Harimkar, S.P. (2008). Laser Fabrication and Machining of Materials, Springer.
[3] Simler, H., Krink, V., Laurisch, F. (2005). Suvremena tehnologija rezanja plazmom, Zavarivanje 48.
[4] Zaimović-Uzunović, N., Lemeš, S., Denjo, D., Softić, A. (2009). Proizvodna mjerenja, Univerzitet u Zenici, Mašinski fakultet, Zenica.
[5] Oruč, M., Zaimović-Uzunović, N., Klobodanović, A. (2008). Mjerenje karakteristika procesa, Univerzitet u Zenici, Mašinski fakultet, Zenica.
[6] http://www.laser-ing.hr/blog/najvazniji-parametri-kvalitete-rezanja-laserom/
[7] http://www.lincolnelectric.com/en-us/equipment/plasma-cutters/process-and-theory/Pages/how-a-plasma-cutter-works.aspx
[8] http://www.hypertherm.com/technology/plasma_history.htm

EXCELLENCE IN BUSINESS PROCESS MANAGEMENT IN THE METALWORKING INDUSTRY

Esad Bajramović[1], Senada Pobrić[2], Belma Islamović[3]
[1,3]University of Bihać, Faculty of Technical Engineering Bihać, dr. Irfana Ljubijankića bb, 77000 Bihać, bajramovic_e@yahoo.com; belma.islamovic15@gmail.com;
[2]University ''Džemal Bijedić''Mostar, Faculty of Mechanical Engineering, Univerzitetski Kampus, 88104 Mostar, senada.pobric@unmo.ba

ABSTRACT:

Achieving the established goals of the organization is the obligation of the employees. The set of activities that fulfill the specific goal of the organization is a business process, which must be under constant monitoring and include all activities from input control to output control that must be carried out in order to achieve the desired goal, which is a product without error and satisfied customer. Each metalworking industry is specific and contains complexity that determines the number of different business processes that must be connected into one integrated unit. We need to optimize existing business processes and focus on the future of the business and meeting customer requirements. Business processes should be continuously measured and their functioning and effectiveness constantly reviewed to achieve continuous improvement. The paper presents operational excellence and efficiency in the metalworking industry.

Keywords: Excellence, Processes, Model, Metalworking industry

1. INTRODUCTION

The metalworking industry in Bosnia and Herzegovina developed in the period 1946-1992. However, as a result of the privatization process in Bosnia and Herzegovina, many metalworking organizations have been destroyed. At the beginning of 2000, metalworking organizations began to recover, and many new factories were opened. In order to bring them to the level of justification and possibility of survival, a systematic approach is needed at the level of cantons, entities and the state. When setting general goals related to strategically committed factories, this step was omitted at the state level, so factory owners have set their own structural plans and strategic goals. In that sense, managers had to investigate the participation of factories in the market, expansion of the range of products and services, development of new technologies and products, optimally reduced costs, reduced waste (non-compliance) and increased customer satisfaction. [1]
Setting specific goals refers to meeting certain properties and product quality characteristics for a competitive contract in the market. When establishing production goals, management must take into account the possibility and ability of the process, current and future needs, environmental and customer requirements, the degree of satisfaction of all stakeholders, implementation of the responsibility matrix of all factory employees, and measurable and achievable goals. [1]

The implementation of the above requires teamwork and the ability of reengineering in management processes, production processes, logistics processes and system processes. [1]
In order to achieve business process excellence in the metalworking industry, all the necessary standards for the industry must be implemented. The metalworking industry is an industry that includes a wide range of products made of different metal materials. The basic raw material of this industry is iron or steel, which are being increasingly replaced by light metals in contemporary age.

2. EXCELLENCE IN PROCESS MANAGEMENT

Business excellence in manufacturing is becoming increasingly important for the future. Excellence in process management can only be achieved by involving all employees in teamwork. The first condition is the selection of candidates for leadership. When choosing management, it is necessary to carefully observe all their previous activities that deserve improvement for future management. [2]
The following should be carefully observed and analyzed during the meetings:

- Did the manager plan the meeting and does the meeting have a clear goal?
- Is the meeting effective? The meeting is a very important step in the broader process of problem solving and decision making in production.
- Is the meeting creative?
- Is the meeting useful?
- Is the meeting goal-oriented?

Those who excel in these areas can easily become candidates for management positions. In addition to the manager who runs the factory, the management processes must also have experts in the field of the factory. Experts are process managers whose basic tool is knowledge, and they work with information and use it in the workplace. The most common managers are engineers in various fields, computer scientists, professors, architects, physicists, economists, lawyers, doctors, scientists, etc.
The factory must have experts with the necessary competencies in order to create new values and follow world trends.
Therefore, what can motivate an expert in the new changed circumstances? Money is no longer the main motivator for an expert. Instead of money, individuals are interested in innovation. Their main asset is their intellectual capital. The main motive for experts is a challenging job, a job that provides opportunities for growth, an environment that exposes them to new innovations and knowledge, places that offer lifelong learning and acquiring new methods and skills, and a job that offers a stimulating work environment with the potential for continuous improvement. In this way, the factory will make a profit and have the opportunity to keep the best experts in its field. In many factories, retaining the best employees has been shown to increase operating costs, which in return help the factory to become profitable. They keep accurate statistics, perform qualitative data analyzes, track new trends, investigate causes and consequences, and create new innovations by creating and changing strategies. Experts are employees who use their knowledge for new values. If management does not recognize their efforts, they will lose them. The path to excellence must be led by the wisest and most skilled employees who use new tools, methods, and teamwork. [2]
According to N. Rupčić ‘’Excellence is an effort to exceed boundaries, limits or standards, i.e., to achieve outstanding results. Excellence is not the goal. It is not even the destination the factory wants to reach. Excellence is the pursuit of best practice, and/or the pursuit of diversity in the marketplace, workplace, personality, etc.’’

2.1. Employee excellence

Quality employees can develop and achieve factory excellence. The excellence of the people in the factory must have two components, competencies and commitment to goals.
In the digital age in which only change is constant, knowledge and experience are crucial elements of development. It is necessary to motivate the development of knowledge and skills. Management should

perform reengineering and factory changes. The goal is to educate people and create a work environment that encourages learning while working, exchange of experiences with their colleagues, exchange of knowledge and experience according to best practice with the use of all material and human resources. It is clear from the above that lifelong learning should be encouraged in order to maintain the required level of competencies of individuals in the factory. Achieving measurable and attainable production goals requires maximum commitment from each individual. The strategic imperative of business excellence is to familiarize all employees with the factory policies adopted by the management. Policy excellence is based on strategic thinking and defining the right direction of the factory and it is a guarantee of survival in the market. [3]

Process excellence will be achieved if the organization creates a product with appropriate market value, and a product without error. It is imperative to increase competitiveness, i.e., achieve the organization of vitality in terms of achieving the naturalness of performing the necessary business processes. Production excellence can be achieved if trained employees are able to meet the needs of their customers so that the product placed on the market represents new value for customers. [3]

For these reasons, value should be supported by good plans, policies, and processes and encourage continuous raising of competencies of all employees. There is a constant need to manage resources efficiently and effectively in order to achieve measurable and achievable goals. The organization should constantly implement methods and tools, perform benchmarking on a daily basis, and seek best practices. [3]

Excellence is hard to achieve and effort is needed every moment and in every situation, or as Robert Townsend put it: ‘’If you don't do it with excellence, don't do it at all! Because if it's not excellent, it won't be profitable or fun, and if you're not in business for fun or profit, what the hell are you doing there?’’

3. EFQM EXCELLENCE MODEL

The EFQM excellence model consists of nine criteria. The first five criteria relate to training the company to achieve excellent results, while the other four refer to the results achieved. For each of the nine criteria, a number of questions have been developed that need to be answered as accurately and impartially as possible in terms of the goodness of the applied approaches or models, and the potential and breadth of their application in the metalworking industry. [4]

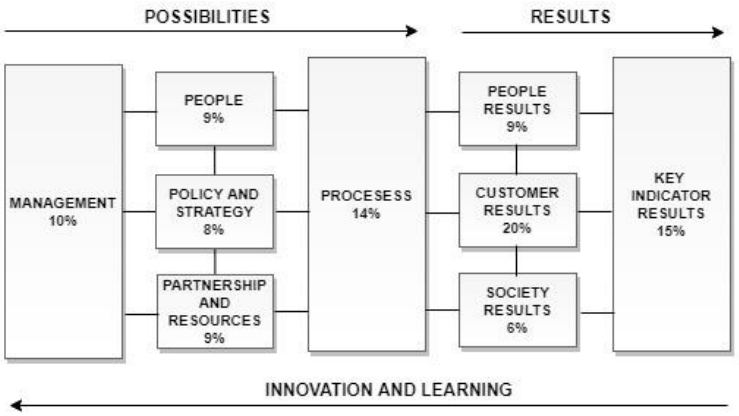


Figure 1: EFQM excellence model [4]

The EFQM excellence model is based on the following basic concepts:

1. Orientation to results,
2. Customer orientation,
3. Leadership and consistency of purpose,
4. Management through processes and facts,
5. Development and involvement of employees,
6. Continuous learning, innovation and improvement,
7. Developing partnerships, and
8. Accountability to the public.

The EFQM excellence model is intended to help factories build their own approach to achieving process excellence. Within this model there are several basic concepts that are mandatory for its application: results orientation, customer focus, leadership and consistency of determination, management of processes and facts, development and involvement of employees, lifelong learning, partnership development, and social responsibility. [5,6,7]

The EFQM model criteria include the following questions:

- Leadership,
- Policy and strategy,
- People,
- Resources and partnership,
- Processes,
- Result according to customers,
- Result according to people,
- Results according to society, and
- Business results.

4. PROCESS FUNCTIONING IN THE METALWORKING INDUSTRY

Factory management must plan, implement and manage the processes required to meet product security requirements, as well as implement measures as follows: determining product requirements, establishing criteria for processes and product acceptance, determining the resources needed to comply with product requirements, implementing controls in accordance with the criteria, and maintaining and storing documented information to the extent necessary. [3]

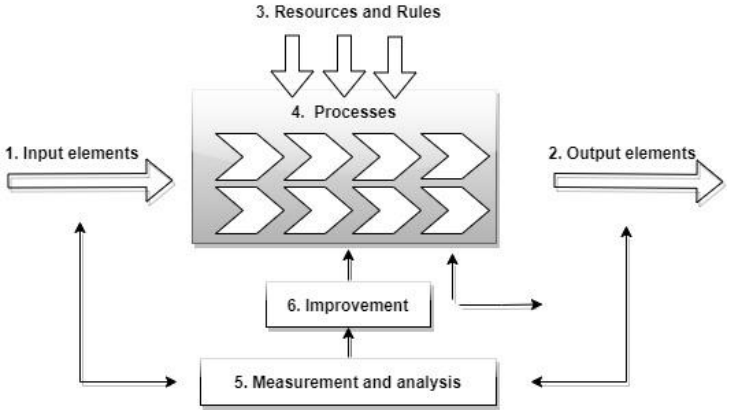


Figure 2: Process management

The outputs of this planning must be suitable for the operation of the factory. The factory management must manage the planned changes and regularly review the consequences of unforeseen changes.
Business excellence can play a significant role in economic recovery, business improvement and global development in the current financial crisis that has affected the entire world. The most important precondition for progress is continuity and consistency in the implementation of activities in which each organization should give everything it can to improve. [7]

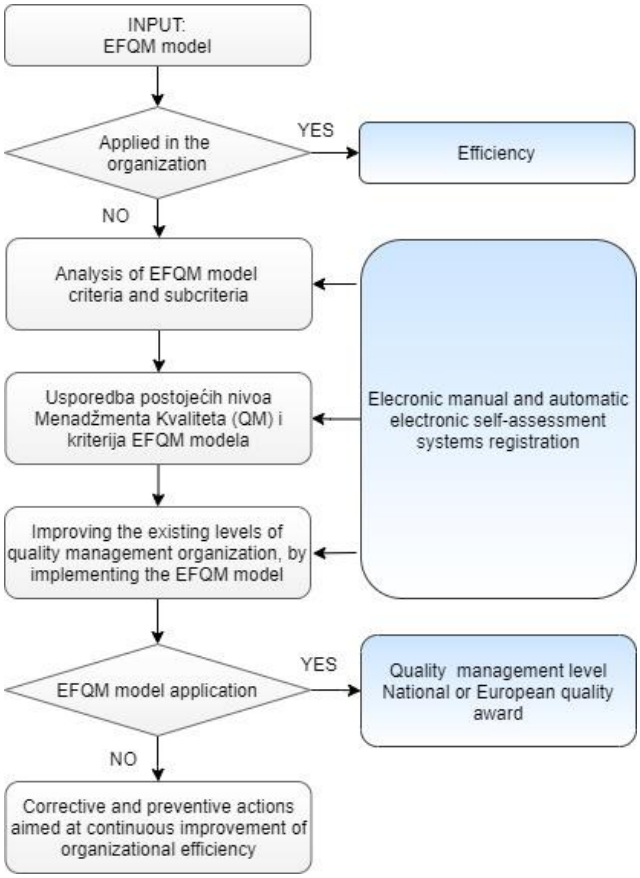


Figure 3: Methodology of EFQM model application

The basic attractiveness of business excellence is a positive concept at its core. No one is against innovation and everyone wants to have it.
At the same time, the notion of innovation, as a rule, leads to confusion and misinterpretation because it is difficult, some say impossible, to define its exact meaning, which is the lack of competencies. Investing in innovation is an investment.

5. CONCLUSION

It can be concluded that performance excellence can only be achieved in synergy with production excellence, employee excellence, policy, process and practical excellence. Excellence is not a skill, but rather an attitude.

The basis for a quality product is the implementation of technical standards, introduced and implemented tools, methods and skills. Quality product and safety in the world market can only be performed by competent employees who are imported into the team. Organizations are increasingly reviewing development and achievement of long-term goals that will contribute to achieving success and increasing competitiveness through the application of new insights in management theory and practice. As a new insight and theory, the concept of business excellence appears as a concept of production process management in factories that has developed progressively over the years, and whose foundations come from best practice and continuous learning from the best. Business excellence is defined as a high level of success of factories in achieving top results.

Several models of business excellence have been developed in the world, which represent a systematic approach to innovation in factories with integrated structural plans, which enable constant review and evaluation of the functioning of the factory. According to the best scientists, one of the models that stand out in Europe is the EFQM excellence model, which leads the organization to create business excellence through its criteria. By implementing the EFQM model of business excellence, factories have the opportunity and a good foundation for further training and improvement. Achieving business excellence opens the way for factories to guaranteed success.

Effective application of the concept of excellence requires extensive process reengineering and fundamental cultural change in the factory. Changes are basically simple but not easy. They require great commitment, discipline, responsibility and teamwork of all employees. The first change is a good and logical strategy and practice of the factory. Good education of all employees in the application of tools and methods is the basis of good practice in their application. Difficulties in applying excellence include conceptual, terminological, structural, and mental reasons.

4. REFERENCES

[1] Heleta, N.M. (2010). Modeli izvrsnosti i integrisani menadžment sistemi. Zavod za udžbenike, Beograd. ISBN 978-86-17-17244-0.

[2] Jašarević, S., Brdarević, S., Isaković, S. (2020). Upravljanje proizvodnjom. Politehnički fakultet Univerziteta u Zenici. ISBN 978-9926-452-18-6.

[3] Bajramović, E., Hodžić, D., Bajramović. E. (2021). Social responsibility recognition and involvement of interested parties. Acta Technica Corviniensis – Bulletin of Engineering, Tome XIX, Fascicule 1, 13-16.

[4] Medne, A., Lapina, I. Zeps, A. (2020). Sustainability of a university's quality system: adaptation of the EFQM excellence model, International Journal of Quality and Service Sciences, Vol. 12 No.1, 29-43. https://doi.org/10.1108/IJQSS-09-2019-0108.

[5] Rivera, D. E., Terradellas Piferrer, M. R., Benito Mundet, M. H. (2021). Measuring Territorial Social Responsibility and Sustainability Using the EFQM Excellence Model. Sustainability 2021 13, 2153. DOI.org/10.3390/su13042153.

[6] Para-González, L., Jiménez-Jiménez, D., Martínez-Lorente, A.R. (2021). The link between people and performance under the EFQM excellence model umbrella. Total Quality Management & Business Excellence 32:3-4, 410-430. DOI: 10.1080/14783363.2018.1552516.

[7] Keshtegar, A., Ghasemi, M., Hosseini, A., Ahang, F., Ghaffari, H. (2021). The impact of business intelligence on enablers of EFQM excellence model with mediating role of knowledge sharing. Int. J. Hum. Capital Urban Manage. 6(2):173-184, Spring 2021. DOI: 10.22034/IJHCUM.2021.02.06.

THERMAL EFFICIENCY OF FLAT PLATE SOLAR COLLECTORS AND ITS IMPROVEMENT

Merima Gadara, Haris Lulić
"Dzemal Bijedic", University of Mostar, Faculty of Mechanical Engineering, Sjeverni logor bb, Mostar, merima.maslo@unmo.ba
University of Sarajevo, Faculty of Mechanical Engineering, Vilsonovo šetalište 9, Sarajevo
lulic@mef.unsa.ba

ABSTRACT:

A thermal efficiency of a low-temperature solar panel collector means its ability to convert a certain amount of radiated solar energy into useful heat, which is transmitted from it by the working medium (liquid or air).
The function of the current thermal efficiency is represented by a second-order polynomial and defines the relationship between the thermal energy delivered to the working fluid and the energy of the total solar radiation arriving at the collector plane. A graphical representation of the efficiency function in a coordinate system with the value data $\Delta T/G$ on the abscissa and the current coefficient of action η on the ordinate represents both visual and mathematical basis for determining the efficiency of flat collectors at a given moment.
In order to achieve better and higher efficiency of solar thermal collectors, it is necessary to take into account several factors.
This paper presenents an overview of the literature research on the thermal efficiency of flat plate solar collectors and the influence of parameters: nanofluids and mass/volume flow on efficiency improvement.

Keywords: the efficiency function, flat plate solar thermal collector, thermal energy, solar radiation

1. INTRODUCTION

The energy of the Sun's radiation that reaches the Earth's surface annually is about 170 times higher than the energy contained in the world's total coal reserves. The capacity of solar energy on Earth is, according to some estimates, about 14,000 times greater than the total energy consumed by humanity today.
From an energy point of view, solar energy is a resource available for the use and substitution of significant amounts of conventional energy forms. Its limited use is caused by technological and economic problems.
Solar energy can have a significant place in the energy of a country because it is a renewable and inexhaustible energy resource. Renewable energy sources are not receiving the same attention in the world. It can be said that a relatively small number of countries, those which are developed pay more attention to this issue.
Solar energy provides a variety of application possibilities. Modern solar systems enable the use of solar energy throughout the year. Such systems can supply up to 35% of all needs in northern and central Europe, more than 50% south of the Alps, and up to 70% in southern Europe. [1]

Although other systems are available, stationary (non-concentrating) and concentrating systems are the main types of water-heating systems in use.Flat-plate solar collectors are stationary collectors used generally to heat water for domestic uses, to heat swimming pools or in industrial application.
This paper presenents an overview of the literature research on the thermal efficiency of flat plate solar collectors and the influence of parameters: nanofluids and mass/volume flow on efficiency improvement.

2. FLAT PLATE SOLAR COLLECTOR

A typical solar thermal flat plate collector is made up of an absorber which is in an insulated box together with transparent cover sheets (Glazing). The absorber is usually made up of a metal sheet of high thermal conductivity such as copper or aluminum, with integrated or attached tubes. Its surface is coated with a special selective material to maximize radiant energy absorption while minimizing radiant energy emission. The insulated box reduces heat losses from the back and sides of the collector. These collectors are used to heat a liquid or air to temperatures less than 80°C. Cross-section of a typical liquid flat plate collector is shown in figure 1. [2]

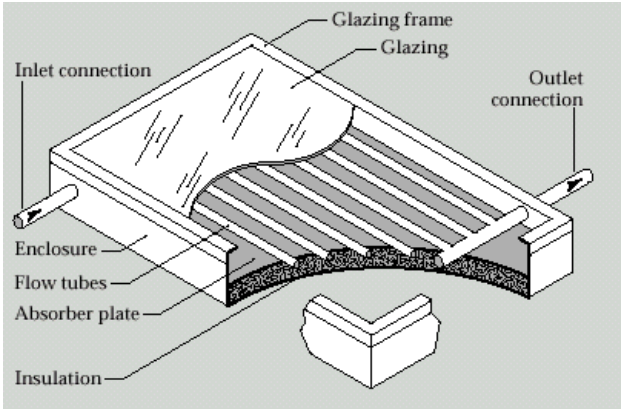


Figure 1: Cross-section of a typical liquid flat plate collector [3]

3. EFFICIENCY OF FLAT PLATE SOLAR COLLECTOR

The thermal efficiency of a low-temperature solar plate collector means its ability to convert a certain amount of radiated solar energy into useful heat, which is transferred from it by the working medium (liquid or air).
Mathematically, it is calculated as the ratio of the useful amount of heat removed from a unit area of a plate solar collector and the energy of global solar radiation that has reached the unit area of that collector.
A measure of a flat plate collector performance is the collector efficiency (η) defined as the ratio of the useful energy gain (Qu) to the incident solar energy over a particular time period:

$$\eta = \frac{\int Q_u dt}{A \int G dt} \qquad (1)$$

where is:

- η - instantaneous thermal efficiency,
- Q_u - useful energy gain $[W]$,
- A - collector area $[m^2]$,

- G - intensity of solar radiation $[W/m^2]$.

The instantaneous thermal efficiency of the collector is:

$$\eta = \frac{Q_u}{AG} \tag{2}$$

Where the useful energy gain Q_u is equal:

$$Q_u = F_R A[G\tau\alpha - U_L(T_i - T_a)] \tag{3}$$

where is:

- F_R - collector heat removal factor,
- τ - transmission coefficient of glazing,
- α - absorption coefficient of plate,
- U_L - collector overall heat loss coefficient,
- T_i - inlet fluid temperature [℃],
- T_a - ambient temeprature [℃].

Replacing equation (2) in equation (1), collector efficiency is now equal, [4]:

$$\eta = F_R\tau\alpha - F_R U_L\left(\frac{T_i - T_a}{G}\right) \tag{4}$$

The graphical representation of the efficiency function in the coordinate system with the value data $\Delta T/G$ on the abscissa and the current collector efficiency η on the ordinate represents both a visual and a mathematical basis for determining the efficiency of flat collectors at a given time. The efficiency curve of flat plate collectors in graphical form represents a simplified operator for any time and any conditions during the year, and for a certain type and construction of collectors for which this curve is valid. Figure 2 gives a graphical representation of the efficiency for a typical plate solar thermal collector. [1]

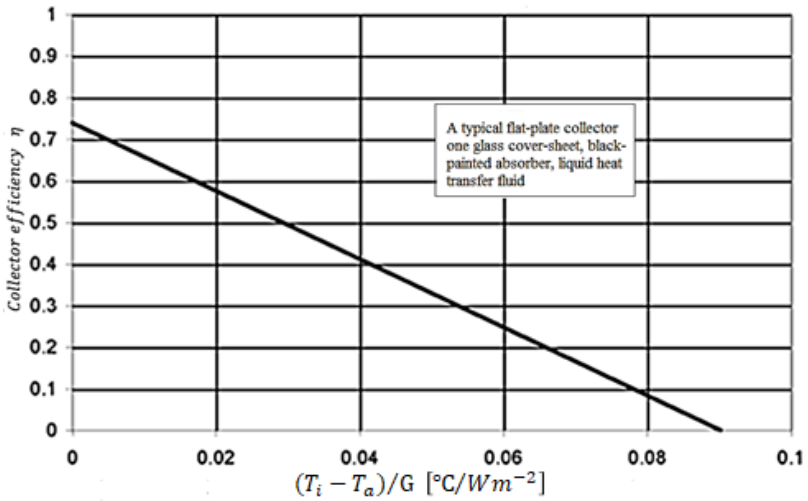


Figure 2: Performance of a typical flat-plate thermal collector, $T_a = 25$℃ [1]

4. WAYS TO IMPROVE THE EFFICIENCY OF FLAT PLATE SOLAR COLLECTOR

The efficiency of the flat plate solar collector is dependent on many factors, including the position of the sun, weather conditions, the orientation and the tilt angle of the panel, the material composition and mounting structure of the panel, the mass/volume flow rate, and the type of working fluid. [5]
Many authors have dealt with and are currently dealing with the problem of increasing the thermal efficiency of flat plate solar collectors.
On the figure 3. there is a graphic interpretation of the parameters that influence on the efficiency of solar thermal collector.
This paper provides an overview using information from the literature how to parameters: working fluid and mass/volume flow rate, affect on the efficiency of flat plate solar thermal collector.

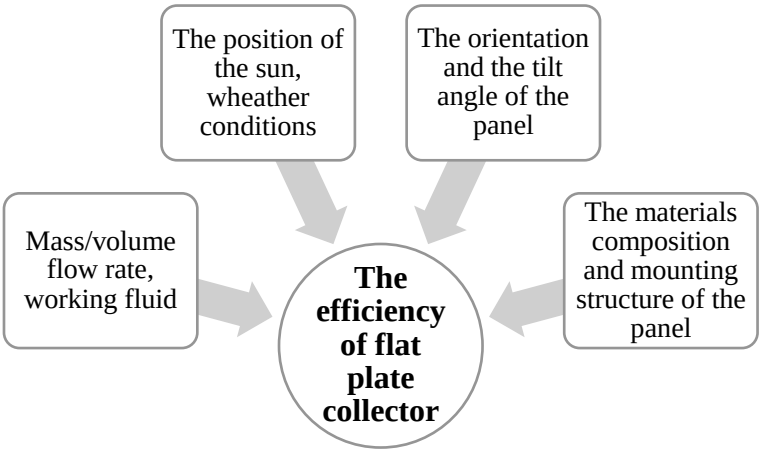


Figure 3: Parameters that affecting on the efficiency of solar thermal collector

4.1. Influence of working fluid type and mass/volume flow rate on the efficiency of flat plate solar collector

Water or mixture of water and ethylene glycol are heat transfer fluids generally used in flat solar thermal collectors. Their thermal conductivity is a limiting factor because it is lower than thermal conductivity of heat exchange solid surface.
Innovative heat transfer fluids have been proposed to enhance efficiency of energy systems, based on mixing of solid nanoparticles (100 nm) of metal or metal oxide with traditional heat transfer fluids as water, ethylene glycol, oil. These suspensions are called nanofluids. Thermal conductivity enhancements have been obtained by several authors. [6]
Moghadam at al. used CuO nanofluid as the absorbing medium on the flat-plate solar collector. The experiment was done for volume flow rate in the range of $1 - 3\ \mathrm{kg/min}$. The volume fraction of nanoparticles is set to 0,4%; the particle dimension is 40 nm. The results demonstrate that using CuO

nanofluid increases the solar collector efficiency in comparison with that of water by 16,7% (especially in the optimum mass flow rate). [7]

Saleh Salavati at al. experimentally studied the effects of nanofluid SiO_2 on the efficiency of flat plate solar collector.

The tests were performed for the various volume fractions and mass flow rates respectively (0, 0,5%, 0,75%, 1%) and (0,018, 0,032, and 0,045 kg/s). The results show that using SiO_2 as heat transfer fluid make a noticeable enhancement in thermal efficiency in comparison with water. Analysis showed that when the heat loss parameter limits to zero, an increase in nanofluid concentration from 0 to 1% results in an efficiency enhancement approximately between 4 and 8%. [8]

Ehsan Farajzadeh at al. numerically and experimentally studied the effect of using nanofluids: Al_2O_3 and TiO_2, on the thermal efficiency of a flat plate solar.

For the Al_2O_3, the volume fraction of nanoparticles is set to 0,1%; the particle dimension is 20 nm. For the TiO_2, the volume fraction is 0,1%, and the particle dimension is 15nm, and for their 1 mixture with equal ratio.

Experimental results show that by using Al_2O_3, TiO_2 and the mixture of these two nanofluids the thermal efficiency will enhance about 19%, 21% and 26%, respectively, compared with water as a working fluid. A mixture of the two nanofluids attains the best thermal performance compared to the two other nanofluids.

Since TiO_2 is more expensive than Al_2O_3, using the mixture of them is more economical with better thermal efficiency. Increasing the concentration of the nanofluid mixture from 0,1 wt% to 0,2 wt% will result in approximately 5% improvement in the thermal efficiency of the solar collector. [9]

Sint at al. also analyzed the effects of nanofluid CuO as working fluid on the efficiency of flat plate solar collector. Analysis was done theoretically.

A mathematical model and a program, written in MATLAB code were used for calculating the efficiency of a flat plate solar collector for a domestic solar water heating system considering weather conditions of a city in Myanmar. This calculation includes three aspects. Firstly, the maximum solar energy availability for the flat plate solar collector tilted at the optimum angle was estimated. Secondly, the convective heat transfer coefficient of nanofluid was calculated as a function of volume concentration and size of the nanoparticle. Thirdly, the overall heat loss coefficient of the flat plate solar collector was calculated using a method of iteration. Through these calculations, the collector efficiency was obtained as a function of volume concentration and size of the nanoparticle.

The use of the CuO nanofluid as a working fluid could improve the efficiency of flat plate solar collector up to 5% compared with water as a working fluid under the same ambient, radiant and operating conditions.[5]

Arikan at al. studied the effect of Al_2O_3 and ZnO nanofluids, with and without ethylene glycol on the efficiency of a flat plate solar collector. Two systems were set up and the nanofluids with and without ethylene glycol were examined at the same time. The volume fraction of the nanoparticles and ethylene glycol were 0,25% and 25%, respectively. The study was conducted on three mass flow rates: 0,05 kg/s, 0,07 kg/s, and 0,09 kg/s. The results showed that an increase in the mass flow rate and use of the ethylene glycol increased efficiency compared to water. In comparison with the water as working fluid, the maximum increase in efficiency is 15,13% and was observed by using an Al_2O_3 with ethylene glycol nanofluid. [10]

Mohsen at al. experimentally investigated the effect of the nanofluid Al_2O_3 on the efficiency of thermal solar collector. The volume fraction of nanoparticles is set to 0,1% with the mean particle size of 20 nm, at three mass flow rates of 1, 2 and 4 l/min. In this study, the solar radiation and ambient temperature parameters are un-controllable and presented in a range of transient data of climatic conditions, where these might take place during the spring and summer seasons of Rafsanjani (Iran).

The experimental results reveal that adding nanoparticles to a base fluid produces a nanofluid which has enhanced thermal characteristics, as well as the collector efficiency, in comparison to water as working fluid. For any working fluid, there is an optimum flow rate, which maximizes the collector efficiency, while in our case study, the nanofluid with the flow rate of 2 l/min is the optimum one and

increases the collector efficiency about 23,6%. Meanwhile, the increment of water temperature in the storage tank, confirms that 2 L/min is the optimum flow rate of this specific nanofluid.[11]
Mirzaei at al. in his analyses concluded that volume flow rate influence on the efficiency of solar thermal collector. Increasing the volume flow rate, efficiency also increases. For the volume flow rates: 1, 2 and 4l/min, efficiency increasing for 15,2%, 17,1%, 55,1% respectively. [12]
Brava at al. in his analysis, which was done experimentally also concluded that increasing the volume flow rate, efficiency also increases.[13]
Vivek at al. analyzed nanofluid Al_2O_3, as the working fluid, and the affect of mass flow rate on the efficiency. It has been also observed that as the mass flow rate of the nanofluids is increased, the efficiency of the solar collector also increases. Where with increase in the mass flow rate the temperature, difference decreases. [14]
Zafar at al. investigated using nanofluid TiO_2 as a working fluid. The volume fraction of the nanoparticles was 0,1% and 0,3% respectively, while the mass flow rates of the nanofluid varied from 0,5 to 1,5 kg/min, respectively. Energy efficiency increased by 76,6% for 0,1% volume fraction and 0,5 kg/min flow rate in comparison with water as working fluid. The highest efficiency achieved was 16,9% and achived for 0,1% volume fraction and 0,5 kg/min flow rate. [15]
Yijie at al. experimentally investigated using Al_2O_3 and CuO as the working fluid.
Experimental results showed that the use of Al_2O_3 and CuO nanofluids in the flat-plate solar collector could improve the thermal efficiency compared to the use of water.
The highest efficiency was 77,5% when the 0,01%- Al_2O_3 nanofluid was used, which was 21,9% higher than that when water was used. The flat-plate solar collector using the CuO nanofluid showed the maximum efficiency of 73,9%, which was a 16,2% efficiency improvement compared with the case of water.
When the Al_2O_3 and CuO nanofluids were applied into the flat-plate solar collector as the working fluid, the efficiency of flat-plate solar collector can be improved significantly. When the 20 nm-1.0 vol% Al_2O_3 and 40 nm 0,5 vol% CuO nanofluid was used, the efficiency improvement of the flat-plate solar collector was 3,4% and 3,7%, respectively, as the mass flow rate of the working fluid increased from 0,033 kg/s to 0,047 kg/s. [16]

5. CONCLUSION

This paper presents a review of the literature research on the thermal efficiency of flat plate solar collectors and the influence of nanofluids and mass/volume flow on efficiency improvement. It can be concluded the following:

- Efficiency of solar flat plate solar collectors can be improved by usnig nanofluid as working fluid. In this paper it is presenetd using the following nanonfluids: CuO, SiO_2, Al_2O_3, TiO_2, ZnO as the working fluid. In all cases the results show an increase in the thermal efficiency compared to water.
- Efficiency of the solar flat plate solar collector was enhanced by increasing the mass/volume flow rate. In all cases which are presented in this paper by increasing the mass/volume flow rate, efficiency also increases.
- Improving the efficiency of flat plate solar collector by using nanofluid is just one ways. Efficiency also depends on many other factors, including the position of the sun, weather conditions, the orientation and the tilt angle of the panel, the material composition and mounting structure of the panel.

6. REFERENCES

[1] Lambić, M., (2013). Solarne tehnologije, toplotni i fotonaponski sistemi, Beograd.

[2] Vijayan, S. N., Karthik, S., Vijayaraj V. T., (2016). Assorted Performance Investigation of Flat Plate Solar Collector - A Review, International Conference on Systems, Science, Control, Communication, Engineering and Technology

[3] Jazlan, A., (2016). Time weighted model reduction of flat plate solar collectors, Australian Control Conference, Canberra.

[4] Struckman, F., (2008). Analysis of a Flat-plate Solar Collector.

[5] Chaw Sint, N.K., Choudhury, I.A., Masjuki, H.H., Aoyama, H., (2017). Theoretical analysis to determine the efficiency of a CuO-water nanofluid based-flat plate solar collector for domestic solar water heating system in Myanmar, Solar Energy 155, 608-619.

[6] Colangelo, G., Favale, E., Miglietta, P., De Risi, A., (2015). Innovation in flat solar thermal collectors: A review of the last ten years experimental results, Renewable and Sustainable Energy Reviews 57, 1141-1159.

[7] Moghadam, A. J., Farzane-Gord, M., Sajadi, M., Hoseyn-Zadeh, M., (2014). Effects of CuO/water nanofluid on the efficiency of a flat-plate solar collector, Experimental Thermal and Fluid Science 58, 9-14.

[8] Salavati, S., Kianifar, A., Niazmand, H., Mahian, O., Wongwises, S., (2015). Experimental investigation on the thermal efficiency and performance characteristics of a flat plate solar collector using SiO_2/EG–water nanofluids, International Communications in Heat and Mass Transfer 65.

[9] Farajzadeh, E., Movahed, S., Hosseini, R., (2017). Experimental and numerical investigations on the effect of Al_2O_3/TiO_2-H_2O nanofluids on thermal efficiency of the flat plate solar collector, Renewable Energy.

[10] Arıkan, E., Abbasoglu, S., Gazi, M., (2018). Experimental Performance Analysis of Flat Plate Solar Collectors Using Different Nanofluids, Sustainbility 10, 1794.

[11] Mohsen, M., Seyed, M., Sadegh, H., Amir Mansour, M. K., (2018). Assessment of Al_2O_3nanoparticles for the optimal operation of the flat plate solar collector, Applied Thermal Engineering 134, 68-77.

[12] Mohsen, M., (2018). Experimental Investigation of CuO Nanofluid in the Thermal Characteristics of a Flat Plate Solar Collector, Wiley Online Library.

[13] Bava, F., Furbo, S. (2014). Correction of Collector Efficiency Depending on Variations of Collector Type, Solar Collector Fluid, Volume Flow Rate and Collector Tilt, IEA-SHC Info Sheet 45.A.1. 22.

[14] Vivek, V., Lal, K., (2013). Thermal Performance Evaluation of a Direct Absorption Flat Plate Solar Collector (DASC) using Al_2O_3-H_2O Based Nanofluids, Material Science, Journal of Mechanical and Civil Engineering.

[15] Zafar, S., Monny Akter, S., Rahman. S., Hepbaslic, A., Rahim, A.N., Mekhilef, S., Ward, T., (2015). Performance enhancement of a Flat Plate Solar collector using TiO_2 nanofluid and Polyethylene Glycol dispersant, Journal of Cleaner Production.

[16] Yijie, T., Hoseong, L., Woobin, K., Honghyun, C., (2019). Energy and exergy comparison of a flat-plate solar collector using water, Al_2O_3 nanofluid, and CuO nanofluid, Applied Thermal Engineering 159, 113959.

ROBOTIC WELDING USING INDUSTRIAL ROBOT KR16-2

Ramiz Sijamhodžić, Samir Vojić
University of Bihać, Faculty of Technical Engineering,
ramizsijam2017@gmail.com, vojics@gmail.com

ABSTRACT:

Welding today is one of the most common procedures for joining the same or different elements. Initially, welding was done manually which required much more time and labor to do some work. With the advancement of technology and automation, today welding is largely robotic and automated, which greatly shortens the duration of the operation, and gives a better position among the competition in the market. In the last 10 years, the application of industrial robots has increased sharply. Globally, the largest number of robots in the industry is used in Asia, Australia and Europe. Of the total number of robots used in production in the world, about 35% are used in the welding process. Through this paper is presented an example of robot programming and industrial robot welding in the process of column support welding.

Keywords: robot, welding, KUKA, KUKA robot

1. INTRODUCTION

Since the advent of the first industrial plants, there has been a tendency for jobs that are difficult, strenuous, complicated and harmful to human health to be done by machines. As welding is a very complicated operation, and very important in almost all industries, there was a problem with the parts that are joined by welding. Since the quality of a welded joint depends on the skill and knowledge of the welder, the same parts can have completely different welded joints. With the advent of the welding robot this problem has started to solve. In addition to the fact that robots can perform completely identical movements when welding on an unlimited series of workpieces, they need far less time to perform certain tasks than humans, and on the other hand harmful welding gases are not harmful to robot operation. With the advancement of technology and science, today's robots are modern and have the possibility of 6 degrees of freedom of movement in space, and are equipped with various sensors, counters, optical vision, etc. By using modern robots, the welding process can be fully automated what brings us great advantages in the market

2. WEELDING PROCESS

The beginnings of metal fusion are linked to the very beginning of metal discovery, for the Iron Age. The first forms of welding were to heat the two parts until they glowed, and then by removing the oxides from their glowing surfaces pure metals would remain. The interatomic forces of such pure metals would act and a solid bond would be formed after cooling.

It was not until the early 19th century that Russian scientists discovered the electric arc and began to apply it to welding. Welding is the process of joining two or more, the same or dissimilar elements by pressing or melting, with or without the addition of additional material, in a way to obtain a homogeneous medium. Figure 1 shows a cross section of a welded joint with all essential weld zones [1].

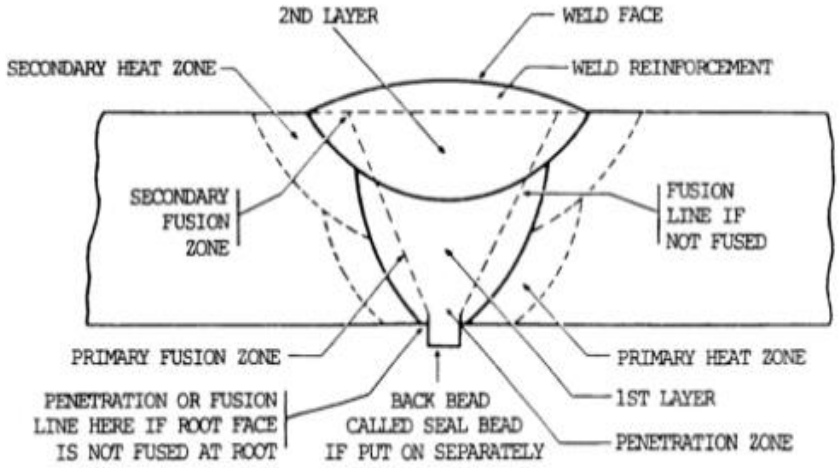


Figure 1: Cross section of a welded joint [4]

With the constant development of science and technology, the welding process also developed. Today there is a large number of welding processes. As it is necessary to provide a huge amount of energy and heat for welding, therefore, during the welding process itself, certain exhaust gases and gases which can be harmful to the health of the welder. With the advent of robots in industry, the welding process began to be transferred from man to robot, and the reasons for this are multiple. The first and basic advantage is in the protection of man from electric shock, fire, gases and vapors, and in the global protection of human health. Then the advantages of robots in relation to humans are higher speed of work, better quality of work performed, long-term economic justification, continuous work without stopping, robots are not subject to fatigue, lack of motivation. All of the above fully justifies the introduction of robots in the welding process.

3. KUKA KR 16-2 AND OTHER WELDING EQUIPMENT

The cause of every investment is long-term profit and improvement of market position. Therefore, the introduction of robotic welding has the task of increasing production capacity, while reducing production costs. The answer to whether an investment will be profitable or not will be obtained from a comparison of the usefulness of the existing and potential new invested system. The main reason for introducing robots in the welding process and the advantages of robotic welding are shown in the figure 2.

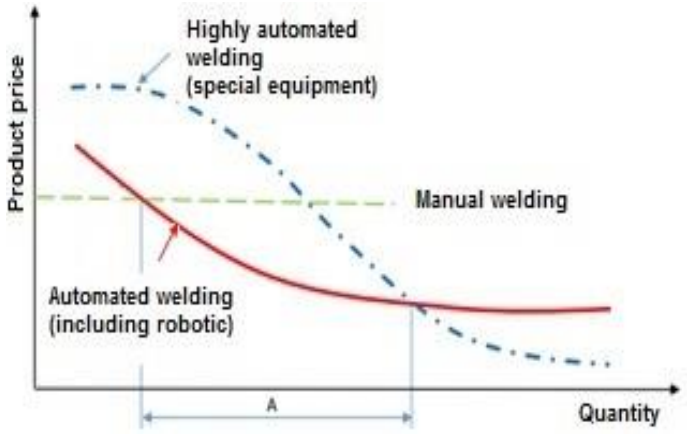


Figure 2: Schematic of the efficiency of different welding [2]

The area marked A - represents serial production and is most suitable for the use of robotic welding;
The area to the left of A - represents small-scale or individual production and manual welding is most suitable there;
Areas to the right of A - large-scale or mass production where a highly automated drive is suitable [2].

3.1. KUKA robots in the welding process

KUKA is a German manufacturer of industrial robots and devices for factory automation. KUKA Robotic Corporation has 25 sales and service subsidiaries around the world from the USA, Australia, Canada, Mexico, Brazil to most European countries. In 1973, KUKA designed and produced its first robot called FAMULUS, which had six electromechanical axes. Most of today's KUKA robots are recognizable orange or black [3].
Each robotic system consists of three parts:

a) controller (KR C4 control cabinet),
b) manipulators (robotic arms),
c) learning pendant (HOOK smartPAD).

In order to use robotic welding we must have economic justification. Today's welding robots are suitable for jobs that are repeated periodically, jobs where access is difficult and where high accuracy, precision and speed of tasks are required.
With robotic welding, it is very important that the welding equipment and the robot are aligned so that the welding process can run smoothly. In addition to the robot, a DKP 400 workbench, a FRONIUS CMT VR 7000 welding unit and a welding gun were used to perform the task of welding the column support on the KUKA robot KR 16-2.

3.2. Controler KR C4

The KR C4 controller is more powerful, safer, more flexible, and above all more intelligent than its predecessor. This controller reduces automation costs for maintenance, integration and servicing. Thanks to this controller, the efficiency and flexibility of the system has increased. All controllers are integrated in this structure, such as: SafetyControl, RobotControl, MotionControl, LogicControl and

ProcessControl. All controllers have a common database, which they use intelligently. The following Figure 3 shows the KR C4 controller

Figure 3: KR C4 controller

KR C4 controller features:

- simple planning, maintenance and operation,
- quick and easy handling thanks to the constant use of known operator supervision concepts,
- high compatibility with previous programs for KR C2,
- Safety, Robot, Motion and ProcessControl are on one control system,
- real-time communication between dedicated control units,
- maximum availability [3].

3.3. Desk DKP 400

Figure 4 shows the DKP 400 workbench. This workbench model has two degrees of freedom of movement, axis A and axis B. Axis A has freedom of movement ± 90 °, while axis B has freedom of movement ± 360 °. The work of the desk is coordinated with the work of the robot [3].
With this workbench, welding of circular parts is facilitated, and hard-to-reach welding places are made more accessible. The channels on the worktop are used to attach the workpieces to the workbench.

Figure 4: Desk DKP 400

3.4. FRONIUS CMT VR 7000 welding unit

In this version of the VR 7000, the wire tank holder is located inside the device to protect the wire from dirt, external shocks and other external adverse effects. The maximum wire diameter is up to 300 mm. Figure 5 shows the welding unit, with accompanying equipment.

Figure 5: Welding unit FRONIUS CMT VR 7000 (with accompanying equipment)

The welding unit consists of:

- armored gas cylinder (1),
- wire splitter (2),
- wire power supply (3),
- power supply - electricity (4),
- cooling unit (5),
- control unit / remote control (6),
- electrode holder / robot connector (7),
- electrode tip (8).

3.5. Welding gun

In automatic (robotic) welding, the role of the gun is to direct the electrode into the arc, to conduct current to the electrode and to be a shield for the arc area. Pistols also vary depending on whether they are straight or angled. Angular guns are used for robotic welding so that they can access the weld. The welding gun is placed on the end of the robot, as a receiver. In order for the robotic welding equipment to be reliable and correct, periodic cleaning of the gun is mandatory. Figure 6 shows the FRONIUS welding gun.

Figure 6: Welding gun

4. ROBOT PROGAMMING

Of particular importance for the cost-effectiveness of robot applications in industry is the time spent on developing robotic programs for appropriate tasks. Programming involves creating a program and entering the program into a robotic controller. The program itself is a successive sequence of instructions that requires a manipulative system to perform motion cycles or work cycles. The basic division of programming procedures is into:

- direct (online) programming,
- indirect (offline) programming.

This example shows the direct programming of the KR 16-2 robot, ie the programming of the robot in the workplace. The disadvantage of this method of programming is that the robot cannot be used productively during programming.

Programming comes down to guiding the robot tools from point to point and saving those positions in the controller's memory. Entering additional motion commands, such as speed and acceleration commands or defining the type of control, allows programming of complex movements. The robot can perform three types of movements: PTP from point to point arbitrarily, LIN from point to point along the line and CIRC from point to point in a circle.

Figure 7 shows the programming plan in the welding process.

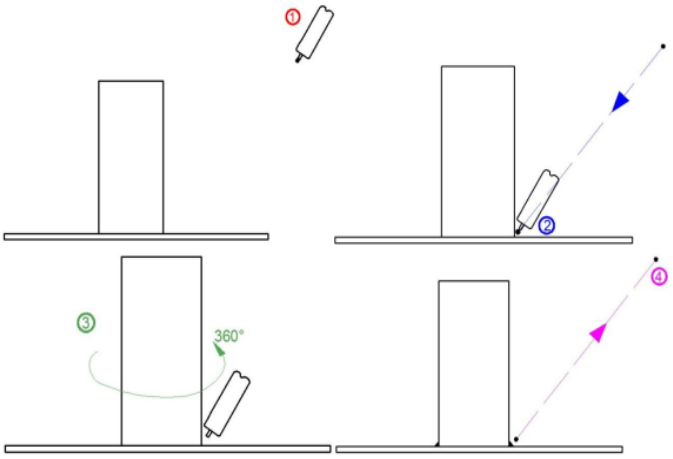


Figure 7: Programming program of KUKA robots in the welding process

4.1. Elaboration of the task

The goal of the task is to obtain a column support by robotic welding. Figure 8 shows an example of a column support. The bracket is attached to the ground with four screws, and then a pole is mounted on the bracket.

Figure 9: Example of a column girder

Figure 10 shows a column support consisting of two parts, namely the plate and the cylinder. The task is to weld the cylinder to the column plate by robotic welding.

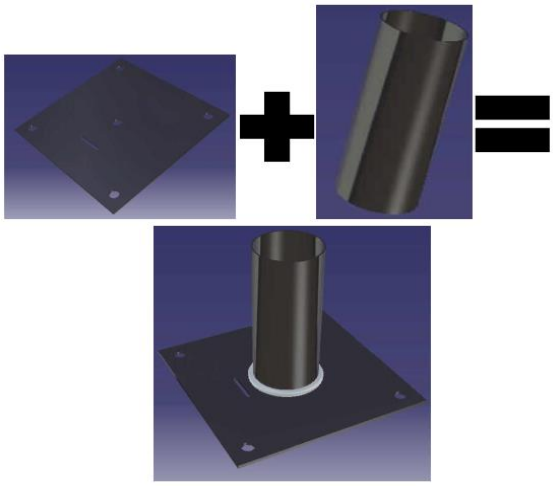


Figure 10: Stair support modeled in Catia software

To weld the column girder, it is necessary to make a welded seam in the shape of a circle that connects the cylinder to the girder plate. The support plate is to be attached to the robot's workbench. It is important that the center of the plate coincides with the axis of the table which can rotate around its axis. After placing the cylinder, in order to prevent it from moving, we must fasten it to the support plate. After that, the work table rotates around its axis and the welding process takes place.
Figure 11 shows the part of the code on the SMART PAD that was created when programming the job.

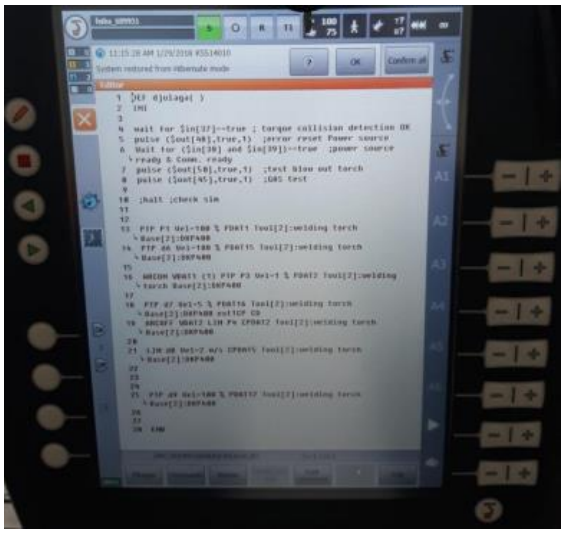


Figure 11: Part of the program code

5. ANALYSIS OF THE WELDING PROCESS

In this paper, it is shown how the KUKA robot performs welding of a cylindrical column support. Figure 12 shows the initial and final state of the welding process, ie the workpiece before welding, the process of dipping the cylinder for the bearing plate and the finished part after the welding process.

Figure 12: Analysis of the welding process (a. Placement of the workpiece, b. peeing, c. finished product)

At the initial position (Figure 12.a.), a work piece is shown attached to the work table and a cylindrical support is placed on it, which is centered with the axis of the work table. In Figure 12.b. the cylinder is piqued to the worktop, ie the cylinder is fastened so that there is no movement during the further welding process. In Figure 12.c. the state after the welding process is shown when these two elements are joined into an inseparable connection. The welding process was performed so that the work table rotated around its axis by 360 °, while the welding gun remained in the initial position it occupied after the creation of the electric arc.

6. CONCLUSION

In order to facilitate the process, increase productivity, reduce welding errors and humanize work, robotics in production plants is increasingly being approached.
The most important thing in the robotization process is to calculate well the cost-effectiveness of introducing robotics. During the welding process, gases that are harmful to human health are released, but by introducing robots, we reduce human exposure to harmful gases, and in addition, workers are protected from the possibility of injury. By applying robots in the welding process, we achieve greater productivity and precision in work, which brings us a better ranking in the labor market. In the welding process, in order for a company to do all the work on time, a large number of qualified labor is needed, which certainly creates large costs for the employer, because training for welders is very expensive and time-consuming. The robots proved to be a complete success in terms of humanity and cost-effectiveness. When we look at all things and see where the world of industry is going, we witness that every day technology is advancing more and more, artificial intelligence is becoming more common in many machines, we come to the conclusion that one day robots will find application
in all areas of life.

7. BIBLIOGRAPHY

[1] https://hr.wikipedia.org/wiki/Zavarivanje (21.02.2021)
[2] http://robotsko-zavarivanje.blogspot.com/2011/12/zasto-i-kada-koristiti-robotsko.html (25.02.2021)
[3] KUKA System Software, Operating and Programming Instructions for End Users, KUKA Roboter GmbH, 2013.
[4] https://weldguru.com/smaw-nomenclature-joints/ (21.06.2021)

VERIFICATION OF THE END POSITIONS OF THE PLATFORM AND STRUCTURAL FUNCTIONALITY FOR DIFFERENT LOAD POSITIONS

Anel Maslo[1], Mirza Manjgo[2]
1.University of Mostar, Faculty of Mechanical Engineering, Computing and Electrical Engineering
a.maslo@emka.ba, 2. Prisika d.o.o. Mostar

ABSTRACT:

The hydraulic lifting platform serves as a two-level vertical lift. By operating it, under load, ie overload, it can cause failures of parts of the structure. As a concrete example, the paper analyzes the movement of the guided mechanism and load from the aspect of load distribution on the work surface of the platform. By conducting the above, it was concluded that the constructive solution is acceptable from the point of view of load, which shows the justification of the proposed simulation approach instead of a real experiment. Load distribution on the platform as well as the position of the platform itself does not affect on the functionality of the structure.

Keywords: Working platform, finite element method (FEM), simulation, mechanism, stress-strain state.

1. INTRODUCTION

Paper is oriented in the field of "Design and exploitation". Calculations and simulations are needed to determine the correctness of the execution of functions, safety in operation and verification of possible adverse effects. An analysis of the movement mechanism, ie the trajectory of the guided point mechanisms during the raising and lowering of the platform in order to check the vertical movement, was performed. Then, the analysis of the load distribution on the work surface and in different positions of the mechanisms was performed in order to determine the critical position using the finite element method. Based on the analysis of the construction of the hydraulic lifting platform, the functionality of the platform is shown from the point of view of placing loads on different measures of the work surface and in different positions of the platform. The application of the modeling method in the construction process is a prerequisite for quality and successful construction as well as the verification itself. These methods allow minimizing the cost of testing while increasing the quality of the product itself. It is necessary to present the application of the modeling method, simulation on a practical example, ie on a hydraulic lifting platform. As it is a construction in operation, it is necessary to check the function through time savings and test costs. An analysis of the movement mechanism as well as the load of the structures in relation to the position of the load on the work platform will be performed.

2. DESCRIPTION AND CONSTRUCTION DEVELOPMENT

In the warehouse, to lift the load to a higher level, a hydraulic lifting platform has been installed, which serves as a vertical elevator on two levels. The working surface of the platform should be at the level of the warehouse floor and should be raised 3 m, ie to the first floor, so that it can be stopped in any intermediate position. The allowable load of the work platform is Q = 30000 N. The basic mechanism

that allows lifting the work surface is an articulated quadrangle with two walkers, while the other members of the mechanism are used for parallel guidance of the work platform. Due to the movable connections, plain bearings were used. Only lubrication is done through the pins, on which the lubricators are placed. The members of the mechanism are solved in the form of frames, which increases the rigidity of the structure. The frames are made of box profiles 200 x 120 x 6 mm.

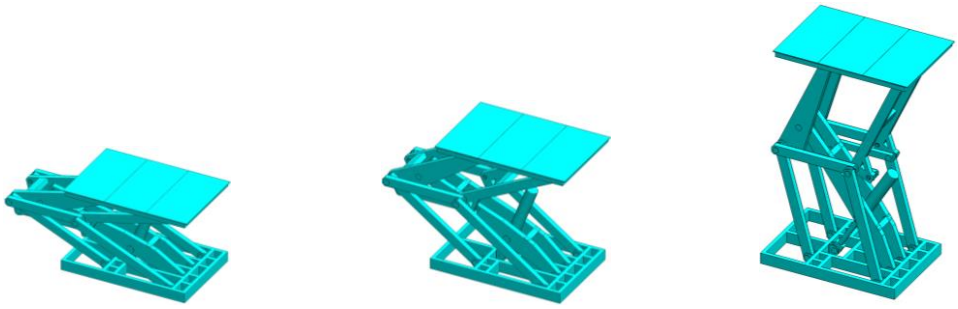


Figure 1: Platform in lower, middle and upper working position

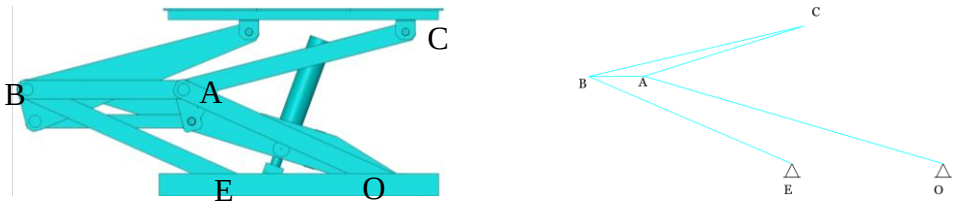


Figure 2: Schematic view of the basic mechanism of the platform

2.1. The path of the guided point "C" of the mechanism using software

If we compare the coordinates of point "C" at the very beginning of the lift and the coordinates in the maximum position, it can be seen that it deviates in the upper position by 237.41 mm in relation to the lower position along the x axis.

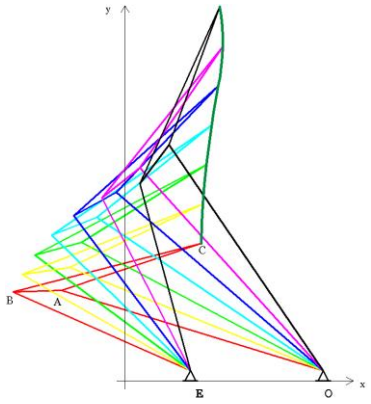


Figure 3: The path of movement of the mechanism from AutoCAD software

A motion sensor is installed in point "C" using SolidWorks software, which is used to read the coordinates of point "C" when raising / lowering the platform. Figure 4 shows the position of the sensor with the current coordinate.

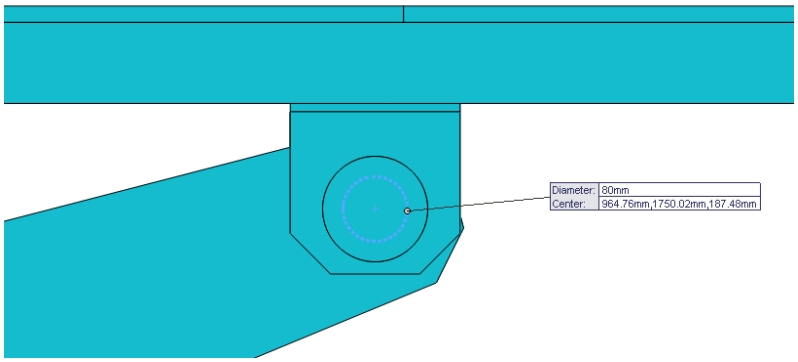


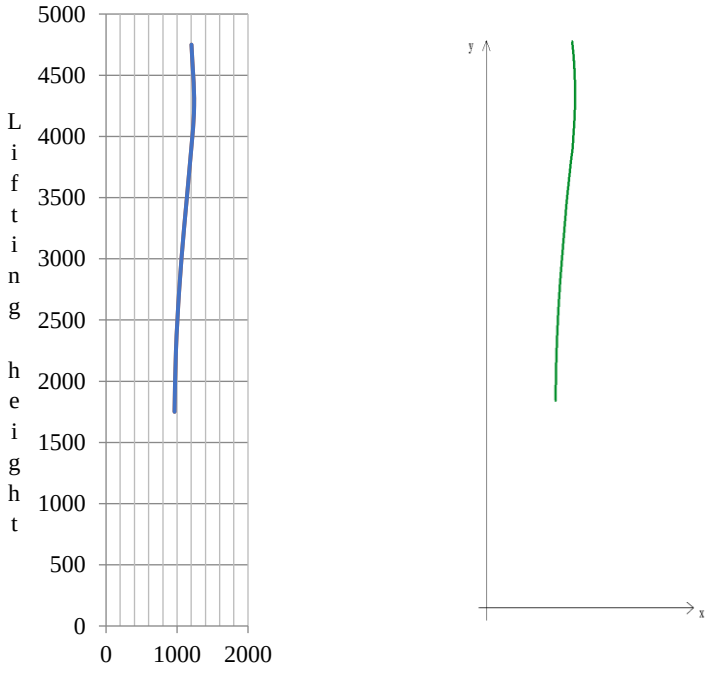
Figure 4: Position of the sensor

Main purpose is to check by simulation, the movement of the trajectory of the guided point "C" without any loads, in order to determine the functionality of the mechanism from the aspect of movement, ie to check the vertical movement of the work surface. For the analysis, 7 positions of movement of the path of point "C" were taken. The "Sensor" option in the SolidWorks CAD application reads the coordinates of point "C" for the above 7 positions (0 m, 0.5 m,…, 3 m).

Table 1: The coordinates of the point “C“

Lifting height	Coordinates of points	
	x	y
0 m	964,76 mm	1750,02 mm
0,5 m	984,66 mm	2250,02 mm
1 m	1031,09 mm	2750,02 mm
1,5 m	1099,03 mm	3250,02 mm
2 m	1177,57 mm	3750,02 mm
2,5 m	1240,84 mm	4250,02 mm
3 m	1203,40 mm	4750,02mm

Based on the coordinates of point "C", a diagram was drawn in MS Excel, Figure 5. In this way, the path of movement of point "C" was obtained during the movement of the mechanism of the hydraulic lifting platform. If we compare the coordinates of point "C" at the very beginning of the lift and the coordinates in the boundary, upper position, it can be seen that it deviates in the upper position by 238.64 mm in relation to the lower position along the x axis.



a) b)

Figure 5: Horizontal displacement of the guided point C of the mechanism – Figure 5.a the path obtained by software is shown in blue, and in Figure 5.b - in green, the path obtained graphically

In the figure 5 it is shown that path obtained by software and path obtained graphically is same.

2.2. Load distribution on the work surface

The minimum and maximum position of the mechanism is interesting, ie when the hydraulic lifting platform is lowered and when the load needs to be lifted and raised to the maximum. Depending on the position of the load on the hydraulic lifting platform, the following situations are considered when the load is placed:

a. on one side of the platform, on the side of the guided point "C" of the mechanism
b. on the other side of the platform, opposite to the guided point "C" of the mechanism
c. continuous, across the platform

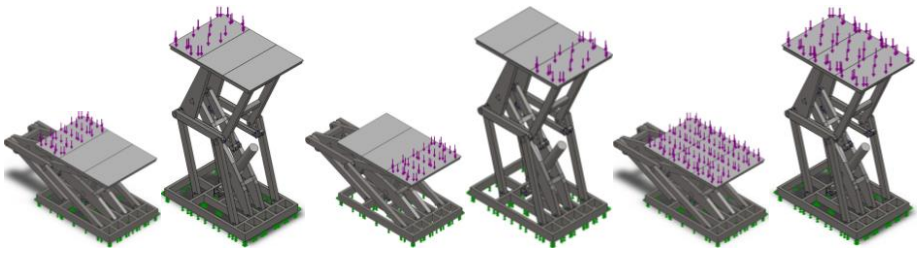


Figure 6: Position of the load on the hydraulic lifting platform for heights H = 0 m and H = 3 m

3. ANALYSIS OF THE RESULTS OF THE STRESS-DEFORMATION CONDITION DUE TO THE GIVEN POSITION OF THE LOAD ON THE WORKING SURFACE

Using SolidWorks software, an analysis of the stress-strain state of the mechanism under load was performed using FEM. A 3D model was used as input. Then, the mesh of finite elements of the triangular finite element in the shape of a triangle was made (Figure 7). Boundary conditions are also defined. The construction is tied to a pedestal that is placed in the floor of the room. The members of the mechanism are connected by articulated ligaments. The material of the mechanism members (Č.0361), place of action, mode of action and size of load are defined. After that, the calculation of stresses, deformations and displacements of the mechanism members was started.

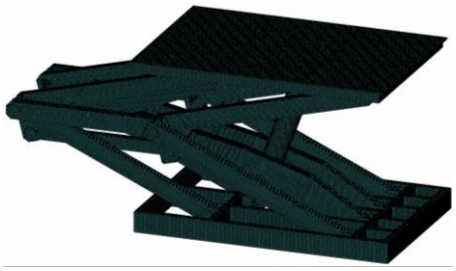


Figure 7: Finite element mesh

Figure 8 shows the stresses when the load is placed continuously across the entire platform. The highest stress is in the member of the OA mechanism at the places around point A and is 106.576 MPa ≤ 220 MPa.

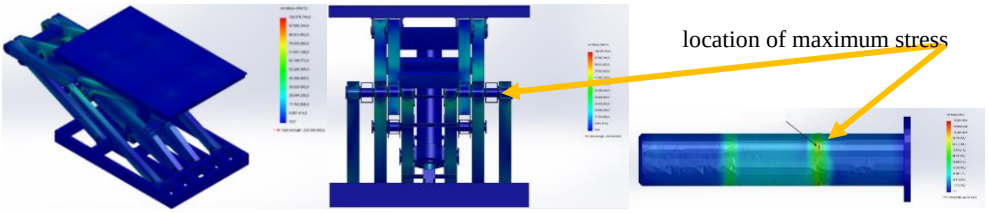
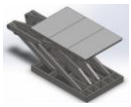


Figure 2: Stress distribution by mechanism members

Stress values depending on the position and load distribution are shown in Table 2. Based on the obtained results, it can be seen that the highest stresses are when the platform is in the lower position. It can be stated that the stresses in all positions are within the allowed limits (< 220 MPa.).

Table 2: Stress values in different positions

Platform position	Load position	Max. stress
H = 0 m 	*On the side of the guided point C*	**89.594 MPa**
	On the opposite side of the guided point C	**129.86 MPa**
	Continuously	**106.576 MPa**
H = 3 m 	*On the side of the guided point C*	**53.492 MPa**
	On the opposite side of the guided point C	**50.193 MPa**
	Continuously	**42.01 MPa**

4. CONCLUSION

The functionality of the construction is favorable regardless of the position of the load on the work surface and in different positions of the mechanism. The guided point "C" of the mechanism occupies the same starting and ending position, along the vertical axis. Load distribution on the platform as well as the position of the platform itself does not affect on the functionality of the structure. As the maximum stresses are lower than allowed and as this difference is about 40%, for future research on the use of this mechanism, optimize the work platform according to the criteria for determining the dimensions.

5. REFERENCES

[1] M. Ognjenović, Razvoj i dizajn mašina, Mašinski fakultet Beograd, 2007
[2] Adisa Vučina, Uvod u metodičko konstruiranje, Fakultet strojarstva i računarstva Mostar, 2009
[3] Mersida Manjgo, Osnovi principa konstruisanja-predavanja, Mašinski fakultet Mostar, 2008
[4] Remzo Dedić, Ibrahim Badžak, Mehanizmi-predavanja, Mašinski fakultet Mostar, 2008
[5] Senad Rahimić, Edin Šunje, Dizajniranje proizvoda, Mašinski fakultet Mostar, 2012
[6] Finite Element Method, Yijun Lie, University of Cincinnati, 2003
[7] Hubka, V. & W.E. Eder (1992) Engineering Design, Zürich: Heurista (2nd edition of Hubka, V. (1982)
[8] Bojan Kraut, Strojarski priručnik, Tehnička knjiga Zagreb, 1988
[9] Emir Humo, Safet Isić, Kvantitativne metode u inženjerstvu i biznisu, Mašinski fakultet Mostar, 2006
[10] Joko Stanić, Upravljanje kvalitetom proizvoda – Metodi I (treće dopunjeno i izmjenjeno izdanje), Mašinski fakultet Beograd, 1995
[11] Joko Stanić, Upravljanje kvalitetom proizvoda – Metodi II, Mašinski fakultet Beograd, 1991
[12] International K. Kim, Y. M. Choi, B. U. Nam, and M. G. Lee, "Dual servo stage without mechanical coupling for process of manufacture and inspection of flat panel displays via modular design approach," Journal of Precision Engineering and - Manufacturing, vol. 13, no. 3, pp. 407-412.

3D PRINTING TECHNIQUES AND TECHNOLOGIES

Dženan Bajrić
University of Bihać, Technical faculty Bihać
dzenanbajric9@gmail.com

ABSTRACT:

Additive technologies are processes of making models, prototypes, parts of molds and tools and finished products of complicated geometry in a very short time. There are different ways of production by additive processes, but they all work on the principle of adding material layer by layer.
Additive technologies and especially 3D color printing gives engineers who develop and design the product a clear insight into the design process, the ability to highlight various parameters, the ability to easily and early detect possible errors and their quick and effective removal.
Areas of application of 3D printers are: architecture, design, jewelry, informatics, education, machine industry, medicine, geo-info systems, molecular chemistry, etc. Through this paper, 3d printing techniques and technologies are presented.

Keywords: Additive, CAD, FDM, 3D print, technology.

1. 3D PRINTING AS ADDITIVE TECHNOLOGY

Additive technologies are relatively new methods of making elements, molding components of assemblies by adding materials layer by layer.
Modeling with additive technologies bypasses the entire process of processing technology because the positions are made directly from 3D models that are modeled in one of the 3D software.
Positions made with 3D printing technologies are not cheap due to the slow way of making and the price of raw materials for making models.
The first step in any additive technology process is to model the position to be created, after which the file needs to be saved in STL format where the model is converted into a large network of small triangles, this process is called model layering .After the completion of the stratification process, it is necessary to position the model on the worktop due to the higher usability of the material and the work surface, followed by the development of the model. It is very important that when positioning the model on the desktop, we take care of the correct rotation of the model due to the support that needs to be placed under certain parts of the model that do not touch the surface or do not have a support. By choosing the right positioning of the model, we save time and material, and ultimately the product itself. [8] Additive technologies are most often used for individual production, production of prototypes, replacement elements that cannot be found. The advantage of 3D printing compared to other additive technologies is that it is possible to make models in different colors, which can give product designers

and engineers insight into the process of model design, the ability to measure and highlight various parameters, insight and detection of early errors in product development. .
„The established division of additive technologies focused on product development is: RM (Rapid manufacturing) rapid product development, RT (Rapid tooling) rapid tool development, RP Rapid prototyping. “[1]

1.1. Rm manufacturing additive 3d printing technology

Rapid Manufacturing is a basic additive technology that 3D printing strives for. The goal of this technology is to obtain a functional and usable product directly from the model by 3D printing. The application of RM technology shortens the time until the product enters the market, which initially gives an advantage over conventional technologies for which it is necessary to issue processing technology. With the early launch of the product, a large part of the cake is taken on the market, which brings significant financial resources and a return on investment in 3D printing technology. RM technology has the ability to personalize and customize products according to market desires, which is certainly of great importance for the market today.
On figure 1 shows the product made with RM manufacturing technology.

Figure 1: *Example of a product obtained by RM manufacturing technology [1]*

Figure 1 shows the product of a small turbine circuit obtained by RM technology made by the SLS process. The Selective Laser Sintering process was used for fabrication due to the possibility of hardening the powder into metal and the precise fabrication of turbine blades, which in this case is impossible to process CNC.

1.2. Rt rapid tooling additive 3d printing technology

Rapid Tooling is an additive technology that is widely used in the aerospace and plastic injection molding industries where it is necessary to make tools for plastic injection molding or casting.
Figure 2 shows the product of molds for the process of injection molding of small series plastics that replace the expensive production of classic molds (tools) for plastic injection molding. „Rapid tooling has also found application in the automotive industry in the production of small tools for making plastic elements of various car models.“ [5]

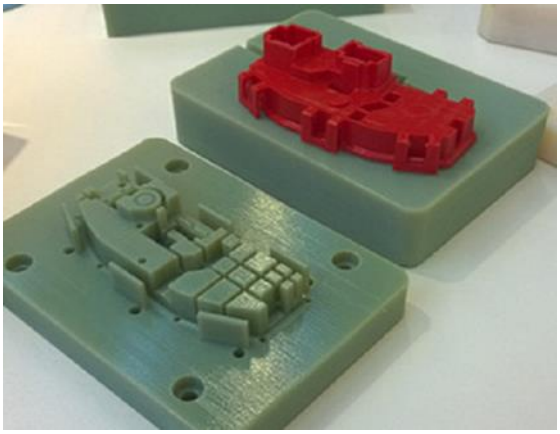


Figure 2: Product made by RT manufacturing technology [3]

1.3. Rp rapid prototyping additive 3d printing technology

Rapid prototyping procedures are increasingly used to create final models using layer-by-layer technology. These processes are most suitable for the production of small batches and complicated shapes. „The duration of the production process can be from 3 to 80 hours, which seems a lot, but if we compare it with conventional technologies where preparation and production takes a couple of months, then we come to the conclusion that RP technologies are much faster and cheaper than conventional technologies in prototyping or individual production.“ [4] Today, RP technologies are used in large global companies where there are special departments for product development using additive technologies such as 3D printing.
Figure 3 shows the product obtained by the RP process.

Figure 3: Product made by RP manufacturing technology [3]

Figure 3 shows the effectiveness of the application of RP technology where it is possible to produce a prototype in a short time, test it and place it on the market. The application of RP technology has

resulted in significant savings in material and a reduction in the weight of the element itself, which is the main goal of the designer in the manufacture.

2. DIVISION OF ADDITIVE TECHNOLOGIES

Additive technologies by material addition processes can be divided based on several criteria such as:
1. According to the method of construction of facilities, as follows:
- selective hardening
- selective sintering and melting
- selective application
- laminate construction of buildings
2. According to the method of production material, as follows:
- procedures with liquids
- procedures with powders
- procedures with solid materials
3. According to the method of application, as follows:
- rapid prototyping
- fast tool making
- fast product production

2.1. Division of procedures according to the method of model developmentr

According to the method of making the building layers of the product, the procedures can be divided into four basic types.

2.1.1. Selective hardening

Selective curing is a process in which the liquid resin solidifies by the action of a laser beam and thus forms a model. Energy air causes photopolymerization and solidification and bonding of layers to each other.
Figure 4 shows the selective curing scheme.

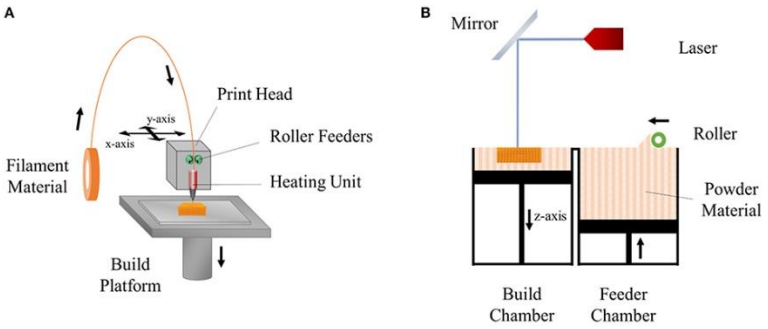


Figure 4: Selective hardening

Another way of applying selective curing is by applying UV light that acts on a precisely defined place, thus performing curing and gluing of the layers.The third way is by applying mirrors (micro-mirrors) that refract UV rays and thus solidify the model.

2.1.2. Selective sintering and melting

The selective sintering process uses laser beams to melt the powder following the contours of the object it is making. Figure 5 shows a scheme of selective laser sintering.

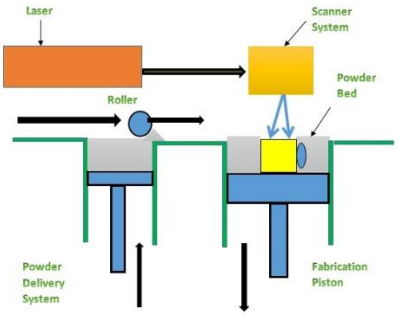


Figure 5: Selecive sintering and melting [3]

„Due to the high temperature required to be reached to dissolve the powder, infrared heaters or electric beam heating are used. Prior to exposure to the laser beam, it is necessary to apply a certain liquid that allows the laser beam to be absorbed. The application of the liquid is sprayed in the form of a cross-section of the model to be made. Today, the most modern method of selective curing is by placing apertures that rotate when the model grows and occupy a specific position that blocks the passage of UV rays.“[3]

2.1.3. Selecive application

Selective application is a procedure by which matter is directed directly to a precisely determined position and thus forms a model. According to the method of material delivery, we distinguish: drip, continuous, drip-powder application of the material.
Figure 6 shows a selective application scheme

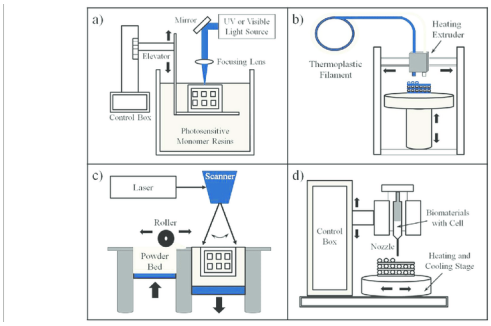


Figure 6: Selective application [3]

„When making with the drip process, the material from the nozzle is sprayed in drops and at the same time the supporting and building material for making comes out. Fabrication (FDM) by the process or application of a continuous supply of material is done in such a way that the material in the form of a

wire is brought to the head of the device where it melts and thus a model is formed. In the droplet-powder process, during the production of the model, the liquid is sprayed from the nozzle and the construction is done by passing rollers with powder. "[3]

2.1.4. Lom laminate fabrication of buildings

LOM technology uses solid materials in the form of paper as a building material, and by cutting and gluing layers, a model is formed. The precision of production depends on the thickness of the building material, with which the thickness of the layer is defined. It is necessary to cut layer by layer of building material and apply glue, after which the roller passes through the last layer of tan and thus performs the joining of layers.

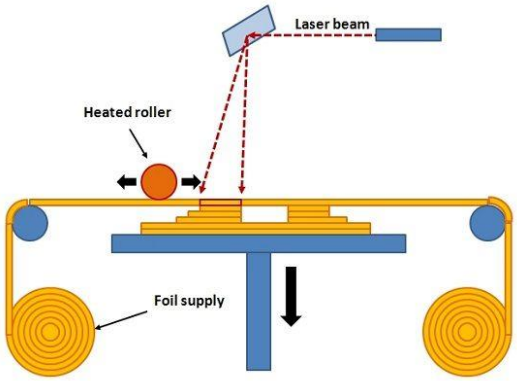


Figure 7: LOM procedure [3]

The material for the LOM process comes in a roll that is unwound and passes over rollers that are heated, after which there is a moving table where it is usually cut by a laser beam according to the cross section of the object. After applying the adhesive and moving the rollers, the platform is lowered and the next cross section is obtained.

2.2. Division of procedures according to the metho of production materijal

Liquid materials used for additive technologies are most commonly in the form of resins or photosensitive polymers that react on contact with a particular type of light. Powder processes use different types of powders which can be of different composition, eg as metal powders, nylon, polyester, etc. When applying powder processes, it is necessary to use a binder with powder. Solid material processes use materials such as plastics, peppers, foils, etc. that are cut or melted to produce the model.

2.2.1 Stereolitography

"Stereolithography is a process of making a model with liquids that uses a photosensitive resin as a building material. The process is based on photographic methods with UV polymerization. The basic parts of the stereolithography device are the laser with its optical equipment and mirrors for directing light. A very important component is also the movable platform on which the model itself is created. Figure 8 shows the stereolithography procedure." [6]
The basic part of the procedure is the action of a laser beam that is refracted over moving mirrors and follows the contour of the object in a certain layer. The initial layer is most often applied to a metal

work table, is a movable surface. After one layer is finished the table is lowered to the thickness of the next layer.

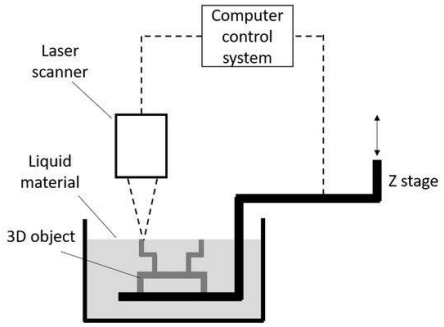


Figure 8: Stereolitography [3]

2.2.2 Selective laser sintering (SLS)

„Selective laser sintering belongs to the group of powder processes, most often used for the production of metal parts. The method is based on sintering metal, nylon, polystyrene powders. Sintering is a process that applies pressure and heat to form a model without melting the material. After one layer is completed, the table is lowered to the height of the next layer and the process is repeated. Figure 9 shows a diagram of the SLS process“. [1]

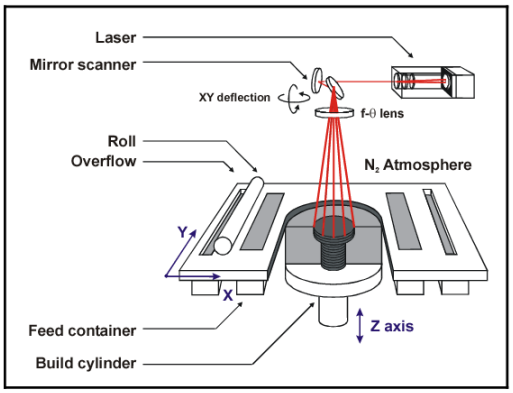


Figure 1 A typical SLS machine layout

Figure 9: Selective laser sintering

The advantage of applying this procedure is that it is not necessary to use a support material because the model is surrounded by unsintered powder. The disadvantage of this technology is that it is not possible to produce hollow completely closed models.

3. APPLICATION OF 3D PRINTING AS ADDITIVE TECHNOLOGIES

There are different ways of production by additive processes, but they all make models by adding material layer by layer. Additive processes do not require process flow planning, mold making, specific equipment for working with materials, transport between jobs, etc. The main drawback, at present, is

the restriction to only certain materials. „But as additive processes themselves are increasingly sought to be improved, today's prototypes can be used as functional ready-made models.Additive technologies, especially 3D color printing, give engineers who develop and design a product a clear insight into the design process, the ability to highlight various parameters, the ability to easily and early detect possible errors and their rapid and effective removal." [4**]**
Areas of application of 3D printers are: architecture, design, jewelry, informatics, education, machine industry, medicine, geo-info systems, molecular chemistry, etc.
It is to be expected that 3D printing will also be used in the conservation of restored works of art.

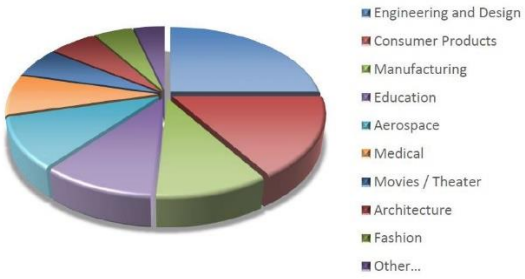


Figure 10: Areas of application of 3D printing [2]

Areas of application of additive technology are found in almost all branches, from academic institutions, consumer electronics, military industry, medical industry, etc., to branches such as art. The purpose of production can be visualization (presentation), prototyping, production of finished products, parts, tools, and mold making. Figure 10 shows the share of additive production (3D printing process) in individual branches.

4. FDM 3D PRINTING PROCESS

The FDM (Fused Deposition Modeling) process was developed by S. Scott Crump in the late 1980s and commercialized by Stratasys in the 1990s. Areas of application of the FDM procedure are found in almost all branches, from academic institutions, consumer electronics, military industry, medical industry, etc., to branches such as art. The purpose of production can be visualization (presentation), prototyping, production of finished products, parts, tools, and mold making. [1]
Figure 11 shows a schematic of the FDM procedure
In almost all FDM devices, the plastic thread is supplied via a material transfer system to a heated nozzle of a certain diameter. The heated nozzle melts the supplied material and applies it in layers. When performing the program, the nozzle moves in the direction of the X-Y axis and constantly pushes the material onto the surface. The application is done layer by layer, after the completion of one layer, the worktop is moved by the height of the layer in the direction of the Z axis, and the procedure is repeated again. When performing the process, the working surface of the printer needs to be heated due to better adhesion of the model to the substrate. Since the material is fed directly into the nozzle, there is a small amount of unused material. „The most commonly used material in the FDM process is ABS (Acrylonitrile Butadiene Styrene), which is a very light, durable and surprisingly strong material that has made it the first choice in the plastics industry." [5]
Melting of plastic in the FDM process is done in a heating chamber where the material is introduced in the form of a wire

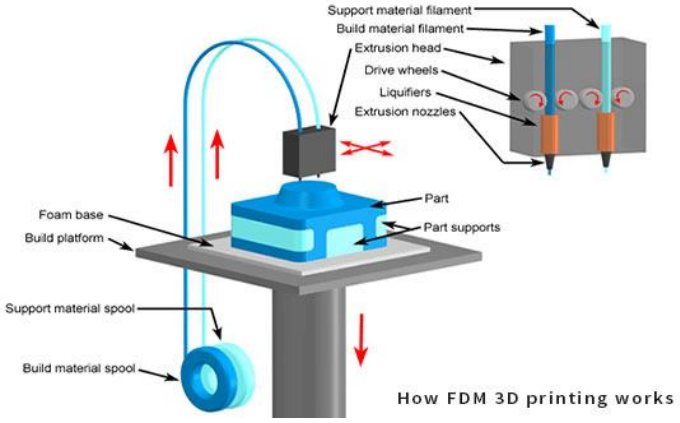


Figure 11: FDM 3D printing process [8]

. The material is pressed into the chamber by means of a set of gears which ensure a constant flow of material [2]. The nozzle through which the molten material exits follows the contours of the model. [1]

4.1. Application of FDM process

The production of tool parts and molds is applied to products of lower precision where there are no narrow tolerances, because the application of the FDM process cannot achieve the appropriate dimensional accuracy for the production of high-precision products. However, it is used in the medical industry for the production of molds for the production of bone replacement parts, but it is not possible to print metal parts such as replacement hips or tooth implants. In medicine, it is most often used in the dental branch, where molds for plastic dentures are made using the FDM procedure. Figure 12 shows the percentage of application of FDM technology by industry.

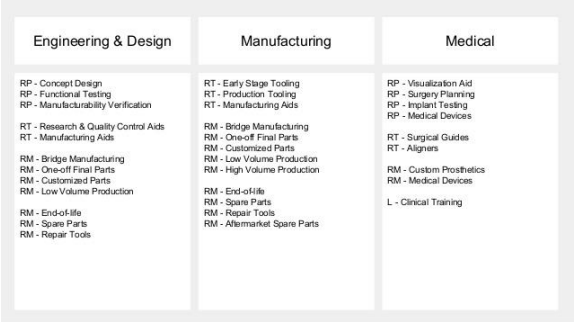


Figure 12: Areas of application of the FDM procedure

„In the academic part, the FDM procedure finds the greatest application because it is acceptable for the price, quality and size of the device. Devices for the FDM process are generally affordable for academic institutions for a number of reasons because of their size and weight they are easily portable and mobile on the other hand they are very affordable. For academic purposes, they are used as a basis for getting acquainted with additive technologies in all branches, while they are mostly used in mechanical engineering, construction, electrical engineering“. [6]

FDM devices have even found their application in construction where they are used for making models, visual representations of buildings, structures, etc. Large construction companies are developing laboratories with 3D printers that use the FDM process because of visual prototypes of buildings that show customers. for the production of models for presentation in buildings, the FDM concrete printing procedure has been applied for some time for the production of functional buildings such as bridges

5. CONCLUSION

Given the development and achievements, it is obvious that additive technologies IV. Industrial revolution - the application of 3D printers can be found in almost all branches of industry, especially mechanical engineering. Manufacturing processes by additive technologies are applied to models in which the manufacturing process by conventional methods is complicated or impossible. Great progress has been made in the application of additive technologies for medical purposes where the creation of vital organs is sought. The application of additive technologies, according to experts, has a bright future, not only as a commercial technology for the production of prototypes and finished products, but also in everyday life. Additive technologies have an increasing scope of application and a wider range of different materials for production, which contributes to its spread. The development of 3D printers or additive technologies has a similar way to the Internet where, in addition to scientists, users also participate in the development of new printer models, new materials, etc. Today, additive technology is used mainly for prototyping or individual production of complicated parts In the future, additive technology or 3D printing will find application in the direct production of functional assemblies.

6. REFERENCES

[1] Barešić V. (2016). Izrada FDM uređaja. undergraduate thesis University Karlovac
[2] Budimir I. (2015) 3D printeri, undergraduate thesis University Rijeka
[3 Edina Karabegović, Miran Brezočnik, Mehmed Mahmić i dr.: Nove tehnologije u proizvodnim procesima (Razvoj i primjena), Faculty of Mechanical Engineering in Mostar University of Mostar, Bosna i Hercegovina, 2014, ISBN 978-9958-058-02-8, COBISS.BH-ID 21640454.
[4]Ognjanović, M. (2007) Razvoj i dizajn mašina, Mašinski fakultet Beograd, ISBN 978-86-7083-603 , Beograd
[5] Vidović R.(2016) Digitalno proizvodnja, (2016) završni rad graduate thesis, Faculty of Architecture in Zagreb
[6] V. Hammer (2015) Procesni pristup tehnologiji 3D printanja, graduate thesis, University of Zagreb
[7] Z. Hercigonja T. Krištof.(2019) Postupci brze izrade prototipova u trodimenzionalnom ispisu.professional worrk International Journal of DIGITAL TECHNOLOGY & ECONOMY
[8] https://zir.nsk.hr/islandora/object/vuka:1144/preview (maj 2021)

CHEMICAL COMPOSITION OF WELDING FUME PARTICLES IN WELDING WITH HIGH-ALLOY ELECTRODES

Razija Begić
Faculty of Technical Engineering, University of Bihać, Bihać, Bosnia & Herzegovina
razijabegic@yahoo.co.uk

ABSTRACT:

During the welding process, chemical processes take place, related to the change of the chemical composition and structure of the material, initiated after the establishment of the electric arc and the development of high temperature in the electric arc. Chemical processes are related not only to changes in the composition and structure of substances that participate in them, but also to changes in the energy of the reaction system. The energy of an electric arc is transformed into various forms such as heat, light and radiation. All these phenomena are an integral part of the complex process of arc welding processes. For the purposes of this experiment, two variants of one rutile Cr-Ni commercial electrode, designated E 23 12 2 LR 12, were designed and fabricated. In order to show the influence of base and additional material on the chemical composition of welding fume particles, welding fume particles were collected in the welding chamber. Two types of base material were used, stainless steel X6CrNiTi18.10 and low carbon general structural steel S235JRG2. Chemical analysis of welding fume particles was performed for 13 chemical elements, by the AAS method, one of the methods of analytical chemistry. Testing of the chemical composition of welding fume particles is necessary to examine and determine the degree of toxicity to humans and the environment [1].

Keywords: MMAW, high alloy coated electrodes, welding fumes, particles, AAS, chemical composition

1. INTRODUCTION

Testing of the chemical composition of WF particles is necessary to examine and determine the degree of toxicity to humans. Qualitative and quantitative analysis of the chemical composition of WF particles can be determined using the methods of analytical chemistry. There are several techniques for analyzing the chemical composition of particles, and thus WF particles. The paper presents the results of chemical analysis of WF particles obtained by the AAS (Atomic Absorption Spectrometry) method. In addition to the AAS method, there are a number of other methods for chemical analysis of WF particles, such as SEM-EDS spectroscopic methods (Energy Dispersion Spectroscopy - Raster Electron Microscopy), XPS (X-ray Photoelectron Spectroscopy), AES (Auger Electron Spectroscopy, and Auger Electron Spectroscopy), [2,3,4,5,6].

For the purposes of this experiment, two electrodes of the Cr-Ni type were used, made according to a predetermined composition of the lining and core in the laboratory of the factory for the production of additional welding material "ELEKTRODA ZAGREB", marked A and B. Electrodes A and B represent

two variants of one commercial electrodes, designations E 23 12 2 LR 12. After tests carried out, it was found that both electrodes give a quality weld. Electrode E 23 12 2 LR 12 is a rutile coated electrode intended for welding identical and similar stainless steels and for mutual welding of dissimilar steels in MMAW welding process To show the influence of the base material on the chemical composition of particles .10 and low carbon general structural steel S235JRG2. [1,7].

The standard EN ISO 14343 prescribes the quality of the chemical composition of the drawn wire from which the electrode core is made. Two types of wire, marked 316 L and 308 L, purchased from the wire manufacturer "Rodacciai" Italy, were used to make the core of the laboratory electrodes. The precondition for performing this experiment was to make a functional welding chamber for the production and collection of WF particles in which welding will be performed, which was done according to EN ISO 15011 and described in the preliminary experimental part of the doctoral thesis [1,8,9] .

2. CHEMICAL COMPOSITION OF WF PARTICLES IN HIGH-ALLOY ELECTRODES

The most influential alloying chemical elements in electrodes A and B are: Mn, Mo, Cr and Ni. The alloying elements, Cr, Ni, Mn and Mo, contained in electrodes A and B have higher melting and evaporation points and begin to evaporate at higher temperatures which increase with increasing current. Each chemical element has a different melting and evaporation point, and conditions for creating chemical reactions with welding consumers, which significantly affects the chemical composition of WF particles and is a function of the strength of the welding current. As part of the experiment to determine the chemical composition of WF particles, according to the plan of the experiment, 16 tests were made, Table 1 [1].

Table 1: Experimental plan for chemical analysis of WF particles

ser. nmb. of the sample	Electrode / wire designation	Basic material	Test mark
1.	Electrode A žica 316 L	X6CrNiTi18.10	A1
2.			A2
3.			A3
4.			A4
5.		S235JRG2	A5
6.			A6
7.			A7
8.			A8
9.	Electrode B žica 308 L	X6CrNiTi18.10	B1
10.			B2
11.			B3
12.			B4
13.		S235JRG2	B5
14.			B6
15.			B7
16.			B8

2.1. Results of chemical analysis of WF particles

Chemical analysis of WF particles was performed for 13 chemical elements, using the AAS method. The results of the chemical analysis, as well as the mean values of the contents for four samples each, for electrode A are shown in Table 1, and for electrode B in Table 2 [1].

Table 1: Results of chemical analysis of WF particles for electrode A

CONTENT OF CHEMICAL ELEMENTS IN PARTICLES %											
ser. nmb.	Ch. el.	elekctrode A									
		X6CrNiTi18.10					S235JRG2				
		A1	A2	A2	A4	**$\overline{A2}$**	A5	A6	A7	A8	**$\overline{A1}$**
01.	Ca	0,010	0,040	0,010	0,009	**0,0173**	0,010	0,040	0,020	0,0300	**0,025**
02.	Mg	0,300	0,600	0,420	0,390	**0,4275**	0,270	0,360	0,330	0,3700	**0,333**
03.	K	6,580	5,920	6,890	5,940	**6,3325**	5,470	5,960	6,150	5,4300	**5,753**
04.	Na	2,720	4,080	3,290	2,970	**3,265**	2,340	3,200	2,510	3,0300	**2,770**
05.	Fe	4,350	4,900	3,960	3,890	**4,275**	4,000	4,360	4,000	3,8700	**4,058**
06.	Cu	0,030	0,040	0,030	0,030	**0,0325**	0,020	0,030	0,020	0,0200	**0,023**
07.	Mn	2,800	2,300	2,840	2,820	**2,69**	2,700	2,310	2,800	2,4500	**2,565**
08.	Zn	0,070	0,070	0,060	0,050	**0,0625**	0,030	0,050	0,030	0,0300	**0,035**
09.	Cr	9,850	10,50	14,00	13,32	**11,918**	8,060	10,09	11,28	9,8700	**9,825**
10.	Cd	0,001	0,002	0,001	0,001	**0,0013**	0,001	0,001	0,001	0,0008	**0,001**
11.	Pb	0,058	0,068	0,061	0,058	**0,0613**	0,043	0,052	0,045	0,0480	**0,047**
12.	Ni	0,051	0,042	0,034	0,032	**0,0398**	0,046	0,039	0,038	0,0350	**0,040**
13.	Co	0,002	0,001	0,000	0,001	**0,001**	0,002	0,001	0,002	0,0020	**0,002**

Table 2: Results of chemical analysis of WF particles for electrode B

CONTENT OF CHEMICAL ELEMENTS IN PARTICLES %											
ser. nmb.	Ch. el.	electrode B									
		X6CrNiTi18.10					S235JRG2				
		B1	B2	B3	B4	**$\overline{B2}$**	B5	B6	B7	B8	**$\overline{B1}$**
01.	Ca	0,020	0,030	0,030	0,020	**0,025**	0,040	0,020	0,0600	0,0400	**0,04**
02.	Mg	0,310	0,350	0,310	0,320	**0,323**	0,390	0,400	0,3500	0,3700	**0,378**
03.	K	7,200	7,670	7,450	5,880	**7,05**	6,680	7,970	5,7600	7,0200	**6,858**
04.	Na	2,420	2,470	2,500	2,110	**2,375**	2,260	2,640	2,5600	2,3700	**2,458**
05.	Fe	3,600	3,730	3,520	4,180	**3,758**	4,070	4,060	3,8000	4,0600	**3,998**

06.	Cu	0,020	0,020	0,060	0,080	**0,045**	0,030	0,030	0,0800	0,0900	**0,058**
07.	Mn	2,520	2,500	2,570	3,200	**2,698**	2,530	2,630	2,3500	2,7100	**2,555**
08.	Zn	0,050	0,050	0,090	0,050	**0,06**	0,070	0,070	0,1600	0,1000	**0,1**
09.	Cr	5,440	5,140	6,600	7,630	**6,213**	5,600	6,300	5,8000	7,1500	**6,203**
10.	Cd	0,001	0,001	0,001	0,001	**0,001**	0,001	0,001	0,0005	0,0009	**0,001**
11.	Pb	0,039	0,040	0,035	0,033	**0,037**	0,047	0,046	0,0430	0,0400	**0,044**
12.	Ni	0,029	0,029	0,036	0,037	**0,033**	0,034	0,032	0,0280	0,0310	**0,0313**
13.	Co	0,001	0,001	0,001	0,001	**0,001**	0,001	0,001	0,0010	0,0010	**0,001**

The weight of one sample consists of the amount of WF particles generated by welding with three coated electrodes by the MMAW. The strength of the welding current was identical for all samples, it was I = 95 A, the diameter of the electrodes was Ø 3.25 mm [1].

2.2. Analysis of WF particle results for Cr, Mn and Ni

The most influential alloying chemical elements in high-alloy electrodes are Mn, Mo, Cr and Ni, whose percentages in the coating, wire core and electrodes A and B are known. The contents of Cr, Mn and Ni are known in pure weld metal. For this reason, a graphical representation of Cr, Mn and Ni content in WF particles is given depending on the content of these chemical elements in the coating and core of electrodes A and B. Dependence of Cr percentage in WF particles on Cr percentage in coating, core and electrodes for electrodes A and B, for two types of base material X6CrNiTi18.10 and S235JRG2 is shown in the diagram (Figure 1) [1].

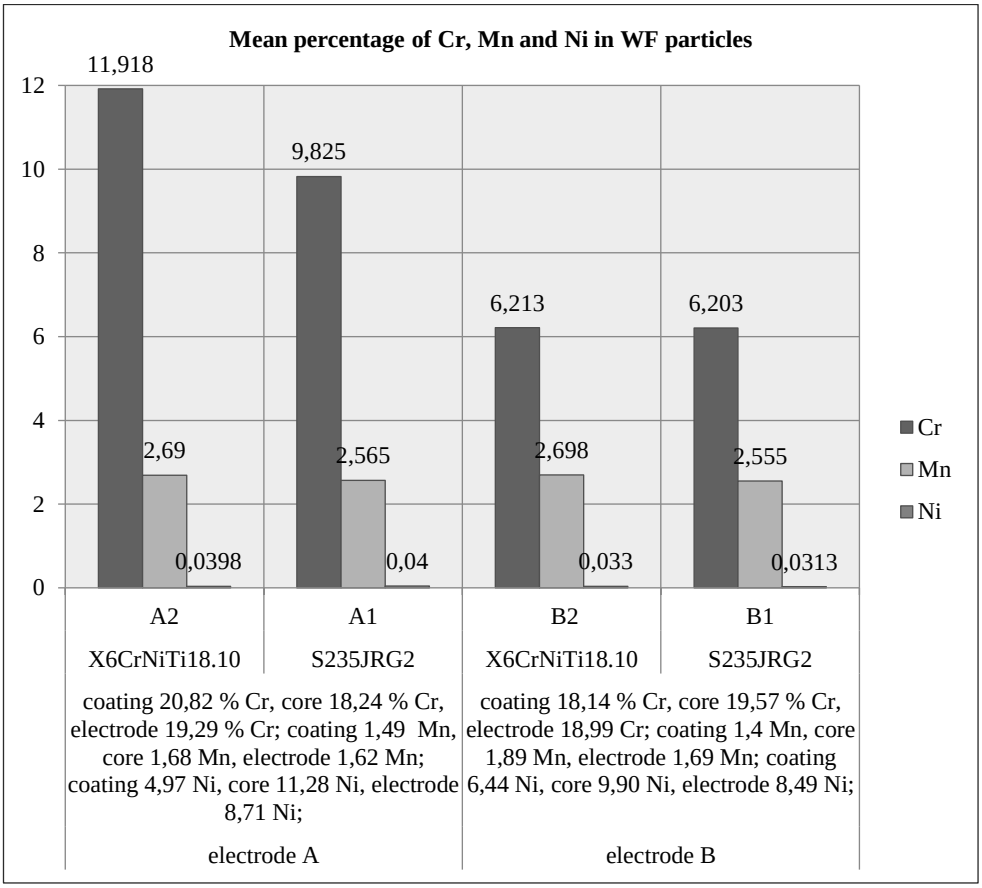


Figure 1: Mean percentage of Cr, Mn and Ni in WF particles

From Tables 1 and 2, on the basis of which the diagram shown in Figure 1 is made, it can be seen that WF particles formed by welding with electrode A contain a higher amount of Cr, compared to the amount of Cr in fume, particles generated by welding by electrode B. According to recent studies, arc welding processes are again proving to be processes with a high level of danger to human health. These results help to improve our understanding of the risks that these surgeries pose to human health and should increase the need to control and mitigate them. The introduction of 3D modeling of the dispersion of the particle size of WF, during the welding arc, proved to be a suitable method for their characterization [1,10].

The mean Cr content for electrode A, (Table 1), and the base material of high-alloy steel is 11.92%, while the mean Cr content for electrode A and the base material of low-carbon steel is 9.825%. The mean Cr content for electrode B, (Table 2), and the base material of high-alloy steel is 6.213%, while the mean content of Cr for electrode B and the base material of low-carbon steel is 6.203% [1].

The reason for this is that electrode A has a higher Cr content in the coating (20.82%) compared to the coating of electrode B (18.14%). At the same time, the Cr content in the wire core is lower for electrode A (18.24%) compared to electrode B (19.57%). Also, the Cr content is higher for electrode A (19.29%) compared to the Cr content in electrode B (18.99%) [1].

Also, the level of Cr content in WF is slightly higher when welding high-alloy steel X6CrNiTi18.10, with both types of electrodes, compared to welding low carbon steel S235JRG2, which shows the influence of chemical composition of the base material on the chemical composition of WF particles [1].

The mean contents of other chemical elements in the WF particles generated by welding during electrode A and electrode B are given in Tables 1 and 2 [1].

The percentage contents of Mn in the electrode coating, the electrode core and the electrodes do not differ much, so that the differences in the results of the Mn content in the WF particles for electrodes A and B are not large [1].

The mean Mn content for electrode A, (Table 1), and the base material of high-alloy steel is 2.69%, while the mean Mn content for electrode A and the base material of low-carbon steel is 2.57%. The mean Mn content for electrode B, (Table 2), and the base material of high-alloy steel is 2.70%, while the mean Mn content for electrode B and the base material of low-carbon steel is 2.56% [1].

Higher Mn contents in fume particles are present in both electrodes when high-alloy steel is used as the base material. There is no significant difference between the Mn content in the fume particles for electrodes A and B, since the differences in the Mn content in the coating, core and electrode are also insignificant [1].

The mean Ni content for electrode A, in fume particles (Table 1), and the base material of high-alloy steel is 0.04%, while the mean content of Ni for electrode A and the base material of low-carbon steel is the same 0.04%. The mean Ni content for electrode B, (Table 2), and the base material of high-alloy steel is 0.03%, while the mean content of Ni for electrode B and the base material of low-carbon steel is the same 0.03% [1].

The percentages of Ni in the electrodes A (8.71%) and B (8.49) do not differ much, so that the differences in the results of the content of Ni in the welding particles for the electrodes A and B are not large. The Ni content in the fume particles for electrode A (0.04%) for both base materials is slightly higher than the Ni content in the fume particles for electrode B (0.03%), also for both base materials. The Ni content is slightly higher in electrode A. The Mo content has not been analyzed in WF particles [1].

3. CONCLUSION

The MMAW welding process generates a large amount of welding fumes. Often the conditions in which the application of this welding procedure is necessary are bad for the welder, who cannot always apply the necessary self-protection measures. Higher values of welding fume production do not mean a greater danger to the health of welders. The real danger is the unauthorized amount of harmful ingredients in the particles of welding fume, which can be determined by chemical analysis of the particles. Tests of the chemical composition of welding fume particles are aimed at finding the most favorable ratio of the main components of the electrode, especially the electrode coating, which will give the lowest production of welding fume particles and the lowest content of harmful components in welding fume particles. people and the environment, while meeting all technological and economic requirements. Among other chemical elements, chemical compounds and gases that can be found in welding fume, the greatest harmful effect on the health of welders, among others, have the chemical elements Cr, Mn, Ni and Mo. For that reason, chemical analyzes of welding fume particles for these chemical elements were performed. The most harmful chemical element is Cr, it gladly forms chromates with other chemical elements and it is easier to go into slag and welding fume. Increasing the Cr content in the electrode (core and coating) increases the Cr content in the welding fume particles

for both basic materials. Significantly higher amount of Cr in welding fume particles is if the base material is welded from high-alloy steel which has (17 to 19)% Cr in its composition. A higher amount of Cr in the welding fume particles is for electrode A, which has a higher content of Cr in its composition. Electrode A has 19.29% Cr (core and coating), electrode B has 18.99% Cr (core and coating). Nickel is not prone to oxide formation and there is not much of it in the slag and particles of welding fume, so it mostly turns into welding. Content Nor in welding fume particles has similar values for electrode A and B, the base material has no significant effect on the chemical composition of the particles. The largest amount of Ni is generated from the electrode (core and coating). The results of chemical analysis of welding fume particles for some chemical elements showed that most of the components are generated from the electrode coating during the welding of alloy steel. The complex issue of welding flue generation requires further research and interactive action of electrode components and welding parameters during the welding process, in order to be able to influence the output size, production and chemical composition of fume
particles with greater certainty.

4. REFERENCES

[1] Begić R., Investigation of the optimal technological composition of the electrode coating from the aspect of minimizing welding fume, Doctoral thesis, Faculty of Mechanical Engineering, University of Bihać, 2011.
[2] Begić R., Imamović A., Oruč M., Chemical analysis of welding fume particles by AAS and SEM-EDS methods, IX Scientific / professional symposium with international participation "METAL AND NON-METAL MATERIALS" Zenica, B&H, 23-24. April 2012.
[3] V. Tomović, Basic principles of atomic absorption spectrometry, november, 2009.
[4] Goldstein, J.; Newbury, D. E.; Joy, D. C.; Lyman, C. E.; Echlin, P.; Lifshin, E.; Sawyer, L. C.; Michael, J. R., Scanning Electron Microscopy and X–ray Microanalysis. Springer Science: New Yourk, 2003; Vol. 3.
[5] Briggs, D.; Grant, J. T., Surface Analysis by Auger and X–ray Photoelectron Spectroscopy. 1st ed.; 2003.
[6] Briggs, D. Seah, M. P., Practical Surface Analysis: Auger and X–Ray Photoelectron Spectroscopy. 2nd ed., 1996.
[7] Catalog of additional factory material „ELEKTRODA ZAGREB“, 2018.
[8] Rodacciai, Certificato di collaudo, Italia, 05.2008.
[9] EN ISO 15011-1, Health and safety in welding and allied processes-Laboratory method for sampling fume and gases generated by arc welding-Part 1: Determinaton of emission rate and sampling for analysis of particulate fume, april 2002.
[10] K. Yu. Kirichenko1, A. I. Agoshkov1, V. A. Drozd1, A. V. Gridasov1, A. S. Kholodov1, S. P. Kobylyakov1, D. Yu. Kosyanov1, A. M. Zakharenko 1, A. A. Karabtsov2, S. R. Shimanskii3, A. K. Stratidakis5, Ya. O. Mezhuev4, A. M. Tsatsakis5,1 & K. S. Golokhvast1, Characterization of fume particles generated during arc welding with various covered electrodes, november 2018, www.nature.com/scientificreport.

SECTION/SEKCIJA
B

OPTIMIZATION OF TEHNOLOGICAL PROCESS BY ANALYSIS OF EXISTING SITUATION OF PRODUCTION PROCESS

Elvin Okugić[1], Milan Jurković[2]
[1]Univerzitet u Bihaću, Tehnički Fakultet Bihać, Ul. Dr. Irfana Ljubijankića bb, 77 000 Bihać, Bosna i Hercegovina
email: elvin.okugic@gmail.com[1]
[1]Univerzitet u Bihaću, Tehnički Fakultet Bihać, Ul. Dr. Irfana Ljubijankića bb, 77 000 Bihać, Bosna i Hercegovina
email: mi.jurkovic@gmail.com[2]

ABSTRACT:

The main goal of the research in this paper is the analysis and optimization of the technological process of production in the company SANI GLOBAL with the aim of finding measures for improving and enhancing the process. These measures should enable the improvement and optimization of the technological process of production, and the result will be a reduction in production costs, increased labor productivity and utilization of production capacity and raw materials. The paper explains the analysis of the existing state of the production process, which is applied in a way to analyse the existing state of the production process, to identify problems in the production process and bottlenecks and finally to apply the optimization procedure by analyzing the existing state.

Keywords: optimization, process, tehnology, wood procesing, analysis

1. INTRODUCTION

In engineering, optimizing means finding the maximum or minimum of given goal or goals within a certain limit. Restrictions can be as different as they are available resources, quality level, inability to invest, etc. Optimization is not tied only with engineering, so it can be said that people also in everyday life constantly optimize, although they are not always aware of it. Finding the right way of allocating and plan for spending income is a good example of daily optimization. Sequence of performing jobs is usually determined on the basis of some criteria (minimum time, minimum costs, etc.). Unlike general optimization, the engineering optimization process requires systematic search for the optimal solution of the engineering problem, in accordance with the objective function and within the permissible range of solutions that determine the various constraints. With the mentioned optimization method, there are a number of different methods of process improvement that can successfully optimize the production process. Some of them are: Six sigma, Reengineering of business processes, Lean management, Kaizen, Benchmarking, Process of Business reengineering, etc. The optimization of the technological process affects the work of the company and contributes to the company in a way that the company has numerous benefits from optimization. Process optimization increases business productivity, which is very important because of competition. This paper presents ways to increase the productivity of the company by optimizing the production process, taking into account all the issues in the analysis of the current state of the production process. Regardless of the size of the company, effective company management is extremely important. With effective management, all operations and processes are performed without downtime and this should be the daily activity of every company. Production optimization is the constant introduction of new methods of work that improve the production process. Increased market demands and the need for quality products create the need to optimize the production

process while consuming the optimal amount of raw materials and applying available resources. [2]

2. COMPETITIVE ADVANTAGE AND REDUCTION OF OPTIMIZATION COSTS OF TECHNOLOGICAL PROCESS

The process of manufacturing wood products is a continuous process that is determined by a high level production, high costs, continuity of production and high energy costs. Costs of energy are extremely high, and can reach up to 60 % of total production costs. Because the most optimization methods have goal to reduce production costs, it is evident that optimization processes in the wood industry will seek to reduce production costs and thus total production costs. By reducing production costs in the company, competitive advantage grows. A very important activity in the process of cost reduction is identifying the places where unjustified spending or energy loss occur. Although technology itself very often determines energy loss, it is important to try to use at least part of that energy, and thus raise the efficiency of production process. Elimination of losses should not be limited only to energy, but it should be applied to all existing resources. In the wood industry and in wood products and wood materials in general, the method of analysis of the existing condition can be applied because that method continuously improves the processes, based on the measurement of key parameters and detailed analysis. By the method of analysis of the existing condition, the desired quality is achieved, it also reduces variability of process and aims to meet customer requirements and desires and reduces losses of energy. The main recommendations for reducing costs in Sani Global company are optimal electricity consumption, especially for machines that consume the most electricity, such as a horizontal band saw in primary wood processing. It is recommended that the primary wood processing is performed during the lower electricity price and the installation of frequency converters on bigger electric motors. This could reduce electricity consumption by 6 %, ie the total production costs would be lower. An important measure to reduce costs is maximum use the most of logs. Sawing logs produces the sawdust waste. The largest amount of sawmill waste is produced during the sawing of logs in sawmills, ie when sawing with a band saw. This does not refer to sawdust as sawdust residue but to the edges of the log. This approach does not use the entire log and unnecessarily neglects the part of the log that becomes sawmill waste. It is also recommended to reduce the time for operations that lasts long. In this case, the operation of drying wood boards, which lasts 30 days, was chosen. In this case, laboratory tests are very useful. It is recommended that wood boards samples from the company be sent to a laboratory testing in order to test whether the drying can take less time but without losing the physical and mechanical characteristics of the wood. By reducing the drying time, the total production time is also reduced. Further recommendations for the optimization of the technological process are the introduction of CNC machines and quality control. In order to better organize the production, it is recommended to introduce the Kaizen and Just in time method. Both methods recommend involving all employees in the work, proposing optimization solutions, shortening the transition time from one operation to another, etc., which can significantly reduce costs and increase the competitive advantages of the company. [1][2]

3. ANALYSIS OF CURRENT STATE OF PRODUCTION IN "SANI GLOBAL" d.o.o. Bihać

The production process in the company "Sani Global" d.o.o. Bihać is divided into several separate production sections, so the processes are analyzed separately, and they are as follows:

- production of massive panels,
- production of beech plywood,

- production of wood elements and panels for workbenches.

This paper refers to the production of massive panels.

3.1. Production of massive panels

Production of massive panels in the company "Sani Global" d.o.o. Bihać takes place in production plant, and the production plant consists of the following phases: 1. Log yard, 2. Primary sawmill, 3. Secondary sawmill, 4. Administration building, 5. Space for sorting and stacking sawn timber, 6. Wood steaming chamber, 7. Drying kiln and 8. Auxiliary hall that serves as a storage room and for tool sharpening.
Figure 1. shows a massive panel that is produced in the production plant of company Sani Global d.o.o. Bihać, which contains the following characteristics (Table 1.).

Figure 1: Massive panel [1]

Table 1: Characteristics of massive panels

Big products	Length and width joined panels	Width-joined panels
Type of wood	Beech, Oak	Beech, Oak
Thickness	18, 20, 25, 40, 45 mm	20, 25, 40, 45 mm
Length	Up to 5000 mm	Up to 3000 mm
Width	Up to 1250 mm	Up to 700 mm
Width of lamellae	20 to 42 mm	40 to 72 mm
Quality	A/B, B/B and Kern	A/B and Kern
Humidity	8 % ± 2 %	8 % ± 2 %
Gluing	DIN EN 204 / D3 or D4	DIN EN 204 / D3 or D4
Finishing	On request	On request

All these phases need to be carefully performed in order to obtain a quality massive panel that meets the requirements and wishes of customers.The analysis of the phase of the technological process of the company that was carried out identified several functional problems. Numerous irregularities were identified due to poor organization of the production process. The biggest problem was discovered in the primary sawmill, ie in the primary processing of wood when sawing logs into boards. Primary processing is performed on one horizontal band saw. This phase is not performed according to standard procedures which causes problems. Wood boards are often not subjected to quality control because the logs have natural defects (defects in structure, defects in color and consistency of wood and defects from insects). Boards with such wood defects unnecessarily increases the company's costs and are often the reason for delayed delivery to customers. In addition, the company does not control the quality of materials or raw materials from which solid boards are made. Materials (logs) without previously performed quality controls are forwarded to the primary processing of wood where the logs are sawn into the boards. After the log is sawed into boards, boards are sorted and stacked, and than dried in a dryer, followed by secondary wood processing. In primary wood processing, there is another problem that interferes regular functioning of the technological process. This problem is frequent downtime of band saw which cause disturbances in the whole technological process, and the waiting for the repair of machines is relatively long. It was also noted that the company has no spare parts so that machinery and equipment can be repaired quickly after a breakdown. In addition, there are no instructions for use for all machines and equipment located in the company. Machine downtime slows down production, time is wasted, and one of the goals of optimization is production in the shortest possible time. Another problem with a band saw is that the sawdust is not completely sucked out. By sawing the logs, the sawdust goes through the suction hose for further processing, but not all sawdust. A significant amount of sawdust still remains on the band saw. One of the problems in the company is the drying of the boards. Drying is an important phase of the technological process, and the biggest problem is that drying takes too long. Due to this, the production will last longer. The company did not test the quality of glued joint in tension for finger jointing of elements, and also company did not test the quality of the glued joint for edge jointing. These two glued joints are extremely important for achieving the quality of the final product. Achieving product quality is one of the goals of optimization. In the analysis of the existing state of the process, it was noticed that the elements are often of badly glued during finger jointing. When the lamellaes come out of the press, there is often a break on it because the two elements are not glued well. [1]

4. OPTIMIZATION OF THE TECHNOLOGICAL PRODUCTION PROCESS OF MASSIVE WOOD PANELS

Today, at the beginning of the 21st century, but also 30 years ago, technologies and processes can be the same by the procedure of performing, and yet between them there may be great differences which are the result implementation of knowledge, innovation and optimization methods when technological processes take higher techno-economic level and significantly higher profitability. In the past it was important to produce, but today, survival is possible by constantly improving processes and technologies, all with the goal to achieve a competitive advantage in the market. It is produced so that it can be sold, and it can be sold if the optimal techno-economic results in all segments of the work cycle are achieved. Otherwise, a successful result on the market is questionable, and with it, the real survival of producers. Modern production systems have their own polygon of proof in the market, there are wins or loses. And, that's why production is a dynamic process that needs to be nurtured, upgraded, improved, in which there must be no stagnation, because stagnation is a setback and loss of the market, and then the disappearance of the production-business system.

4.1. Goals of optimization

The full definition of optimization is determined by four basic elements (Figure 2), the object of optimization, the goal of optimization, the methods of optimization and by the conditions in which optimization performs.

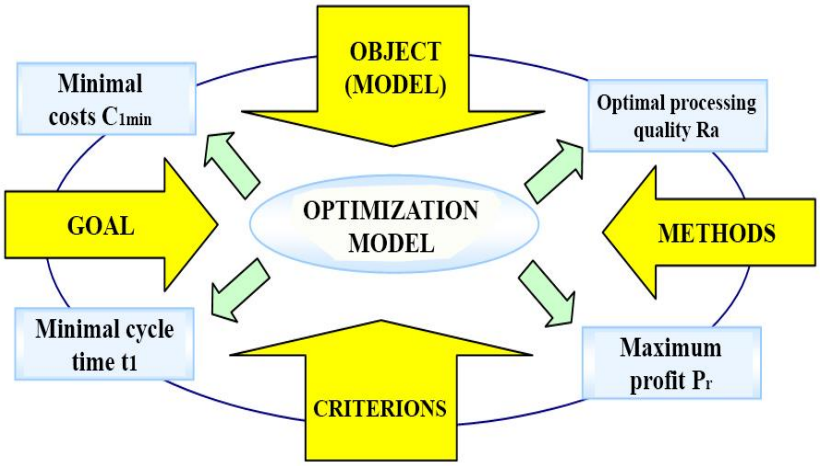


Figure 2: Basic elements and requirements of the optimization process [6]

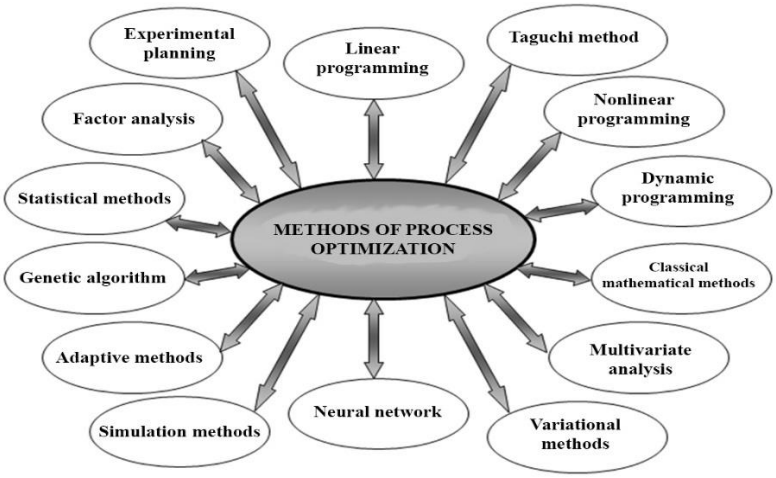


Figure 3: Methods of process optimization [5]

The goal of optimization is expressed using optimization criteria (optimization model and goal function), while with the appropriate optimization method it is achieved the desired optimization goal on specific optimization object (process, processing system, product, device, technology, design, management, etc.).

4.2. Optimization by analysis of the existing situation

The analysis of the existing situation determines the real state of macro and micro processes whose goals are shown in Figure 2. and the bases for the performance of optimization can be achieved by applying: detailed macro and micro analysis of the current state of production, modelling of processes and systems as pre-optimization phases, implementation of innovations and incorporation of knowledge and implementation of new technologies and processing systems in production processes. Analysis of the existing situation is a source of information about the real state of production, which must be concrete with measurable goals and a higher levels, and not a formal understanding of the situation. The analysis should be performed in several directions: 1. Technology analysis; 2. Process analysis; 3. Comprehensive analysis of cycles and cycle times; 4. Analysis of equipment, capacity utilization, technological level; 5. Product quality analysis; 6. Cost analysis for each product and total cost analysis; 7. Management analysis. Therefore, optimization must be based on a complex analysis of the effectiveness of the existing technological process and / or production process and all their components. In order to improve the technology and economy in the company, it is necessary to improve existing processes, technologies and machining systems by applying the methods of optimization, cost minimization and shortening of manufacturing cycle, application and introduction of modern CNC technologies and systems in the process and expanding the existing production facilities in accordance with market requirements and criteria of techno-economic efficiency, and implementation of modern quality systems in production and business processes. [5]

5. CONCLUSION

Objective was to prepare a development strategy for the production - business system “Sani Global” d.o.o. Bihać for the next 10 years with the aim of introducing modern technologies and processing systems and achieving a higher technological level, quality and quantity of products that will have greater competitiveness in the market.
Also, the construction of a new production hall creates production conditions for well-known foreign customers who are satisfied with the quality of the product, but this is not a constant, so the quality should be constantly improved.
It should be emphasized that modern CNC technologies and processing systems should be introduced, that provide higher product quality and better techno-economic efficiency.

6. REFERENCES

[1] Elvin Okugić.: (2020), Analiza i optimizacija tehnološkog procesa u proizvodnom pogonu Sani Global s prijedlogom mjera za unaprijeđenje procesa, Magistarski rad, Tehnički Fakultet Univerziteta u Bihaću
[2] Elvin Okugić, Milan Jurković.: Analiza tehnološkog procesa u proizvodnom pogonu Sani Global [DEMI 2017, Univerzitet u Banjaluci, Bosna i Hercegovina]
[3] Grladinović T. Upravljanje proizvodnim sustavima u preradi drva i proizvodnji namještaja. Zagreb: Šumarski fakultet; 1999.[2] Jurković M. Matematičko modeliranje inženjerskih procesa i sistema. Bihać: Mašinski fakultet; 1999.
[4] Jurković M. Reinženjering proizvodnje: Razvoj i modernizacija proizvodnje. Bihać: Tehnički fakultet; 2007.

[5] Jurković M. Reinženjering proizvodnih poduzeća: Razvoj i modernizacija proizvodnje. Bihać: Univerzitet u Bihaću; 2011.
[6] Jurković M, Tufekčić Dž. Tehnološki procesi: projektiranje i modeliranje. Tuzla: JU Univerzitet u Tuzli; 2000.
[7] Grupa autora – Inženjerski priručnik IP4, Proizvodno strojarstvo, Treći svezak, Organizacija proizvodnje, I izdanje, Školska knjiga, Zagreb, 2002.

JUSTIFICATION OF THE PRESSING PRESSURE OF PARTICLE BOARDS WITH MODIFIED ADHESIVES

Galina Varankina, Dmitry Rusakov, Anatolii Chubinskii
Saint Petersburg State Forestry University (SPbFTU),
varagalina@yandex.ru, dima-ru25@mail.ru, a.n.chubinsky@gmail.com

ABSTRACT:

Investigation of the deformability of packaging made of wood particles of aspen, birch and glue based on urea-formaldehyde resin by the method of searching for optimal values of variable factors and corresponding values of performance indicators. The work presents graphical dependencies: experimental curve of the package compliance; deformation changes during the pressing period; experimental curve of compliance of a bag glued with modified adhesives; deformation changes during pressing of the package glued with modified adhesives. The results of the work can be considered the following achievements, namely, the deformation of the package in the production of wood-based panels based on urea-formaldehyde resins modified with shungite sorbents will be higher than on urea-formaldehyde resin with no additives. Experimental studies on the search for optimal values made it possible to determine, to a large extent, the formulation of the adhesive composition and the modes of pressing of chipboards.

Keywords: partical board, modification, deformation, pressing mode, urea-formaldehyde resin, shungite.

1. INTRODUCTION

The process of pressing chipboards (chipboard) is accompanied by a change in the physicochemical and mechanical properties of the original chipboard-adhesive composition [1-5]. Wood and glue used to make boards are viscous media [3]. In the process of piezothermal treatment, with a changing temperature and humidity regime, relaxation phenomena have time to develop in the chip package, which are reflected in the properties of the formed material and on the kinetics of its formation [1,2,3].

2. INVESTIGATION OF THE DEFORMABILITY OF PARTICLE BOARDS

2.1. Experimental research technique

As an experiment, the deformability of a package consisting of aspen and birch particles and a glue based on KF-MT-15 urea-formaldehyde resin was investigated at a constant pressing pressure of 2.2 MPa and a press plate temperature of 200 ° C. The amount of shavings and glue in the package was set based on the manufacture of a three-layer chipboard 13 mm thick, 500x500 mm in size and 650 kg / m3 density, with a ratio of wood particles of the outer and inner layers in the total mass of the board

35:65 and the consumption of the glue for the outer layers 13.5% and for the inner layer 9.0% (Fig. 1). To describe the creep of the compressed package, we use the theory of Boltzmann – Volterra [1]. The creep equation has the form of the Volterra equation of the second kind (1):

$$\varepsilon(t) = \frac{\sigma(t)}{E} + \frac{1}{E}\int_0^t K(t-\tau)\sigma(\tau)d\tau \tag{1}$$

where $\sigma(t)$ and $\varepsilon(t)$ – stresses and strains at the time of observation (t) in a uniaxial stress state; τ – the time preceding the moment (t); E – is the modulus of elasticity; $k(t)$ – resolvent (creep rate). In the case of constant stresses at $\sigma(t) = \sigma_k = constt$ the creep equation has the form (2):

$$\varepsilon(t) = \frac{\sigma_k}{E}\left[1 + \int_0^t K(\tau)dt\right] \tag{2}$$

In equation (2), the quantitative values σ_x are established from the conditions of the experiment, are $\varepsilon(t)$ - experimentally. The influence function is taken on the basis of recommendations [1] in the form: $Ae^{-\beta t}t^{\alpha-1}(0 \le \alpha < 1)$, resolvent of which is (3):

$$k(t) = \frac{e^{-\beta t}}{t}\sum_1^\infty \frac{[A\Gamma(\alpha)]^n t^{\alpha n}}{\Gamma(\alpha n)} \tag{3}$$

where $\Gamma(\alpha)$ – Euler's gamma function; α, β, A – parameters of the influence function.

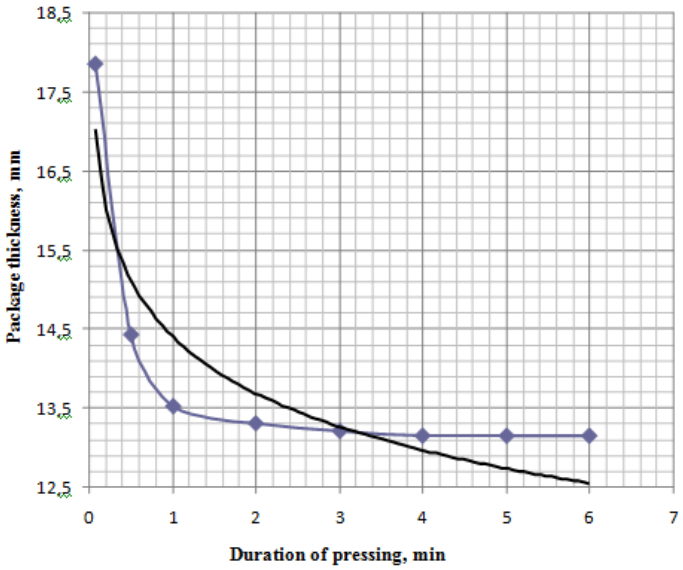


Figure 1: Graph of the experimental packet compliance curve.

In Fig. 1 shows a graph of the experimental curve of the packet compliance. To determine the parameters of the influence function, it is necessary to plot the experimental compliance curve for the

given conditions of pressing the package $\varepsilon(t) = \frac{\varepsilon(t)}{\sigma_к}$ in a logarithmic grid of coordinates, and then in the well-known family of theoretical curves [1] find a similar experimental one. Using experimental data $\varepsilon(t)$, $\sigma(t)$ and the values of the expression $1+\int_0^t k(\tau)d\tau$ from [1], using the known parameters of the influence function α, β, A from equation (2), we can determine the values of the modulus of elasticity of the package (E) at the moment of time (t) (table 1).

Table 1: Calculation of relaxing stresses in a chip-adhesive package during its pressing

Current time, min	Chipboard package thickness, $S_n(t)$, mm	Chipboard package deformation $\varepsilon(t)$	$\varepsilon \equiv \frac{\varepsilon(t)}{\sigma_k}$	Chipboard package modulus of elasticity, $E(t)$, MPa	Relaxing stresses $\sigma(t)$, MPa
0	17,85	—	—	—	—
0,08	16,12	0,150	0,056	84	—
0,5	14,43	0,203	0,064	96	—
1	13,52	0,356	0,096	102	—
2	13,31	0,454	0,114	103	—
3	13,2	0,458	0,132	105	1,91
4	13,14	0,475	0,142	138	1,21
5	13,14	0,480	0,179	212	0,78
6	13,14	0,480	0,181	422	0,46

Relaxing stresses in the package during its pressing can be calculated using the equation (4):

$$\sigma(t) = E(t)\varepsilon_k\left[1-\int_0^t T(\tau)dt\right], \tag{4}$$

where $T(\tau)$ – is the relaxation rate function; ε_k – permanent deformation.

The quantity ε_k it is taken equal to the deformation of the package to obtain the required plate thickness, i.e. at the point in time when the press plates have reached distance planks. The change in deformation is represented by equation (5), and the graph in Fig. 2:

$$y = 0{,}005x^3 - 0{,}0704x^2 + 0{,}2815x + 0{,}115$$
$$R^2 = 0{,}978 \tag{5}$$

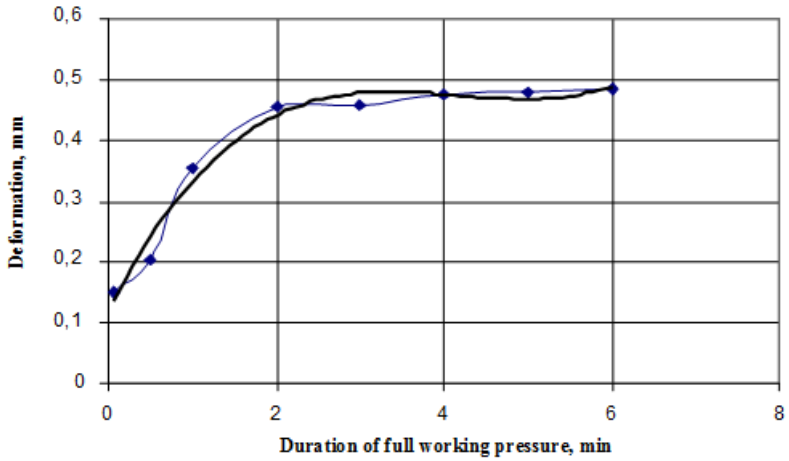


Figure 2: Graph of deformation change during the pressing period

2.2. Research results and discussion

Based on the resulting dependence $\sigma = f(t)$ a pressure diagram can be proposed, which provides for a stepwise decrease in the pressing pressure in such a way that the external force is equal to or slightly higher than the elastic resistance of the package. Deformation of the package to obtain the required thickness of the board when gluing with adhesives filled with shungite sorbents [6], i.e. at the time when the press plates have reached the distance planks, there will be fewer than unmodified ones. The change in deformation is presented (Table 2,3), (Fig. 3,4) and described by the equation (6):

$$y = 0{,}0051x^3 - 0{,}0653x^2 + 0{,}2754x + 0{,}0099$$
$$R^2 = 0{,}9902 \quad (6)$$

Table 2: Changing the thickness of the package depending on the duration of pressing

Pressing time (T), min	0,08	0,5	1	2	3	4	5	6
Package thickness, mm	18,5	17,4	16,5	15,42	14,88	14,4	14,22	14,22

Table 3: Deformation of the package to obtain the required board thickness when gluing with adhesives filled with shungite sorbents

Deformation, mm	0,04	0,108	0,241	0,35	0,372	0,385	0,40	0,40
Duration of exposure to working pressure, min.	0,08	0,5	1	2	3	4	5	6

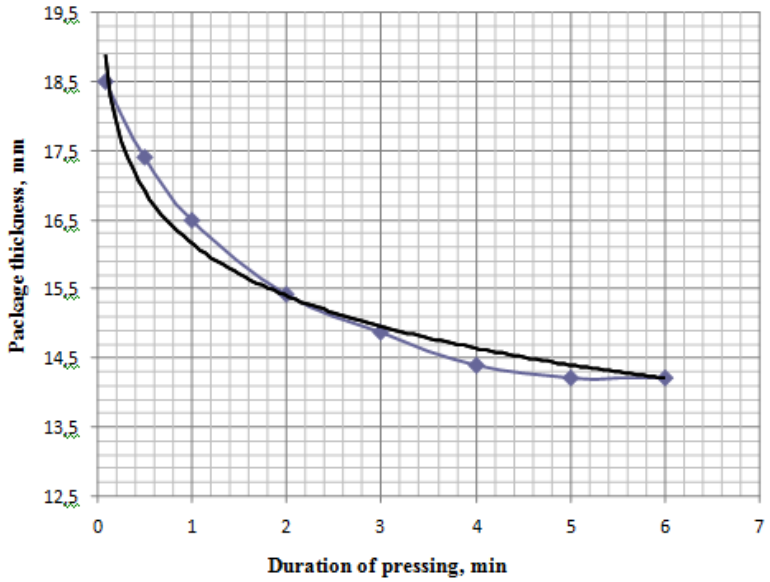


Figure 3: Graph of the experimental compliance curve of a bag glued with modified adhesives

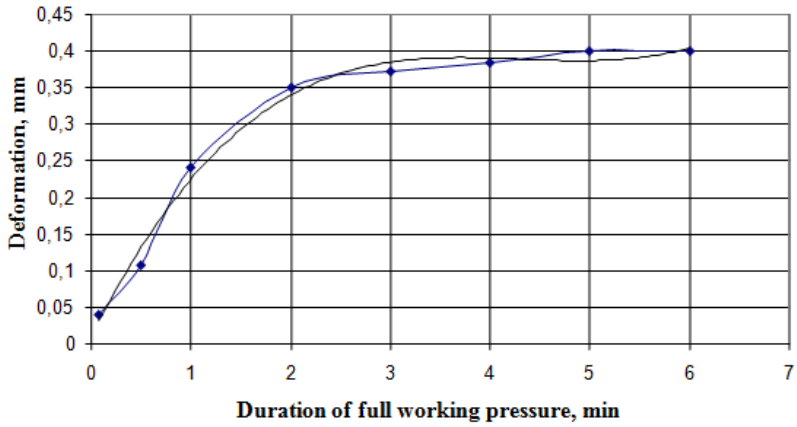


Figure 4: Graph of deformation change during pressing of a bag glued with modified adhesives

Using the methods of searching for the optimal values of variable factors and the corresponding values of efficiency indicators, we find the required parameters of the adhesive composition and the pressing mode (Table 4).
The pressing pressure required at the beginning of the process is 2.2 MPa, as the package heats up and the elastic modulus of wood decreases, it can be reduced according to the law of relaxing stresses.

Table 4: Calculated values of the investigated parameters of the technological mode of gluing partical board

Name of the influencing factor	Factor designation	Dimension	Value
Amount of added filler	X_1	wt.h	10
Press plate pressure on the package	X_2	MPa	2,5
Press plate temperature	X_3	° C	190
Duration of pressing	X_4	min	3
Dispersion of filler particles	X_5	mm	0,3

3. CONCLUSION

The deformability of a package consisting of aspen and birch wood particles and a glue based on urea-formaldehyde resin has been investigated. It is proved that the deformation of the package for obtaining the required thickness of the partical board when gluing with adhesives filled with shungite sorbents, i.e. at the time when the press plates have reached the distance bars, there will be fewer than unmodified ones. Using the methods of searching for the optimal values of variable factors and the corresponding values of the performance indicators, the formulation of the adhesive composition and the mode of pressing the chipboard were determined.

4. REFERENCES

[1] Koltunov, M. (1976). Creep and relaxation. Higher School.
[2] Karpenko, N., Travush, V. (2014). Determination of creep deformations under complex loading conditions. Housing construction.
[3] Chubinsky, A. (1992). Formation of glue joints of wood. St. Petersburg: St. Petersburg State University.
[4] Isaev, S. (2018). Description of relaxing stresses in a glued larch veneer package. Journal of Advanced Research in Natural Science.
[5] Isaev, S. (2018). Selection of the mode of pressure reduction on the larch veneer package during gluing. Journal of Advanced Research in Natural Science.
[6] Varankina, G., Chubinsky, A. (2013). Modification of urea-formaldehyde resins shungite sorbents. International conference on production engineering. Bihac: Bihac University.

WOODEN POTENTIAL FROM RIVERBEDS

Nataša Pantović
KLASTER DRVO, Srbija,Beograd, Kičevska1
infocontentserbia@gmail.com

ABSTRACT:

The use of fossilized wood aims to create unique products and to place them on the market that is interested in luxury items of unique appearance and unlimited duration. Riverbeds, in their mud, store wooden treasures, in the shape of trees that once grew on the river banks. The biological age of these tree logs, before immersion, reaches several centuries and the time they spent in river mud is measured in thousands of years. Long staying in river mud and specific conditions, changed the physical, mechanical, chemical, and aesthetic properties of submerged logs. Structures have been obtained which, with appropriate preservation of logs after extraction from riverbeds, guarantee a unique appearance and unlimited shelf life for future products. The time the tree' was staying in the river mud affects the color and properties of the wood. The longer the logs stayed underwater, the darker the wood. The markets of rich countries have recognized these values and buyers, in their craving for luxury, give large sums of money for such wood and the products that can be made of them.

Keywords: fossil wood , altered wood properties, unlimited lifespan,unique luxury products

1. INTRODUCTION

In historical writings, fossilized wood from riverbeds is called "ebony" or "ironwood". It is impossible to say when the use of this wood first began, but it certainly has an impressive history. It is believed that the first fortification of Prince Rurik, on the shores of Lake Ilmen, built in the 9th century, was made of this wooden material. There is indisputable evidence that the thrones for imperial rulers were made of this wood (the throne of Peter the Great, which was made by English masters and donated to the sovereign, and the throne of James II). Peter the Great was impressed by this wood and ordered that special care had to be taken of its resources and use. In 1712, as one of the wedding gifts, he presented Catherine Alexeyevna with a box made of fossilized oak. The giving of "ebony" on special festive occasions became a tradition and lasted until the revolution. Offices, armchairs, bureaus for anniversary celebrations, and official meetings were equipped with this wood. The decoration of the premises with this wood clearly testified to the solvency of the person and his "weight" in society. The material became elite, and access to it had to be earned.

2. RESOURCES

The resources of this material are not unlimited. It is believed that there is very little of it in Europe and that the largest stocks of this wood are in Russia. From there, in the past centuries, this material had been delivered to Europe, and then it was used to make interiors in Royal Residences, stairs, fences, and other parts of royal houses.
Today, the lost technology of extraction and processing of this treasure from riverbeds is being revived. The procedure is complex and time-consuming, requires a lot of work and resources, and is available only to professionals.
The "mining" of wooden treasures from the bottom of the riverbeds began in the areas of the Sava and Morava rivers in the last decades.

3. WHAT HAPPENS IN THE WATER

For thousands of years, due to the erosion of the banks and the meandering of the riverbeds, the flooding of the surrounding land, the coastal oak groves were underwater. Submerged trees have layed for centuries and millennia in the mud of riverbeds. There, without access to air and exposed to high pressure, they gained a strength that is not inferior to the strength of the stone. Special conditions, water composition, water flow rate, depth, time spent at the bottom of the river, in a completely natural way have created durability, a unique range of colors, unique textures, and unique properties of these wood. The color of the wood speaks for itself: the soft brownish-purple speaks of 300-400 years spent in the mud, while the black color says that the tree has spent more than 1000 years on the river bottom. The most valued are oak trees.

Figure 1: Extracting a tree from a riverbed (a)

4. FEATURES

Fossil wood, usually called "black" or "ebony", is oak wood, mineralized with metal salts "in vivo". In the process of natural humification, rotting vegetation releases tannin. Tannins keep the wood from decaying. Under the influence of tannin (gallobic acid - gross formula C76H52O46) wood changes its chemical composition. The result is a change in the content of iron oxide: in ordinary oak, the content of iron oxide is 3.8%, and in fossilized, from the river, this oxide makes from 9.7-32.33%! Wood becomes one-third of iron! The color of the wood becomes dark brown, gray, and black. For several thousand years, it matured in river mud, without the presence of air, changing its properties under the influence of minerals from water. The wood became solid, hard, heavy as granite, calcified, and resistant to rot. The rings, the center of the plant, and all the channels that fed the tree are chained and

preserved in time. This tree becomes eternal and irreplaceable in art, church architecture, making instruments, furniture!

5. EXTRACTION FROM THE RIVER

Finding and extracting trees from riverbeds is a complex, time-consuming, and demanding job. Before the start of the season, it is necessary to examine the river channel, analyze the characteristics of the banks, the speed of the current, the depth, and the composition of the river bottom. At places of presumed deposits, at different depths, divers examine the bottom of the river in search of submerged trunks. If trees are found, they dig the area around the trunk so that they can pull the trunks to the shore with the help of technical devices. The wood is heavy, and the weight of one trunk can reach up to 50 tons. The entire procedure must be performed professionally and carefully, and the wood must be stored under special conditions after removal from the trough. Due to non-compliance with all the rules for extracting and storing wood, it can lose its properties, which is why it completely loses its value. All such wood becomes unusable and goes for firewood. Attempts to restore the properties and characteristics of the wood by returning it to the tanks will not yield results. Today, there are few experts who know exactly the procedure of storing and drying fossil wood. Fossil oak, "ebony", is very demanding for drying. Only 20% of the trunk is finally used (data from "Tara Concept doo"), which is one more reason why this material has a high price. Before drying, the trees are stored in different ways: buried in the mud on the shore, wrapped in foil, or immersed in tanks.

The trunk of the oak tree must be sawn within a few days after the extraction. Otherwise, it becomes unusable. This is one of the characteristics that is known only to masters.

Figure 2: Extracting a tree from a riverbed (b)

6. THE TREE IS ON THE LAND AGAIN

The trees are on land again and their moisture content is 100%. The process of drying fossilized oak is a long and arduous job. If the wood is not dried properly, its internal stresses will sooner or later turn into cracks.

Natural drying:

This material should be dried in conditions close to natural: a little air, a little wind, a little moisture, everything as in nature, but in a special room. Exposure to sunlight is detrimental to this material. This drying usually takes about 3 years. After that, the material is selected for further processing. Fossilized oak is, due to the saturation of wood with iron oxide, a very capricious material, capable of losing its original beauty and properties in just a few hours outdoors. After the completion of natural drying,

which lasts for several years, only a small percentage of the total extracted wood biomass remains suitable for further processing and production of products.

An important factor for drying fossil wood is cutting the planks within a maximum of three days of removing the tree from the water. If the tree is sawed only after four or more days, the planks obtained from it will crack along the edges. The drying time depends on the parameters of the planks, but the most important thing is that the drying is done under a canopy and without exposure to direct sunlight. In the first three weeks, the syllable must be watered every 3-4 days with a hose, always on a cloudy day. Technological processes of drying fossilized wood are characterized by complexity and take a long time.

Figure 3: A sample of fossil wood (exhibited in a museum in Russia)

Vacuum dryers:

There are recordings of the procedure of vacuum drying of fossilized wood in the dryer type BKS V3-5 on the Internet. The procedure took place in two stages. The first stage lasts 8 days. From a package with a volume of 0.6 m3, the initial moister content of the elements was 100%, the thickness of the elements was 45-70 mm, a water output of 206 l was measured. The output moisture of the elements was measured in the range of 4 -18%. The material was then prepared for the second stage of drying for 16 days. The second stage lasted 7 days, during which another 72 liters of water were extracted. The output moister content of the elements was in the range of 4-8%.

Dryers in Ukraine:

Another example is dryers in Ukraine. The procedure took 45 days. The elements were 32-34 mm thick, the inlet moister content was 60-75% (which means that the elements were previously air-dried), the outlet moister content was 10-12%.
Drying was done in four phases:

- first phase: equalization of moisture content through the thickness of the elements;
- second phase: drying to moisture content equalization at 45%;
- third phase: further drying according to a special program to a final moister content of 10-12%;
- fourth phase: additional conditioning.

Figure 4: Elements of fossil wood after drying

7. SORTING, CLASS

The material obtained after drying was carefully sorted by geometric dimensions, color, density, texture for subsequent production of unique products. The sorting of these elements is special and differs from the usual class determination. This classification applies only to fossilized wood. The first class contains elements without any physical, chemical, or other defects. The second class consists of elements with minimal deviations, and the third class is elements where the deviations are more visible. It is not surprising that products made of this wood can only be made by experts in this field. They are also very interested in their reputation, so the most famous ones accompany their products with a certificate that serves as a guarantee of quality.

It is important to say a few sentences about forgeries here. Namely, by using ammonia, an aesthetic effect can be achieved that can deceive the customer. The treated wood is seemingly the same as fossilized, but it does not have the physical properties and durability of fossilized wood. Attempts at such machinations have their cost: the perpetrators lost the contract, but they also caused serious damage to the reputation of the manufacturer.

8. USE

Fossilized wood has remained a material that can be afforded by those who have a lot of money and who want use-value for eternity, which this material certainly gives. Interiors of religious buildings, homes of rich people, furniture, art products, jewelry boxes, chess, wooden elements of weapons. The list is endless. The limiting factor is the available amount of money.

Figure 5: A chair made of fossil wood (exhibited in a museum in Russia)

9. CONCLUSION

Fossilized wood can be found in river mud. The tree is completely preserved by river mud and in conditions without oxygen. Its biological age at the time of immersion can be determined on the basis of cross-section and number of years, but the time spent underwater is not included in that age. The color of the wood gives information about the length of stay underwater, and a radiocarbon test can be done, in order to get more precise data. This information can also be used as a basis for drafting product certificates. The properties of this material are fascinating, its durability is unlimited and it is ecologically unsurpassed. These trees grew on the banks of rivers for centuries and millennia before the advent of industrialization and before the beginning of any environmental pollution. No chemicals are used in the processing of this material. Each tree is absolutely unique in color, texture, beauty. Objects made of fossil wood radiate the energy of health and eternity. Extraction and preparation of fossilized wood for making objects is a demanding, long-lasting, and expensive job that can only be done well by experts. The material is very sensitive immediately after extraction from the riverbed and can be completely destroyed by careless and unprofessional handling. This wood is considered to be the most expensive wooden material in the world. It carries with it a history of several millennia and no one can help but admire it. Items made of fossilized oak can be afforded by institutions and people who have a lot of money.

Figure 6: Bath tub made of fossilized wood

10. REFERENCES

[1] Kretovich V.L. Biljna biohemija: udžbenik za biol. fakulteti un-tov. - M.: Više. shk. - 1980 - S. 307 – 308

[2] Kuryanova, TK, Platonov, AD, Petrovsky, VS Drying of hardwoods with preliminary thermochemical treatment [Text] / TK Kuryanova, AD Platonov, VS Petrovsky // Forest Journal. - 2004. - №4. - P.58-63.

[3] http://mari-el.gov.ru/minsport/Pages/news/2018/muzei-morenogo-duba.aspx

[4] https://pediaa.com/what-is-the-difference-between-tannin-and-tannic-acid/

[5] https://pdoshka.ru/uk/wallpaper/usushka-drevesiny-duba-morenogo-pri-razlichnyh-rezhimah-obrabotki-kak-pravilno/

GLUED LAMINATED TIMBER FOR HOUSES

Salah-Eldien Omer

Antuna Vramca 17, 10000 Zagreb, Croatia, sagzagreb@gmail.com

ABSTRACT:

Glued laminated timber production in the world is advanced at all levels. The exploration into wood mass is continuously increasing the new quality levels of wood products. The mechanical and physical characteristics of wood products are very important to the place of their usage. The modern production of glue-laminated timber is continuously improving by using new sophisticated types of glues. The ability to shape the laminated timber in the production process makes it more suitable for the final stage in the house's construction and building. In Croatia after the earthquake and especially in the Bania area, a lot of engineers and architects are preferring wood-constructed houses more than the houses from classical local materials used till now.

Keywords: Glued laminated timber, usage of laminated timber in houses

1. INTRODUCTION

In Croatia and surrounding counties, from old times they use timber to build houses. In eastern Croatia especially in the area of Petrinja we sow a lot of houses built from timber, logs, and combinations of all types of wood material. When the industry of timber laminated products came to the ex-Yugoslavia area, as in Croatia, Slovenia, and Bosnia they started to use the glue-laminated timber widely, especially in sports halls and similar. In the nineteen usages of glue-laminated timber spread widely, especially when the local architects accept it.

Several civil and architectural engineer's hereafters the earth quick in Croatia suggested that the rebuilding of the houses in the area where it is suitable to be built for the families and as well as for the public buildings.

Glued laminated timber is an industrially manufactured building product for load-bearing structures. It is made of board lamellas, which are finger-jointed lengthwise and then glued together with parallel fibers. This produces an elongated beam, similar to a solid wooden beam. Compared to this, glulam as a building product has decisive advantages: On the one hand, the load-bearing capacity is greater than with solid wood, as defects (knots, etc.) are cut out in advance and a homogeneous cross-section is created by the gluing. On the other hand, finger-jointing allows longer beam lengths to be realized. Thus, column-free spans of roof trusses of up to 60m are possible. The glued joints from glulam must be produced with special care. For example, a suitable climate (temperature and humidity) must be ensured during bonding.

Glulam is produced as a standard product or according to a list in any desired length and dimension. In addition, there are also custom-building elements that exceed the standard dimensions, but there are also shapes such as raised beams, pent-roof beams, arched trusses, and free shapes. Ceiling elements

can also be produced from glulam. In addition, there are also country-specific structural elements for load-bearing purposes.

Production of glulam is standardized by EN14080 Timber structures. Glued laminated timber and glued solid timber. Requirements and all standard beams must be CE-marked. During the production of glulam, the following factors should be tightly controlled to assure the quality of the final product:

- The strength of the purchased timber, whether pre-graded or visually graded in-house.
- Moisture content of the timber. The timber should have a moisture content equal to that which the member will reach in service.
- Temperature and humidity in the plant during production, the curing chamber whilst glue sets, and in the area where the timber is stored.
- The strength of glue lines and finger joints.
- The age and storage conditions of the glue.
- The mix proportions of the glue.

The benefits of using glue laminated timber include:

- Sustainability: The manufacturing process consumes less energy than steel or concrete.
- Appearance: Designers often choose it over steel or concrete for its 'natural' appearance.
- Adaptability: The lamination process is very flexible allowing a wide range of sizes and shapes to be produced.
- Strength: It has a good strength-to-weight ratio in comparison with steel and concrete which improves the buildability of glulam structures.
- Durability: The timber species as well as the type of adhesive and preservative (chemical treatment) used all impact on the durability. With the right treatment, glulam can provide effective low maintenance solutions to problematic environments such as swimming pool roofs.
- Fire resistance: Large section timber elements perform well in fires as they char at a known rate and unlike steel resist deformation. Fire protective finishes can be applied to glulam members to further increase performance.

2. GLUE LAMINATED TIMBER AND THE ENVIRONMENT

Glue laminated timber products have a natural place in an eco cycle society. The engineered wood is renewable and recyclable, while its manufacture is largely based on bio-energy.

Environmental properties of Glue laminated wood:

The manufacture of glulam is a resource-efficient process. The raw material is mostly home-grown spruce/fire from sustainably managed forests, plus a synthetic glue. The proportion of glue is negligible – less than 1% by weight. The products are normally supplied by the glulam manufacturer with what equates to a target moisture content of no more than 14%. The drying process largely makes use of bioproducts from the plants' own production line. Glulam that is customised for the client ensures minimal waste at the construction site. The protective film in which it is wrapped is a recyclable material. Glulam has no negative environmental effects. Repairability is high and parts of a glulam beam or post can be replaced if necessary. Once the glulam product has reached the end of its life, it makes an excellent biofuel. Eco cycle thinking is an important starting point for research and development work on local glulam products – and it is applied to the whole life cycle of glulam products.

An environmental profile is a quantitative calculation of a product's environmental impact in the form of emissions to:

1.Air
2.Water
3.Land

Plus, information on:

4. primary resource extraction – resources that have been taken from the earth's crust.

5. energy use – the part of the primary resource extraction that is used for energy and is converted into emissions.
6. input materials – materials whose environmental impact has not been taken into account in calculating the environmental profile of the glulam product.

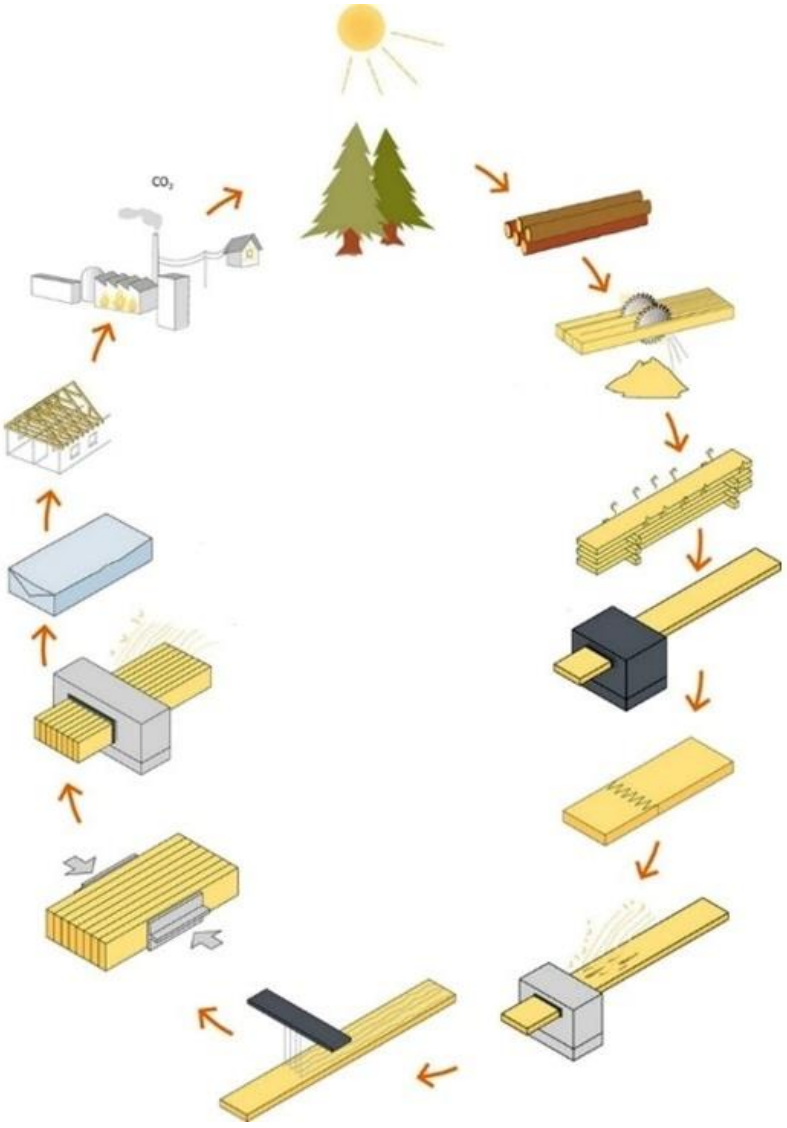


Figure 1. Glue laminated timber and the environment

The manufacturers' environmental product declarations set out the product's environmental profile.

It is generally the case that the manufacturer can only give quantitative and objective data for its product from cradle to gate. To obtain quantitative data for the entire life cycle, it is necessary to work

with credible scenarios – as the eventual fate of the product must also be taken into account, and that may be 5, 50 or 100 years down the line, since no one actually knows what will happen to the product.

To conduct a complete life cycle analysis (LCA), the use phase and the end-of-life phase must also be added into the equation. This information is held by the producer company, who knows where the product will be used.

A key step in an LCA is the inventory analysis. In this case, producers assume that they have three environmental product declarations in front of us, for:

- glulam
- steel
- concrete.

As this is a simplified study, the environmental impact of installing the beam, etc. and then taking it down when the building is demolished is considered to be of marginal significance. It is also assumed that all the beams are recycled in some way.

The problem is that there is no generally accepted environmental assessment index, which is why such a thing is not used in the environmental product declaration.

3. GLUE LAMINATED TIMBER IN MODERN HOUSES

In west Europe and Scandinavia in the last few years they are many studies comparing the wood prefabricated houses with the traditional ones all over from different materials. Most of the studies confirm the advantages of wood prefabricated houses especially those which build from modern produced glue laminated timber. The tests in several characteristics for building material shows several advantages of glue laminated timber.[1,3,4]

A case study comparing energy use, greenhouse gas emissions and costs for roof beams found it takes two to three times more energy and six to twelve times more fossil fuels to manufacture steel beams than it does to manufacture glulam beams. It compared two options for a roof structure of a new airport in Oslo, Norway – steel beams and glulam spruce wood beams. The life cycle greenhouse gas emission is lower for the glulam beams. If they are burned at the end of their service life, more energy can be recovered than was used to manufacture them. If they are landfilled, the glulam beams result in greater greenhouse gas emissions than the steel beams. The cost of the glulam beams is slightly lower than the steel beams.

Due to the low conductivity of the block wall, the wall in a block house does not radiate cold. Relatively little heating energy is therefore required.

Figure 2. Profiled glue wood beams produced for certain houses

The glue wood beam has advantage that pays off. The wood is not chemically treated because it is dried before processing. Harmful evaporation of protective agents and solvents are therefore not available in these log house. Independent experts also found that the resins contained in a massive log house significantly reduce electro smog.

Possible wall thicknesses of timber are a solid, breathable wall, which due to its material properties does not require any further thermal insulation. In contrast to heartwood and solid wood beams, glued wood beams are composed of several narrow beams. The beams are glued to each other with glue (not extended). The individual beams are usually approx. 4 cm wide, so that a 20 cm wide block beam consists of 5 beams glued together.

Glued wood beams offer the advantage of lower settlement compared to heartwood or solid wood beams. The beams also hardly warp and form fewer cracks on the surface.

However, the glue minimizes the open diffusion, which worsens the often touted natural living space climate in the log house. In return, however, the insulation value of the beam increases, which reduces the heating costs depending on the construction.

A ready-to-install construction that has been precisely sawn, mortised and marked in the factory.

The European tradition on producing the laminated timber are very good and the production is developing frequently based in the new experiences gain from the building companies or studies searching for better quality for the glue laminated timber. One of the main reasons for such intensive development is the market need for natural materials and environmentally friendly buildings. One of the big advantages of using glue laminated timber in building is possibility of producing it in many shapes which needed for certain designs in constructions.

Figure 3. Several different houses from glue laminated timber. (tabela)

Those buildings, manufactured with advanced technology, have also a certificate of conformity to the "NFPA 5000" codes, abbreviation of American Fire Codes.

Due to the water resistance property used in the inner and outer coatings of buildings, no deformation of the materials occur over time.

Another advantage, at least as important as the above advantages, is that there is absolutely no harmful to human health. The materials used are completely healthy.

Comparison of different types of houses show in Table 1.

Table 1. Comparison of different types of houses

	Durability	Architecture freedom	Prompt construction	Good microclimate	Ecology
Glued laminated timber houses	+	+	+	+	+
Log houses	+	-	-	+	+
Brick houses	+	+	-	-	-
Prefab panel houses	-	+	+	-	-

The sustainable initiative of these projects stems from their reduced amount of waste, efficient environmental performance, and material versatility, creating a great connection with the outdoors. The biophilic attributes of wood help improve human well-being, as well as promote environmental consciousness.

With prefabricated projects, efficiency is an almost universal advantage. For those who live by the mentality of “time is money”, these structuresof glue laminated timber promise lower construction costs at a quicker schedule.

4. CONCLUSIONS

The laminated glued timber was developed a long time ago and used in several buildings as the designers were convinced of its strength and life duration. But, the producers of the glues used in laminated products developed new types of glue that assure the quality needed for the products where ever it is used.

The regulations and the tests to define the quality of gluing and all the mechanical characteristics of the laminated products were issued in all standards as well as in the EN. Still, the environmental properties of glue-laminated products show that they have no negative environmental effects.

The laminated glue elements could be produced according to the need of the house's design and easy build in all the phases of the house building. Yet the houses build from laminated glue elements show flexibility and time-saving in the building phases. The comparison of houses build from glue-laminated elements shows certain advances than those build from break, classical logs houses or prefabricated panel houses.

5. REFERENCES

[1] Abbott A R and Whale L R J 1987 An overview of the use of glued laminated timber (glulam) in the UK *Construction and building materials* Vol. **1 (2)** p 104-10

[2] Herawati E, Massijaya Y M and Nugroho N 2010 Performance of glued laminated beams made from small diameter fast growing tree species *The Journal of Biological Science* **10 (1)** p 37-42 DOI: 10.3923/jbs.2010.37.42

[3] Rohanova A and Lagana R 2015 Update of quality requirements of glued products from structural timber Annals of Warsaw University of Life Sciences - SGGW Forestry and Wood Technology No 90, 2015: 172-175

[4] Chung T 2019 Prefabricated Wood Construction Shows Promise, NAIOP, 2019 *Development Magazine*,

[5] Off-Site Studies: Solid Timber Construction, University of Utah, Integrated Technology in Architecture Center, College of Architecture and Planning, 2015, p. 32

IMPACT OF FEEDING SPEED ON THE SURFACE ROUGHNESS OF WOODEN MATERIAL

Erald Kola[1], Ina Vejsiu[2], Holta Çota[3], Hektor Thoma[4]
[1] PhD, Department of Wood Industry, Faculty of Forestal Sciences, Agricultural University of Tirana, Rruga Paisi Vodica 1025, Tirana, ALBANIA
erald.kola@ubt.edu.al
[2]PhD, Department of Wood Industry, Faculty of Forestal Sciences, Agricultural University of Tirana, Rruga Paisi Vodica 1025, Tirana, ALBANIA
inavejsiu@ubt.edu.al
[3] PhD, Department of Wood Industry, Faculty of Forestal Sciences, Agricultural University of Tirana, Rruga Paisi Vodica 1025, Tirana, ALBANIA
hcota@ubt.edu.al
4 Professor, Department of Wood Industry, Faculty of Forestal Sciences, Agricultural University of Tirana, Rruga Paisi Vodica 1025, Tirana, ALBANIA
hektor.thoma@ubt.edu.al

ABSTRACT:

Today, companies engaged in wood processing and furniture production are facing an increased demand for high quality products. For this reason these companies have made significant investments in technological updates in their production departments. These investments consist in the purchase of CNC machines and automatic lines for painting and polishing furniture etc. CNC router are recently being widely used for the advantages they offer, cutting of complex shapes, the production of various profiles, etc.

The presented study takes into consideration the impact of the feeding speed on the surface roughness of beech wood samples (Fagus sylvatica). For this reason we prepared some samples with dimensions 150 mm x 50 mm x 15 mm (length, wide and thickness), which we will cut in the CNC machine. As a variable factor we will use the feeding speed, while the number of rotations per minute (rpm), the volume of the material to be removed, the direction of cutting movement, the way of fixing the material in the machine, the geometric shape of the instrument, the density of the wood material, the porosity, the moisture content of the wood material will be considered as immutable factors.

Tests and measurements are performed at the Faculty of Forest Sciences at the Agricultural University of Tirana, Albania. The results obtained and analyzed show that the roughness of the surface is directly related with the feeding speed of the cutting tool.

Keywords: wood, surface, feed, quality, cnc

1. INTRODUCTION

Wood is an organic material with heterogeneous, with nice textures and with a fibrous structure. It is produced from trees which are living organisms. As a building material wood is used since ancient times. Where adequate housing and security was not provided by geographical and natural elements, man began to build huts[1].

Today, the value of timber has increased significantly. This is also due to the conditions of market, lack of supply and increasing demand for good quality timber. Wood is used to produce furniture, to produce elements for wooden trusses, to produce ladders, doors, windows etc. etc. Wood is also used as a basic element in the production of various panels, etc.

Wooden furniture is a much sought after product in the market. This is because they are comfortable, aesthetic, durable, strong and with a positive impact on climates and microclimates.

A factor that greatly affects the aesthetic aspect of wooden furniture is the quality of the surface on the machined elements. A clean and well-worked surface, with a good uniformity has a positive effect on the proper painting and gluing. Thus, experiments show that the roughness of the surface affects the strength of the joints that are realized by gluing[2]. We can say the same thing also in terms of the quality of painting, where for smoother surfaces we have reduced paint consumption[3].

The roughness of the surface is considered the combination of anatomical irregularities of the wood with irregularities caused during the processing of the pieces on the machine[4].

The factors that affect the roughness of the surface are divided into two large groups, in factors which depend on the characteristics of the wood species and factors related to mechanical processing. In the first group we can mention: wood density, moisture content, porosity, alternating of annual rings, the angle formed between the direction of the fibers and the direction of the machining etc. While in the second group we can mention the conditions under the which is realized the creating of the surface, such as: the geometry of the cutting tool, the volume of the wood material being removed, fixing of the wood material in the working bench of the machine where the processing will be performed, the feeding speed during machining, number of rotations of the cutting instrument, condition of the cutting edge etc.

Experiments show that we get an improved surface roughness in cases where we climb milling (according to the direction of the fibers[5]). Also, we get better results when we process elements of wood with low moisture content[6]. Various studies confirm the fact that early wood gives a smoother surface than late wood[7]. We prove this statement even from everyday practice. The porosity of the wood and the ratio of the annual rings alternation have a great impact on the quality of processed surface.

Regarding to the conditions in which the cutting is performed, we can say that the number of rotations of the cutting tool has an inverse relationship with the surface roughness. Increased number of rotations will cause an improvement in surface roughness[8].

Different methods are used to determine the roughness of the wood surface. Among them we can mention methods based on the senses of sight and touch, which are even more economics. Methods which are based on measurements of processed surfaces are quite accurate but require time for their realization as well as equipping with special measuring instruments, which are also costly[9].

Measuring and quantifying the effect of feeding speed on the roughness of the surface does not have any standard norms and methods to follow. This comes from the fact that wood is a very heterogeneous material, with cellular structure which is processed in different machines, with different characteristics. These combinations make the interpretation of the data more complex and specific to each case [10, 11].

This study takes in consideration the impact that feeding speed has on roughness of the surface obtained. In our country there are no studies conducted in this regard and we intend to build a simple application to make an assessment of the relationship between surface roughness and feeding speed of the tool. Further studies will be based on building an application as well more in-depth studies regarding cutting parameters.

2. MATERIALS AND METHODS

We chose beech material as a testing material for several reasons. Among these reasons we can mention the natural distribution of beech which is almost everywhere in Europe and varies from southern Sweden to northern Sicily, western France, southern England, northern Portugal, central Spain, east and northwest of Turkey etc. In the Balkans there are several hybridizations of Beech

(F.sylvatica) with native Beech (F. orientalis); creating hybrid species called Fagus x taurica. In the southern part of its extension zone around the Mediterranean beech grows mainly at altitudes of 600-1800 m above sea level[12].

Beech is a large tree which can reach a height of up to 50 meters and up to 3 m in diameter of the trunk. But the most normal dimensions are 25-35 m height and up to 1.5 m trunk diameter. Beech has a typical lifespan of 150-200 years although in rare cases it can live up to 300 years. Some 477 year old trees have been found in Izvoarele Nerei[13] (Romania) and even about 500 years old in Uholka-Shyrokyi Luh[14] (Ukraine).

Beech represents the most important forest species in Albania in terms of its contribution to the area and volume of the national forest fund[15]. According to the cadastral data of 2017, forests with occupies an area of about 171 thousand hectares (about 17% of the forest area of the country). But most beech is estimated from the volume it provides as a species, which reaches about 20.4 million m3 (40% of the country's forest fund), with an average volume of 119 m^3/ha. In te picture below we can see a large forest of beech wood in Albania, located in Klos municipality.

Figure 1: A large forest of beech wood in Albania, located in Klos municipality[16]

The characteristics of the wood used in this experiment are given in the table below[17].

Table 1: Characteristics for beech wood

Characteristic	Value
Scientific Name:	Fagus sylvatica
Distribution:	Europe
Tree Size:	30-40 m tall, 1-1.5 m trunk diameter
Average Dried Weight:	710 kg/m3
Specific Gravity (Basic, 12% MC)	53,71
Janka Hardness:	6,460 N
Modulus of Rupture	110.1 MPa
Elastic Modulus	14.31 GPa
Crushing Strength	57.0 MPa
Shrinkage	Radial: 5.7%, Tangential: 11.6%, Volumetric: 17.3%, T/R Ratio: 2.0

To perform the tests we have taken beech boards with dimensions with length of 150 mm x 50 mm x 15 mm (length, wide and thickness). These elements are obtained clean without knots, without

visible deformations regarding to the directions of the fibers, without cracks. The samples were obtained from boards with a moisture content of about 15%, in order to better adapt to the conditions in which the processing will take place. Special care has been shown against the fact that the samples are taken from the central part of the sawn body. In this way we will have radial and tangential surfaces.

Figure 2: European beech sanded[18]

Figure 3: European beech sealed[19]*, (coated with a protective top coat of polyurethan)*

The cutting tool used is a wood router bit used on cnc machines with a diameter of 6mm and HWM material. It is constructed by two helical edges with an angle of 30°. The manufacturer is the well-known company CMT. To carry out our experiment we will use the numerically controlled machine located at the Faculty of Forest Sciences. The tested elements will be fixed to the working bench of the machine by means of special clamps in such a way as to eliminate possible vibrations during the work. We used climb routing technique, "from thick to thin". In edge climb routing, the chip thickness decreases from the beginning of the cut and eventually reaches zero at the end of the cut.

Figure 4: Specimen being routed on the cnc machine

As we have pointed out before, the only factor that will change during the experiment will be the feeding speed of the cutting tool. We will use two different feeding speeds (2m/min and 6m/min) and for each we will perform 20 tests. The test consists of removing the same amount of material in both cases with the same number of revolutions (rpm = 16000) in both cases.

Figure 5: Tool used during the experiments

To measure the surface roughness we will use the MITUTOYO SURFTEST SJ-201. This instrument performs the measurement of the surface roughness by means of a special head. Which through direct contact, this head controls the irregularities in the tested surface and gives a two dimensional profile of it. Despite some limitations, this is the most common method for verifying surface roughness[20].

As a heterogeneous material, in order to have reliable data, we made four measurements in four edges of the machined surface and calculated the average surface roughness for each specimen.

Figure 6: measuring the surface roughness with the MITUTOYO SURFTEST SJ-201

3. RESULTS

As mentioned, before we are testing the impact of feeding speed on the surface roughness. The parameter to be taken in considerations is the Ra value, measured with the Mitutoyo rugosimeter. The Ra value represents the average of a set of individual measurements of a surfaces peaks and valleys measured in a certain given length. Ra (μm) is calculated according to the formula (1)

$$Ra = \left(\frac{1}{L}\right) \int_0^L |Z(x)| dx \qquad (1)$$

Where:
L- evalutation length
Z(x) – profile height function

The digital representation is expressed by:

$$Ra = (|Z_1| + |Z_2| + \cdots + |Z_n|/N) \qquad (2)$$

The results measured are shown in the table below:

Table 2: Ra values for both cases of feeding speed expressed in µm for each specimen

Specimen	Average value of Ra for feeding speed of 2 m/min expressed in µm	Average value of Ra for feeding speed of 6 m/min expressed in µm
1	1.61	2.51
2	1.91	2.66
3	1.65	2.43
4	1.99	2.91
5	2.34	2.92
6	2.11	3.08
7	1.86	3.34
8	2.18	2.59
9	2.16	2.81
10	2.44	2.76
Average	2.025	2.801

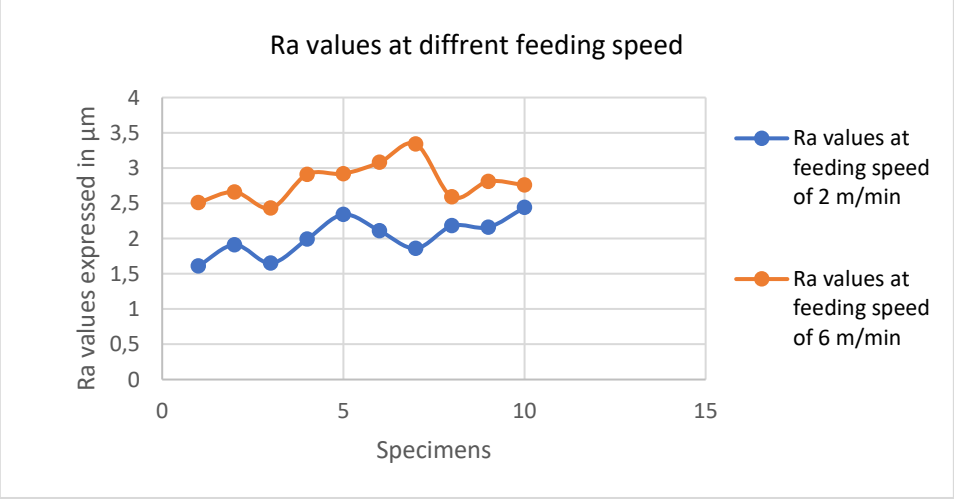


Chart 1: Surface roughness at diffrent feeding speeds

We ran a descriptive statistic for both results as we can see in table 3.

Table 3: Descriptive statistic for both feeding speeds

	Descriptive statistics for feed 2m/min	*Descriptive statistics for feed 6 m/min*
Mean	2.025	2.801
Standard Error	0.086631403	0.087107214
Median	2.05	2.785
Mode	#N/A	#N/A
Standard Deviation	0.273952551	0.275457196
Sample Variance	0.07505	0.075876667
Kurtosis	-0.819981417	0.183273261
Skewness	-0.140076875	0.620101443
Range	0.83	0.91
Minimum	1.61	2.43
Maximum	2.44	3.34
Sum	20.25	28.01
Count	10	10

4. CONCLUSIONS

As we can see by the graphs we notice that we have a slight decline in the surface quality with the increased feeding speed from 2 m/min to 6 m /min. We notice an increase of 0.776 μm in the Ra parameter. This phenomenon can be explained by the increase in the chip thickness and greater compression between the fibers during the cutting process. This result is in line with experiments made by other authors[21]. The uniformity of the texture or the size and distribution of the pores can give wood a very uneven texture explaining the differences between measurements at different points of the same species specimen[22]. Some deviations of the measured value from the expected ones both in case of measurements at different points or between parameters measured in the same point could be explained by the anisotropic nature of the wood.

Anatomic structure of the material has a significant impact on surface roughness. Resistance to penetration blade cutting edge in the specimen depends on type of cell walls. The axial tool leaves kinematic irregularities on the finished surface in the form of slot cycloid which is characterized by the length and depth of the wave, as can be felt even when touched.

Figure 7: A single specimen after routing

Figure 8: Some specimens after being routed

4. REFERENCES

[1]- Borràs, X., (2010). A brief history of the wood as building material
[2]- Marian JE, Stumbo DA, Maxey CW., (1958). Surface texture of wood as related to glue-joint strength. Forest Prod. J., (12):345-351.
[3]- Richter K, Feist WC, Knabe MT., (1995),. The effect of surface roughness on the performance of finishes. Part 1 Roughness characterization and strain performance Forest Prod J, 45(7/8): 91-97
[4]- Cota, H., Ajdinaj, D., Habipi, B., (2017). The influence of machining process on wood surface roughness. Agricultural Sciences. 16. 7.
[5]- Goli G, Bleron L, Marchal R, Uzielli L, Negri M., (2002). Formation and quality of wood surfaces processed at various grain angles: Douglas fir and Oak. In: Wood Structures and Properties, Arbora Publisher, Zvolen, Slovakia,: 91-98
[6]- Pinheiro C., De Sampaio C, Alves M., Simões Amaral S,: Moisture Content and its Influence on the Roughness and Noise Emission during Wood Machining, Advanced Materials Research, 015; Vol. 1088: 680-685
[7]- Malkocoglu A.: Machining Properties and Surface Roughness of Various Wood Species Plane in Different Conditions Building and Environment 42; 2007: 2562 – 2567
[8]- McKenzie WM; (1961) Fundamental analysis of the wood cutting process. Department of Wood Technology, University of Michigan Press, Ann Arbor, MI.
[9]- Fujiwara, Y.; Fujii, Y.; Okumura, SH. 2005. Relationship between roughness parameters based on material ratio curve and tactile roughness for sanded surfaces of two hardwoods. Journal of Wood Science 51:274–277.
[10]- Funck, J.W.; Forrer, J.B.; Butler, D.A.; Brunner, C.C.; Maristany, A.G. 1992. Measuring surface roughness on wood: a comparison of laser scatter and stylus tracing approaches. SPIE 1821:173–184.
[11]- Krisch, J.; Csiha, C. 1999. Analyzing wood surface roughness using an S3P perthometer and computer based data processing. Paper presented in the XIII Sesja Naukowa Badania dla Meblarstwa Poland
[12] -Diku, A. Shuka L, (2018) Pyjet e vjeter te ahut ne Shqiperi, Tirane
[13]-http://true-romania.tours/romanian-beech-forests-included-unesco-world-heritage-list/
[14] - https://en.wikipedia.org/wiki/Uholka-Shyrokyi_Luh_primeval_beech_forest
[15]- Marku, V.,Dendrologjia, Tirane, 2013
[16]- http://archive.ata.gov.al/2018/07/12/pyjet-e-vjeter-te-ahut-europian-te-ruajtura-qe-nga-koha-e-akullnajave/
[17]- https://www.wood-database.com/european-beech/
[18-19] https://www.wood-database.com/european-beech/
[20]- Sandak J, Negri M; (2005). Wood Surface Roughness –What Is It?, Proceedings of the 17th International Wood Machining Seminar, Rosenheim, , Vol.1: 242- 250
[21]- Barcík, Štefan & Pivolusková, Eva & Kminiak, Richard & Wieloch, Grzegorz. (2009). The influence of cutting speed and feed speed on surface at plane milling of poplar wood. Wood research. 54. 109-116.
[22] - Thoma, H., & Peri, L., & Lato, E., (2014). Evaluation of wood surface roughness depending on species characteristics. Maderas. Ciencia y tecnología. 17. 10.4067/S0718-221X2015005000027.

SECTION/SEKCIJA
C

TRAFFIC REGULATION USING FUZZY-ANN TECHNOLOGY

Ammar Merdanić, Zlatko Bundalo
Faculty of Technical Engineering, University of Bihać, Bosnia and Herzegovina,
ammar97.merdanic@gmail.com,
Faculty of Electrical Engineering, University of Banja Luka, Bosnia and Herzegovina,
zlatbun2007@ gmail.com

ABSTRACT:

Artificial intelligence, or in this case specifically the expert system, consists of fuzzy sets and logic, and artificial neural network (ANN). This paper describes the creation of an expert system that regulates traffic on the basis of artificial intelligence. The system is primarily divided into 5 input and 2 output states. In order to have a more precise and, better quality operation of the system, all states, both input and output, have a minimum of 3 parameters. By mutual and carefully selected correlation of all states and parameters, the rules on which the work of fuzzy logic is based are created. For the proper operation of the ANN network, numerical values of inputs and outputs are defined through Excel, on the basis of which the neural network is trained. All of the above is realized through the MATLAB software package, which essentially connects fuzzy logic and ANN artificial neural network, and through a specially created graphical interface offers the possibility of interaction between the expert system and the user.

Keywords: Artificial Neural Network (ANN), Artificial Intelligence, Expert System, Fuzzy Logic, Graphical Interface, MATLAB

1. INTRODUCTION

Nowadays, there is a tendency in all segments of human life and production processes to reduce the volume of human labor, and increase the share of machines and automation. Given that the degree of automation is currently at a very high level, the next step is the increasing implementation of artificial intelligence. As a modern and relatively young branch of science, artificial intelligence is studied and implemented through numerous programs and platforms. One of them is the mutual use of fuzzy sets and logic, and ANN network. The use of these elements would not be possible without the MATLAB software package in which, in addition to fuzzy logic and ANN artificial neural network, a graphical interface is created for entering input and displaying output values.

The paper primarily shows the way of defining technical characteristics, i.e., input from output values, as well as their associated parameters. The second part of the paper describes the creation of fuzzy sets, and the determination of the rules on the basis of which fuzzy logic will operate. After that, the creation and training of ANN network is explained. Finally, the interaction of fuzzy logic and ANN artificial neural network is shown, which is essentially an expert system.

2. DEFINING OF CONTROLLED SYSTEM

As in any other approach to problem solving, i.e., creating a system, so in this case, the first step is to define the system that is controlled or managed. That implies determining the technical characteristics, condition and parameters of the system.
Taking into account the goal of this system, what is Traffic regulation using fuzzy - ANN technologies, the following input and output parameters and values were selected as the most appropriate and optimal:

Input parameters and their states:

- Car frequency (small, normal, large),
- Pedestrian frequency (small, normal, large),
- Time (late evening, morning, afternoon, early evening),
- Zone (school, populated areas, outside the populated areas),
- Weather conditions (snow, rain, sun).

Output parameters and their states:

1. Speed (low, medium, high),
2. Traffic light (car priority, warning, pedestrian priority).

After defining the input and output parameters together with their states, it is necessary to create certain rules on the basis of which the system will function. The importance of rules is reflected in the fact that the system, based on input data, entered by the user or received from a sensor, performs processing using defined rules. That results in output values generated by the system, the accuracy of which depends on the quality of the given rules.
The rules are created by mutual and carefully selected correlation of all states and parameters. When creating rules, it is necessary to take into account all conditions and parameters. Of course, the greater the number of combinations is, the greater the precision of the system will be. However, with too many combinations, certain rules can be contradictory, which would then disrupt the accuracy of the system. [1]
Specifically, this system consists of 324 rules. Since it would be too extensive to show them all, some of the rules used by the system can be seen in Table 1.

Table 1: Individual rules for system operation

	Car frequency	Pedestrian frequency	Time	Zone	Weather conditions	Speed	Traffic light
1	Small	Small	Late evening	School	Snow	Small	Warning
47	Small	Normal	Morning	School	Rain	Small	Pedestrian priority
276	Large	Normal	Afternoon	Populated areas	Sun	Medium	Car priority
324	Large	Large	Early evening	Outside the populated areas	Sun	High	Car priority

After defining the technical characteristics, conditions and parameters of the system, as well as the rules for the operation of this system, the next step in creating an expert system is to create a fuzzy model and ANN model.

3. CREATING FUZZY AND ANN MODELS

Fuzzy logic is based on the theory of fuzzy sets, which can be understood as a generalization of the theory of classical sets, i.e., on the theory that refers to objects with unclear boundaries. In contrast to the traditional set theory, in the theory of fuzzy sets the values of the membership function are within the interval [0, 1]. A value of 0 indicates that the object is completely outside the set, a value of 1 indicates that it is completely inside the set, and any value in between indicates a partial membership. [1] Taking into account that fuzzy logic allows partial membership of set elements, and functional values of membership function are within the interval [0, 1], we define the membership function with expression (1):

$$\mu_A(x): X \longrightarrow [0,1]. \tag{1}$$

Another feature of fuzzy logic is based on natural language, i.e., on the basis of human understanding. Thus, input and output variables can have different linguistic names. [2]
Accordingly, the creation of sets, their associated elements, and membership functions for the traffic regulation system is performed. The input and output parameters, defined in Chapter 2, form sets, while their states form the corresponding elements. Figure 1 shows the fuzzy model of the set "time" together with its corresponding elements.

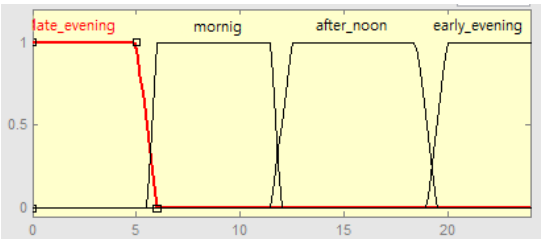


Figure 1: Fuzzy model of the set "time"

The set "time" has a range from 0 to 24, which represents the hours in one day. The trapezoidal function was chosen as the most optimal function for these variables. The mathematical model of the variable "morning" is defined in expression (2).

$$f(x) = \begin{cases} 0, & x < 5.5 \; U \; x \geq 12 \\ 1, & 6 \leq x \leq 11.5 \\ 1 - \frac{6-x}{0.5} & 5.5 \leq x \leq 6 \\ 1 - \frac{x-11.5}{0.5}, & 11.5 \leq x \leq 12 \end{cases} \tag{2}$$

This is where the theory of fuzzy sets comes to the fore, which allows a partial membership of the elements of the set, and the functional values of the membership function are within interval [0, 1]. The trapezoidal function for the variable "morning" excludes all values that are less than 5.5 and greater than 12, i.e., their membership function is 0. The membership of the function increases in the interval from 5.5 to 6, after which the membership reaches the maximum. In the interval from 6 to 11.5, the membership function is 1, which represents the maximum membership. The interval from 11.5 to 12 represents the decreasing interval of the membership function after which the membership decreases to 0. The structure of all other sets is based on this principle. The only difference between the input and output sets, besides the interval, is that the output sets are expressed by a triangular function as can be seen from Figure 2 for the set "speed".

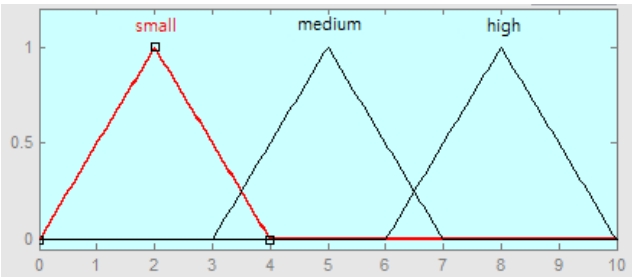


Figure 2: Output fuzzy set "speed"

The set "speed" has a range from 0 to 10 in which slow, medium and fast speed are evenly distributed. The triangular function was chosen as the most optimal function for these variables. The mathematical model of the variable "slow" is defined in expression (3).

$$f(x) = \begin{cases} 1, & x = 2 \\ 1 - \frac{2-x}{2} & 0 \leq x \leq 2 \\ 1 - \frac{x-2}{2}, & 2 \leq x \leq 4 \end{cases} \quad (3)$$

The only difference between the previously described trapezoidal function and the triangular function is that the triangular function has a maximum membership at only one value. In this case it is a value of 2.

In this way, all other sets, their corresponding elements and membership functions are created. In order to complete the fuzzy model, it is also necessary to define the rules on the basis of which the created system will work. Rules are created by mutual and carefully selected permutation of parameters. Permutation is performed using the "and", "or" and "not" operators. [3]

ANN as an artificial neural network simulates a network of brain neurons, i.e., it is a replica of the human brain that seeks to simulate the learning process. Thus, an artificial neural network is a simplified model of a biological neural network and consists of a set of interconnected process elements or neurons. The power of processing is reflected in the strength of the connections between individual neurons, i.e., the weights obtained by the learning process from a set of learning data. Data in a neural network is processed by the distributed parallel operation of its nodes. [4] Creating an artificial neural network is made possible through an MATLAB tool called nftool.

Before the training process, it is necessary to set the following few parameters. The first step is to define the input and output data. This data is created through Excel spreadsheets as follows. Separate input and output tables are created. The "input" table has 5 columns that make up 5 operating parameters, defined in Chapter 2. In addition, the table "input" has 324 rows, through which all combinations of input parameters and their states are presented. Analogously, the "output" table has 2 columns that make up 2 operating parameters and 324 rows of combinations of their states, defined in Chapter 2. The second step is to determine the training, validation, and testing of the artificial neural network. The following were chosen as the most optimal parameters:

- Training: 90%,
- Validation: 5%,
- Testing: 5%.

Based on all of the above, network training is performed. Training is performed using the Levenberg-Marquardt algorithm which makes it one of the standard training algorithms in nftool. It is important to emphasize that there is no universal training time for all networks. Each creator decides when his network is sufficiently trained. Some of the parameters that represent a well-trained network are to perform all 1000 repetitions in an epoch. It is also important for the values of training, validation and testing to be as close as possible to 1. Figure 3 shows the results of training this artificial neural network.

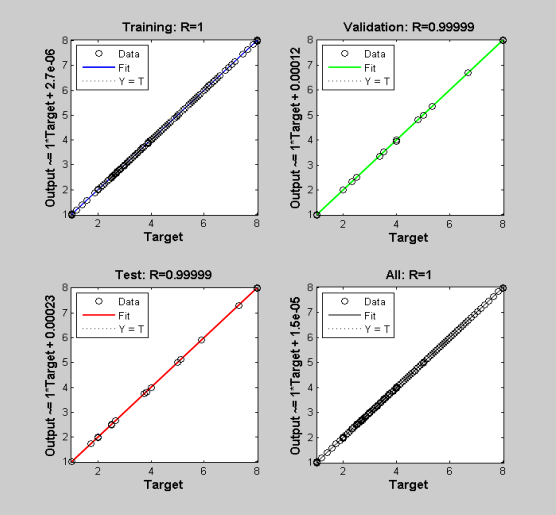


Figure 3: Results of ANN training

A well-trained artificial neural network is "packaged" into a MATLAB Simulink model through which it can be used both separately and in combination with the fuzzy model, which will represent the expert system.

4. CREATING EXPERT SYSTEM

The expert system forms a blend of previously created fuzzy and ANN models. An expert system is created for the reason that by merging the fuzzy and ANN models, the system results in producing the most optimal results. [5] In order to create an expert system, it is necessary to connect blocks of fuzzy and ANN models through MATLAB Simulink. A Simulink model of expert traffic control system is shown in Figure 4.

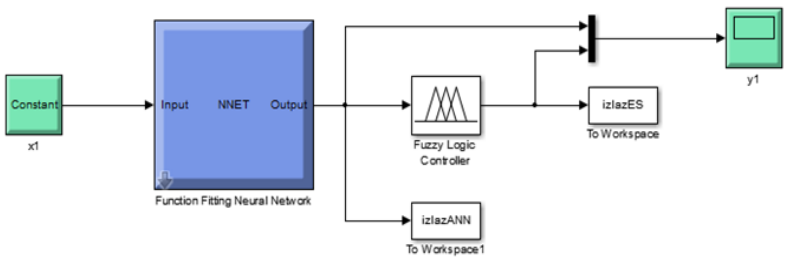


Figure 4: A Simulink model of expert traffic control system

As can be seen from Figure 4, ANN and fuzzy blocks are connected to the input in series, resulting in the output value of the expert system. Also, the possibility of a separate display of ANN and fuzzy output has been created, for a better overview.
Since this model is not practical for wider use, a graphical interface is created that facilitates the input and output values of the system. Figure 5 shows the layout of the final graphical interface.

The left block contains the input values that the user enters arbitrarily. These values are processed by the system and printed in the right block as a result.

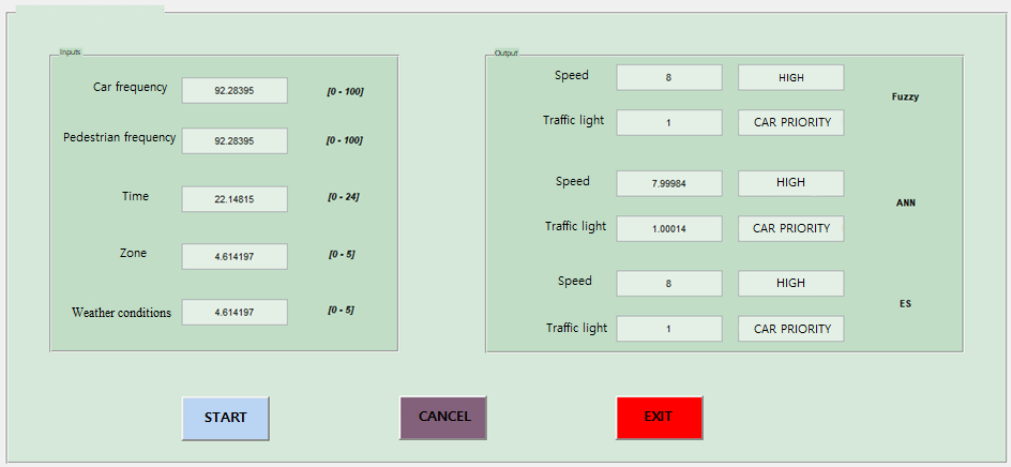


Figure 5: Final graphical interface

The graphical interface, for a better and more comprehensive overview, was created to display the results of fuzzy, ANN and the expert system separately.

5. CONCLUSION

The aim of this paper was to create a system for traffic regulation. Due to the dynamic way of life that is happening around us, we are witnessing increasingly dense and unsafe traffic in both urban and rural areas. One of the ways to increase traffic safety is very high-quality traffic regulation. This paper describes a way to create a traffic regulation system based on artificial intelligence. Fuzzy and ANN models were used, which are an integral part of the MATLAB software package. First of all, the control system is defined, the parameters for work are determined, and the rules on the basis of which the system will work are created. Based on the parameters, fuzzy sets and explained membership functions were created. An artificial neural network was created, and the way of its training was explained. In the end, everything was merged into one model, an expert system and a graphical interface was created to facilitate the use of the entire system.
Through testing, this system has proven to be a relatively high quality and accurate system. Of course, as this is a relatively small set of data and a small number of attributes, the results are more than satisfactory. For better and more complete traffic regulation, it is necessary to have a larger number of samples and a larger number of attributes.

6. REFERENCES

[1] S. Sivanandam, S. Deepa. Introduction to Fuzzy Logic using MATLAB, Berlin, Springer Verlag.

[2] https://plato.stanford.edu/entries/logic-fuzzy/ Visited: 14.01.2021. god.

[3] https://en.wikipedia.org/wiki/Fuzzy_rule Visited: 14.01.2021. god.

[4] https://www.mathworks.com/discovery/neural-network.html Visited: 14.01.2021. god.

[5] U. A. Rooh, L. Aijun. (2015) Fuzzy, Neural Network and Expert Systems Methodologies and Applications, Journal of Mobile Multimedia.

PHOTOVOLTAIC POWER PLANT DESIGN - CASE STUDY OF BURCH UNIVERSITY CAMPUS

Ensan Klepo[1*], Nedis Dautbašić[2], Samir Avdaković[1,2]
[1]Internacional Burch University, [2]Faculty of Electrical Engineering, University of Sarajevo,
*ensan.klepo@stu.ibu.edu.ba

ABSTRACT:

The design of photovoltaic (PV) power plants is not an easy process. It requires knowledge in a number of areas, such as technology, local power grids and systems and regulation. The design process involves: analysis of available data, regulatory analysis and local power distribution operator recommendations, evaluating a building site for its solar potential, common grid-connected PV system configurations and components, considerations in selecting components, considerations in design and installation of a PV system, typical costs and the labor required to install a PV system, building and electric code requirements. As a result in this thesis all aspects of the photovoltaic power plant project required for practical implementation are given. For the purpose of cost-effectiveness assessment the paper presents the concept of a solar plant with energy and economic analysis using the appropriate software tool.

Keywords: Photovoltaic power plant, power grid and system, solar potential, regulation, software tool

1. INTRODUCTION

Nowadays, renewable energy sources are becoming increasingly important in the electricity system, and developed countries are largely stimulating their use. The reason for this should be especially emphasized in the high price of fossil fuels with their constant increase, as well as the high environmental pollution that affects climate change. Bosnia and Herzegovina has a very favorable geographical position in terms of solar energy use.
Solar energy can be converted into electricity in several ways, and the simplest is direct conversion using photovoltaic (solar) cells. The principle of operation of a solar cell is based on the direct conversion of solar energy into electricity based on the photoelectric effect. Photovoltaic systems have numerous advantages such as: Solar energy is free and practically inexhaustible, energy conversion technology is clean, it is possible to supply consumers in places where there is no built power system, it is characterized by high reliability and low operating costs, and ensures long life photovoltaic modules (> 25 years). The disadvantages of the photovoltaic system are that production depends on sunshine, large areas are needed for larger power plants. The solar module consists of several series-connected and parallel-connected solar cells in order to maximize its total output power. Nowadays, solar modules are made in different shapes and with different numbers of solar cells [1,2].

Renewable electricity sources, such as photovoltaic (PV) systems, wind farms, fuel cells and small hydropower plants are increasingly being connected to the distribution network to satisfy the needs of increasing consumption, reducing electricity production from fossil fuels and reducing environmental pollution [3,4]. However, distribution systems with a large number of connected distributed generators, as described in [5], face various problems, such as:

- Change of voltage conditions in the network depending on production and consumption, and two-way power flows,
- Occurrence of voltage transients resulting from connection and disconnection of generators,
- Increasing the short-circuit power in the network,
- Power losses become dependent on production and consumption,
- Impact on electricity quality and system reliability,

The distribution network protection must be readjusted due to the two-way power flow.

PV systems are most often connected to low-voltage and medium-voltage networks and their power ranges from 1 kW to several MW. In Germany, 80% of photovoltaic systems are connected to a low-voltage network [6]. Recently, there has been a drop in PV module prices over the last ten years [7]. The technology of connecting photovoltaic sources to the network, management of distribution systems and geographical, topological and meteorological factors were studied in their work. The high variability of the solar energy source, due to different weather conditions, makes this electricity source a stochastic producer, which is a great challenge for the power system (EES). Connecting the PV system causes various technical problems in the system, such as power quality, system management and regulation, and system stability. Modern power systems operate close to their stability limits due to economic factors, so a detailed analysis of the impact of the connection of PV systems on the stability of the power system is crucial for the proper operation of the system [8]. U [9]: The sizing of the suggested PVPP is achieved, such as array sizing and enhanced perturb and observe maximum power point tracking (MPPT) technique, in order to overcome the disadvantages of conventional method such as oscillation and slowly tracking under sudden change of atmospheric conditions. While [10] he gave the basics of designing photovoltaic power plants. In [11] explores how electricity systems may evolve in the 21st century.The paper focuses on some fundamental challenges facing the utilization of electricity today and for years to come. Paralleling the challenges, several directions of how new solutions may emerge are suggested. In this context, some new approaches to manage power system development and deployment are outlined. In this paper [12] involves the introduction of energy storage units (e.g. batteries); the objective is to avoid fluctuations caused by renewable energies (e.g. wind/solar energy) during generation and supply. Simulations show the effect of energy storage units and their role in providing grid stabilization and power quality. In the book [13] provides clear and comprehensive explanation of how Digital Signal Processing (DSP) and Computational Intelligence (CI) techniques can be applied to solve problems in the power system. Also, techniques are present today for optimal design of PV systems using hybrid optimisation and artificial neural network [14,15].

2. CASE STUDY – INTERNATIONAL BURCH UNIVERSITY

International Burch University is currently supplied with electricity from the local LV electricity distribution network from the secondary substation TS 10 / 0.4 kV. The basic parameters of the electricity distribution network are defined by the Grid Rules. The PV Sol program was used in this paper. The annual solar radiation for this area (Latitude 43.818886750000004 °, Longitude 18.31116680625186 °) is 1311.5 kWh / m^2. Figure 1 shows the solar radiation by months and temperature for the case under consideration, while Figure 2 presents a visualization of the proposed solution. The total required area for the 45 kW power plant is 566.16 m^2 and will have 150 photovoltaic panels. As can be seen from Figure 2 three groups of panels are placed in the southeast direction, while one group of panels (60 panels) is placed in the southwest direction. This choice was made because the south side is the sunniest. Position of panels are fixed, mounting angle is 30 ° similar to the roof construction. There are no objects or anything else nearby that would affect the panels in the shadows.

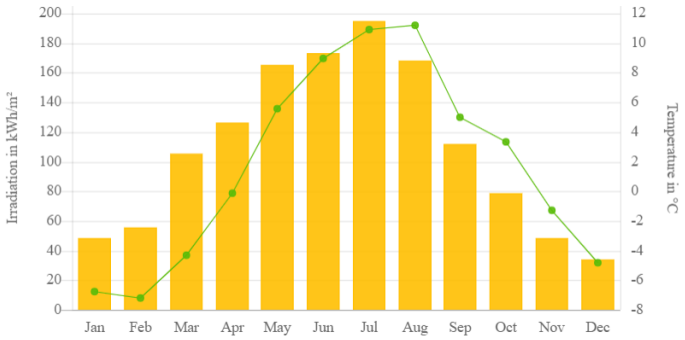


Figure 1: Solar radiation and average temperature by months

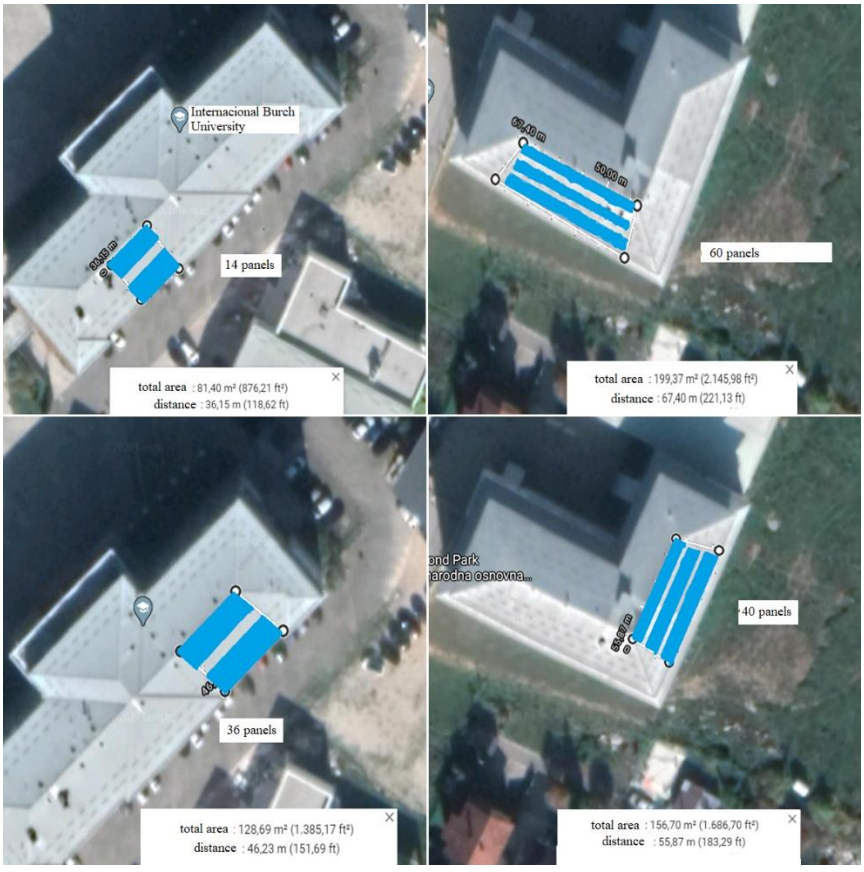


Figure 2: Visualization of the proposed solution

2.1. Electricity consumption analysis

The total electricity consumption of International Burch University for 2019 is 726,594 kWh, of which the higher tariff is 416,428 kWh (representing 57.31%), while the lower tariff is 310,166 kWh (representing 42.68%). Figure 3 provides an overview of the total electricity consumption of International Burch University for 2019. The total consumption in some months reaches up to 80 kWh, which for this facility is quite high consumption.

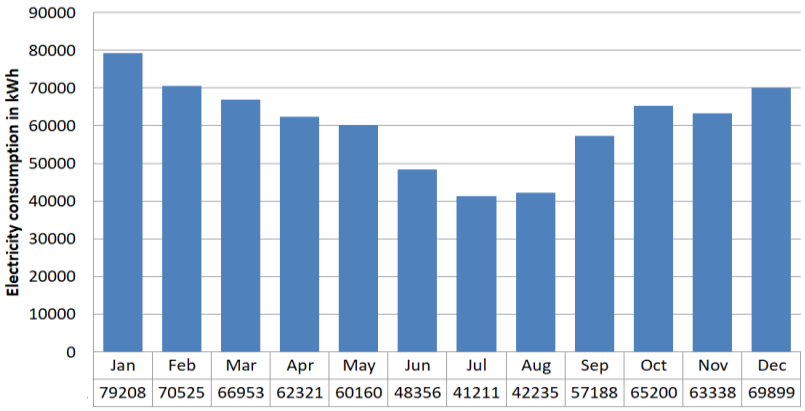


Figure 3: Total electricity consumption of the facility for 2019

Figure 4 provides an overview of the monthly electricity consumption of International Burch University for 2019. From the picture we can see that the monthly consumption is more pronounced in the higher tariff, so the investment in a photovoltaic power plant makes sense. About 57.3% of consumption refers to consumption in a higher tariff, which represents a significant financial cost for the facility but also the potential for good profitability of the installation of a photovoltaic power plant.

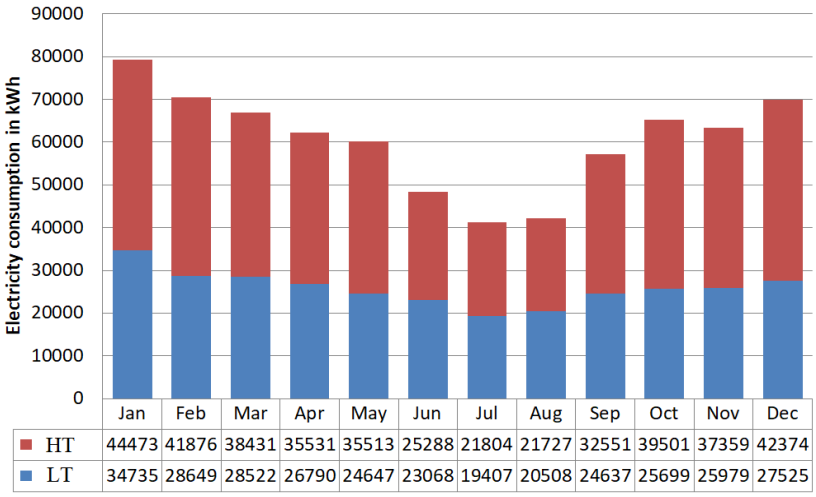


Figure 4: Monthly electricity consumption for 2019

The normalized consumption curve of International Burch University for 2019 is shown in Figure 5. It represents the result of data submitted by the competent distribution system operator. The normalized curve also provides information in maximum power, minimum power, and total (in this case) annual energy consumption.

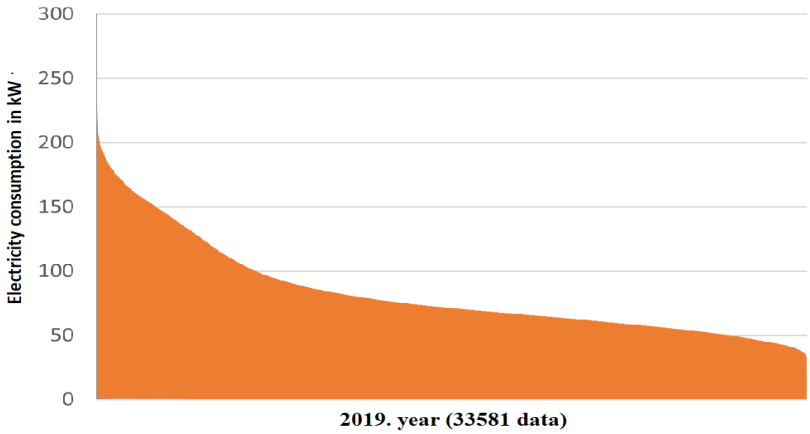


Figure 5: Normalized building consumption curve for 2019

The maximum consumption was 242.8 kW, while the minimum consumption was 30.8 kW in the observed period. The average value of power consumption is 82.95 kW.

2.2. Technical analysis

The basic idea is to build a photovoltaic power plant with a planned power of 45 kW. The installation of photovoltaic modules is planned on the roof of the building. The supply of this area with electricity is done through the distribution network under the jurisdiction of ED Sarajevo. This photovoltaic power plant is a relatively low power plant, and its connection should not have a significant impact on the electricity distribution network. The photovoltaic power plant will be composed of a photovoltaic generator composed of modules, mains inverters, and other AC and DC equipment. Equipment (panels, DC and AC cabinets, inverters and a handover measuring point) will be located on the building and in the building which is owned by the investor. The photovoltaic generator will be composed of 150 FN modules with a nominal power of 300 W. The connection to the electricity distribution network will be made by mains inverters (8x15 kW). The block diagram is given in Figure 6.

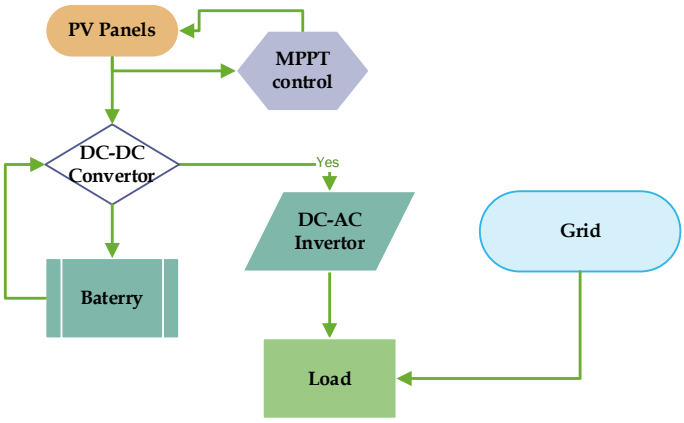


Figure 6: The block diagram

Grounding will be performed in such a way that all metal parts (supporting structure: Fe and Al, modules) are interconnected and connected to the Fe-Zn earthing strip and the TN-S system is selected. Neutral and protective conductors are separated along the entire TN-S system. The characteristics of the protection device and the impedance of the circuit are selected so that in the event of a fault anywhere in the installation, an automatic power failure occurs, within the time specified in the technical regulations. For equipotential bonding, a single-potential bus is used on which galvanic interconnection is performed. All installation is performed with five-core cables, where the fifth conductor is connected to a protective contact or grounding screw, and at the other end to a protective single-pole bus located in a low-voltage distribution cabinet that is galvanically connected to a common grounding conductor. The connection to the single-pole bus is made with a separate conductor type PF 10 mm^2.

2.3. Economic analysis

Given the different prices on the market of equipment for photovoltaic power plants, where primarily the prices of panels depend on the manufacturer and quality, several scenarios for assessing the economic evaluation of this project have been made. Based on the calculations made on the basis of production, consumption, the current tariff system, the saings that would be achieved with this investment were identified. Given the different prices on the market of equipment for photovoltaic power plants, where primarily panel prices depend on the manufacturer and quality, several scenarios for assessing the economic evaluation of this project, shown in Figure 7. They relate to investment prices of:

- Model A: 500 € / kW,
- Model B: 625 € / kW and
- Model C: 750 € / kW.

The return on investment method or payback period is the simplest criterion for financial investment decisions. He gives an answer about the number of years for how much we will return the invested funds. In other words, when will the cash flows return the investment, respecting the invested funds. After that period, all other cash flows represent earnings for the company. According to the given graph, model A is proposed.

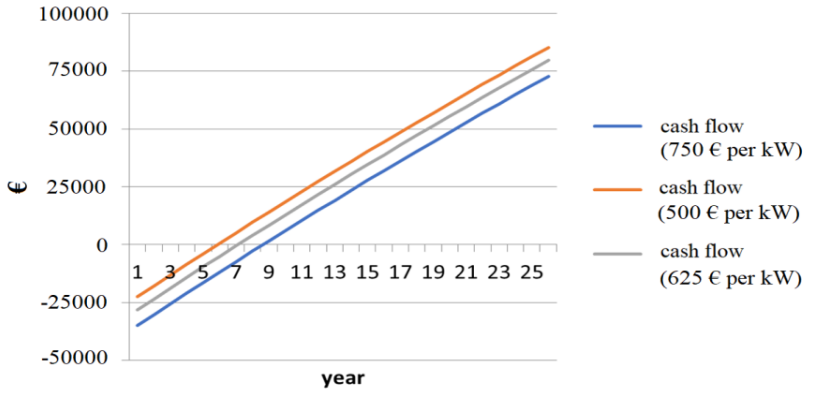


Figure 7: Graphical interpretation of the return time or photovoltaic power plant for different models

2.4. Benefits of the proposed photovoltaic power plant

The applied method in the study is the processing of primary data consisting of collected data related to the potential of the site, then the price of electricity, the price of necessary equipment and more. This chapter summarizes the results of calculations and analyzes. Figure 8 shows the graphical energy flow obtained using the PV SOL program.

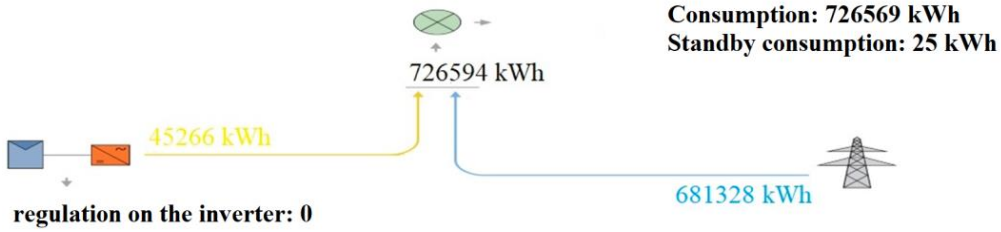


Figure 8: Graphic energy flow

Thus, Figure 9 shows the monthly production at FNE Burch tariffs, while Figure 10 shows the electricity savings at tariffs for this power plant. Based on the budget and everything presented, it can be concluded that the investment in a solar power plant is justified. Given the benefits realized in terms of reducing the load on the network, as well as avoided CO_2 emissions during the life of this plant. It can be seen from Figure 9 that the solar power plant has a higher production during the period of high tariff, ie per day on working days when the consumption of the building itself is higher in relation to the period of lower tariff. It is this scenario that leads to a reduction in daily maximum loads.

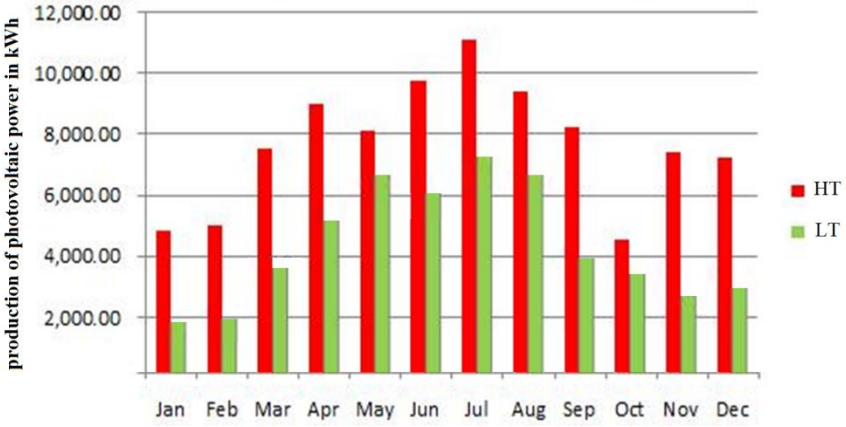


Figure 9: Display of monthly production by tariffs

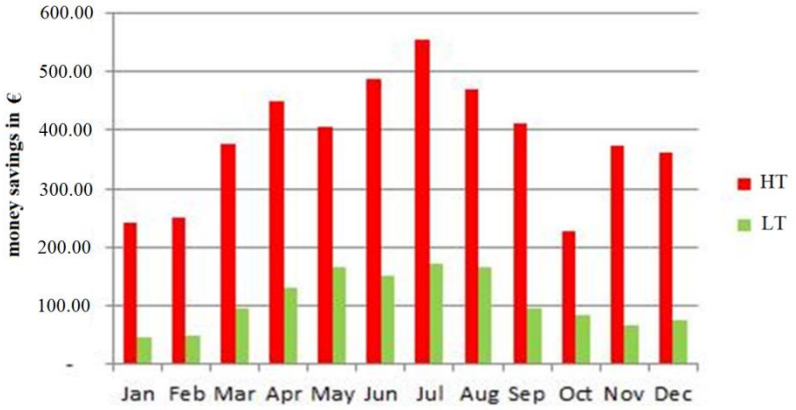


Figure 10: Display of electricity savings by tariffs

Figure 11 shows the production of a photovoltaic power plant, then the consumption of the considered facility and the difference between these two quantities for one week in order to have a better insight into the impact of solar power plant production on maximum loads during the day.

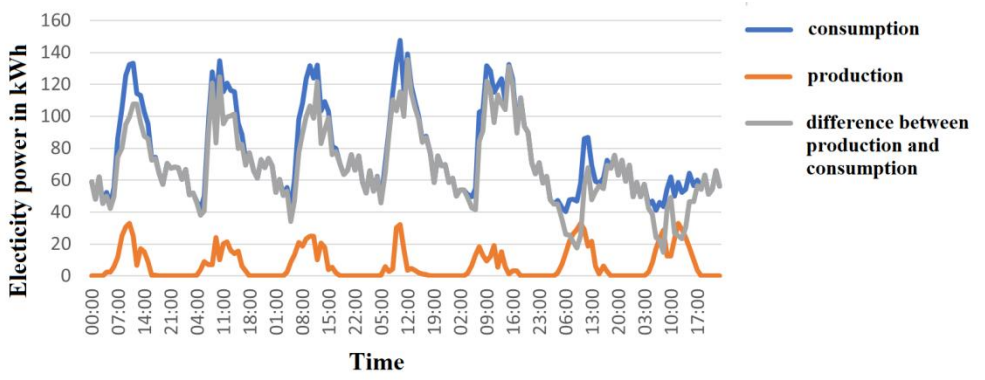


Figure 11: Production-consumption-difference for the period 10-06.-16.06

3. CONCLUSION

The aim of this paper was to conduct an assessment of the cost-effectiveness of building a photovoltaic power plant on the Burch University. In order to assess the cost-effectiveness, the concept of a solar plant was made with all the segments that can be found within the plant, and an energy and economic analysis of the project was made. The economic budget was made using the net present value of money methodology as well as the return on investment method. The energy audit, as well as the analysis, presented in the paper, were calculated using an appropriate program. Due to the increase in energy needs and the desired reduction of CO_2 emissions, solar plants are one of the best solutions, along with wind turbines, of course, as the price of photovoltaic modules is rapidly declining as technology advances.

The considered concept of the solution took into account the available road and electric power infrastructure, available space and characteristics of the area interest and the modern way of construction the solar plant. Based on the available data and prices of equipment on the market, the investment, revenues and expenditures were estimated, and an analysis of the cost-effectiveness of the construction of FNE was performed according to a standardized methodology. Depending on the amount of investment (or the considered investment model), the estimated return on investment in this case is from 6 to 8 years. These results tell us that even if sensitivity analyzes were conducted in case of reduction of electricity purchase prices by over 20%, or in case of increase of annual operating costs by over 2.5 times, in relation to the considered scenario, they would indicate stability and justification of investment in the construction of this power generation facility.

4. REFERENCES

[1] Jackson, F. (2007). Planning and installing Photovoltaic Systems. Green Dragon Energy. Berlin.
[2] Solar Electric System Design (2009). Operation and Installation, Washington State University Extension Energy Program.
[3]Mohammadi, K., Naderi, M., Saghafifar, M. (2018). Economic feasibility of developing grid-connected photovoltaic plants in the southern coast of Iran. Energy, 156, 17–31.
[4] Zou, H., Du, H., Brown, M.A., Mao, G. (2017). Large-scale PV power generation in China: A grid parity and techno-economic analysis. Energy, 134, 256–268.
[5] Jimenez, M.J., Madsen, H., Bloem, J.J., Dammann, B. (2008). Estimation of non-linear continuous time models for the heat exchange dynamics of building integrated photovoltaic modules. Energy and Buildings. Vol. 40. Pp. 157–167.
[6] Hudson, R., Heilsher, G. (2012). PV Grid Integration – System Management Issues and Utility Concerns. Energy Procedia. Vol. 25. Pp. 82-92.

[7] Comello, S., Reichelstein, S., Sahoo, A. (2018). The road ahead for solar PV power. Renew. Sustain. Energy Rev., 92, 744–756.
[8] Kamaruzzaman, Z.A., Mohamed, A. (2016). Dynamic voltage stability of a distribution system with high penetration of grid-connected photovoltaic type solar generators. J. Electrical Systems. Vol. 12-2. Pp. 239-248.
[9] Al-Shetwi, A.Q., Sujod, M. Z. (2016). Sizing and Design of PV Array for Photovoltaic Power Plant Connected Grid Inverter. The National Conference for Postgraduate Research, Universiti Malaysia Pahang.
[10] Momoh, J. (2012). Smart Grid: Fundamentals Of Design And Analysis. IEEE, New Jersey, USA..
[11] Kezunovic, M., McCalley, J.D. , Oberbye, T.J. (2012). Smart Grids and Beyond: Achieving the Full Potential of Electricity Systems. IEEE.
[12] Worighi, I., Maach, A., Hafid, A. (2016). Modeling a Smart Grid Using Objects Interaction. IEEE.
[13] Ribeiro, P.F., at all. (2014). Power Systems Signal Processing for Smart Grids. John Wiley and Sons Ltd.
[14] Zidane, T.E.K., and all. (2020). Optimal Design of Photovoltaic Power Plant Using Hybrid Optimisation : A Case of South Algeria. Energies.
[15] Farayola, A. M., Sun, Y., Ali, A. (2018). Optimization of PV Systems Using ANN-PSO Configuration Technique Under Different Weather Conditions. 7th International Conference on Renewable Energy Research and Applications (ICRERA), pp. 1363-1368,

DIGITAL IMAGE AN EVIDENCE IN CASE LAW AND SOFTWARE FOR FORENSICS OF DIGITAL IMAGE

Jasna Hamzabegović, Nejra Mesić
University of Bihac, Faculty of Technical Engineering, Bosnia and Herzegovina,
nejra.mesic@unbi.ba

ABSTRACT:

Technology is a powerful weapon that can be used for good but also for evil. The development of computer networks and information and communication technologies has brought the possibility of using advanced technologies for illegal purpose that has made computer crime an everyday occurrence. In a large number of criminal offenses, the digital image is the carrier od hidden, and for the process of investigative actions very important information. The paper will present a review of available software for digital image forensics, as well as the incidence and importance of digital imaging as relevant evidence in case law.

Keywords: Computer crime, Digital forensics, Metadata, Digital image

1. INTRODUCTION

Due to the accelerated development of information and communication technologies and the easier access to photographic devices, the manipulation of digital photographs has become part of everyday life. Learning process and skill development, as well as use of number of graphics programs can be beneficial but also harmful.

To commit the crime that we have heard about in the past, only one person willing to take such an activity was enough. Gender, education and even age were not important factors in that intention. However, computer crimes such as photo manipulation are committed only by professionals. Considering that digital photography is one of the most important pieces of evidence in court proceedings after establishing its authenticity, the sophisticated crime on digital photography has prompted the authors of this paper to consider whether this type of crime is sufficiently recognized in Bosnia and Herzegovina and what possible unwanted consequences are.

The use of computers is indispensable in almost all segments of life, but the security of information systems is questionable because it is very easy to possess information that is transmitted in digital form through various media.

2. DIGITAL FORENSICS

Forensics is a science that, by applying certain methodologies and techniques, determines the facts necessary for judicial or administrative proceedings. Digital forensics is a branch of forensics that deals with the collection, search, protection and analysis of evidence in digital form and includes their presentation as material evidence in subsequent court proceedings. Considering the different devices that store digital data, digital forensics is divided into: computer forensics, network forensics, mobile device forensics and database forensics [1].

2.1. Digital forensics and law regulation in Bosnia and Herzegovina

Digital forensics, in addition to enforcement rules, has legal norms. In the Federation of Bosnia and Herzegovina, there is a number of articles in the Criminal Procedure Act related to damage of computer data and programs, computer forgery, computer fraud and computer sabotage.
According to Article 393, Paragraph five, whoever manufactures, procures, sells, possess or makes available to others special devices, means, computer programs or computer data created or adapted for the purpose of committing a criminal offense without authorization, shall be punished by a fine or imprisonment for up to three years. Paragraph six of the same article allows for the confiscation of such data or programs.
According to Article 393, Paragraph five, whoever manufactures, procures, sells, possess or makes available to others special devices, means, computer programs or computer data created or adapted for the purpose of committing a criminal offense without authorization, shall be punished by a fine or imprisonment for up to three years. Paragraph six of the same article allows for the confiscation of such data or programs.

2.2 Analysis process in digital forensics

The process of computer forensic analysis is very complex and as such, requires expertise, logistical support and constant financial support. The aim of the analysis is to preserve the credibility of digital evidence.
Important steps in planning a computer forensic analysis are:

- defining the goals of the planned analysis,
- assessment of human resource needs,
- administrative preparations,
- determination of procedures for evidence management.

The process of conducting digital forensics is strictly defined. Acting in accordance with the provisions of the Criminal Law, after excluding potential evidence, the competent court selects one or more court experts to conduct the analysis and issue an opinion which the court accepts without further examination, unless the accused and/or prosecutor requests a new forensic analysis. The forensic expert assumes responsibility for keeping the material evidence in its original form. The expert witness submits an opinion to the court after he is sure of the same, aware that the outcome of the trial depends on the amount of evidence that is found.

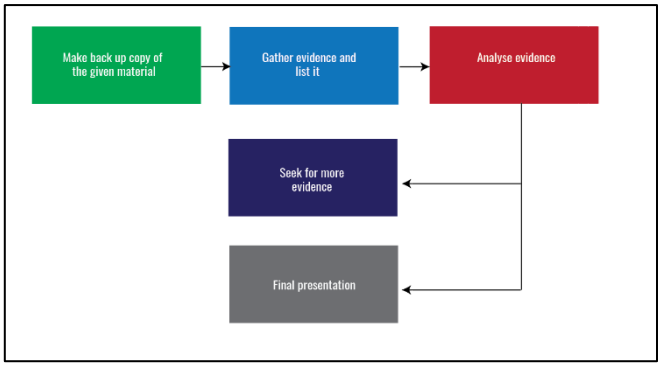


Figure 1. Analysis process in digital forensic

The forensic expert creates multiple backups that he will use in the analysis so as not to alter the original evidence. Evaluation of evidence is a process that precedes the collection of evidence, and can determine the direction of the investigation process. The evidence that a forensic scientist must find is usually not possible to analyze using the basic tools of the operating system, but it is necessary to use specialized software that is unknown or inaccessible to the average user.

3. DIGITAL IMAGE FORENSICS SOFTWARE

Information is being transmitted increasingly and rapidly from one end of the world to the other, which reflects the real power of the Internet. Considering that in the distant past people had the need to transmit information in a form understood only by the sender and receiver, the key question is how to be sure that the digital image, that has become a mean of communication in our daily lives, does not hide certain information. Digital images used in court proceedings are the result of recording real events in real time.

By selecting the property option for a specific digital image, the recorded data can be read, as follows:

- image title
- format
- default program for opening the image
- location
- the size that the image occupied on the disk
- dimensions
- date and time of creation
- date of the change
- access date

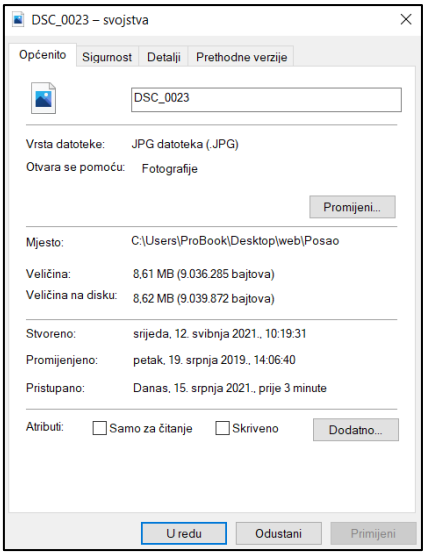


Figure 2. Metadata display

Digital image forensics is in the domain of computer forensics, and it aims to answer the following questions:

1. How and with what devices was the image created?
2. What is the quality of the sensor of that device?
3. Has the image been manipulated?
4. Does the image contain hidden information?

Manipulation implies the application of one or more techniques over a digital image to achieve the desired appearance of that image. Whether the digital image was manipulated is a very complex question, which requires detailed analysis. After creating copies of the evidence, the forensic expert hired by the competent court initiates the analysis of the digital image, mainly starting from the metadata manipulation software.

3.1. PhotoME

PhotoME is a free version of metadata manipulation software, easy for installing. The software enables the view and modification of metadata in a very simple way [3].

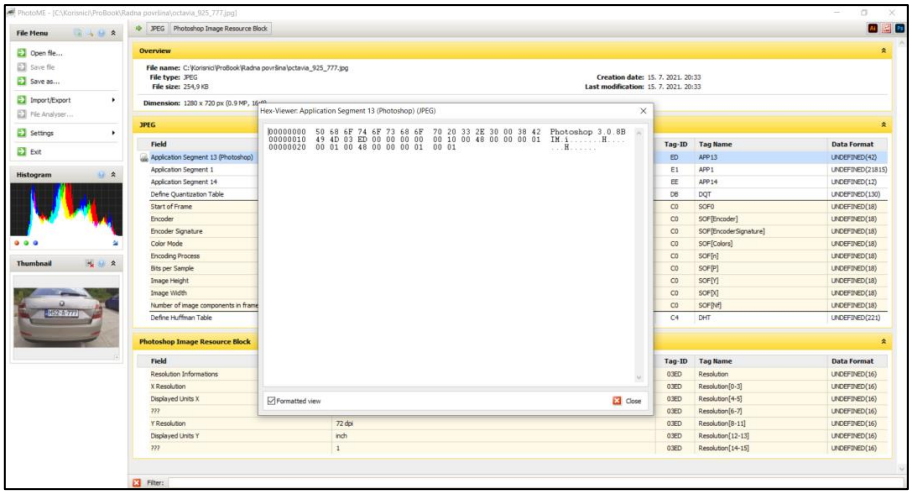


Figure 3. Metadata manipulation

Modern digital cameras, whether amateur or professional, use the Exchangeable Image File Format - EXIF standard to store information about the parameters of a photo in the moment of its creation. EXIF includes: camera model, time and date of the photo, lens aperture, ISO sensitivity, exposure time, resolution, focus, focal length, GPS coordinates and many other information related to the photo.
Apart from digital cameras, EXIF is also used in mobile devices, scanners and photo editing programs. In forensics, it is one of the most important elements in the investigation due to obtaining a large amount of information that is important for the further investigative process. The EXIF record and the fields that are displayed are not the same for all manufacturers, so we should be careful when analyzing metadata.
The manufacturers of certain devices decide for themselves which fields of EXIF records will be displayed and which will not. Figure 3 shows the user interface of the PhotoME software as well as an example of metadata manipulation. Processing of the uploaded image was performed in Photoshop, which is confirmed by the exact analysis. It is necessary to be very careful with potential evidence, because even though no real manipulation happens, it is enough to open the image with any program [4].

3.2. ExifTool

ExifTool is software of open code. It is independent of the platform on which it operates. It allows manipulation of metadata digital image, but also audio and video [5]. Metadata can be used to validate the origin of the image. ExifTool makes it possible to analyze the date of creation of the digital image, the software used in image processing, the date of modification, the model of the device, etc.
The field Modify Date indicates whether a change has occurred in the image. In order to check if an image editing tool has been used, it is necessary to check the Software field. The original image should have a program in this field, which created the same image, for example, the operating system of the device through which the image was created.
If the image was modified using one of the tools such as Adobe Photoshop, PhotoScape or GIMP, the Software field will have its name entered. The following figure shows the metadata of a photo edited using Adobe Photoshop. The image also shows when this photo was changed, the Modify Date field, and that this date does not correspond to the date of creation (Create Date and Date/ Time Original) [6].

```
Photometric Interpretation      : RGB
Make                            : Apple
Camera Model Name               : iPhone XS Max
Orientation                     : Horizontal (normal)
Samples Per Pixel               : 3
X Resolution                    : 72
Y Resolution                    : 72
Resolution Unit                 : inches
Software                        : Adobe Photoshop CC 2019 (Macintosh)
Modify Date                     : 2020:12:26 16:06:05
Tile Width                      : 512
Tile Length                     : 512
Exposure Time                   : 1/33
F Number                        : 2.4
Exposure Program                : Program AE
ISO                             : 640
Exif Version                    : 0231
Date/Time Original              : 2019:12:25 21:38:46
Create Date                     : 2019:12:25 21:38:46
Offset Time                     : +01:00
Offset Time Original            : +01:00
Offset Time Digitized           : +01:00
Components Configuration        : Y, Cb, Cr, -
Shutter Speed Value             : 1/33
```

Figure 4. Metadata extraction

3.3. GeoSetter

GeoSetter is a free version of software for the Windows operating system. It enables the display of geographical coordinates of the image and the metadata. The modest graphical interface of this software is available in several world languages [7].

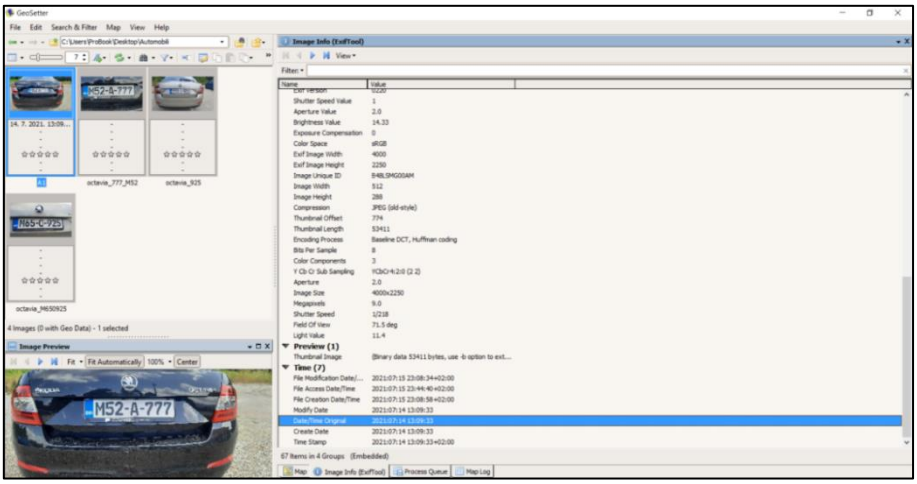


Figure 5. Metadata display in GeoSetter

3.4. Exif Eraser

Free software designed for the Windows operating system is intended to delete all metadata. As social media are a hunting ground for blackmailers, this simple tool makes it possible to preserve privacy.

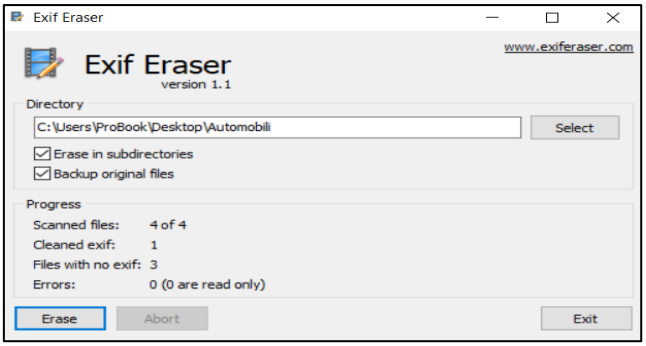


Figure 6. Exif Eraser user interface

Does the image contain any hidden information?
We communicate on a daily basis by exchanging digital images, but we rarely wonder if we see everything we need to see. The creation time for both images is set exactly the same, and each image hides a secret text message.

Figure 7. The result of photoshopped image

For example, a photograph can serve as proof that a person is in a particular location at a particular time. The GPS location of the device on which the photo is stored, the date and time of creation, etc. are all being used. It is also possible to detect whether data has been intentionally altered and falsified, if there are some inconsistencies among metadata that study traces of data modification when someone changes it.

4. ANALYSIS OF THE STATE OF DIGITAL FORENSICS IN THE UNA-SANA CANTON

Given that digital forensics deals with the collection, search, protection and analysis of evidence in digital form, and for the purpose of the research, the authors of this paper wanted to find answers to the following questions:

1. Do courts in the Una-Sana Canton keep records of the number of cases in which digital image is one of the relevant pieces of evidence in court proceedings?
2. Has a case of photo manipulation at a higher level been recorded in the area of Una-Sana Canton, i.e., have any traces of the application of steganographic methods been observed?
3. What is incidence of computer crime cases in the last 4 years?

The first question was submitted to the competent courts in the Una-Sana Canton. The answers are as follows.

‘’In a large number of cases, the photograph is taken as evidence after determining its authenticity, but we do not have the exact number because we do not keep such records. The answer to your question can be given by the Cantonal Prosecutor's Office.’’According to the response of the Cantonal Prosecutor's Office, in over 90 % of the formed cases, the digital photograph is taken as evidence after the confirmation of authenticity.

The Agency for Forensic Affairs at the Ministry of Security of Bosnia and Herzegovina was asked another question. The following answer was provided to the authors. “We would like to inform you that the Agency for Forensic Examinations and Expertise is acting on the orders of the courts and the prosecutor's office and the requests of police agencies from the entire territory of Bosnia and Herzegovina. To date, the Agency for Forensic Investigations and Expertise has not received an order for an expert opinion with the aim of detecting the application of steganographic methods and therefore no similar expertise was conducted here.”

The answer to the third question, submitted by the Ministry of Internal Affairs of Una-Sana Canton, which refers to the number of committed crimes in the field of computer crime, is shown in the form of a graph in Figure 8..

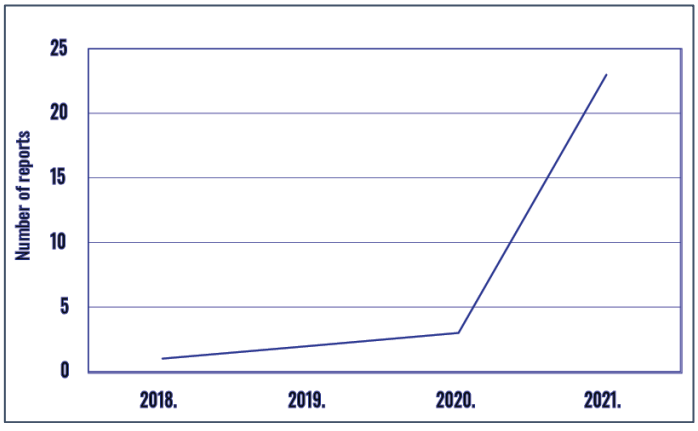


Figure 8. Reports on criminal offenses in the field of computer crime in the area of the Una-Sana Canton

The analysis of the obtained data shows that the number of reports or criminal offenses in the field of computer crime has drastically increased in the current year. Under the supervision of the acting

prosecutor, an investigation is being conducted in 10 additional cases where there are grounds for suspicion that the criminal offense of Computer Fraud was committed.

5. CONCLUSION

In court practice, the digital image is an important piece of evidence. Field research shows that in over ninety percent of cases formed, the digital image is taken as evidence after confirmation of authenticity. The software industry today offers a large number of different digital forensics software tools that allows detailed image analysis.

Unfortunately, according to the official response received from the Agency for Forensic Examinations and Expertise in Bosnia and Herzegovina, this institution has not received any requests from the competent institutions for expertise in order to detect the application of steganographic methods and therefore no similar expertise has been performed.

All of the above points to the conclusion that educational workshops should be conducted in the judiciary system with the aim of viewing the digital image as a significant carrier of information, especially due to the possible application of steganographic methods in hiding information and implications for forensic investigations.

6. REFERENCES

[1] Digital forensics; https://detektiv-mreza.hr/hr/usluga/digitalna-forenzika-27; (accessed 10. 5. 2021.)
[2] Criminal law of the Federation of Bosnia and Herzegovina; https://www.paragraf.ba/propisi/fbih/krivicni-zakon federacije-bosne-i-hercegovine.html; (accessed 28. 4. 2021)
[3] PhotoME; https://photome.en.softonic.com/; (accessed 21. 6. 2021)
[4] Exif photo data; https://tomislavdekovic.iz.hr/exif-podaci-o-fotografiji/ (accessed 21. 6. 2021.)
[5] Installing ExifTool; https://exiftool.org/install.html; (accessed 30. 6. 2021.)
[6] Computer forensics; http://racfor.zesoi.fer.hr/doku.php?id=racfor_wiki:alati_za_ekstrakciju_i_uredivanje_metapodataka_datoteka; (accessed 12. 8. 2021.)
[7] Reljić D, Miočić-Stošić V, Butula S and Andlar G 2017 An Overview of GIS Applications in Landscape Planning *KiG*

CONTROLLING DC MOTOR SPEED USING H-BRIDGE AND ARDUINO MICROCONTROLLER PLATFORM

Benjamin Haurdić

JU Mješovita elektrotehnička i drvoprerađivačka srednja škola Bihać, Ulica dr. Irfana Ljubijankića 64
77000 Bihać, benjaminh1986@gmail.com

ABSTRACT:

A DC motor is any of a class of rotary electrical motors that converts direct current electrical energy into mechanical energy. DC Motor is used for variable speed operation because in DC motor torque and flux that can be control independently and that is achieved by armature and field current control respectively. D.C motor has many advantages delivering high starting torque, ease of control and non linear performance. Small DC motors are used in tools, toys, and appliances. An H-bridge is a simple circuit that lets you control a DC motor to go backward or forward, it is normally used with a microcontroller, such as an Arduino, to control motors.

Keywords: DC motor, Arduino platform, H-Bridge, Controls , Microcontroller

1. INTRODUCTION

In this paper, we realizied to controlling a dc motor speed usinh the H-bridge and the arduino microcontroller platform. A electrical motor is a device that converts electrical energy into mechanical energy. It is arguably the most important component in a robot because it is responsible for all the structural movements. In robotics, DC motor, stepper motor, and servo motor are the three common types of motors. Each is ideal for a particular application. In this paper, the focus will be on the use and control of a DC motor.

DC mostor is the most common type of motor. DC motors normally have just two leads, one positive and one negative. If you connect these two leads directly to a battery, the motor will rotate. If you switch the leads, the motor will rotate in the opposite direction.

Arduino is an open-source platform that includes both hardware and software. The hardware of Arduino contains many programmable circuit boards as a microcontroller for connecting sensors or other modules to build up a project.

The SN754410 chip, so-called the H-bridge is a fast motor driver that controls the speed and direction of a DC motor. It is capable of driving a high voltage motor of 4.5V – 36V and constant 1A using TTL 5V logic levels. This H-bridge is designed for positive-supply applications only and can drive up to two motors [1].

2. DC MOTORS

The DC motor use a magnetic field generated by an electromagnet to turn the armature of a motor. The electromagnet is activated by applying voltage, so when the power is on, the magnetic field it generates will cause the armature (a coil of wire) to generate its own nagmetic field, these fields push eachother away and cause the armature to spin. The figure 1. shows the construction of the DC motor [2].

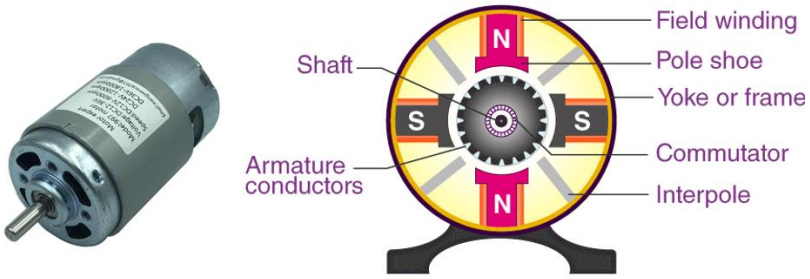


Figure 1: Left) Type of DC motor, right) Construction parts of DC motor

A direct current, or DC motor is the most common type of motor. DC motors normally have just two leads, one positive and one negative. If you connect these two leads directly to a battery, the motor will rotate. If you switch the leads, the motor will rotate in the opposite direction [3].

To control the direction of the spin of DC motor, without changing the way that the leads are connected, we use a circuit called an H-Bridge. An H bridge is an electronic circuit that can drive the motor in both directions. H-bridges are used in many different applications, one of the most common being to control motors in robots. It is called an H-bridge because it uses four transistors connected in such a way that the schematic diagram looks like an "H“ [4].

3. ARDUINO MICROCONTROLLER PLATFORM

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online[5].

The figure 2. shows the Arduino platform [6].

Figure 2: Arduino platform (bord)

The figure 3. shows the architecture of the Arduino platform [6].

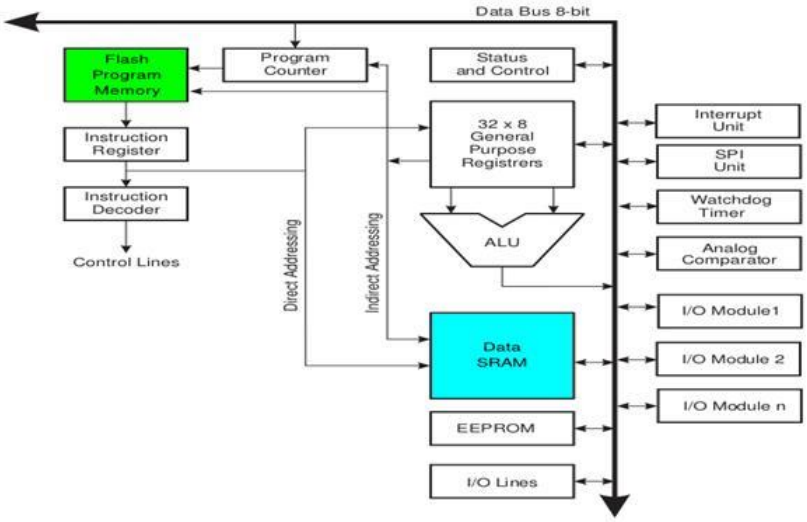


Figure 3: Architecture of the Arduino platform (board)

Arduino's processor basically uses the Harvard architecture where the program code and program data have separate memory. It consists of two memories- Program memory and the data memory. The code is stored in the flash program memory, whereas the data is stored in the data memory. The Atmega 328 has 32 KB of flash memory for storing code (of which 0.5 KB is used for the bootloader), 2 KB of SRAM and 1 KB of EEPROM and operates with a clock speed of 16MHz. Over the years Arduino has been the brain of thousands of projects, from everyday objects to complex scientific instruments. A worldwide community of makers - students, hobbyists, artists, programmers, and professionals - has gathered around this open-source platform, their contributions have added up to an incredible amount of accessible knowledge that can be of great help to novices and experts alike [6].

4. H-BRIDGES

An H-Bridge is a circuit that allows voltages to be applied across a load in either direction. Electric current flows from the source to ground, and many components need to be oriented according to the direction of current to work as expected. An H-Bridge is a circuit built to change the direction of the voltage and thus the current flowing to a load. In electrical terms, a load is any piece of a circuit that consumes electric energy to do things like heating, turning, lighting up, and so on. An H-Bridge is made up of four switches: two in series, and two in parallel, with the load placed in between the switches. In this configuration the circuit takes an "H" shape. The figure 3. shows the H-Bridge circuit [7].

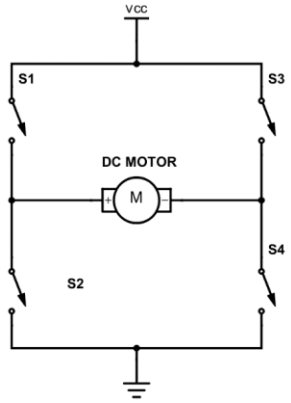


Figure 3: H-Bridge circuit

In order to change the direction of the voltage supplied, the H-Bridge controls the switches that deliver power to the load (S1). Looking on the diagram, if closing S1 and S4 while leaving the rest open, the voltage will be applied from left to right across the motor. If S2 and S3 are closed instead and the others open, the voltage will be applied from right to left. The SN754410 chip contains two H-bridges, gives four outputs, there allows to control two DC motors. The figure 4. shows the SN754410 chip and his Pinout connection diagram [8].

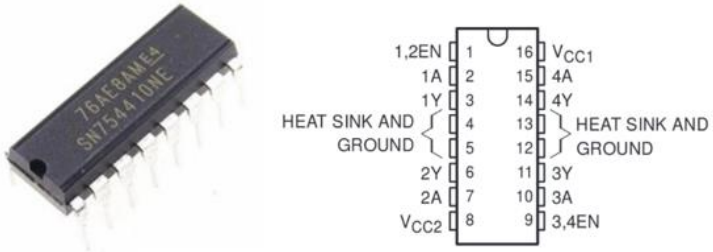


Figure 4: The SN SN754410 chip and his Pinout connection diagram

On the chip, 1A controls the polarity of 1Y, same goes for 2A and 2Y. At a very high level, this H-bridge chip changes the output voltage (to the pins labelled Y) according to the input voltage sent to the pins labelled A. For example, sending a 'high' to 1A will send the same to 1Y. The difference is the signal sent out to Y pins use the voltage supplied to pin 8 regardless of what the input voltage is [9].

5. IMPLEMENTED DC MOTOR SPEED CONTROL

The figure 5 shows the wiring diagram of the implemented DC motor speed control.

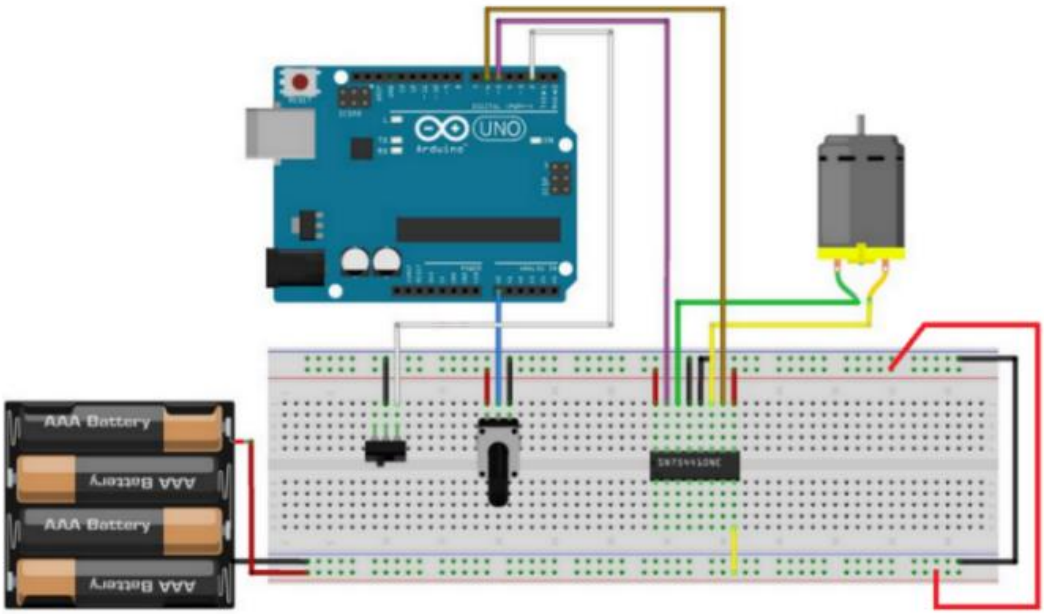


Figure 5: Wiring diagram of the implemented DC motor speed control

The potentiometer used to control the motor speed and a small switch will control the motor direction. There are a couple reasons for using a potentiometer to control the speed of a motor. The main one being that it gives us a much more natural tactile feel when controlling the speed of the motor. The resistance at the both ends of the potentiometer is fixed, while the resistance of the middle pin can be changed by either rotating a knob or sliding a contact depending on its construction. A potentiometer is no different. It too has maximum voltage and current rating values within which they operate efficiently. When uses a potentiometer to control the speed of a motor, you will have to choose a potentiometer that matches the maximum ratings of the motor. For example, if we have a motor that has ratings of 5V, and 1A, we will have to choose a potentiometer with ratings that are the same (5V, 1A) or higher [9].

The figure 6 shows the Block diagram of the implemented DC motor speed control.

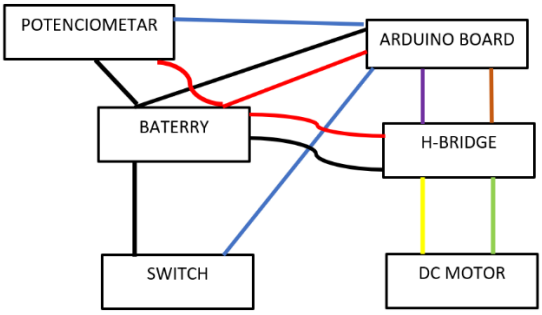


Figure 6: Block diagram of the implemented DC motor speed control

An H-bridge is an integrated circuit that allows voltage to each output to be applied both ways. Each output can be configured either a positive or a ground in the circuit meaning a motor can be driven in either direction with relative ease. DC motors themselves are very simple, any basic DC Motor will have two leads that can be directly attached to a battery or power supply of sufficient capacity. The side of the motor that is connected to the positive of the power source will determine which way the motor rotates. The motor can be run in each direction on the command. The H-Bridge chip does all of the heavy lifting and can be directly connected to the DC motor and the Arduino, no additional parts are required [10].

Developed source code for the Arduino microcontrolle bord is given:

```
const int enableBridge1 = 2;
const int MotorForward1 = 3;
const int MotorReverse1 = 5;
int Power = 80; //Motor velocity between 0 and 255
void setup() {
  pinMode(MotorForward1, OUTPUT);
  pinMode(MotorReverse1, OUTPUT);
  pinMode(enableBridge1, OUTPUT);
}
void loop() {
  digitalWrite(enableBridge1, HIGH);
  analogWrite(MotorForward1, Power);
  analogWrite(MotorReverse1, 0);
  delay(2000);
  analogWrite(MotorForward1, 0);
  analogWrite(MotorReverse1, Power);
  delay(3000);
  analogWrite(MotorForward1, 0);
  analogWrite(MotorReverse1, 0);
  digitalWrite(enableBridge1, LOW);
  delay(1000);
}
```

The code can be uploaded into the Arduino platform. Pluging the motor power supply in so the motor has power and after a few seconds we adjusting the potentiometer to adjust the motor speed. When changing directions, we ensure us that the motor is stopped and it is not a good idea to reverse the polarity of a motor while running.

6. CONCLUSION

Direct Current motors are oftenly used with a gearbox to increase the torque while keeping small dimensions. DC Motor is quite simple to use. To make it run, the only thing to do is to apply voltage to it. Sign and level of the voltage will determine the speed and direction of rotation. The device we use for this project is the H-bridge. It can drive two dc motors and has several pins that have their own purpose. With an Arduino board, the H-bridge only needs three inputs from the board. The first one is a speed control input and the other two are digital inputs for controlling the spin direction. Therefore, on the Arduino board, you will need to reserve at least three digital output pins; one as a PWM and the other two as digital outputs. An H-bridge distributes power to electrical motor and modulate the voltage accroding to signals sent to its inputs.

Advantages of this metod to control the DC motor speed is the armature voltage control method gives good speed regulation and high efficiency, it gives a large speed range with any desired number of speed points. Disadvantge maybe the circuit who used in the circuit makes speed control less precise.

7. REFERENCES

[1] Ahmed, S. (2018) Speed Control of Sensorless Brushless DC Motor.
[2] Jeffrey, J. K. (2008) Electricity 4: AC/DC Motors, Controls, and Maintenance.
[3] Massimo, B. (2012) Getting Started with Arduino (Make: Projects)
[4] Uday, A.B., Mayuresh V.B., (2020) Electric Motors: D.C. Motors, Induction Motors, Synchronous Motors and Special Purpose Motors.
[5] Richard, B. (2012) Arduino Programming in 24 Hours, Sams Teach Yourself.
[6] Boxall, J. (2013) Arduino Workshop: A Hands-On Introduction with 65 Projects 1st Edition.
[7] Damon, P. (2020)vArduino Programming: The Ultimate Guide For Making The Best Of Your Arduino Programming Projects.
[8] Simon, M. (2010) Programming Arduino: Getting Started With Sketches (second edition).
[9] Thorpe E. (2020)Arduino: Advanced Methods and Strategies of Using Arduino.
[10] John-David, W., Josh ,A., Harald, M., (2010) Arduino Robotics (Technology in Action).

THE USE OF RASPBERRY PI MODULES TO CONTROL DC MOTOR USING ANDROID APPLICATION

Ejub Piralić, Hana Muslić, Melisa Balkić
University of Bihać, Technical faculty Bihać, tfb@unbi.ba
Branko Blanuša
University of Banja Luka, Faculty of Electrical Engineering, branko.blanusa@etf.unibl.org

ABSTRACT:

Electrical motors are very important part in the world of electronics. Today, in the modern world, electronic devices are everywhere. The paper describes an example of remote control of a direct current (DC) motor using WiFi communication. The DC motor is controlled via L298N driver connected to the Raspberry Pi computer. An Android application has been developed on the smartphone, which enables setting the direction and speed of rotation the DC motor. In this way, it is possible to control and remotely monitor the operating mode of the DC motor, which can be significant from a practical point of view.

Keywords: DC motor, Raspberry Pi, L298N Driver, Computer, Android Application

1. INTRODUCTION

Computing systems are introduced wherever accuracy and speed is needed. A typical computing system works on the principle of input-process-output. In the conventional computing system, the input is keyed in by human beings and the software algorithm running at the computing system processes the inputted data and produces an output. However, through the Internet, do not only communicate people, but also devices without the direct human participation. Internet of Things (IoT) is the third wave of Internet and is supposed to have a potential to connect about 28 billion items by 2020, ranging from small to big things [1]. The IoT is the next technology transition where device will allow us to sense and control the physical world by making object smarter and connecting them through and intelligent world. The basic premise and goal of IoT is to „connect the unconnected“. This premise means that object that aren't currently joined to a computer network (Internet), will be connected so that they can communcate and interact with people and objects [2]. In this project, from the hardware, we used Raspberry Pi 3 B+ microprocessor, DC motor, L298N driver and power supply unit (PSU). The goal of the project is remote control and monitor of the DC Motor.

In the second section, the basic idea and description of the project are presented. The third section gives a brief description of the hardware components used in the project.
The software implementation of the application on the Raspberry Pi controller and smartphone is given in section 4.

2. DESCRIPTION OF THE PROJECT

The project is designed to be managed via an Android application on a system built on the Raspberry Pi. The system works so that the DC motor can be controlled via the Android application. On the application there are options for starting the DC motor, turning off, steering left or right, different speeds (low, medium, high). The DC motor is connected to the Raspberry Pi microcontroller via the L298N driver. Control of the DC motor was realized by using pulse-width modulation (PWM) technique. By changing of duty factor of the control signals, the applied mean value of armature voltage is changed, and thus its rotataion speed. From the other side, the application on the controller communicates via WiFi communication with the Android application on the smartphone. The functional code is written in the Python programming language, and the application is designed in the MIT App Inventor. Raspberry Pi 3 and the whole system works so that it is located on the "https" server on the Raspberry Pi, where there are certain commands (start, stop, direction control at different speeds), and commands from the Raspberry Pi are called via IP addresses. In particular, the MIT App Inventor and Python programming language will be described in more details in section 4.)

3. HARDWARE IMPLEMENTATION

Hardware of implemented system for the remote control of DC motor consists of permanent magnet DC motor, L298N Motor Driver, Raspberry Pi 3 B+ microcontroller, DC power supply and smartphone (Fig. 1).

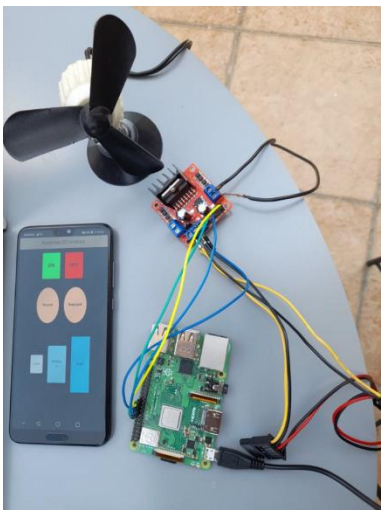


Figure 1: Hardware of implemented system for the remote control of DC motor

3.1. DC MOTOR

In today's industrial sector, DC motors are everywhere. These motors are usually used in application of postition or speed control. DC motor is supplied by DC voltage/current, such that is provided by battery or convertor which converts AC voltage/current to DC voltage /current [3] [4].The mostly used DC motor in controlled electric drives is motor with independent excitation or permanent magnet DC motor.
In this application is used permanent magnet DC motor. Nominal parameter values (nominal rotor voltage, nominal rotor current and nominal mechanical speed) for used motor are: $V_{a,nom}$=12V, $I_{a,nom}$=0.5A and $\omega_{r,nom}$=6500rpm. Basic equations which describe this motor are:
for rotor voltage:

$$v_a = R_a i_a + L_a \frac{di_a}{dt} + \omega_r \phi_m \quad (1)$$

where: v_a - rotor voltage, i_a - rotor current, R_a - armature resistance, L_a - armature inductance, ω_r - rotor speed, ϕ_m - excitation flux,

for electrical torque:

$$m_e = i_a \phi_m \quad (2)$$

and for mechanical subsystem:

$$J_m \frac{d\omega_r}{dt} = m_e - m_L \quad (3)$$

where J_m - motor inertia and m_L - load torque.
For a staedy state operation, equations (1) and (2) can be written as follows:

$$v_a \approx \omega_r \phi_f \quad (4)$$

$$m_e = i_a \phi_f \quad (5)$$

Based on equations (4) and (5) it can be concluded that rotor speed is changed by rotor voltage and electric torque is approximately proportional to rotor current. Control circuitry employs electrical switches to deliver power to the motor and a controller can govern the motor's operation using PWM signals [5]. This control strategy enables change of rotor voltage mean value and on that way change of rotor speed.

3.2. RASPBERRY PI 3

The Raspberry Pi is a single-board computer created by the Raspberry Pi Foundation. The Raspberry Pi is a cheap computer that runs Linux, but it also provided a set of GPIO pins, allowing us to control electronic components for physical computing and explore the IoT. The Raspberry Pi launched in 2012, and there have been several iterations and variations released since then. All over the world, people using the Raspberry Pi to learn programming skills, build hardware projects, do home automation, implement IoT applications and use them in industrial applications [6], [7].

3.3. L298N Motor Driver

The L298N Motor Driver is a controller that uses an H-Bridge to easily control the direction and speed of up to 2 DC Motors. This Motor driver module consists of an L298 Motor Driver IC, 78M05 Voltage Regulator, resistors, capacitor, Power LED, 5V jumper in an integrated circuit. The L298N motor driver is based on the H-bridge configuration (an H-bridge is a simple circuit that lets us control a DC motor to go

backward or forward.), which is useful in controlling the direction of rotation of a DC motor. It is a high current dual full H-bridge driver that is constructed to receive standard TTL logic levels. It can also be used to control inductive loads e.g. relays, solenoids, motors (DC and stepping motor), etc [8].
Also, applying PWM control signals and changng their duty factor, it is possible to change armature voltage ie. rotor speed (eq. 4). Period of PWM control signals is set to 2kHz (T=0.5ms), and duty factor is changed due to different operating modes from D=0.15 for low speed to D=0.85 for high speed. PWM control signals for different operating modes are shown in Fig 2.

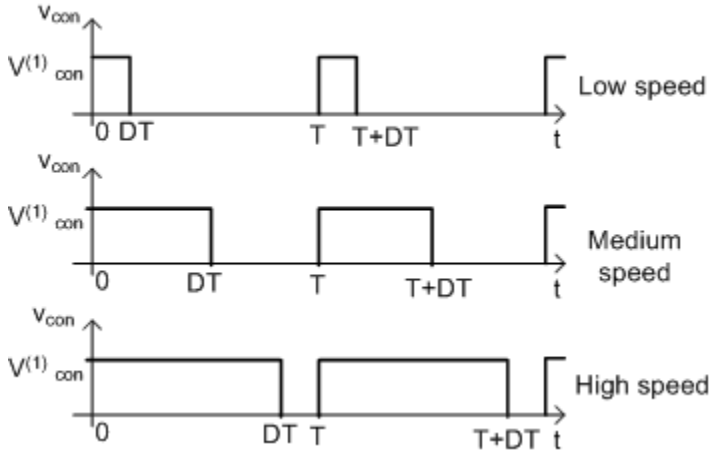


Figure 2: PWM control signals for different operating modes.

4. SOFTWARE IMPLEMENTATION

4.1. ABOUT PYTHON AND PYTHON CODE FOR PROJECT

Python is an interpreted, object-oriented, high-level programming language with dynamic semantics. It's high-level built in data structures, combined with dynamic typing and dynamic binding, make it very attractive for Rapid Application Development, as well as for use as a scripting or glue language to connect existing components together. Python's simple, easy to learn syntax emphasizes readability and therefore reduces the cost of program maintenance. Python supports modules and packages, which encourages program modularity and code reuse. The Python interpreter and the extensive standard library are available in source or binary form without charge for all major platforms, and can be freely distributed [9]. The flow chart of implemented Pyton program is shown in Fig. 3.
The Pyton program implemented on the Raspbery Pi controller performs next functions:
1. It exchanges data with the Android application on the smartphone via WiFi communication
2. Decodes the commands received by the smartphone
3. Depending on the received command, it generates control signals which start the DC motor, stop, and determine the direction and the speed of rotation.

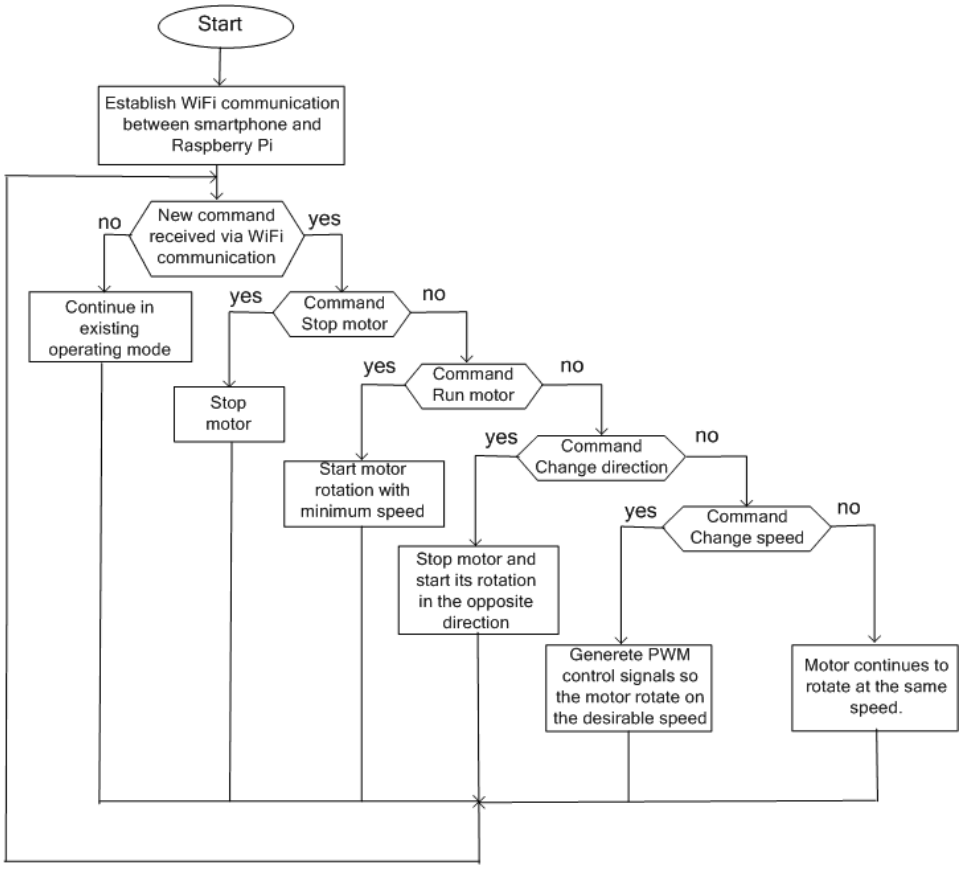


Figure 3: The flow chart of the Pyton program implemented on Raspberry Pi 3 microcontroller for the remote control of the DC motor.

4.2. ANDROID APP AND MIT APP INVENTOR

MIT App Inventor is an online platform designed to teach computational thinking concepts through development of mobile applications. Creating of applications by dragging and dropping components into a design view and using a visual blocks language to program application behavior facilaiates programming. Key takeaways include use of components as abstractions, alignment of blocks with the mental models, and the benefits of fast, iterative design on learning. It is an online development platform that anyone can leverage to solve real-world problems. It provides a web-based "What you see is what you get" (WYSIWYG) editor for building mobile phone applications targeting the Android and iOS operating systems. This platform is used to create an android application that communicates with the Raspberry Pi

controller via WiFi communication and sends commands for remote control of the DC motor. The realized interface on the smartphone is shown in the Fig. 4.

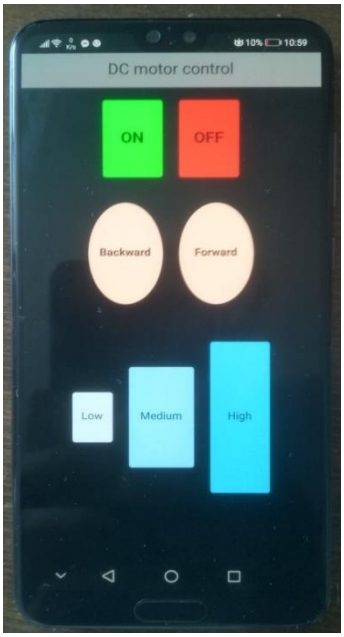


Figure 4: MIT App interface for the remote control of DC motor

Within the Mit App Inventor there are predefined elements for creating an application. Using layout elements that are different, the construction of the external appearance of the application is defined. Then, Buttons and Text Box were used from the User Interface group of elements. Buttons are grouped into 3 groups, depending on the purpose, ie. Buttons for starting and stopping the DC motor(ON / OFF), Buttons for changing the rotation direction of DC motor (BACKWARD / FORWARD) and Buttons for changing the speed of DC motor (LOW, MEDIUM, HIGH). Also, from the group of Connectivity elements, the Web element was used, in order to be able to establish communication with the Raspberry Pi. The final look of the application (background, button color, etc.) has been modified using the tools located in the Properties toolbar.

Each button has a specific group of code blocks, and each code block represents a separate function. The functionality of the button is determined via the while function (represents a button push). The web block, which was mentioned earlier, is changing, ie. its value changes to a specific web-url that represents a function in python. The code block is shown in Fig. 5.

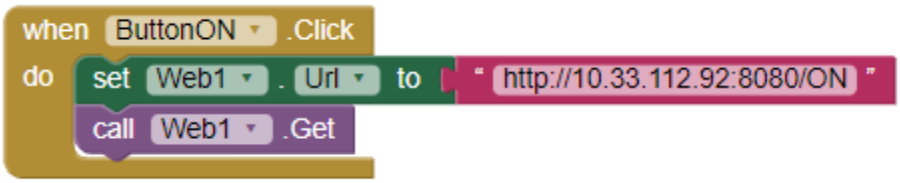


Figure 5: Code block for ON Button

This system is working over the global network (internet). That means you can control it from anywhere in the world as long as you are connected to the internet. The Raspberry Pi is working as a web-server, and the commands for controlling the DC motor are connected with the IP adress. The android application is using that principle to communicate with the microprocessor. For example: After the ON button is pressed on the application it connects trough the internet to the specifed IP adress, port and comand. Which for this situation is "10.33.112.92:8080/ON", 10.33.112.92 is the IP adress,8080 is the specifed port , and the command is ON. You can also manually send commands to the Raspberry Pi, by typing the before mentioned IP command in any web browser.

5. CONCLUSION

This paper is realized as a group work of students of the Technical Faculty in Bihać. The system is controlled via an Android application made in the MIT App Inventor, whose commands are connected via IP addresses to the Raspberry Pi, to control the DC motor i.e. the Raspberry Pi works as a web-server. Options that exist are on, off, direction, and speed control. Also, what else is shown are the components used in the physical connection of the system and a general description of these components. The implemented system for remote control of DC motor is shown in Fig. 1. An appropriate Python program for the Raspberry Pi has been created (Fig. 3), as well as an application in the MIT App Inventor for smartphone that provides functionality of the entire system (Figs. 4 and 5). All the listed functions of the system have been tested and work correctly. In order to realize remote control it is only necessary to have internet access and know the IP address and port number of the target device (Raspberry Pi computer).
The implemented system can be improved by adding new functions. In that case, no additional investment in hardware is required, but only a software upgrade of the existing solution. An example is the continuous speed control and in addition speed control loop which achieves speed control for variable load. It is also possible to apply software protection for the system against unauthorized access.

6. REFERENCES

1. B.K. Tripathy, J. Anuradha (2018). Internet of Things (IoT): Technologies, Applications, Challenges, and Solutions. Taylor and Francis Group: CRC Press.
2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton, Jerome Henry (2017). IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things. Cisco Press

3. https://www.monolithicpower.com/en/brushless-vs-brushed-dc-motors, Visited: 13.08.2021. god.
4. https://sigma.octopart.com/37142386/image/Adafruit-Industries-711.jpg, Visited: 13.08.2021.
5. Matthew Scarpino (2015). Motors for makers: A Guide to Steppers, Servos, and Other Electrical Machines. Pearson Education.
6. https://opensource.com/resources/raspberry-pi
7. https://www.chipoteka.hr/images/proizvodi/raspberry-pi-3-model-b-ugradeni-wi-fi-i-bluetooth-81059-1063.jpg
8. https://components101.com/modules/l293n-motor-driver-module
9. https://www.python.org/doc/essays/blurb/
10. https://link.springer.com/chapter/10.1007/978-981-13-6528-7_3

SECTION/SEKCIJA
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THE WORKER'S SAFETY IN THE CONFINED SPACE

Snježana Kirin, Manuela Žakula, Lidija Jakšić
Veleučilište u Karlovcu, Trg J.J.Strossmayera 9, 47000 Karlovac
snježana.kirin@vuka.hr, manuela.zakula@vuka.hr

ABSTRACT:

The confined space is defined as a space in which a worker difficulty comes in. On the basis of technical documentation, it is essential to make a risk assessment, for every stay in the confined space, either follow specific and detailed preparations, or making risk assessmen. It is also analysed the level of satisfaction for workers in the confined space. [1] It is conducted survey about worker's satification in the confined space. The survey results showed that there was a high percentage of respondents who are satisfied with labour conditions given by the employer (salary, paid travel costs, adding working stimulus). Satisfaction with working conditions provides positive psychological impact on the worker so can do his work unhampered, in the confined space.

Keywords: worker's safety, risk assesement, confined space, prevention and satisfication

1. INTRODUCTION

The confined space is a space which has spatial and physical limits, so the worker with all his body difficulty comes in to do work assignments and risks for safety and health are increased. These are the spaces in which temporarily do a work. In the confined space it is included: closed tanks, tanks, stored containers, condensing and other pipes, barrels, tanks for carrying cargo on ships, chimneys, manholes, wells, caves or various excavations [1]. By Labour protection law (NN 71/14, 118/14, 154/14) , it is defined labour in the confined space. On the basis of this Law, the employer is obliged to make risk assessment for the workplace which determines the levels of danger, harm and effort in terms of possible injuries at work. Some of the sub-legislation rules by Labour protection law relate on dangers, harms and efforts for workers in the confined space who are exposed to [1]. Regulation on the protection of workers from risks due to exposure to hazardous chemicals at work [NN 091/2015] regulates minimal requirements for protection from exposure to hazardous chemicals as it can jeopardize worker's safety and health at the workplace. Regulation on the protection of workers from risks due to exposure to biological agents at work [NN155/2008] regulates minimal requirements for protection from exposure to biological agens at workplace. Regulation on the protection of workers from risks due to exposure to noise [NN 046/2008], regulates minimal requirements for protection from exposure to noise at the workplace. Regulation on the protection of workers from risks due to exposure to electrical energy at work [NN 088/2012] regulates minimal requirements for safety and health with work at electrical installations, plants and equipment Their implementation eliminates danger from electrical energy's effects for safety and health. The Regulation on the market of personal protective equipment must comply with the aim of ensuring the protection of the users health and safety and, the Regulation on the use of personal protective equipment [NN 039/2006], regulates general employer's obligations for personal protective equipment used by workers [1].

2. RISKS AND MEASURES FOR WORKER'S SAFETY IN THE CONFINED SPACE

At work in the confined space, the worker is exposed to certain dangers such as: fire, mechanical dangers, electrical energy dangers, falls, weather hazards, lack of oxygen, fluid, solids and residues in containers or barrels, increasing liquid levels, curing solids, sudden starting/freeing of energy or working media [2]. Dangers such chemical danger, reduction oxygen concentration, biological danger, unnatural worker's place and noise represent risk for worker's safety in the confined space. One of the examples is biological dangers due to space configuration, specify that the level of noise is higher than outside the confined space. The consequence is hearing impairment. It is important to learn the worker with potential risks and the implementation of special protection rules, nevertheless. So, in that way, the noise risks reducing at acceptable level [3].

Also, respecting regulations from Labour Law [4] may be a signposting of compliance with work safety measures in the confined spaces, especially, in the Article 11. Labour Law regulates general prevention principles (risk assessment, avoid risks and risk prevention at their source). In the Article 13, Labour Law, it relates on special working protection regulations - the setting of specific signs giving instructions and information, on the instructions on working procedures and the ways for operations and procedures with the injured worker are carried out. In addition to security measures, it shall always be necessary to check that all workers are trained to work safely, and whether all workers meet the conditions for work on special working conditions. It is necessary to agree on how to communicate through radio station and other voice signals and to agree on procedures in the event of a dangerous event. Before entrance in the confined space, it is done risk assessment for that part, then prepare all equipment, determine the number of people who will ensure the worker, prepare confined space in the direction of ventilation or cleaning. The control of the presence of dangerous gases shall be carried out, specified and prepared the proper procedure in the event of the need for the extraction of the worker [5]. One of more important measure at the workplace is to mark the confined space which requests the permission, and it indicates that all identified confined spaces, with essential permission, must be clearly marked [5]. It is possible to do alternative entrance procedure. It is used in the situation when atmosphere dangers (real or potential) are identified and may be proven that continuous ventilation is just enough to keep the confined space safe for entrance.
Initial atmospheric data are required to demonstrate that only ventilation is sufficient. The air supply for the ventilation air must be from a clean source and must not increase dangers in the confined space [6] It means, the test must confirm that there is no atmospheric danger within the confined space before any authorised entry. Likewise, in the Guidelines for the best practice published by the Croatian Institute of Health and Safety at Work [7], Zagreb, the concept of a confined space for which the combination of work danger is to be given: Mechanical dangers and chemical harms.
On the basis of Law protection work [8] and Regulation for assessment risk ,[9] it is essential to make an assessment risk for a certain confined space, to which needs to be defined/determined that workplace is confined; determine predictable exposure to dangers in the confined space (make a description, categorization, extent and kind of danger, for every individual work operation and every worker in these operations; imperatively ensure confined space for sudden start/release of energy or working media, apply Lock-out according to risk assessment Tag-out system (LOTO), involve key workers and managers in its development, determine the general principles of risk prevention, basic and special safety and preventive measures for each work operation, provide information/training of workers, supervisors to work in confined spaces, as and responsible managers and managers. Notification or training is carried out for all necessary work operations in the specified area.The basis of notification / training is a risk assessment and determine the placement of signs, warnings, danger[9] The fundamental task for protective measure implementation is primarly focused on the reduction of number of accident not injuries. The injury is ultimate unfavorable result of a series of events, which are mutually conditioned [5].The work in the confined space requires knowledge, skills and abilities which must be framed with worker's satification, especially in these working conditons. One of the key factors

for company success is to invest in the employees. So, the main aim of every modern business organization is worker's satification, buyer's satification and profit' s production [10].

The work organization must be done that enables overtime working hours' reduction and increased overlapped working number hour. It is clear that work in the confined space may require higher number of working hours because of sensitivity and the nature of work. But the stressful way of work may bring the worker into the state of physical, mental, and emotional exhaustion, even more. It is possible to feel dissatisfaction due to the inability to reconcile all obligations and work tasks, so it leads to stress-making among employees. As the working environment dictates the pace of business, employees become demotivated and work assignments seem pointless. It's all one cycle leading to the symptoms of anxiety. A weakened level of satisfaction can weaken the effectiveness of the work and thus jeopardise working in the confined spaces. One way to increase the level of satisfaction is to change the relationship between one another. Within the organisation should exist on respect among employees, which fosters interest in personal development and better involvement in dealing with tasks[10].

Motivated employees achieve better work success and at the same time, the overall performance of the organisation and its competitiveness on the market develop also. In doing so, the organisation's motivational system must be designed to meet the needs and desires of employees and focus on raising individual performance by creating and rewarding desirable patterns of behaviour. An appropriate and effective motivation system includes several different forms of remuneration, as well as fairness in the allocation of awards to employees. The motivation of employees is so much more important that occupations are more complex and complex. Motivation is an important trigger that guides, maintains and induces employees for the purpose of desirable and obscene behaviour within action. Indeed, proper selection and motivation of employees constitutes a competitive advantage for successful companies. [11]. Not surprisingly, today's operating conditions, they place motivation and employment satisfaction in the focus of the management profession. By building up a quality motivational system and achieving the satisfaction of employees, the work organisation achieves better productivity, competitive ability and competitive advantage.

3. RESEARCH STUDY

It is carried out a survey about the protection and safety measures among 80 workers who work in the confined space, in Karlovac and Međimurje county. The survey questions are:

1. The level of worker's protection at the workplace
2. The level of safety-preventive measures for workers who work in the confined space
3. Is there a possibility of education training workers during a year?
4. Is there a need for overtime work in the confined space?
5. Do you feel that the amount of salary is proportional to the responsibility of the work you do in a confined space?
6. Do you receive adding stimulus for your work?
7. How would you assess the level of stress for staying in the confined space?
8. Does the employer issue a work permit in a confined space and on the basis of a risk assessment only after the examination and categorisation of such a space?

4. DISCUSSION RESULTS

In the accordance with research results about the level of worker's protection and safety at their workplace [Fig.1] , it can be concluded that safety is on relatively high level (43% respondents) . (48% respondents) believe that the level of safety is on the middle level, while (9%) believe that the safety

and security are on the low level. It is surprising that the respondents proportionally believe that the level of protection is high and middle. Regarding the research results about safety-preventive measures, for worker's protection who work in the confined space, it is perceived that there is relatively middle level [Fig.2] 38% respondents, while (43%) respondents believe that the level of safety-preventive measures is middle and 19% respondents believe it is low.

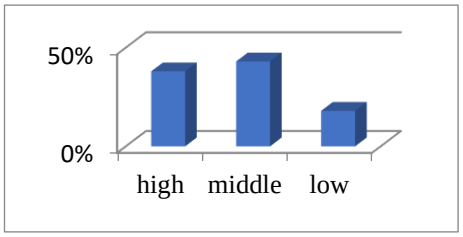


Figure 1: The level of worker's safety

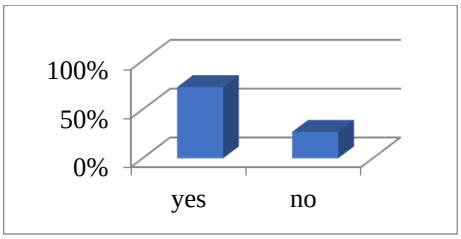


Figure 2: The level of safety-preventive protection measure

High percentage of respondents (73%) believe that there is a possibility of professional training during a year [Fig.3] unlike (27 %) respondents who believe that there is no possibility of professional training. These results indicate positive trends for worker's professional training. It may be the only positive indicator. The research results about the need for overtime working hours for work in the confined space indicate that high percentage of respondents (73%) believe that there is a need for overtime working hours unlike small number of respondents (27%) who believe there is no. The need for overtime working hours indicates that the workers want to work calmly and slowly by not bothering to follow the rules of working hours.

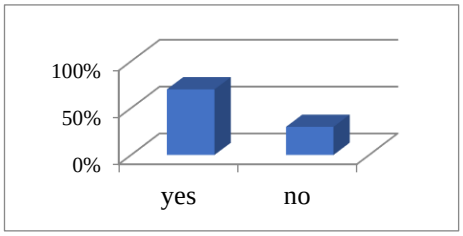


Figure 3: Worker's professional training

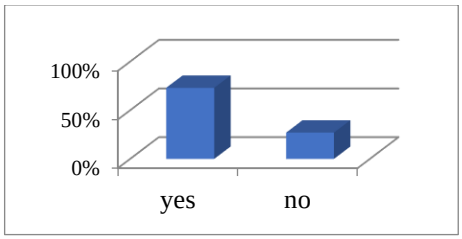


Figure 4: Need for overtime working hours

70% respondents believe that the salary is proportional to responsibility, while 30% respondents believe that it is not proportional to the responsibilty [Fig.5]. The research result [Fig.6] about adding working stimulus (65%) respondents reports that they receive adding working stimulus, unlike (35%) respondents do not receive. Relatively high number of respondents receive working stimulus, so it has positive impact on the worker. In that way, the motivation can reach higher point, so worker can achieve it own personal aims and psychological feeling for growth, independence and will to work..

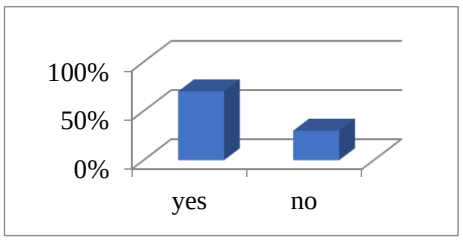


Figure 5: The salary of worker who work in the

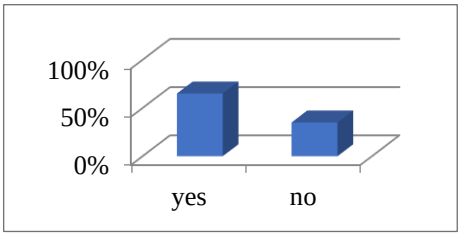


Figure 6: Stimulations for the work in confined space

Stress is inescapable for workers who work in confined spaces due to the high level of exposure to labor [Fig. 7]. Very low stress levels are reported by 10% of respondents, while intermediate stress levels are reported by 50% of respondents, and severe stress levels are reported by 40% of respondents. The research findings regarding the issuance of a permit to work in a restricted place [Fig.8], based on risk assessment following inspection and categorization by employee report high percentage of compliance with risk assessment measures by the employer (66.7%), which indicates a good and positive business trend of the employer in contrast to (33.3%) respondents.

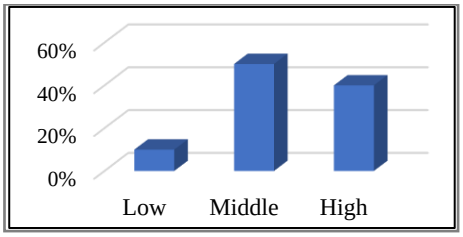


Figure 7: Assessment of stress levels

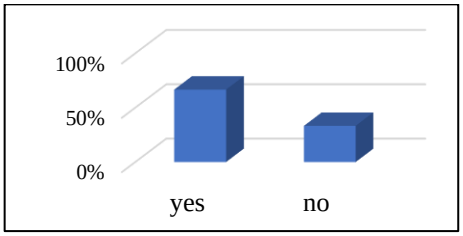


Figure 8: Does the employee issue work permit?

In accordance with the results, it can be concluded that a high percentage of respondents are satisfied with the working conditions given by the employer (salary, paid travel costs, adding work stimulus). Satisfaction with working conditions has a psychological impact on the worker, allowing him to do work unhindered, in the confined space.The research results on the frequency of measurement, identification and assessment of dangers and dangers for work in confined spaces by an authorized person [Fig.9] indicate that there is a small difference between the implementation of the necessary hazard assessment measures once a month (40%) and once a year (35%). Weekly implementation of the necessary risk assessment measures (25%) indicates a relatively low weekly frequency of assessment. There is a need for more frequent implementation of risk assessment measures. But certainly, each new assessment requires certain financial resources. In any way, it is always better to do prevention than to remedy the difficulties that have arisen. Prevention is determined by the Law of labour protection

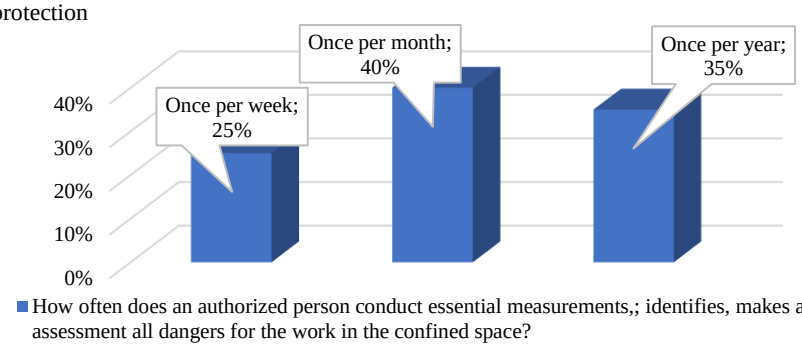


Figure 9: Frequency of measuring, identifying and assessing all dangers and hazards for work in confined spaces

5. CONCLUSION

The work in the confined space represents risky work and require quite trained workers who are psychophysically capable comes in the confined space, do requested work and comes out the confined space. The safety risk assessment is the very serious and relevant document issued by an authorized person. On the basis of this relevant document, the worker may or may not come into the confined space. Crucially for safe and qualitative work, for the worker in the confined space, it is an acceptable

level of satisfaction, measured by social conditions, work procedures and work organization. The solution for achieving acceptable level of satisificaton is in interconnecting and executing these fundamental groups with mutual respect and teamwork. It is essential to ensure the best possible working conditions, so they can achieve tasks. The risk assessment is the most effective when the effects of one or more working risk factors are identified. It is conducted the survey for respondents from Karlovac and Međimurje County. It showed that workers are satisfied with working conditions and stimulations. But it is determined a need for more frequent risk assessment in the confined space by complying the legislative rules.

5. REFERENCE

[1] Ministarstvo rada i mirovinskog sustava, (2019). Vodič za rad u skučenom prostoru: Zagreb.
[2] Dundović, K. & Stašić, S., (2020). Rad na siguran način u skučenim prostorima. Zbornik Veleučilišta u Rijeci, Vol. 8 (No. 1), pp. 395-412.
[3] Hrvatski zavod za zaštitu zdravlja i sigurnost , 2016. Rad u skučenim prostorima. Zagreb.
[4] Zakon o zaštiti na radu, (2018). NN 71/14, 118/14, 154/14 , 94/18, 96/18. Zagreb.
[5] Žakula, M., (2020). Sigurnost radnika u ograničenom prostoru. Karlovac: VUKA.
[6] Zavarivanje info (2020) Ventilacija. Zagreb.
[7] HZZZSR,(2020). Smjernice dobre prakse. Zagreb.
[8] Zakon o zaštiti na radu, 2018. NN 71/14, 118/14, 154/14 , 94/18, 96/18. Zagreb.
[9] Ministarstvo rada i mirovinskog sustava, (2014). Pravilnik o izradi procjene rizika. Zagreb.
[10] Kirin, S. & Šimić, B., (2020). Psihosocijalni čimbenici na radnom mjestu i zadovoljstvo radnika u hotelijerstvu. Sigurnost : časopis za sigurnost u radnoj i životnoj okolini,2020., Vol. 62(No. 1), pp. 1-10.
[11]Želježić, I. Motivacija kao komponenta upravljanja ljudskim resursima (2019), Zbornik radova Međimurskog veleučilišta u Čakovcu, svez. 10, br. 1, pp. 1-7, 2019.
[12] Ministarstvo rada i mirovinskog sustava, 2019. Ograničeni i skučeni prostori - Dobra praksa i iskustvo rada u ograničenim prostorima iz inozemstva. Kanada: Bechtel&Enka.

INVESTIGATION OF THE RELATIONSHIP BETWEEN METEOROLOGICAL FACTORS AND SEA LEVEL CHANGES: ANTALYA BAY

Erkin Taş, Rıfat Tür, Ali Danadeh Mehr
Akdeniz Universtiy Department of Civil Engineering, erkintas07@gmail.com
Akdeniz University Department of Civil Engineering, rifattur@akdeniz.edu.tr
Antalya Bilim Universty Department of Civil Engineering, ali.danadeh@antalya.edu.tr

ABSTRACT:

In this paper, the effects of the meteorological factors on the sea level changes in Antalya Bay were investigated., To this end, hourly sea level and meteorological factors time-series were obtained from Antalya tide gauge station for the period 2007-2008. Tidal components of the region were determined by using harmonic analyze. Then, these components were subtracted from the measured sea level time-series to eliminate tidal effect. After subtracting the tidal effects, the meteorological factors such as air pressure and temperature on the remaining sea level time-series were investigated. The results showed that air pressure has an inverse effect on the sea level changes in the region, while air temperature has a direct effect on it.

Keywords: Sea Level, Meteorological Factors, Tide Gauge, Antalya Bay

1. INTRODUCTION

Civil engineering is a versatile branch of engineering that includes both the law of physics and the foundations of natural science. For this reason, not only the structural design rules, but also the investigation and analysis of various climatic and natural events affecting the structures is an important civil engineering issue. Sea level changes such as rise, or fall is important for coastal structural design. On the other hand, sea level changes have a potential impact on the coastal regions such as coastal erosion, more extensive coastal inundation, storm surge flooding, landward intrusion of seawater in estuaries and aquifers, change in surface water and ground water characteristics [1].

Several factors are caused to changes on the sea level height in a coastline, or in a bay. These factors that affect the sea level changes can be defined as meteorological factors, oceanographic factors, tidal effects, climate change, and vertical land motion. Meteorological factors are air pressure, air temperature, wind speed and wind duration. At the same time, air temperature is most common factor that effecting the sea level changes within the context of climate change. Oceanographic factors are generally considered by the earth science related studies. It covers changes in the sea water density and the effects of ocean currents on sea level changes. Another most common effect that causes the sea level changes is tidal effects. The sun and moon exert a gravitational effect on the sea due to their huge masses. Therefore, some periodic changes on the sea level are occurred. One of the most important disruptive factors that change the sea level is the vertical land motion of the Earth. Sea level is measured

relative to a benchmark on land. If land rises over time, sea level decrease relatively, conversely, if land collapses over time, sea level increases.

Focusing on the meteorological factors that effecting the sea level changes, several studies have been published by researchers in literature. For example, Cui et. al [2] presented a linear statistic model upon a long-term sea level data of Japanese coasts. The monthly mean values of sea level, temperature and air pressure measurements were collected from 15 tide gauge stations along the Japanese coasts. Canonical correlation analysis was performed to identify local wind setup water due to regional low-frequency wind anomalies and a planetary-scale atmosphere-ocean interaction which take place in the eastern North Pacific. The link between the sea level variations and two meteorological factors were examined for both downscale (regional) and largescale (North Pacific) exercise. Alpar et.al [3] collected hourly sea level, air pressure and wind measurements from a tide gauge located in Izmir Bay, Turkey. Hourly sea level data were converted to daily data by using 119-point tide killing filter to subtract the semi-diurnal and diurnal tidal effects. Wind data were separated by their direction using frequency distribution histogram. Sea level and air pressure data were plotted together to investigate relationship between them. Similarly, mean sea level and N-S and E-W wind components were plotted together. The results showed that sea level changes and air pressure have an inverse relationship. A significant relationship was found between the sea level changes and wind speed. It was observed that the wind speed can increase the sea level height sufficiently. Wroblewski [4] put forward stochastic methods to investigate the effect of North Sea on the mean monthly sea level of Baltic Sea. The long-term sea level and air pressure measurements were collected from different tide gauges around the Danish Strait which includes North Sea and Baltic Sea. The computations revealed that zonal circulation and mean sea level of North Sea effects the mean sea level of Baltic Sea. Also, author concluded that the atmospheric pressure has no significant static effect on Baltic Sea level. Andersson [5] presented a model to analyze seasonal sea level variations using air pressure differences in Baltic Sea. The results showed that wind speed and atmospheric circulation has an important role on sea level changes on the region. Omstedt et.al [6] investigate the interrelation between air temperature, sea level variation, ice cover and atmospheric circulation on Baltic Sea region using a dataset of 200 year. The results showed that air temperature and sea level height have positive trends. Also, authors concluded that sea level variation in Baltic Sea can be partly explained by atmospheric circulation. Chen and Omstedt [7] investigated the relation between sea level variation and large-scale atmospheric forcing such as air temperature, vorticity, zonal and meridional wind speed of Baltic Sea. Stepwise regression analyze was performed to identify key predictors. Then, multiple linear regression model was applied to determine relative importance of the predictors on sea level variation. The results demonstrated that wind plays an important role in the period January-May, while vorticity plays an important role in the period June and December in Baltic Sea level variations. Authors also indicated that the upward trend on the sea level might be related with the air temperature. Singh and Aung [8] investigated the effect of air pressure on the sea level changes in Pacific Region. To this end, sea level and air pressure measurement were collected for twelve Pacific Island countries. The results showed that sea level changes and air pressure have an inverse relationship based on the reverse barometric effect that firstly presented by Crowder [9]. Hünicke and Zorita [10] focused on relation between sea level variation and meteorological factors such as sea surface temperature, sea surface pressure, and precipitation. The required data collected from 30 tide gauges around the Baltic Sea for the period of 1900-1998. A linear regression model was developed to identify relative importance of the predictors on the sea level variations. The period 1960-1998 was used for calibration and the period 1900-1959 was used as validation data. The results showed that 35% of the total variance on sea level can be explained by the meteorological factors. Simav et.al [11] investigated the atmospheric, steric and land motion effects on the sea level heights. The required data were derived from two different tide gauges in Turkey. In addition to tide gauge data temperature/salinity climatology and GPS data were used for investigation. Based on the results, authors indicated that atmospheric and steric contributions have high correlation coefficients with sea level changes. Johannson and Kahma [12] were investigated the statistical relationship between the Baltic Sea levels and geostrophic wind. Long-term monthly sea level values were collected from

Permanent Service for Mean Sea Level database. Zonal and meridional wind components were calculated. Statistical analysis revealed a considerable correlation between the geostrophic winds and sea level changes. Çoşkun [13] analyzed the relationship between the sea level change and meteorological factors for Izmir Bay, Turkey. A dataset including sea level heights, air pressure, wind speed, and wind direction was created by using a tide gauge measurement. The tidal effects were eliminated from the sea level measurements by using 25-hour running mean filtering. Then, sea level and air pressure time-series were plotted together for analysis. Air pressure contributions on the sea level changes were subtracted based on the inverse barometric effect. Then, remaining sea level height and wind data time-series were plotted together for analysis. Inverse relationship was observed between the sea level changes and air pressure, whereas direct relationship was observed between the wind features and sea level changes. Also, authors indicated that the results of the study support the findings of Alpar et.al. [3].

Based on the literature review, the motivation of this study is investigating the relationship between the meteorological factors and sea level changes in Antalya Bay. To this end, firstly the study area and used data were presented in section 2. The basics of sea level height were explained in Section 3. The methodology was presented in Section 4. The results of the study were given in Section 5, and we concluded this article in Section 6. Presented methodology in this study can be used for the other regions by researchers to investigate the relationship between the sea level change, air pressure and air temperature.

2. STUDY AREA

Under the responsibility of the General Command of Mapping of Turkey, sea level monitoring activities in Turkish coast started in 1930s. Sea level variations were recorded to daily or weekly charts with an analogous system. Readings were obtained through a float on a cable in a stilling well [14]. Afterwards, stilling wells replaced with acoustic gauges later in 1999 [11]. Presently, Turkish National Sea Level Monitoring System (TUDES) has 20 active tide gauge stations along the Turkish coast consist of a data collection unit with sensors to measure sea level, wind speed, wind direction, air temperature, air humidity, and air pressure. In this study, hourly sea level measurements and meteorological factors data were derived from a tide gauge station (see Figure 1) that is in Antalya Bay for the period January 2007-January 2008. In addition to sea level data, two frequently used meteorological factors such as air temperature, and air pressure data were adopted to use in the study.

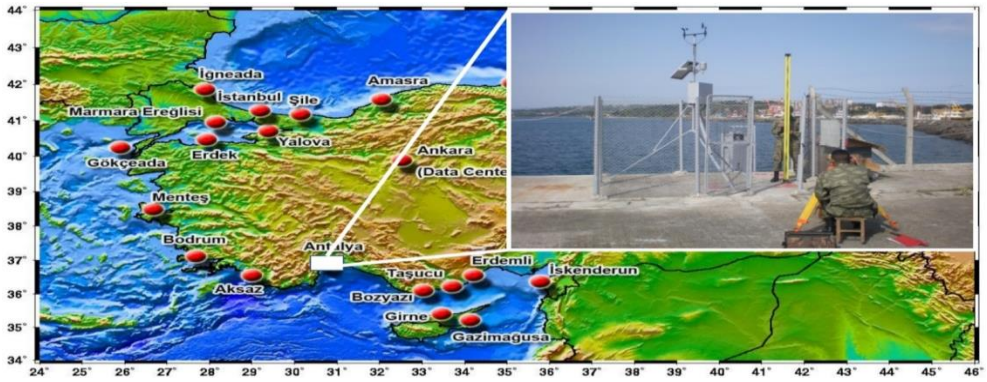


Figure 1: Antalya Tide Gauge Station [17]

3. BASICS OF SEA LEVEL HEIGHT

3.1 Sea Level Height

The sea level in a region is determined by collecting the contribution of mean sea level height, tidal effects, and meteorological effects. It can be explained mathematically as follows [15]

$$X(t) = Z_o(t) + T(t) + R(t) \quad (1)$$

Where, X(t) represents total sea level height, Z_o(t) represents mean sea level height, T(t) represent meteorological effects such as air pressure and air temperature, and R (t) represents tidal effects that caused by the movements of Sun and Moon.

3.2 Tidal Effects

The sea level measurements that derived from Antalya tide gauge also includes the sea level changes due to tidal effects which is also affected by the movements of the Sun and Moon. The main movements of the Sun, moon, and Earth that cause tides are mainly, Earth's rotation, Moon's orbit around Earth, Earth's orbit around Sun. These movements effects on tidal wave periods. Therefore, in order to investigate the relation between sea level changes and meteorological factors, tidal components of the sea level measurements should be subtracted. To this end, harmonic analysis was applied to sea level time-series to define lunar wave periods such as M2, S2, N2, K2, and solar wave periods such as K1, O1, P1, Q1. A MATLAB script [16] that referred as "U-Tide "was used to determine these lunar and solar wave periods features such as amplitude and phase lag. Tidal effects defined by the sum of this harmonic components. Each harmonic componenets can be determined by the following formula:

$$n(t) = \sum_{i=1}^{N} Ai\,(t) ai \cos\,(wi\,t + fi + Fi(t)) \quad (2)$$

Where, n(t) represents sea level, wi represents frequency of component, ai represent amplitude of component, and fi represent phase lag of component. If one-year hourly sea level measurements are to be found by estimation, it is sufficient to consider the K1, O1, M2, and S2 components. The importance of these components is expressed by a Form Factor (FF). FF can be expressed by the following formula [17].

$$FF = \frac{(K1+O1)}{(M2+S2)} \quad (3)$$

Where K1, O1, M2, S2 are the amplitude of tidal components. Four amplitude components of tidal wave periods must be used to determine FF. FF value divides the tide types into four categories (see Table 1).

Table 1: Classification of Tide Types [17]

FF Value	Category
0.00 – 0.25	Semi-diurnal type
0.25 – 1.50	Mixed, more of semi-diurnal type
1.50 – 3.00	Mixed more of diurnal type
> 3.00	Diurnal type

3.3 Meteorological Effects

One of the most common meteorological factors that used in coastal, meteorological or earth science related studies is air pressure. Changes in atmospheric pressure cause sea level changes in the vertical direction. This interaction is called as the "Reverse Barometer Effect ". If air pressure increase, sea level decrease based on this effect. Similarly, if the air pressure decrease, sea level increase. As a result, it can be concluded that there is an indirect relationship between the air pressure and sea level changes.

Also, air temperature is another meteorological factor that effecting the sea level change. Air temperature is continuously increasing due to global warming. One of the consequences of global warming is the rise in sea level due to thermal expansion of the upper layer of the sea and melting of ice caps and mountain glaciers. Areas that far from the ocean air temperature generally effects sea level due to thermal expansion.

4. METHODOLOGY

The proposed method to investigation of the relationship between meteorological factors and sea level changes have several steps. Firstly, sea level time series and meteorological factor time-series are derived from a tide gauge station. Secondly, amplitude of tidal components such as K1, O1, P1, Q1, M2, S2, N2 and K2 are determined by using U-Tide MATLAB script. Then, FF value is determined by using previously found amplitude values of tidal components. If the FF value indicates a semi-diurnal type of tide, sea level time series should be 12-hour averaged. Similarly, If the FF value indicates a diurnal type of tide, sea level time series should be 24-hour averaged. Thus, the tidal effect on the sea level height can be subtracted. Thirdly, the mean sea level height value is calculated and subtracted from the remaining sea level time series. Similarly, the mean values of air pressure and air temperature are calculated and subtracted from each time series. The last step of the proposed investigation method is plotting biaxial charts using final sea level time series, air pressure time-series and air temperature time-series.

5. RESULTS and DISCUSSION

In this study, the relationship between the meteorological factors (air pressure, air temperature) and sea level changes was investigated. To this end, firstly, required data were derived from Antalya tide gauge station. These data include 2 year (24 month) of hourly sea level measurement time-series as well as 2 year (24 month) of hourly air pressure and air temperature time-series. Then, to eliminate the tidal effects from the sea level time-series a MATLAB script was used. That script apply harmonic analyze to sea level time-series to determine amplitude values of tidal waves. The data was separated into two as covering data of 2007 and covering data of 2008. In Table 2, the determined amplitude values of tidal waves can be seen for each year.

Table 2: Determined amplitude values of tidal components for 2007 and 2008.

Year	K1	O1	P1	Q1	M2	S2	N2	K2
2007	0,0242	0,0155	0,00788	0,00297	0,0759	0,0462	0,0789	0,0122
2008	0,0205	0,0144	0,00615	0,00191	0,0701	0,0445	0,0115	0,0141

Then, to calculate the FF value (see eq.3) required amplitude values were used for each year. The FF values of 0.33 and 0.30 were found for the year of 2007, and 2008, respectively. Therefore, a semi-

diurnal type of tidal effects was found in Antalya Bay based on the Table 1. Therefore, each sea level time-series were 12-hour averaged using moving average methods. Thus, tidal components of the sea level time-series were subtracted. After subtracting tidal effects from the sea level measurements, the mean sea level value was calculated. Then, mean sea level value was subtracted from the remaining sea level values. Similar procedure was done for the meteorological factors. In Figure 2, 3, 4, and 5 the biaxial charts between the sea level, air pressure and air temperature were presented.

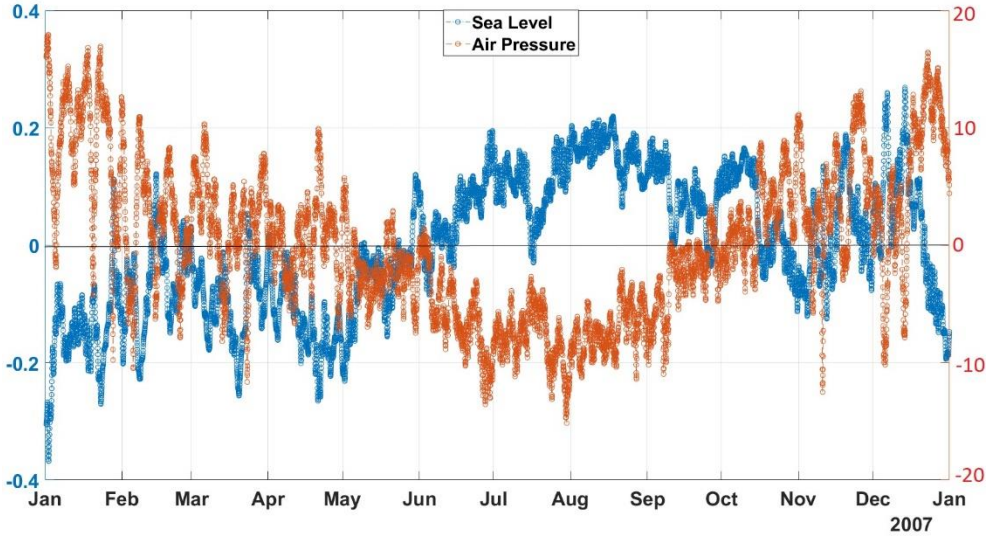


Figure 2: Sea level versus air pressure in 2007

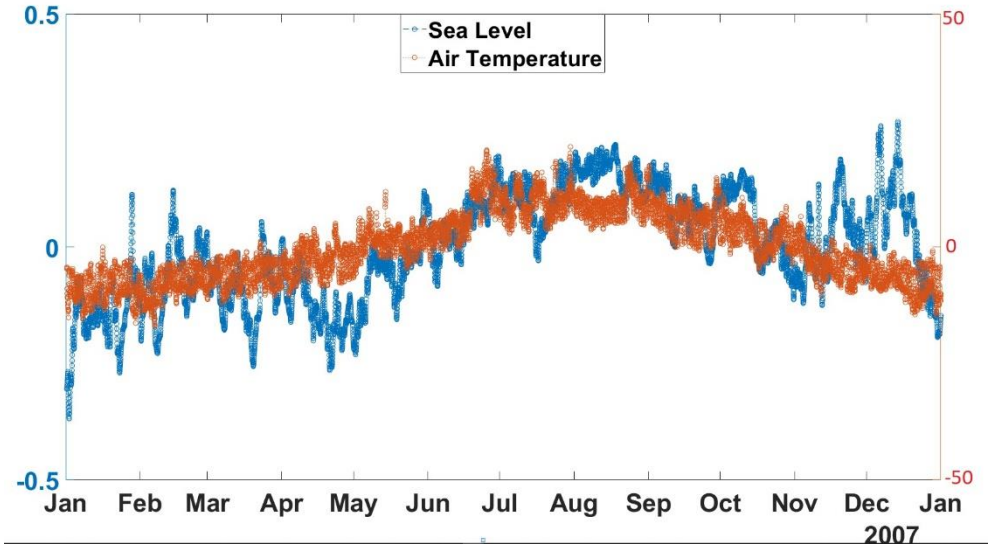


Figure 3: Sea level versus air temperature in 2007

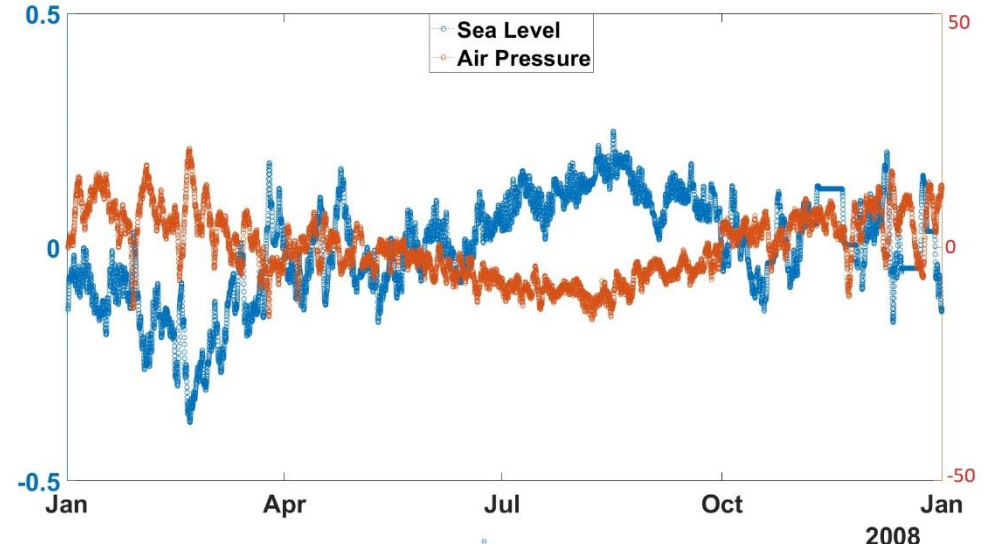


Figure 4: Sea level versus air pressure in 2008

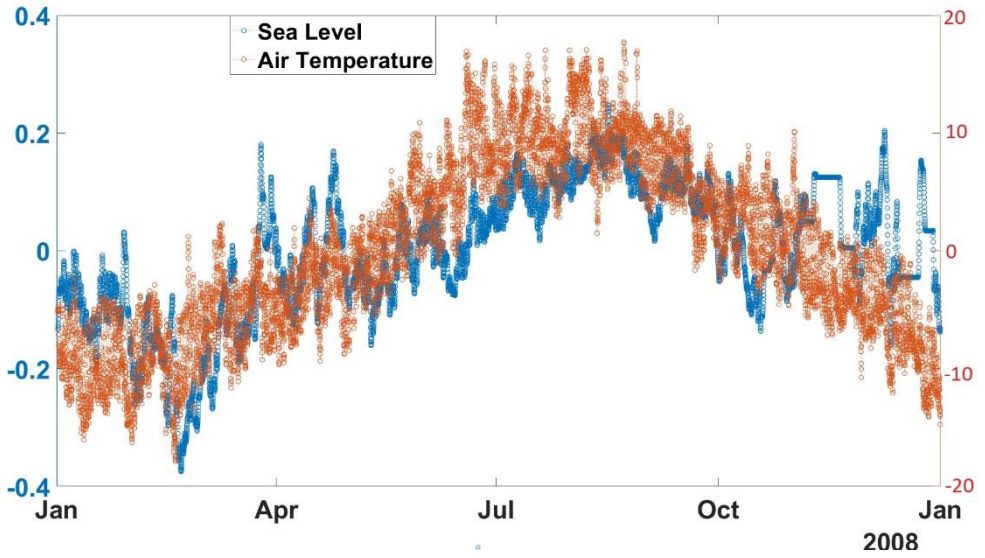


Figure 5: Sea level versus air temperature in 2008

It was observed that an inverse relationship between the sea level heights and air pressure values for Antalya Bay, based on the Figure 2, and 4. Air pressure approached highest values for period of January-March, whereas sea level approached lowest values for same periods. Highest values of the sea level were observed between the period of June-September, whereas the lowest values of the air pressure were observed for same period. On the other hand, the highest and lowest values of the air temperature and sea level heights were observed for the period of June-September, and January-March respectively (see Figure 3 and 5). This clearly represents a direct relationship between the sea level and air temperature time-series for the Antalya Bay.

Our findings are in agreement with the relevant literature presented in Section 1. Similar to our results an inverse relationship between the sea level changes and air pressure was reported for Pacific coast [8], and Turkish coast [3, 13]. But, surprisingly no significant relationship between sea level change and air pressure was reported by Wroblewski [4] for Danish Strait region. On the other hand, a direct relation between the sea level changes and air temperature was reported for Baltic Sea region [6,7,10].

6. CONCLUSION

Since the beginning of the 20th century, anthropogenic activities have led to an increase in greenhouse gases, such as water vapor, carbon dioxide, methane etc., released into the atmosphere. Global warming is the name given to the increase in average temperatures measured throughout the year on earth as a result of the greenhouse effect. It causes climate change which is the long-term changes in climate of earth. Changing climate directly affect the meteorological conditions and as a result both eustatic and steric sea level changes occurred. Sea level changes are non-uniform along the Earth, due to fact that the meteorological factors are differs from region to region. Therefore, the relationship between the sea level changes and meteorological factors can be change for each region. In this study we investigated the relationship between the sea level changes and meteorological factors for Antalya Bay, Turkey. Presented methodology in this study can be used for the other regions by researchers to investigate the relationship between the sea level change, air pressure and air temperature.

Based on our results, an indirect relationship between the sea level and air pressure was observed. An increase on the air pressure causes fall of sea level in Antalya Bay. On the other hand, a direct relationship between the sea level and air temperature was observed. Therefore, an increase on the air temperature causes rises of sea level in Antalya Bay.

There are some limitations of this study. Firstly, wind speed, wind direction, precipitation, and some other meteorological factors were not included presented study. Secondly, the investigation was performed by using two-years data. In the future studies, it will be a good practice to investigate the relationship between the sea level and afore-mentioned meteorological factors with using long-term measurements.

7. REFERENCES

[1] Ding, X., Chao, J., Zheng, D., Chen, Y. (2003). Long-term sea-level changes in Hong Kong from tide-gauge records. Journal of Coastal Research 17 (3), 749-754.

[2] Cui, M., von Storch, H., Zorita, E. (1995). Coastal sea level and the large-scale climate state: A downscaling exercise for the Japanese Islands. Tellus A: A Dynamic Meteorology and Oceanography. 47 (1), 132-144.

[3] Alpar, B., Burak, S. Gazioğlu, C. (1997). Effect of weather system on the regime of sea level variations in Izmir Bay. Turkish J. Mar. Sci. 3(2), 83-92.

[4] Wroblewski, A. (1998). The effect of the North Sea on oscillations of the mean monthly sea levels in Baltic Sea. Continental Shelf Research, 18 (5), 501-514.

[5] Andersson, H. C. (2002). Influence of long-term regional and large-scale atmospheric circulation on the Baltic Sea level. Tellus A: A Dynamic Meteorology and Oceanography, 54 (1), 76-88.

[6] Omstedt, A., Pettersen, C., Rodhe, J., Winsor, P. (2004). Baltic Sea climate: 200 yrs. of data on Air temperature, sea level variation, ice cover, and atmospheric circulation. Climate Research, 25 (3), 205-216.

[7] Chen, D., Omstedt, A. (2005). Climate-induced variability of sea level in Stockholm: Influence of air temperature and atmospheric circulation. Advances in Atmospheric Sciences. 22 (5): 655-664.

[8] Singh, A., Aung, T. (2005). Effect of barometric pressure on sea level variations in the Pacific region. The South Pacific Journal of Natural Science. 23: 9-15.

[9] Crowder, R. B. (1995). The wonders of the weather. Australian Government Publishing Service. Chapter-3: 46-48.

[10] Hünicke, B., and Zorita, E. (2006). Influence of temperature and precipitation on decadal Baltic Sea level variations in the 20th Century. Tellus A: Dynamic Meteorology and Oceanography, 58 (1), 141-153.

[11] Simav, M., Yıldız, H., Türkezer, A., Lenk, O., and Özsoy, E. (2012). Sea level variability at Antalya and Menteş tide gauges in Turkey: atmospheric, steric and land motion contributions. Studia Geophysica et Geodaetica. 56 (), 215-230.

[12] Johansson, M. M., Kahma K.K. (2016). On the statistical relationship between the geostrophic wind and sea level variations in the Baltic Sea. Boreal Environment Research, 21, 25-43.

[13] Çoşkun, E. (2019). Meteorolojik parametrelerin deniz suyu değişimlerine etkisi. Gazi University M Sc. Thesis.

[14] Şeşeoğulları, B., Eriş, E., and Kahya, E. (2007). Trend analysis of sea levels along the Turkish Coast.

[15] Pugh, D. T. (1987). Tides, Surges and Mean Sea Level. John Wiley and Sons Ltd. Wiley, Chichester, 472 pp.

[16] Codiga, D. (2021). UTide unified tidal analysis and prediction functions (https://www.mathworks.com/matlabcentral/fileexchange/46523-utide-unified-tidal-analysis-and-prediction-functions), MATLAB Central File Exchange. Retrieved by July 30, 2021.

[17] Yıldız, H., Demir, Ç., Gürdal, M. A., Akabalı, O. A., Demirkol, E.Ö., Ayhan, M. E. and Türkoğlu, Y. (2003). Antalya-II, Bodrum-II, Erdek ve Menteş mareograf istasyonlarına ait 1984-2002yılları arası deniz seviyesi ve jeodezik ölçülerin değerlendirilmesi. *Harita Dergisi (Harita Genel Komutanlığı),* 17(Özel Sayı): 5-72.

REGULAR MAINTENANCE OF ROAD INFRASTRUCTURE - WINTER ROAD MAINTENANCE

[1]Lejla Bašanović Mahmutović, [2]Edis Softić, [3]Mirsad Ičanović
[1]Univerzitet u Bihaću, Tehnički fakultet Bihać, e-mail: lejlabasanovic@gmail.com
[2]Univerzitet u Bihaću, Tehnički fakultet Bihać, e-mail: edis.softic@bih.net.ba
[3]Univerzitet u Bihaću, Biotehnički fakultet Bihać, e-mail: icanovicmirsad@yahoo.com

ABSTRACT:

Land traffic is as old as humanity, and road traffic is the most common type of land traffic on our slopes. Roads as a means of transport are vital for development and prosperity, due to the primary role of transport / relocation of persons and / or things and the improvement of socio-economic growth and development. The increase in transport also increases the exploitation of roads, in order for the roads to satisfy the smooth and safe flow of traffic, the technical conditions of correctness must be met, which is achieved by continuous implementation of measures and procedures for maintaining the road network.
Road infrastructure maintenance consists of regular summer and regular winter maintenance. Regular maintenance consists of a set of works and actions and measures that are performed throughout the year in accordance with the monthly or multi-month operational plan. A special type of regular maintenance is winter maintenance (winter service). Winter maintenance is the most extensive and expensive aspect of regular maintenance. The winter service includes activities, works and jobs necessary for maintaining the passability of roads in winter conditions and safe traffic.

Keywords: road, transport, maintenance, regular maintenance, winter maintenance

1. INTRODUCTION

Road maintenance is a special discipline that is creditable for preserving, restoring and improving the condition of roads. As part of regular maintenance, various activities are performed to ensure the smooth and safe flow of traffic. A special type of regular maintenance is winter maintenance, which is the most demanding and extensive part of road maintenance, its uniqueness is reflected in the specific conditions in which it is performed. The complexity of the work is reflected in the need to ensure the smooth and safe flow of traffic in conditions that threaten the normal flow of traffic. For that reason well-timed and right reaction of the services that work on winter maintenance is important, because anything to the contrary would cause material damage, collapse of the traffic network and human casualties.

2. REGULAR MAINTENANCE

Unhindered and safe traffic is the primary task of all roads used for the purpose of prosperity and economic progress of the region in which they are located. In order to achieve the aforementioned, it is necessary to ensure the prescribed standards and technical conditions, and the same is achieved by continuous implementation of measures and procedures for regular maintenance of road infrastructure.

The main goals of road protection and maintenance are, first of all, safe traffic and prevention of road deterioration, and protection of the environment from the harmful effects of road traffic. Road maintenance is a set of measures and activities that take place throughout the year in order to achieve the smooth flow of traffic, and to prevent negative impacts due to daily exploitation.
Types of maintenance are:

- regular maintenance (summer and winter),
- emergency maintenance,
- corrective maintenance.

Regular maintenance includes work on road infrastructure throughout the year and represents continuous work on maintaining the functionality of road infrastructure, while other types of maintenance are done as needed and do not require continuous work for the smooth flow of traffic.
The works of regular summer maintenance include the following activities:

- inspection of public roads (road patrol)
- maintenance of drainage systems
- maintenance of road profile elements (sidewalks, berms, gutters, cutting slope, kerf, embankments, retaining walls, etc.)
- road maintenance
- maintenance of signalization and road equipment
- vegetation maintenance works
- maintenance of facilities (tunnels, bridges, underpasses, etc.)

In addition to regular summer maintenance, there is also regular winter maintenance of the so-called. Winter service, which is the most extensive and demanding part of regular maintenance due to the specific conditions in which it is carried out.

3. REGULAR MAINTENANCE - WINTER MAINTENANCE

As a rule, winter maintenance lasts from November 15 of the current year to March 15 of the following year, but if the need arises, interventions as part of winter maintenance can be performed before November 15 or after March 15, all in accordance with the weather conditions. Winter maintenance aims to ensure passability and safety in traffic, and in order to achieve this, it is necessary to prepare for winter maintenance in a timely and planned manner.

The works performed during the winter service are:

- preparatory work before the onset of winter service
- organization of standby places (winter service points)
- measures to prevent icing
- clearing snow from the road and traffic signals
- marking the edges of the road (edge poles)
- installation of special traffic signals
- informing the public about the condition and passability of roads.

Winter service is a common term for all the previously listed measures and work procedures, which take place with the aim of ensuring safety and passability in winter catches.

3.1. Preparatory works

Preparatory works include works performed before the winter service in the period of October and November, consisting of:

- preparation of landfill material for spreading

- installation of edge poles
- installation of snow guards
- installation of traffic signals
- preparation of storage areas for spreading material
- delivery of sufficient quantities of spreading material.

Special attention is paid to the installation of winter traffic signals before the start of the winter service, the signalization consists of the installation of traffic signs II-46 (mandatory chains), the installation of additional signs V-5 (15.11. - 15.03.).

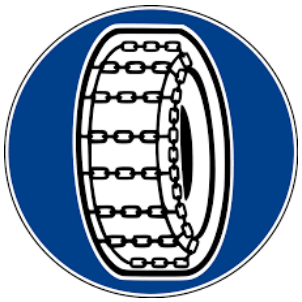


Figure 1: Winter traffic sign II-46

Winter traffic signals include the installation of curb poles along the roads, they serve to mark the width of the road and the direction of the road. The poles are painted with 33 cm wide yellow-red fields, the distance between the edge poles is at most 50 m, places that are considered dangerous or where there are extensions, curbs, fences, etc., should be well marked with edge poles.

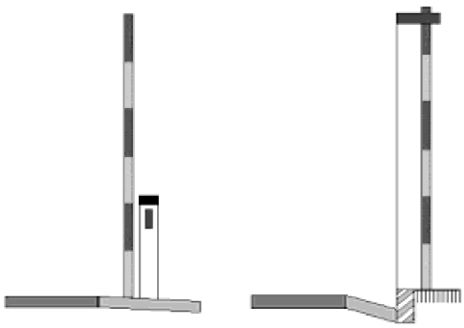


Figure 2: Edge poles

The edge poles must be higher than the average expected snow height and are most often made of wood or composite materials, with a pointed lower end that is protected by a coating.

3.2. Winter inspections

Winter inspections are intended to determine the condition of the road and weather conditions, with special emphasis on the possibility of ice. Inspections are performed in the morning from 3 to 5 o'clock and in the evening from 17 to 19 o'clock, with a semi-truck which, in addition to all the equipment for

the inspection service in the cargo area, also has spreading material to prevent icing. In addition to regular inspections in the morning and evening, there are also extraordinary inspections at the special request of the police, where it is necessary to remove all irregularities that endanger the safe flow of traffic.

3.2.1. Information on the weather situation and the condition of the road

We divide the data on phenomena into data on weather and data on roads, both groups of data are equally important for maintenance. Regular maintenance contractors must have a reliable source for obtaining data. One part of the data is obtained directly from the field based on the winter survey, while the other part of the data is obtained with the help of meteorological stations, which are located at critical points of the road routes.

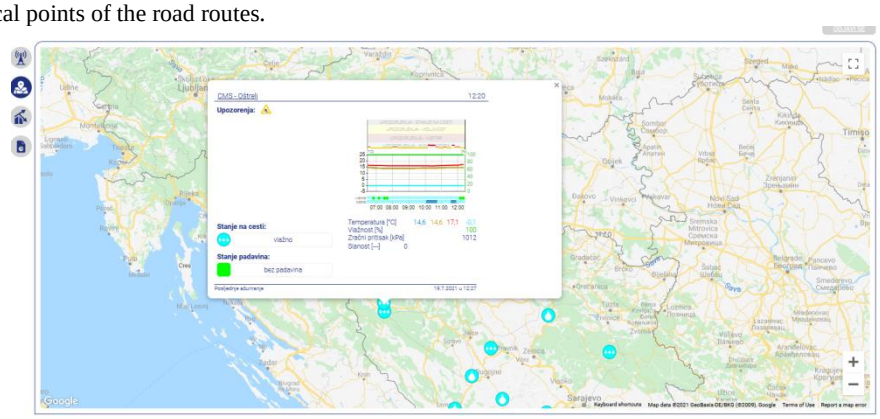


Figure 3: Review of data from the meteorological station RWIS

The data obtained in this way are of great importance for the timely maintenance of roads and the prevention of the consequences of winter on traffic at economically justified costs.

3.3. Duty and readiness in winter service

The readiness in the winter service is divided into three levels and depends on the expected weather conditions, we distinguish between I, II and III levels of readiness.
The first level of readiness is permanent and lasts 24 hours, from 15.11. to 15.03. ie 121 days, while the duty in the second and third degree is determined depending on the religious circumstances and is ordered in writing.

- **I.** **level of readiness -** at all points there must be a worker on duty who performs all the necessary plowing and spreading work, and eliminates all minor deficiencies (driver who performs the work with a truck equipped with a motor spreader and front plow).
- **II.** **level of readiness -** in case of worsening weather conditions, in addition to the duty of the first degree, additional teams are included for the most efficient response to the announced weather conditions.
- **III.** **level of readiness** - workers and mechanization that is included in the case of extremely strong weather conditions, where the previous two levels can not meet the needs of maintaining traffic and unhindered traffic.

During working hours, all workers involved in the performance of winter service, if they do not participate in the actions of the winter service, then perform regular maintenance work that must be performed and are important for the preservation of roads, environmental protection and road security.

3.4. Preventing icing

Preventive sprinkling should be performed to prevent ice, and before the start of the announced snowfall. The same is done with wet salt, which is a mixture of dry NaCl which is moistened with a solution of $CaCl_2$ or $MgCl_2$ in the appropriate ratio. The spreading density is between 5 and 40 g/m^2, depending on the weather conditions and road conditions, while for normal traffic it is enough to sprinkle with 10-15 g/m^2.

Figure 4: Truck with equipment for preventive sprinkling

Preventive spreading equipment consists of spreaders whose spreading belt must cover an area of 2 to 6 m, and must not be higher than 0.5 m above the road.

3.4.1. Spreading material

One of the preparatory works is the procurement of a sufficient amount of spreading material for the upcoming winter service, the assessment of the required amount is done on the basis of experiences from previous seasons. It is necessary to provide at least one third of the estimated required amount, the type and amount of required spreading material depends on climatic conditions, mechanization and road levels.
Ice is prevented and eliminated as follows:

- mechanical method (spreading with abrasive material - sand, ground stone)
- chemical method (spreading with solvent - salt)
- combined method (mixture of abrasive material and solvent).

Abrasives are used in order to increase the roughness of the road and ensure safer driving, in a way that ensures traction, but for that they have to stay between the tires and the ice, which is difficult to achieve given the frequency of passing vehicles. For this reason, large amounts of abrasive material are needed, which significantly affects the economic profitability of their use.

Figure 5: Warehouse for road salt

Chemicals to prevent icing work by lowering the freezing temperature of water causing the ice to melt. In order to achieve that, it is necessary to apply chemical agents before the beginning of the formation

of ice, because it is easier to prevent the formation of a bond than to break the already formed bond of ice.Types of chemical anti-icing agents are: sodium chloride (NaCl), calcium chloride ($CaCl_2$),, magnesium chloride $MgCl_2$), calcium magnesium acetate (CMA), potassium acetate (C2H3KO2) and liquid potassium acetate (CRYOTECH) used for AB and metal structures.

3.5. Activities after the end of the winter service

After the end of the winter service, it is necessary to remove the traffic signals that were placed as part of the preparatory works for the winter service, and it is necessary to clean and store them properly. In addition, it is necessary to clean all vehicles and equipment used for the winter service, and dismantle the winter service points, which includes transporting and storing the remaining salt to a permanent landfill for use in the next winter service.

3.6. Impact on the environment

It is an unquestionable fact that spreading materials are necessary for the safe operation of traffic in winter conditions, but we also come to know that these funds have harmful effects on the environment. Thus, by using abrasives that are deposited in drainage systems, they become clogged, in addition, the abrasive sludge that reaches the watercourse endangers the flora and fauna that lives in them. Research has shown that the use of abrasives causes the emission of dust in traffic, which leads to breathing problems.
It is a well-known fact that the use of salt-based agents can lead to: degradation of concrete and asphalt surfaces, corrosion on vehicles, but in addition there is a greater harmful impact on the environment which is reflected in plant damage as a result of receiving large amounts of sodium and chloride and damage to fish stocks due to water chloride saturation after rain.
Although the harmful effect of all spreading agents is generally known, it is still not possible to ensure safe and uninterrupted traffic in winter conditions without their use. Until a more adequate and efficient solution is found, which is more environmentally and economically acceptable than the above, we will be forced to use what is currently available.

4. CONCLUSION

From the beginning of roads, until today, the need for their maintenance has kept pace with their use, because if they are not maintained properly, they lose their functionality and in the long run we are in a situation where the original investment was lost. A special type of maintenance is winter maintenance, which is specific to the conditions in which it is performed, which are contrary to normal traffic conditions and as such make the whole process more complex. Winter maintenance is necessary in order to prevent the collapse of the traffic network, which would have lasting consequences of economic and commercial importance.

5. REFERENCES

[1] E. Softić, M. Subotić: Održavanje puteva i saobraćajnica, Tehnički fakultet Bihać, Bihać 2018.
[2] M. Burgić: Zimsko održavanje puteva, Tehnološki fakultet Tuzla, Tuzla 2021.
[3] G. Mladenvić: Tretmani redovnog održavanja, Građevinski fakultet Beograd, Beograd 2017.
[4] Smjernice za projektovanje, građenje i nadzor na putevima, Knjiga III-održavanje puteva (dio II-Redovno godišnje održavanje), Sarajevo/Banja Luka 2005
[5] Smjernice za projektovanje, građenje i nadzor na putevima, Knjiga III-održavanje puteva (dio III-Zimska služba), Sarajevo/Banja Luka 2005

CONTRIBUTION TO THE FURTHER SEISMIC RISK EVALUATION FOR BOSNIA AND HERZEGOVINA

Yahya El Shanawany, Sanin Džidić, Dženana Buljubašić, Ahmed El Sayed
International Burch University, Sarajevo, yahyamedhat@gmail.com

ABSTRACT:

Throughout the past year there has been an increased number of local seismic activities in the Balkan region. This calls for immediate seismic risk evaluation and reformulating construction regulations, as needed. The main aim of this paper is to analyze seismically active areas of Bosnia and Herzegovina and their seismic vulnerability, based on past occurrences and earthquake return period. The method applied in this research is comparative quantitative analysis, where utilizing data available, PGA values are extracted for the most seismically active cities, and compared to their corresponding earthquake magnitude values. Based on these observations and comparison, it can be clearly concluded what areas are at the high damage risk and what areas require special attention when it comes to seismic risk protection during future construction projects

Keywords: seismic risk, risk evaluation, PGA, Bosnia and Herzegovina

1. INTRODUCTION

In 2020, world population reached 7.79 billion, which is an increase of about 21.2 percent, compared to the year 2000, when population counted 6.14 billion. The world population has exploded, and, following the recent trends, it will continue to grow even more rapidly. If only the urban population was to be examined for the mentioned periods, in 2000, the number of people living in urban areas was approximately 2.87 billion, whereas in 2020, this number reached 4.38 billion. This is an increase of 34.5 percent [1].

The urban revolution accelerates the transformation of small cities into large and socially complex centers. It is also important to note that the most populated cities are situated in seismic areas. From eight super-mega cities with the population over 20 million, including Tokyo, Delhi, Shanghai, Sao Paulo, Mumbai, Mexico City, Beijing and Osaka, only Sao Paulo is situated in a non-seismic area [2]. Another thing to mention is the difference between seismic activity responses of developed and developing countries. Even though developed countries prone to earthquakes still suffer certain losses, the number of fatalities is nevertheless reduced [3]. Having this in mind and considering the fact that Bosnia and Herzegovina is a developing country [20], the question arises; what areas are at higher risk from a potential earthquake damage and what regulations are currently present in order to minimize them. On the other hand, in developing countries, even relatively light seismic activity can result in significant fatalities. The reason behind this is poorly engineered buildings constructed while ignoring any anti-seismic rules [3]. Developed countries are defined as those with GDP per capita over 12 000 $ US, whereas, developing countries have GDP per capita less than 12 000 $ US [4]. In Figure 1, based

on the data collected from EM-DAT Public [6] and Data Commons [5], it can be seen how earthquakes affect developed and developing countries. For comparison, the USA and Japan, as developed countries, suffer low fatalities, whereas Nepal and Guatemala, as developing countries, suffer higher fatalities.

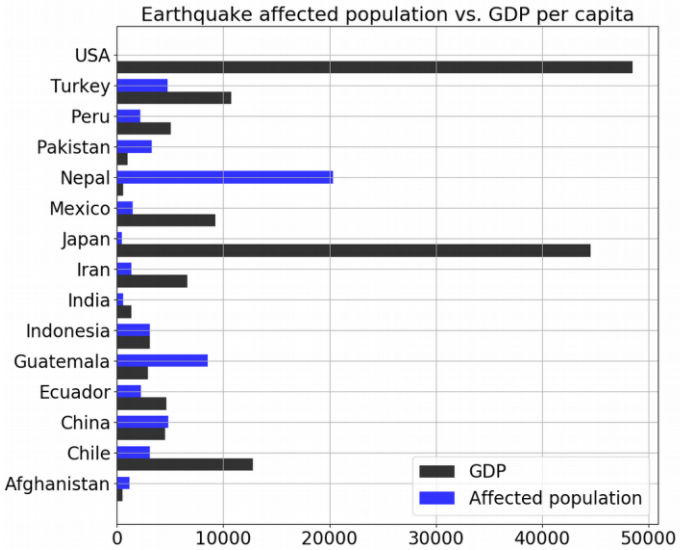


Figure 1: Earthquake fatalities compared to GDP per capita (author's graph)

One of the modern methods and risk control principles in the construction industry is standardizing the Eurocode 8 [7], [8]. These contain global construction regulations which contribute to stability and safety of buildings, and therefore risk reduction. Due to recent events including earthquakes in Zagreb and Petrinja, it is recommended to reevaluate the current seismic map of Bosnia and Herzegovina and its PGA values.

2. SEISMIC RISK ASSESSMENT EVALUATION

Bosnia's seismotectonics follows the Mediterranean region [9], [10]. This is due to the fact that the African tectonic plate is constantly colliding with the Euroasian plate, to be more specific, sliding beneath the European continent, which is largely influencing Balkan region and Bosnia and Herzegovina. Mediterranean belt is characterized by stages of magmatism, volcanic activity and sedimentary regions recycling. Predominantly seismically active areas of Bosnia in Herzegovina are the west and west-southern areas [11], in the outer Dinaric Alps, with the maximal PGA = 0.18 for the return period of 95 years, and PGA = 0.38, for the return period of 475 years. These values are extracted from the PGA maps [12] for Bosnia and Herzegovina, for the Neum area. From the mentioned map PGA values for other cities in Bosnia and Herzegovina can be easily extrapolated, which we have done for Table 1. It should be noted that these maps need to undergo revisiting, which is of key importance in this paper, since some of the PGA values don't add up to the recent events (earthquake that hit Banja Luka over 50 years ago), that is, the intensity of these events. In Table 1, the average PGA values have been summed for bigger cities (population > 100 000) in Bosnia and Herzegovina [12].

Table 1: PGA for biggest cities in Bosnia and Herzegovina [12]

City	Population	A_{gR} (95 years)	A_{gR} (475 years)
Sarajevo	275,524	0.09	0.18
Banja Luka	185,042	0.07	0.17
Tuzla	110,979	0.07	0.21
Zenica	110,663	0.11	0.24
Bijeljina	107,715	0.04	0.08
Mostar	105,797	0.13	0.26

Seismic activity is defined by its annual probability of exceedance P, or, equivalently return period, T [13]. A 475−year return period corresponds to a probability of exceedance in a 50−year building life of $1 - (1 - 1/475)^{50}$ = 10 percent. That is, if the 475-year return period PGA is estimated to be 0.25 g, or 25 percent, there is a 10 percent chance that a larger PGA could be experienced at least once during any 50-year period. In the earthquake design, usually the data from 500-year return periods is used [13], primarily due to the fact that, even though earthquakes might not be as frequent in certain areas, they can be highly damaging. For example, Banja Luka, as shown in Table 1, has PGA for a 475-year return period of 0.17, which corresponds to very strong shaking [14], and light damage. However, in 1969., devastating earthquakes hit Banja Luka [15], with the magnitudes of 6.0 and 6.4 on the Richter scale, leaving thousands of people injured and 20 dead. This raises the question of revisiting the PGA values of some areas in Bosnia and Herzegovina and improving the overall data.

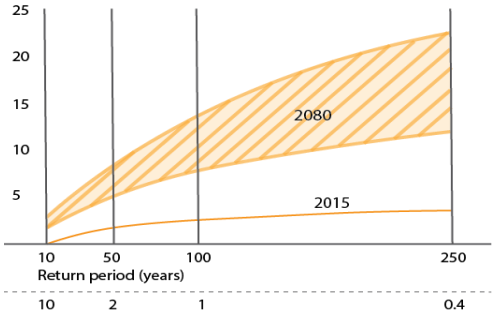


Figure 2: Earthquake – Exceedance Probability Curve (2015 and 2020) [17]

In the past 365 days, Bosnia and Herzegovina has had 25 earthquakes, 3 of which were of magnitude higher than 4.0, two of these located in Blagaj and one in Nevesinje [16]. According to 2015 estimates, earthquakes cause 4 billion $ US worth of damage and affect 700 000 people [17] (for the period of 250 years). Earthquake that happened in Banja Luka 50 years ago, caused 300 million $ US in damage [17]. If the same earthquake were to occur today, it would cause an estimated death toll of over 400 and more than 4 billion $ US in damage, based on present day exposures. Financial losses and human fatalities caused by more intense and less frequent events may be significantly larger than the annual averages. For example, an earthquake with 0.4 percent annual probability of occurrence could cause nearly 1 billion $ US in capital loss (around 7 percent of GDP) [17]. In Figure 2, the exceedance probability curve shows the GDP affected by earthquakes, for different probabilities of occurrence. A solid line here represents affected GDP for 2015, whereas, striped band represents the range of GDP losses based on a selection of climate and socioeconomic scenarios for 2080. That is, if Bosnia and

Herzegovina experienced a 250-year earthquake event in 2015, the affected GDP would have been around 4 billion $ US. In 2080., the affected GDP from the same type of event would range from 10 billion $ US to 20 billion $ US. This is due to population growth, urbanization and the increase in exposed assets [17].

3. SEISMIC RISK ASSESSMENT EVALUATION

The aim of this paper is to analyze potential earthquake risks with respect to corresponding PGA values and Richter magnitude scale in order to make a good strategy when it comes to seismic risk management and evaluation. In Figure 3, it can be seen on the map which areas have high PGA and for what return period. These PGA values can be extracted for 475-year, which is of key interest for seismic risk evaluation. PGA values were already correlated to the Richter magnitude scale [19], which is shown in Table 2. These correlations give a clear guideline to which areas should be seen as potentially affected by earthquakes and to what extent.

Table 2: PGA values and corresponding magnitude on Richter scale [19]

Magnitude	PGA	Shaking	Damage
Under 2.0	< 0.0017	Not felt	None
2.0 – 2.9	0.0017 – 0.014	Weak	None
3.0 – 3.9	0.014 – 0.039	Light	None
4.0 – 4.9	0.039 – 0.092	Moderate	Very light
5.0 – 5.9	0.092 – 0.18	Strong	Light
6.0 – 6.9	0.18 – 0.34	Very strong	Moderate
7.0 – 7.9	0.34 – 0.65	Severe	Heavy
8.0 or higher	> 0.65	Violent	Very heavy

PGA has an indirect connection to the earthquake damage and magnitude expressed on a Richter magnitude scale [23]. It should be noted that these values are only approximations. The real values depend largely on the depth and position of the hypocenter. It was the United States Geological Survey [21] who developed a scale that maps PGA and PGV (Peak Ground Velocity) on an intensity scale.

4. RESULTS AND DISCUSSION

Using a map shown in Figure 3, it was found that the cities with highest PGA, as mentioned at the beginning of the previous section, are the cities in the southern region of Bosnia and Herzegovina. Exceptions are four cities in the central region: Sarajevo, Tuzla, Zenica and Banja Luka, but even so, the PGA for a 475-year return period does not exceed 0.25. The 475-year return period event is the standard used in the industry for assessing seismic risk, and it is the basis for most building codes for seismic design [22]. One year ago, an earthquake of magnitude 5.4 shook Bosnia and Herzegovina, with the epicenter 11 km from Nevesinje at a depth of 10 km.

This earthquake was largely felt even 150 km away, in Sarajevo. Comparing these values, it can be concluded that the previously mentioned cities, as well as the larger areas of the southern region of Bosnia and Herzegovina, with PGA > 0.25, can experience moderate damage due to seismic activities, and some smaller areas with PGA > 0.34, can undergo even heavier impact, with magnitude of 7.0 or higher, on Richter scale.

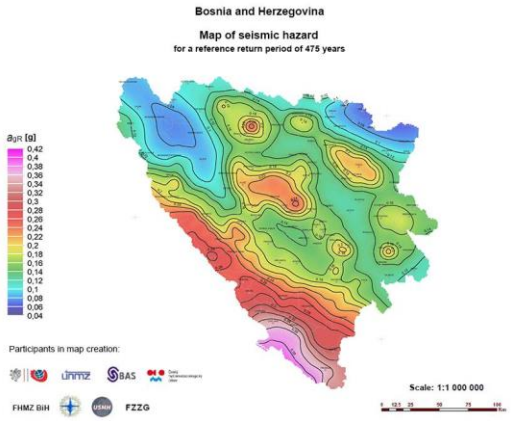


Figure 3: Map of seismic hazard for a return period of 475 years [12]

Table 2: PGA values for return period of 475 years [12]

City	Mostar	Livno	Čapljina	Stolac
PGA	0.25	0.25	0.35	0.35
City	Nevesinje	Blagaj	Trebinje	Neum
PGA	0.27	0.28	0.35	0.38

4. CONCLUSION

Intensive recent construction of residential and commercial buildings is often without appropriate urban plans and permits [18]. This requires revision and control of construction standards, and also taking appropriate measures to achieve resistance to demolition due to strong earthquakes. Complete risk evaluation is highly needed for seismically active areas. In order to implement damage prevention and people protection, it is necessary to take measures that will be implemented through the spatial and urban plans of cities and counties in southern regions of Bosnia and Herzegovina, and also to work on retrofitting and strengthening of the existing buildings. In addition, it is necessary to apply relevant laws and regulations on residential, industrial and infrastructure construction.

Taking into account the specific seismic conditions of the area, locations where certain facilities are being built, and applying the basic principles of seismic engineering in construction, the negative consequences of earthquakes can be greatly reduced. It is also important to start having a scientific approach while analyzing the vulnerabilities of an area, especially urban areas with older buildings or buildings that were built using old technologies, and buildings endangered by illegal construction and recently flood-activated landslides. In this regard, it is suggested that the map of seismic risks of Bosnia and Herzegovina needs to be reevaluated in the light of recent earthquakes in Croatia (Petrinja and Glina). It is even more important that the neighboring countries should jointly reevaluate maps of seismic risks in the bordering areas and especially keeping in mind possible nuclear waste disposal in

the area of Trgovska Gora near the borders of Bosnia and Herzegovina trying to avoid a catastrophe much more than just an earthquake.

5. REFERENCES

[1] World Population by Year. (02.02.2021). Available at: https://www.worldometers.info/world-population/world-population-by-year
[2] World's largest cities. (02.02.2021). Available at: https://www.baruch.cuny.edu/nycdata/world_cit-ies/largest_cities-world.htm.
[3] Gioncu, V. and Mazzolani, F. M. (2011). Earthquake Engineering for Structural Design. New York: Spon Press
[4] Top developing countries. (02.02.2021). Available at: https://www.investopedia.com/updates/top-developing-countries
[5] Place Explorer. (02.02.2021). Available at: https://datacommons.org/place
[6] EM-DAT Public. (02.02.2021). Available at: https://public.emdat.be
[7] Garaplija, E. and Dzidic, S. (2018). Preventivni pristup i upotreba inovativnih programskih alata u cilju upravljanja rizicima od katastrofa. 14th International Scientific Conference, Novi Sad, Serbia
[8] Eurocodes – Building the Future. (02.02.2021). Available at: http://eurokodovi.ba
[9] Omerbashich, M. and Sijaric, G. Seismotectonics of Bosnia - Overview. Acta Geodyn. Geomater., Vol. 3, No. 2 (142), p17-29
[10] Ademovic, N. and Nyarko-Hadoima, M. (2018). Seismic Vulnerability, Damage and Strengthening of Masonry Structures in the Balkans with a Focus on Bosnia and Herzegovina. 16th European Conference on Earthquake Engineering, Thessaloniki, Greece
[11] Danger Zones: Mapping Europe's Earthquakes. (02.02.2021). Available at: http://www.view-softheworld.net/?p=5652
[12] Maps Accompanying National Annexes (NA) - Seismic Zone Maps and Reference Ground Accelerations. (18.02.2021). Available at: http://eurokodovi.ba/?page_id=48
[13] Booth, E. (1988). Earthquake Design Practice for Buildings. London: ICE Publishing
[14] Wu, Y. M., Teng, T., Shin, T. and Hsian N. Relationship between Peak Ground Acceleration, Peak Ground Velocity, and Intensity in Taiwan. Bulletin of the Seismological Society of America, 93: p386-396
[15] Jukić, E. (2012). Earthquake Hit Central Bosnia. (18.02.2021). BalkanInsight. Available at: https://balkaninsight.com/2012/07/31/earthquakes-hit-central-bosnia
[16] Earthquake Track - Recent Earthquakes Near Bosnia and Herzegovina. (18.02.2021). Available at: https://earthquaketrack.com/p/bosnia-and-herzegovina/recent.
[17] Bosnia and Herzegovina – GFDR. (18.02.2021). Available at: https://www.gfdrr.org/en/publication/disaster-risk-profile-bosnia-and-herzegovina.
[18] Program razvoja: Zaštite i spašavanja ljudi i materijalnih dobara od prirodnih i drugih nesreća u Općini Posušje za razdoblje od 2019. do 2023. Godine. (12.02.2021). Available at: https://www.opcina-posusje.ba/wp-content/uploads/2018/12/program.pdf
[19] Elbadawy, M. A. (May, 2014). Seismic response Analysis Considering Soil-Structure Interaction of High-Rise Buildings (Master Thesis). DOI:10.13140/RG.2.1.4773.0321
[20] The Worldbank in Bosnia and Herzegovina. (24.02.2021). Available at: https://www.worldbank.org/en/country/bosniaandherzegovina
[21] U.S. Geological Survey. (24.02.2021). Available at: https://www.usgs.gov
[22] Gould, N. C. Understanding the Language of Seismic Risk Analysis. IRMI. Available at: https://www.irmi.com/articles/expert-commentary/understanding-the-language-of-seismic-risk-analysis

MIX PROPERTIES AND SERVICEABILITY PERFORMANCE OF SELF COMPACTING CONCRETE CONNECTIONS

Hamid FARROKH GHATTE
Assistant Professor, Civil Engineering Department, Faculty of Engineering, Antalya Bilim University, Antalya, Turkey.

ABSTRACT:

The Self Compacting Concrete, SCC is the generation of concrete which is not needed any internal or external compact, and its weight will compact it. Understanding SCC properties will affect the serviceability performance of reinforced self-compacting concrete elements. For this purpose, the self-compacting concrete mix was designed, and the serviceability performance of reinforced connections consisting of SCC was investigated. Additionally, mix properties and slump flow, J-ring, V-funnel, and L- box tests were employed to examine the SCC mix specifications. Six reinforced concrete connections (L = 3 m, b = 0.15 m, h = 0.3 m) were simulated, by this concretes, the maximum and minimum reinforcement ratios ρ and ρ' (percentage of tensile and compressive steel reinforcement) are following the provision of the ACI-17 for conventional RC structures. This study was limited to the case of bending without axial load, utilizing simple connections loaded at mid-span through a stub (b = 0.15 m, h = 0.3 m, L = 0.3 m) to simulate a beam-column connection. During the test, load-deformation of the member was measured, and the applicability for conventional vibrated concrete was verified for SCCs members tested.

Keywords: Beam-column connection; crack; SCC; workability; serviceability

1. INTRODUCTION

Self Compacting Concrete, SCC is nearly a new type of concrete, which has generated tremendous interest since its initial development in Japan by Okamura in the 1980s to reach durable concrete structures (Okamura 1997). Since that time, the contractors have used SCC in different applications. SCC offers both cost and quality improvements over conventional concretes. The high fluidity of SCC certainly contributes to the excellent placement of concrete in all sections of the formwork, but in cases of densely reinforced cross-sections, the maximum aggregate grain size has a crucial impact.
Placement times are decreased, and labor requirements are lowered (Khayat 1999). However, more theoretical and experimental research is required to understand the effect of this type of concrete on structural elements. This research study aims to provide information on the serviceability of the important elements such as connections in reinforced concrete. RC structures made of SCC in literature review indicate that rarely is research available on this field (Maghsoudi 2011, Ghatte 2019 and 2020). However, the reports are available on conventional reinforced concrete connections in American Concrete Institute (ACI).

The load-deformation behavior of RC members made of SCCs loaded to failure, particularly the cracks propagations, that develop at connecting a beam to a column in a frame is investigated and reported. Additionally, the mix properties and the results of SCC tests, and the parameters contributing to the serviceability of beam-column connections for this type of concrete, which is essential when a structure is under the service loading, are investigated. This study concentrated on bending without axial load, utilizing simple beams loaded at mid-span through a stub to simulate a beam-column connection.
A lack of information regarding the mix properties and structural performance of SCC is one of the main barriers to its acceptance in the construction industry. However, recently, SCC has gained wide use in many countries for different applications and structural configurations. Limited published studies dealing with the structural performance of SCC demand the initiation of new research, especially while considering the serviceability of the SCC reinforced connections.
This research investigates the effect strength of concrete and the percentage of tensile and compressive steel ratio (i.e., ρ and ρ') on the serviceability characteristics of SSC connections. The structural response throughout the loading regime was primarily captured in terms of the load-deflection behavior. The serviceability characteristics of the test members were evaluated in terms of the crack width, deflection, and stress in steel and concrete.

2. EXPERIMENTAL PROGRAM

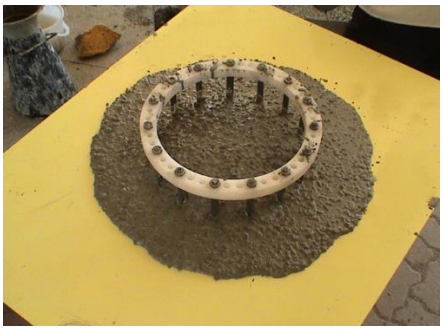
2.1. Test Specimens

In this investigation, the results of an SCC mix and the test results related to the SCC properties of six reinforced connections made by SCC under three-point loads are considered for their serviceability performance. However, the ultimate and ductility considerations for some of such elements are reported as well. Fig. 1 shows the SCC tests, including slump flow, J-ring, V-funnel, and L- box. Table 1 presents the details of the mix properties, and the test results of fresh SCC Fig. 2 shows tests member dimensions, loading arrangements, and reinforcement details of the specimens. Six specimens were prepared and made by SCC throughout the study. Shear reinforcement was provided along the member length. Table 3 presents the details of the tested specimens. The SCC members are designated as S1-S6. The studied parameters include the flexural tensile and compressive reinforcement ratio ρ and ρ' by consideration almost of constant concrete strength

2.2. Materials and Mix Properties

Locally available deformed bars were used as flexural and shear reinforcement rebar. The steel yield stress obtained from tension tests is listed in Table 4. The concrete mixtures for the specimens were mixed in a 200-liter capacity batch mixer. The mix design of concrete used for SCC members is shown in Table 1. The obtained range of results in the fresh phase presented in Table 2 found that the SCCs were consolidated exceptionally well under its own weight. The compressive concrete strength $f_{c'}$ for each beam is shown in Table 4. All beams and control specimens were cast and cured under similar conditions. The beams and specimens were kept covered under polyethylene sheets for 28 days. The mix properties of SCCs and the range of fresh properties obtained are summarized in Tables 1 and 2, respectively.

Slump-flow



J-ring

L-box

V-funnel

Figure 1: Test method for workability properties

Table 1: Mix design of SCC (1 m3)

W/P	Cement (kg)	Gravel (kg)	Sand (kg)	Limestone (kg)	Micro silica (kg)	PCE (kg)
0.39	270	750	870	225	30	4

Table 2: Properties of fresh self-compacting concrete.

Slump flow (mm)	J ring (mm)	L-box(h_2/h_1)	V-funnel time (s)
670	620	0.8	6.1

3. TEST RESULTS

Throughout the test loading procedure was continued to considerable damage or loss of strength capacity, the ultimate situation was considered a point with a negative slope of load-deflection curves. The output of the experimental tests was evaluated regarding the load-crack, load-deflection, and energy dissipation relationships for each specimen.

At the end of each test, damage properties were collected and reported in Fig. 5. The load-deflection relationships of the specimens are represented in Fig. 6. The deflection values at the yielding point of tensile rebar (Δy) and the ultimate load (Δu) are summarized in Table 4. In this table, by decreasing ρ, Δu increases and by adding ρ' as a compression reinforcement in the section, Δu increased as well. Δy increased as ρ increased and decreased as ρ' increases through the cross-section. The ratio of deflection of the ultimate load to the first yielding point deflection of tensile steel has been defined as the displacement ductility during the test (μ=Δu /Δy). In this formulation, the displacement ductility ratios (μ) of the specimens were calculated by considering Δu as the ultimate displacement and Δy as the yield displacement corresponding to the yielding of longitudinal bars in tension. The ultimate load is the maximum load that the beam has carried throughout the test. All of the parameters mentioned above are reported in Tables 4 and 5.

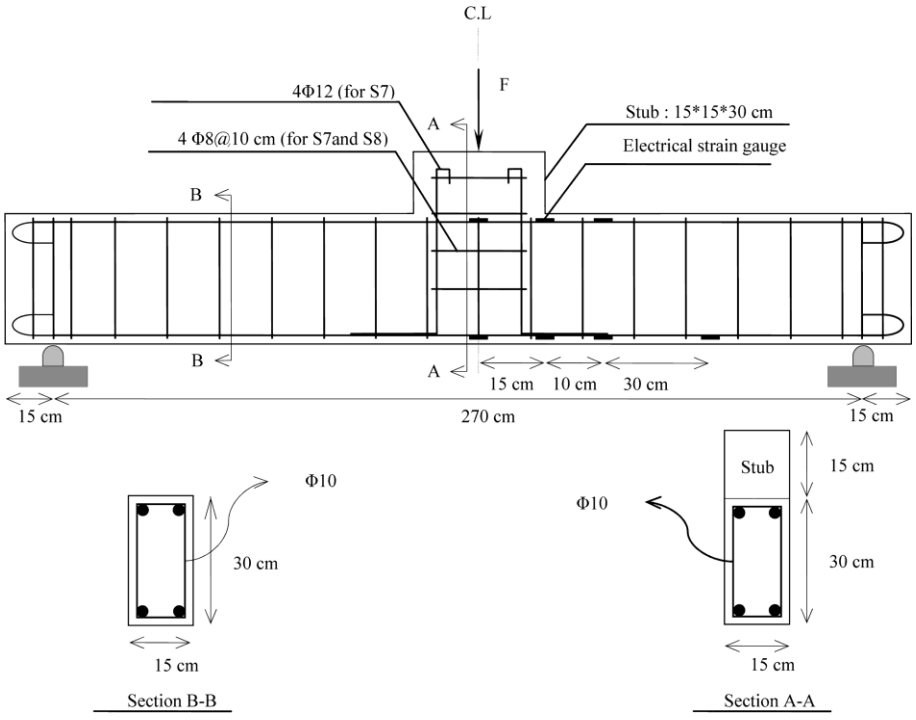


Figure 2(a): Reinforcement detailes of beam-column connection

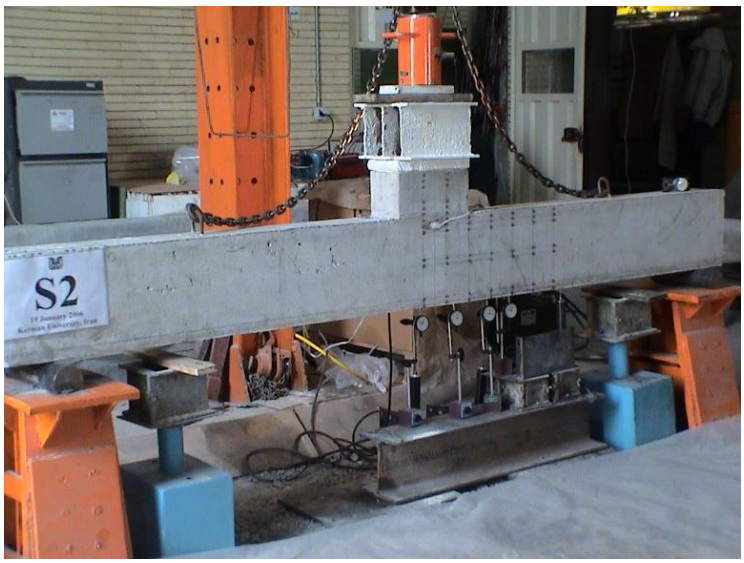


Figure 2(b): General view of test set up of beam-column connection

Table 3. Mechanical specifications of reinforcing bars.

f_y (MPa)	ε_y	f_{max} (MPa)	ε_{max}	f_u (MPa)	ε_u
410	0.001	605.6	0.0.09	513	0.107

Table 4: Test matrix and section properties.

Beam No.	f'_c (MPa)	d (mm)	d′ (mm)	A_s	ρ (%)	ρ/ρ_b	A'_s
S1	30.2	26.3	3.3	2Φ10	0.4	ρ_{min}=0.15	2Φ10
S2	27.9	26	3.4	2Φ16	1.03	0.27	2Φ 12
S3	28	25.8	3.8	2Φ20	1.61	0.33	2Φ16
S4	30.8	25.8	3.6	2Φ20	1.61	0.38	2 Φ20
S5	32.7	25.75	3.9	2Φ25	2.52	0.56	2Φ18
S6	30.7	25.6	4	2Φ28	3.16	0.66	2 Φ20

Stiffness degradation of the specimens was evaluated by considering k =F/Δ, where k is stiffness, F is point loads belong to each step, and Δ is the deflection in the middle of the specimen. All specimens showed comparable stiffness degradation, with an acceptable increase based on increasing the reinforcement ratio. The minimum amount belongs to the minimum reinforcement ratio that shows a critical condition of 0.15ρb in terms of stiffness.

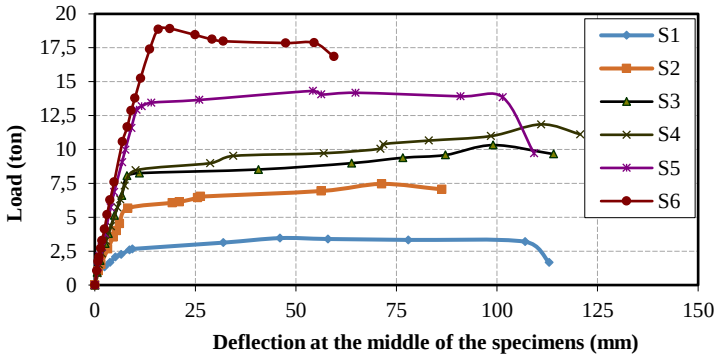


Figure 3: Load-deflection curves in the middle of the connections

Table 5: Displacement ductility ratios of the tested specimens (Experimental results and numerical output)

	Experimental results		μ
	Δ_y	Δ_u	
S1	8.66	106.96	12.4
S2	8.20	86.30	10.5
S3	11.06	114.06	10.3
S4	10.10	120.70	12.0
S5	11.66	100.00	8.6
S6	15.75	54.55	3.5

4. CONCLUSION

The conclusions derived regarding the experimental investigations conducted on the SCC mix results and load-deflection performance of six SCC beam-column joints are summarized below:

- Slamp flow, J-ring, V-funnel, and L- box tests were employed to evaluate the self-compacting concrete properties in the case of workability.
- The plastic hinges have been shaped in the beams close to the column face, and the failure modes were mainly with an acceptable level of ductility by the formation of plastic hinges at beams.
- In the case of serviceability and cracks, applying more reinforcing bars at the compression area can increase the performance of the connections in terms of ductility and energy dissipation capacity by considering the limitation of seismic design codes.
- The displacement ductility of the experimental results is decreased from 12.4 to 3.5 while the ratio of the reinforcing bars was increased from %15 to %66 of the balanced section and 56% reinforcing bars ratio of the balanced section had the most significant energy dissipation capacity among the connections in this investigation.
- The capacity of the connections was dramatically increased (like regular concrete) by increasing the longitudinal reinforcing ratio for RC elements constructed by SCC as workable concrete.
- The minimum reinforcement ratio had the most considerable deflection and energy dissipations among the specimens with minimum load capacity.

ACKNOWLEDGMENTS

I would like to express my deep and sincere gratitude to Prof. Dr. A. A. Maghsoudi for his essential support throughout this work.

5. REFERENCES

[1] ACI Committee 318, ACI 318-19: Building code requirements for structural concrete and commentary, American Concrete Institute, 2019.

[2] Okamura, H. (1997), "Self-compacting high-performance concrete", Concrete Int., 19(7), 50-54. Pateli, R., Hossain, K.M., Shehata, M., Bouzabaa, N. and Lachemi, M. (2004), "Development of statistical models for mixture design of high-volume fly ash self-compacting concrete", ACI Mater. J., 101, 294-302.

[3] Khayat, K.H. (1999), "Workability, testing, and performance of self-consolidating concrete", *ACI Mater. J.*, 96(3), 349-353.

[4] H. Farrokh Ghatte, EVALUATION OF REINFORCING BARS RATIO EFFECTS ON SCC BEAM-COLUMN JOINT PERFORMANCE, Uludağ University Journal of The Faculty of Engineering 24(3) (2019) 141-152, https://doi.org/10.17482/uumfd.587505.

[5] H. Farrokh Ghatte, M. Comert, C. Demir, A. Ilki, Evaluation of FRP confinement models for substandard rectangular RC columns based on full-scale reversed cyclic lateral loading tests in strong and weak directions, Polymers 8(9) (2016) 323, https://doi.org/10.3390/polym8090323.

[6] Maghsoudi, A. A. (2011). Theoretical and experimental serviceability performance of SCCs connections. Structural engineering and mechanics: An international journal, 39(2), 241-266.

[7] H. Farrokh Ghatte, M. Comert, C. Demir, M. Akbaba, A. Ilki, Seismic retrofit of full-scale substandard extended rectangular RC columns through CFRP jacketing: Test results and design recommendations, Journal of Composites for Construction 23(1) (2019) 04018071, https://doi.org/10.1061/(ASCE)CC.1943-5614.0000907.

[8] H. Farrokh Ghatte, External Steel Ties and CFRP Jacketing Effects on Seismic Performance and Failure Mechanisms of Substandard Rectangular RC Columns, Composite Structures (2020) 112542, https://doi.org/10.1016/j.compstruct.2020.112542.

[9] Hamid Farrokh Ghatte, Failure mechanisms and cracking performance of T-shaped SCC beam-column connections at top floor: Test results and FE modeling, Structures, Volume 28,2020, Pages 1009-1018, ISSN 2352-0124, https://doi.org/10.1016/j.istruc.2020.09.051.

RISK MANAGEMENT AND FINANCIAL ANALYSIS OF THE ENERGY EFFICIENCY IMPROVEMENT PROJECT

Aida Husetić, Dalila Demirović
Faculty of Technical Engineering, Bihać, ahusetic@gmail.com, dalila_dem@hotmail.com

ABSTRACT:

Through the example of energy renovation of a residential building, possible risks were identified and considered through all phases of the project, and during the implementation, tried to avoid them. Project activities did not go according to plan, primarily due to the delay of institutions in adopting important documents to increase the energy efficiency of the building. Despite all obstacles, the project was successfully implemented.
The financial flow of the project is important to ensure the solvency of the co-owners of the residential building. during the implementation of the project, the co-owners did not find themselves in a situation where they could not pay the insured receivables.
The financial course of the project has been prepared already in the phase of preparation of the project application, to prepare better the dynamics of project activities, having in mind the available funds for project implementation. Financial flow management was ongoing and a refund request was submitted on time. The analysis showed that the costs of energy renovation are 5% lower than expected.

Keywords: project, risks, construction, the financial flow of the project

1. INTRODUCTION

The aim of the project analyzed (EE improvement project - energy efficiency improvement project) in this paper was to achieve the total annual energy savings for heating of 236,491.59 kWh, and electricity savings for the lighting of 425 kWh by implementing energy efficiency improvement measures. The implementation of construction measures to improve the thermal properties of the outer shell of the building would achieve 73.9% savings in the budget and thermal energy for heating savings of 52.1 tons per year. This paper will cover the stages of implementation of energy renovation of a residential building, which include cost analysis with items: energy audit and energy certificate before renovation, main energy renovation project, implementation of energy efficiency measures, expert construction supervision, energy audit and, energy certificate after renovation, and project management and administration. As the projects are co-financed by EU funds, high-risk projects, in this paper, potential risks will be identified and considered by project phases.
The term energy renovation means increasing the thermal protection of the building facade, replacing the external windows and doors and, improving the heating/cooling system, with measures for the use of renewable energy sources. The choice of measures depends on the energy condition and type of building, the way it is used, the location, etc. It is ideal to apply several measures to ensure their synergistic effect and a significant reduction in energy consumption.

According to the age and type of construction, and depending on the legislative environment, existing buildings in Croatia are divided into:
1. buildings built before 1940,
2. buildings built in the period from 1940 to 1970,
3. buildings built in the period from 1970 to 1987,
4. buildings built in the period from 1987 to 2006,
5. new construction harmonized with the Technical regulation on thermal energy saving and thermal protection in buildings (OG 79/05) with mandatory application from 1 July 2006, and the Technical regulation on rational use of energy and thermal protection of buildings (OG 128/15, 70/18, 73/18, 86/18, OG 102/20). [1]

The construction period is the first and basic data that is checked during the energy audit of the building. Given that the energy audit is carried out according to the Methodology of conducting energy audits of buildings prescribed by the Ordinance on energy audit of buildings and energy certification [1], data on average heat transfer coefficients for external structures in a given period, as well as improved performance after installing thermal insulation on the facade can be found within the Methodology of conducting energy audits of buildings. [3]

Energy audit for the purpose of issuing energy certificates is a legal obligation arising from the EU Directive 2002/91 / EC on the energy performance of buildings (Energy performance of buildings directive-EPBD), which is implemented in Croatian legislation based on the Action Plan for implementation developed by the Ministry of Environment, Physical Planning and Construction in April 2008, through the Law on Physical Planning and Construction (OG 76/07, 38/09, 55/11, 90/11) and the Law on Efficient Use of Energy in Direct Consumption (OG 152/08) and several technical regulations and ordinances.

Energy renewal projects begin with an energy audit, the development of an energy concept, and a financing concept. After securing the financing, the preparation of complete project documentation, selection of contractors, and execution of works, with records of potential financial and operational risks, and the project ultimately ends with the measurement and verification of savings and energy certificate of the building.

In the process of conducting the energy audit, the following is carried out:
1. analysis of construction characteristics of the building in terms of thermal protection (analysis of thermal characteristics of the outer shell of the building),
2. analysis of energy properties of thermomechanical systems of heating, cooling, ventilation and air conditioning and hot water preparation systems,
3. analysis of energy properties of electricity consumption system – a system of electrical installations, lighting, household appliances, and other subsystems of electricity consumption
4. analysis of consumption and costs of all forms of energy, water, energy and cost balance,
5. necessary measurements when necessary to establish the energy status and/or properties,
6. analysis of the possibility of changing energy sources,
7. analysis of the possibility of using renewable energy sources and efficient systems,
8. proposal of measures for improvement of the energy performance of the building that is economically justified, achievable savings, assessment and payback period, and
9. report with recommendations for optimal intervention and sequence of priority measures to be implemented through one or more phases. [3]

2. PROJECT RISK MANAGEMENT

Risk management in projects includes a process consisting of planning, identification, analysis, response plan, monitoring, and control of the project. Risks in a broader sense represent all the potential problems that may jeopardize the success of the project. The goal of project risk management is to increase the likelihood and impact of positive events and reduce the likelihood and impact of negative events in the project. A Risk is an uncertain event or condition, which, if realized, will have an impact on at least one of the project objectives. Objectives cover time, cost, or quality. [4]
Observing all phases of the implementation of the energy renovation project, the most significant risks on the project were singled out. Based on the implemented methodology, ie after the identification, analysis, and risk assessment for energy renovation of a residential building, a risk register can be formed, ie a list of basic risk events with a quantified magnitude of impact and the estimated probability of occurrence. The list of risks on this particular project is given in Table 1. Also, this table lists the planned response strategies in case a risk event occurs. [5]

Table 1: Risk register during the project [5]

PROJECT PHASES	Description of the risk even	Type of risk (external ER and	Probability of occurrence	Impact on project objectives	Total risk size	RESPONSE PLAN
Preparation and application to tender	The project proposal does not contain mandatory documentation, irregularities in the implementation of simple procurement, and public procurement of works on energy renovation	ER	2	3	6	Detailed analysis of the call for project proposals. Sending complaints, supplementing project documentation, proper implementation of procurement, compliance with procurement procedures for persons who are not liable for the Public Procurement Act.
Signing contract on the award of grants	Prolonging the signing of the grant agreement	ER	2	3	6	Reach an agreement with the participants in the energy renovation of the residential building.
	The project did not successfully pass the stages of the grant award procedure	ER	2	3	6	Provide own funds from long-term loans if the building is not able to provide funds to withdraw from the project - at this stage, there are no large costs compared to those that will be in the implementation of the project.
	Extension of the grant agreement	ER	2	2	4	Extension of the contract is possible until the end of the period of implementation of energy renewal projects in December 2020, notify the competent organizational institution (request for extension of the contract).

	Increase in total project costs compared to reported costs	ER	2	3	6	There are no changes to the contract in terms of cost increases, insurance from own funds.
Construction	Rising prices of goods and services of suppliers	IR	2	1	2	Define the price-sliding scale change by the performance contract.
	Delay in material delivery	IR	2	2	4	Early detection need for necessary material and ordering on time.
	Lack of material resources	IR	3	3	9	Regular monitoring of the financial flow of the project to provide the necessary funds for timely payment, regular sending of requests for reimbursement.
	Lack of quality skilled workers	IR	2	3	6	Subcontract parts of the project. Engage associates under contract to specific time.
	Low productivity	IR	1	3	3	Regular monitoring of professional construction supervision - monitoring the dynamics of works, several activities at the same time.
	Modifications of project solutions	IR	2	1	2	Modifications are allowed in case of better technical solutions, to assess the impact of the changes on the dynamics of work.
	Occurrence of extra-cost works (unforeseen and subsequent works)	IR	2	2	4	The construction contract shall provide for unforeseen works in the amount of 10% of the number of cost items, if the works exceed 10%, the contractor shall bear the incurred costs.
	Insolvency / non-payment to the supplier	IR	2	3	6	Regular monitoring of the financial flow of the project to provide the necessary funds for timely payment, regular sending of requests for reimbursement.
Refund	Energy renovation of a residential building did not achieve the planned energy savings for heating/cooling (energy certificate after renovation)	ER	2	3	6	Expert supervision must ensure that the execution is done according to the main project of energy renovation, monitoring of installed materials.
On-site inspection	Possibility of error in any of the project phases	ER	3	3	9	Collection and storage of the necessary documentation for all phases of the project, all phases of the project must correspond to the attached document.

The risk assessment for the energy renovation project of a residential building was determined using Table 2. The total risk size was obtained using a 3x3 matrix, ie by multiplying the impact points with the probability points. The risk with the highest impact and the highest probability (each with the

highest score of 3) can be assessed with a maximum of nine points. The overall risk probability value can be low (score 1, 2), medium (score 3, 4), and high (score 6, 9). [5]

Table 2: Risk probability assessment [6]

Probability	Rating	Description
High	3	This event is expected to occur in most cases
Medium	2	An event can happen sometimes
Low	1	The occurrence of the event is unlikely

3. FINANCIAL ANALYSIS OF THE PROJECT

The Environmental Protection and Energy Efficiency Fund of the Republic of Croatia has supported more than 35,000 projects in Croatia and enabled investment of HRK 5.2 billion. As for investments in energy renovation of buildings, 1.656 billion HRK has been invested so far, 660 million in family houses, 279 million in residential buildings, 262 million in public sector buildings, and 46 million in commercial buildings. The main goal of the activities carried out by this fund is to reduce energy consumption, primarily energy for heating and cooling facilities, as a decisive factor in reducing CO_2 emissions, and reducing financial expenditures for energy costs.
In this residential building, natural gas is used as the predominant energy source for heating, and the building's heating system is gas-fired. In the estimate of annual savings, the price of annual gas consumption before and after energy renovation was calculated.
In the decision to implement energy efficiency measures, an important factor is a cost-effectiveness. Cost-effectiveness was calculated by basic economic estimates of the project. The following data are required to assess profitability:
- **investment** - all project costs, including design, implementation of measures, expert supervision, etc.
- **annual savings** - total savings that are realized on an annual basis by the project, and are simply calculated as annual energy savings [kWh] x energy price [kn / kWh]

The price of energy is a very important parameter in energy efficiency projects because the profitability of the project will depend on what the net annual savings are. As energy prices rise, the energy efficiency project becomes more and more financially attractive. There are many methods for assessing the profitability of an investment that includes the inflation rate, discount rate, technical life of some equipment, and the like, however, in this analysis, the criteria of financial decision-making on investments were used, which is the payback period. Once the payback period has been reached, the cash flows of the project for the rest of the time represent the earnings of the investor.

ERP (EASY RETURN PERIOD) = INVESTMENT / ANNUAL SAVINGS [year]

Table 3: Annual savings [5]

BEFORE EE IMPROVEMENT	QH,nd	287,735.97	kWh/a	112,217.03 kn
AFTER EE IMRPOVEMENT	QH,nd	71,761.94	kWh/a	27,987.16 kn
Natural gas price with VAT		0.390	kn/kWh	
		ANNUAL SAVINGS		84,229.87 kn

Sources of financing for the energy renovation project of a residential building include funds from the European Structural and Investment Funds, joint reserves of the building, and loans. [5]
Total costs of the project proposal submitted to the call Energy renovation of apartment buildings in 2016. is HRK 1,897,448.27, of which the value of total eligible costs is HRK 1,493,632.37. Grants awarded make to 61% of the total eligible costs, and the rest of the costs (eligible and ineligible costs) must be provided by the co-owners of the residential building. Other funds are secured by a long-term loan whose interest rate is reduced by 0.25 percentage points because it increases energy efficiency by at least one class, and funds from the common reserve of the building.
The funds provided according to the methodology and reported on the call are data in Table 4.

Table 4: Energy renovation project costs reported on the call Energy renovation of apartment buildings

		Energy audit and energy certificate, before and after the renewal of HRK	**Main energy renovation project HRK**	**Implementation of energy efficiency measures (execution of works) HRK**	**Professional construction supervision HRK**	**Project management and administration HRK**	**Total amount HRK**
1	**Total costs**	16,609.74	59,320.51	1,726,445.74	86,322.28	8,750.00	**1,897,448.27**
2	**Total ineligible costs**	0.00	0.00	403,815.90	0.00	0.00	403,815.90
	Total eligible costs	16,609.74	59,320.51	1,322,629.84	86,322.28	8,750.00	1,493,632.37
3	**Non-refundable funds**	14,118.27	47,456.50	793,577.90	51,793.36	7,437.50	**914,383.53**
	Support intensity	85%	80%	60%	60%	60%	
4	**Resources of the co-owner of the residential building (eligible and ineligible costs)**	2,491.47	11,864.01	932,867.84	34,528.92	1,312.50	**983,064.74**

Due to the termination of the contract with the contractor for energy renovation in the amount of HRK 1,726,445.74, the co-owners of the residential building again conducted a public procurement. The new construction contract amounted to HRK 2,288,837.51, which increased the construction cost by 30%. [5]

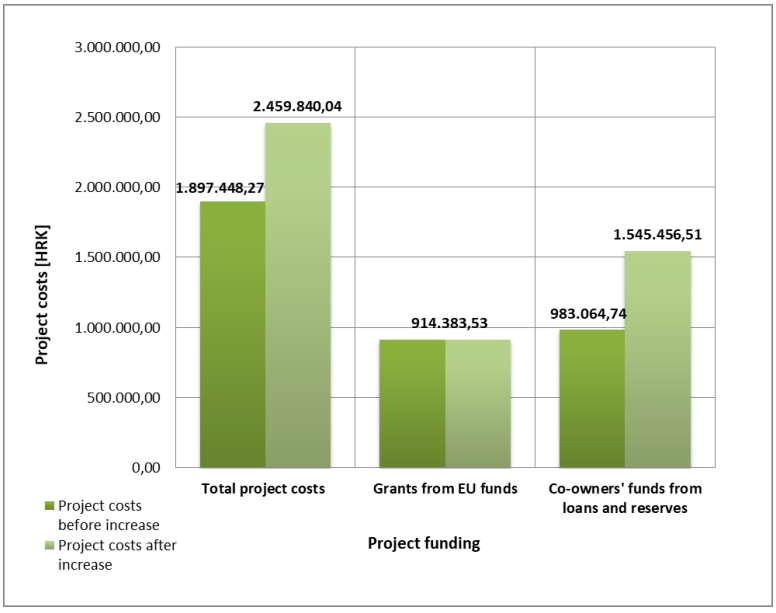


Figure 1: Overview of project costs before and after the increase of the contract price [1]

The financial flow of the project is important to ensure the solvency of the co-owners of the residential building. During the implementation of the project, the co-owners did not find themselves in a situation where they could not pay the incurred receivables.
As the cash flow was regularly monitored, the co-owners of the apartment building noticed in time the possibility that they would run out of funds to implement the project. The co-owners took out a long-term loan before signing a new construction contract and provided funds for the price difference between the two construction contracts, ie HRK 562,391.77. The financial flow of the project has been prepared already in the phase of project application preparation, to better prepare the dynamics of project activities, having in mind the available funds for project implementation. Financial flow management was ongoing and the Reimbursement Request was submitted on time.

Table 4: Payback period based on realized costs [5]

	TOTAL INVESTMENT	EU INVESTMENT
Investment	2,268,356.91 kn	1,353,973.38 kn
Annual savings	84,229.87 kn	84,229.87 kn
Investment payback period	**26.93 years**	**15.95 years**

The final request for reimbursement (Request for reimbursement 3) was revealed after the successful handover of the contracted works. Price of performed construction works based on actually performed works, recognized in the measurement book and unit prices from the tender cost estimate are HRK 2,183,676.66, which is 5% lower than the contracted value.
The final financial analysis showed that the payback period of the spent funds is 15.95 years, which is considered a reasonable and long-term payable period in energy renovation projects.
The energy savings are also very large. The required thermal energy before the energy renovation for heating the building is QHnd=287,735.97 kWh / a, and after the energy renovation of the residential building is reduced to QHnd=71,761.94 [kWh / a], and the building from energy class G has passed in energy class C. This is shown in the energy certificate that was made after the renovation of the building. [7]

4. CONCLUSION

The life cycle of co-financing a project from EU funds is long, complex, and full of bureaucratic, administrative, and financial risks and obstacles. Co-owners of residential buildings do not have the necessary previous experience and are not familiar with the EU funds system. Qualitative and administrative requirements are extremely high for the project applicant, but also for the project itself and its quality, preparedness, and potential sustainability. The realization of co-financing from EU funds is a potential double-edged sword. Project preparation and project application is a demanding and complex process, but compared to the implementation of the project itself, it is an easy and averagely demanding task. In addition to the marked difference in the complexity of the implementation of these two tasks, there is an equally pronounced difference in the risk that occurs in the case of unsuccessful implementation of each of them. A realistic view of their possibilities can save the co-owners of a residential building in advance from unwanted consequences.

Through this paper, the issue of project management of EE improvement project of a residential building from the aspect of project risk management and financial analysis is presented. Project activities on the EE improvement project of the building did not proceed as planned. The delay occurred already in the project definition phase, which affected the prolongation of works caused by the delay of institutional bodies, ie the Ministry of Construction and Spatial Planning decided on project financing 8 months after the deadline for this activity, which significantly affected the project dynamics, as well as to project participants. The selected contractor terminated the contract due to the impossibility of waiting for the Financing Decision.

Therefore, it is easy to conclude that despite seriously planned project activities and analyzes from the aspect of financial and risk management, there are external factors that inevitably affect the course of the project, which must be considered as high-risk factors during these activities.

Based on the examples of energy renovation of a residential building and the results presented in this paper, it is possible to report several basic conclusions;
- energy renovation of buildings is one of the basic goals of the EU, and the EU encourages it with significant co-financing,
- local experiences in the preparation and implementation of such projects are important both for Croatia and for candidate countries such as Bosnia and Herzegovina,

- Financial analysis and management of finances and possible risks are areas that civil engineers have to deal with in more detail precisely because of administrative restrictions coming from the EU, and guided by the rules of the profession, dynamic planning, and project management.

The paper emphasizes the importance of energy renovation of buildings, presents the concept and financial framework of such renovation, and provides an overview of risks and recommendations for their elimination. The paper is part of broader, concrete research and practical work on the facility, and as such can be used as a basis for an analytical approach to the principles of management of energy renovation projects that are just emerging in Bosnia and Herzegovina. The importance and significance of the activities of the authors on such projects thus go beyond hypothetical considerations and gives a concrete and practical contribution to this scientific and professional field.

5. REFERENCES

[1] Andrassy M., Balen I., Boras I., Dović D., Hrs Borković Ž., Lenić K., Lončar D., Pavković B., Soldo V., Sučić B., Švaić S. (2010). Ordinance on energy audit of buildings and energy certification, Official Gazette, 48/14, 150/14, Zagreb, 133.
[2] Pavković B., Zanki V., Hrs Borković Ž., Lenić K., Franković D., Grozdek, M., Bukarica V.,(2012). Manual for energy certification of buildings, Part 2, UNDP, Zagreb.
[3] Ministry of Physical Planning Croatia, (2014). Methodology for conducting energy audits of buildings Construction and State property, 5.
[4] Meštrović H., Radujković M. (2015). Risks in the contract management process, Zagreb, 1-2.
[5] Demirović, D. (2019-2021). Master's thesis: Management of a residential building energy efficiency improvement project, Faculty of technical engineering Bihać,
[6] Kozina D. (2011). Risk management as an integral part of the strategic planning process, www.mfin.gov.hr, March 15, 2020.
[7] Sustainable Development d.o.o. (2016).Construction project: Project of rational use of energy and thermal insulation, Zagreb, 104.

MANAGEMENT OF A RESIDENTIAL BUILDING ENERGY EFFICIENCY IMPROVEMENT PROJECT

Dalila Demirović, Aida Husetić, Mateja Čupić
Faculty of Technical Engineering, Bihać, dalila_dem@hotmail.com, ahusetic@gmail.com, cupic.mateja@gmail.com

ABSTRACT:

The paper presents an overview of the energy efficiency improvement project management, financed by the European Regional Development Fund. The lifespan of co-financing a project from EU funds is long, complex and full of bureaucratic, administrative and financial risks and obstacles, as shown in a concrete example of energy renovation of a residential building in Zagreb. Energy renovation of a residential building includes renovation of building facades, i.e., installation of thermal insulation, partial replacement of exterior joinery (part has already been replaced), insulation of the ground wall in the basement, repair of waterproofing of the foundation on the courtyard side of the building, as well as the repair of a flat impenetrable roof by dismantling all existing layers to the load-bearing structure and installing thermal insulation and new waterproofing.
As can be seen in the above-mentioned analyzed construction measures to improve the thermal properties of the exterior shells, 73.9 % savings were achieved in the calculation of thermal energy for heating. The building transferred from energy class G to energy class C.

Keywords: energy renovation, EU grant, managing authority, renovation, annual energy required for heating and cooling, reimbursement

1. INTRODUCTION

The performance of buildings and energy efficiency are mostly regulated in The Energy Efficiency Act. In accordance with EU requirements, Croatia compiles national energy efficiency action plans (NEEAP) every three years. Multi-family residential buildings are considered as a residential building with three or more apartments managed by a building facility manager, who is a legal or natural person, in accordance with the Act on Ownership and Other Property Rights. A typical multi-family home built before 1970 in the continental area was built of solid brick, plastered on both sides. Buildings built in the littoral zone are typically made of reinforced concrete plastered on both sides. The roof is usually wooden and the floor is concrete, mostly without thermal insulation. The windows are wooden framed with single glazing. The hollow brick (continental climate zone) or reinforced concrete (both climate zones) and concrete beams were used from the 1970s until 2005 with an additional 2 – 4 cm of thermal insulation. The wider application of thermal insulation began after 1986. The outer walls of buildings constructed after 2006 have an additional 8 – 15 cm insulation, and windows are usually wooden with double glazing. The specific energy consumption for space heating of houses built before 1970 goes up

to 270 kWh/m^2 per year in the continental climate zone and up to 120 kWh/m2 per year in the littoral climate zone. [1]

The paper presents the management of the energy renovation project of a residential building in Zagreb, co-financed with EU funds, through the Call for Proposals (grant) ‘’Energy renovation of apartment buildings’’ in 2016, published by the Ministry of Physical Planning, Construction and State Assets. The possibility of achieving thermal and financial savings is analyzed on the example of a residential building. Under the Call „Energy renovation of multi-apartment buildings“ 584 agreements were signed on the award of grants from ERDF funds. The total value of the projects exceeds HRK one billion, whereas grants of the ERDF amount to more than HRK 554 million. To date, energy renovation works have been completed on more than 350 multi-apartment buildings. [1]

An example of good energy efficiency renewal practice for residential buildings [2]:

- The residential building at the address Trnsko 24 in Zagreb. It was built in 1966. The total floor area of a building is 4.400,00 m^2. The total value of this project amounts to HRK 1.235.000,00 kuna. Energy renewal measures: improvement of thermal insulation of envelope, reconstruction of the roof above the heated space, thermal insulation of external walls and replacement of external doors and windows. The required thermal energy before the energy renovation for heating the building is QHnd=578.217,00 kWh / a, and after the energy renovation of the residential building is reduced to QHnd=188.189,00 [kWh / a]. By implementing this project annual energy savings of 67 % have been achieved, and the residential building has shifted from energy class E to C. The payback period for this investment is 8 years with annual savings of 152,110,00 kuna per year.
- The residential building at the address Kolarove Breze 10, 12, 14 in Zagreb. It was built in 1964. and the total floor area of a building is 1.230,00 m^2 The total value of this project amounts to HRK 602.154,00 kuna, co-financing rate is 40% for eligible expenses. Energy renewal measures: improvement of thermal insulation of envelope, reconstruction of the roof, thermal insulation of external walls and replacement of external doors and windows. The required thermal energy before the energy renovation for heating the building is QHnd=158.303,00 kWh / a, and after the energy renovation of the residential building is reduced to QHnd=30.269,00 [kWh / a]. By implementing this project annual energy savings of 80 % have been achieved, and the residential building has shifted from energy class F to B. The payback period for this investment is 12 years with annual savings of 48.933,26 kuna. The payback period for this investment with co-financing is 4.82 years with annual savings of 48.933,26 kuna per year.
- The residential building at the address Vincenta iz Kastva 2 in Zagreb. It was built in 1968. The total floor area of a building is 4.449,00 m^2. The total value of this project amounts to HRK 2.600.000,00 kuna. Energy renewal measures: improvement of thermal insulation of envelope, reconstruction of the roof, thermal insulation of external walls and replacement of external doors and windows. The required thermal energy before the energy renovation for heating the building is QHnd=549.281,00 kWh / a, and after the energy renovation of the residential building is reduced to QHnd=136.697,00 [kWh / a]. By implementing this project annual energy savings of 75 % have been achieved, and the residential building has shifted from energy class E to B. The payback period for this investment is 16 years with annual savings of 160,907,00 kuna per year.

The obtained results show positive effects of energy renovation of multi apartment buildings on climate changes, primarily through the decrease of the amount of energy consumption in an energy renovated area and the decrease of harmful particle emission (CO_2).

2. ELEMENTS OF THE RESIDENTIAL BUILDING ENERGY RENOVATION PROJECT

Energy renovation of a residential building in Zagreb includes the renovation of the outer shell of the building at the request of the investor or co-owner of the residential building, represented by a representative of the tenants. The residential building was built in 1961 [3]:

- total gross construction area (GBP) 1.898,26 m^2,
- total net area 1588,53 m^2,
- heated net area (Ak) 1229,18 m^2 te,
- volume of the heated part of the building 4093,52 m^2.

The building is irregular in shape and consists of two residential wings, each of which has a separate entrance on the southwest side. The total number of residential units of both wings is 24. The residential building consists of a basement, ground floor, 1st, 2nd and 3rd floors, common storage, and stairwells. The clear heights of the living space are the same on all floors and amount to 280 cm, while the clear height of the basement space is 235 cm. Access to the common roof is provided via an internal staircase. The dimensions of the building have maximum dimensions of 30.99 x 26.07 m and have irregular ground plan. [3]

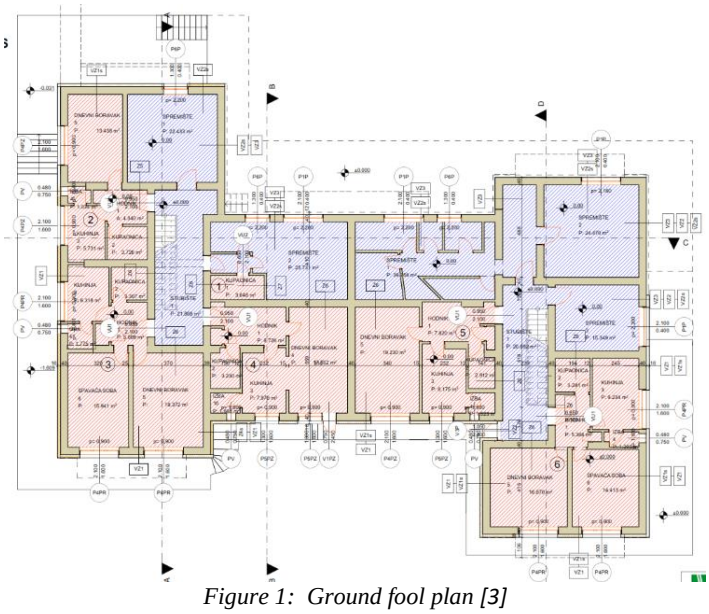


Figure 1: Ground fool plan [3]

The building is connected to the electricity network, water supply, and drainage. The heating of the building is performed as gas central heating through gas boilers, which are installed in the apartments, while one apartment is heated by electricity. Domestic hot water is heated by gas and electric boilers. Ventilation in the building is natural. The thickness of thermal insulation that is installed on the facade and roof is defined by the Project of Rational Use and Thermal Protection prepared according to the Technical Regulation on Rational Use of Energy and Thermal Protection in Buildings (OG 128/15) and according to the conditions prescribed by the Public Call for Proposals (grants) ‘’Energy renovation of

apartment buildings'' in 2016. The project of rational use and thermal protection for energy renovation (reconstruction) of the building was prepared in the computer program KI Expert, which is harmonized with the Technical Regulation on Rational Use of Energy and Thermal Protection in Buildings (OG 128/15). In order to achieve energy savings for heating/cooling on an annual level (kWh/year) of at least 50 %, as prescribed by the Call for Proposal, it was necessary to ensure the following [3]:

- 16 cm thick mineral wool had to be placed on the existing exterior walls,
- the base of the exterior walls (plinth) is insulated with 12 cm thick extruded polystyrene,
- replacement of part of external joinery Uw = 1,40 W/m^{2}K,
- basement walls of heated basements adjacent to the ground will be insulated with 12 cm thick extruded polystyrene (XPS), and will be additionally protected with dimpled tape along the entire wall surface.

Figure 2: Residential building in Zagreb before energy renovation [3]

Figure 3: Residential building in Zagreb after energy renovation [3]

The goal of the project of energy renovation of a residential building is to achieve 73.9 % savings in the thermal heating energy budget by implementing all the above analyzed construction measures to improve the thermal properties of the outer shell. The annual heat required for heating the building would be 68,03 kWh/m2a for reference climate data, which would transfer the building from energy class G to energy class C. After the implemented measures, CO2 emissions would be reduced by 52, 1 t/year. [4]

3. ENERGY RENOVATION PROJECT IMPLEMENTATION MANAGEMENT

3.1. Organizational structure of the energy renovation project

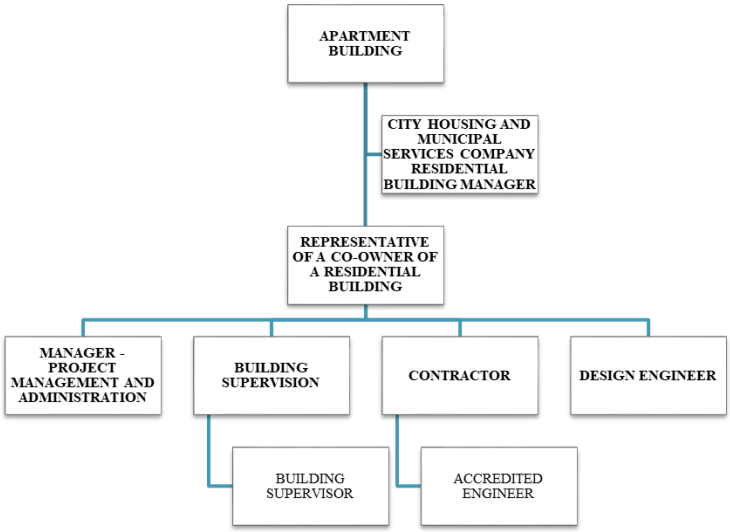


Figure 4: Organizational structure of the energy renovation project [3]

2.2. Stages of implementation of the energy renovation project

The project of energy renovation of a residential building co-financed by European funds consists of a large number of phases. The implementation of the project depends on the decision of the institutional bodies in charge of implementing energy renovation projects.

Table 1: Phases of the energy renovation project [3]

WBS	Phases of the energy renovation project of a residential building
1	**Energy renovation of residential buildings**
1.1	**Project design**
1.1.1	Study of the call for project proposals for energy renovation of a residential building and market research
1.1.2	Appointment of a representative of the building co-owners (collection of signatures of building co-owners)
1.1.3	Preparation of the Inter-ownership Agreement and the Management Agreement (City Housing and Communal Services - building manager)
1.2	**Project design**

1.2.1	**Simple procurement (procurement of project documentation preparation service)**
1.2.1.1	Sending calls to 3 business entities
1.2.1.2	Receipt of bids
1.2.1.3	Selection decision
1.2.1.4	Signing a contract for the preparation of project documentation
1.2.2	**Creating project documentation**
1.2.2.1	Energy review and energy certificate prior to renovation
1.2.2.2	Main energy renovation project
1.2.3	**Public procurement of energy renovation works**
1.2.3.1	Website design
1.2.3.2	Receipt of bids
1.2.3.3	Records of receipt of bids
1.2.3.4	Selection decision
1.2.3.5	Signing a contract with the contractor
1.2.4	**Simple procurement for expert supervision over energy renovation**
1.2.4.1	Sending calls to 3 business entities
1.2.4.2	Receipt of bids
1.2.4.3	Selection decision
1.2.4.4	Signing contracts for professional supervision services
1.2.5	**Direct agreement (project management and administration)**
1.2.5.1	Project management and administration
1.2.6	**Application of the project proposal to the public call under reference number KK.04.2.2.01**
1.2.6.1	Acceptance and registration
1.2.6.2	Administrative check
1.2.6.3	Making a decision on co-financing the energy renovation of the residential building
1.2.6.4	Signing the contract between the residential building and the Ministry of Regional Development and EU funds
1.3	**Energy renovation of the residential building Zelenjak 50_Execution**
1.3.1	**Preparatory works**
1.3.1.1	Scaffolding delivery and installation
1.3.1.2	Plastering of external slats on facade windows and doors
1.3.1.3	Dismantling of exterior window sills
1.3.1.4	Dismantling of interior window sills
1.3.1.5	Dismantling, removal and temporary disposal of exterior joinery - windows and doors
1.3.1.6	Dismantling, removal and temporary disposal of existing exterior partitions between balconies and balcony side wind protection
1.3.1.7	Dismantling of canopies and awnings
1.3.1.8	Dismantling of existing sheet metal edging (roof, chimneys, ventilation ducts)
1.3.1.9	Dismantling of all layers of the roof covering to the load-bearing AB structure
1.3.1.10	Dismantling of all layers on balconies to the load-bearing AB structure
1.3.2	**Earthwork**
1.3.2.1	Wide machine and manual excavation of a construction pit for the basement of the building up to approx. 1,5 m

1.3.2.2	Supply, transport, backfilling and compaction of large gravel tampons around the building
1.3.3	**Masonry work**
1.3.3.1	Masonry treatment of exterior and interior joists on doors and windows after dismantling of windows and doors
1.3.3.2	Plastering of flat chimney surfaces
1.3.4	**Insulation works (thermal insulation and waterproofing)**
1.3.4.1	Flat roof execution (thermal insulation)
1.3.4.2	Supply and installation of waterproofing (flat roof, balconies)
1.3.4.3	Construction of the wall towards the ground
1.3.5	**Façade works**
1.3.5.1	Execution of the ETICS façade system, a system of thermal insulation of external walls
1.3.5.2	Works on the base of the outer wall XPS = 12 cm
1.3.5.3	Balcony base insulation XPS = 5 cm
1.3.5.4	Wall insulation to the ground XPS = 12 cm
1.3.5.5	Final cleaning of the building and garbage delivery
1.3.6	**Tinsmith works**
1.3.6.1	Supply, delivery and installation of roof drain
1.3.6.2	Construction of various edgings
1.3.6.3	Ceramic work
1.3.6.4	Supply and installation of anti-slip tiles on balconies
1.3.7	**Locksmith works**
1.3.7.1	Cutting and painting balcony railings
1.3.7.2	Installation of previously removed canopies
1.3.8	**Carpentry**
1.3.8.1	Production, delivery and installation of exterior windows and doors
1.3.9	**Concrete works**
1.3.9.1	Construction of concrete on a flat surface of the load-bearing structure of a flat impenetrable roof
1.4	**Supervision of energy renovation**
1.4.1	Expert supervision over energy renovation
1.4.2	**Request for reimbursement of EPEEF funds**
1.4.2.1	Request for reimbursement 1_project documentation
1.4.2.2	Request for reimbursement 2_performance, supervision
1.4.2.3	Request for reimbursement 3_performance, supervision, project management
1.5	**Closing the project**
1.5.1	Energy audit and certificate after the renovation
1.5.2	Final report of expert supervision
1.5.3	On-site inspection

Project activities on the energy renovation of the residential building did not proceed as planned due to the delays of the Institutional Bodies as well as due to the mutual relations of the co-owners of the building. According to the dynamic plan, the duration of the works was 91 days. However, the actual duration of the works was 207 days. The deviation from the planned dynamics of works was mostly influenced by the delay on the construction site due to the unpaid advance. Requests for reimbursement of funds generated by the energy renovation of the building were sent to the Fund for Environmental Protection and Energy Efficiency, which also carried out on-the-spot inspections of project progress. [3]

2.2. Financial analysis of the project

Grants awarded make up 61 % of the total eligible costs, while the rest of the costs (eligible and ineligible costs) must be provided by the co-owners of the residential building. To assess the profitability of the investment, the criteria of financial decision-making on investments were used, which is the return on investment period. Once the return on investment period has been reached, the cash flows of the project represent the earnings of the investor for the rest of the time. [3]

Table 2: The return on investment period is based on the realized costs [3]

	TOTAL INVESTMENT	**INVESTMENT BY EU**
Investment	2,268,356.91 HRK	1,353,973.38 HRK
Annual saving	84,229.87 HRK	84,229.87 HRK
Return on investment period	**26.93 years**	**15.95 years**

4. CONCLUSION

It can be concluded with certainty that the preparation and implementation of an energy renovation project co-financed by EU funds is not a simple process, but rather an activity that brings many challenges both on the part of the project leader and the participating institutions. Despite all obstacles (delays of Institutional bodies, conflicts between co-owners of the building, limitation of labor workforce and materials) the project of energy renovation of a residential building in Zagreb was successfully implemented, regardless of delays in project implementation. The required thermal energy for heating the building was reduced from QHnd = 287,735.97 [kWh/a] to QHnd = 71,761.94 [kWh/a after the energy renovation project], i.e., the building transferred from energy class G to energy class C. Delivery of works was organized at the end of the project, followed by field visits by members of the Fund for Environmental Protection and Energy Efficiency.

5. REFERENCES

[1] Croatia green building council (2018). Creating an energy efficient mortgage for Europe, Zagreb.
[2] Saeptum d.o.o. (2017). Good practice in energy efficiency, Osijek.
[3] Demirović, D., (2019). Master's Thesis: Management of Energy Renovation Project, Faculty of Technical Engineering Bihać.
[4] Sustainable Development d.o.o. (2016). Construction project: Project of rational use of energy and thermal insulation, Zagreb.

APPLICATION OF COMPOSITE MATERIALS IN THE CONSTRUCTION OF WATER ACCUMULATION TANKS IN IRRIGATION SYSTEMS

Mirzet Beganović
Regeneracija d.o.o. Velika Kladuša, I Muslimaske brigade bb, mirzet.beganovic@regeneracija.ba

ABSTRACT:

This paper will give an example of the application of composite materials in the construction of tanks for water accumulation used in irrigation systems. In this paper we will also present an example from practice.

Keywords: Composite materials, irrigation systems, water accumulation, tanks

1. INTRODUCTION

Composite materials have a special place among modern materials, because they represent a combination of two or more diverse materials, with basic properties that depend on the properties of these materials. Advanced composites based on continuous fibers and polymer matrices in many areas are gradually replacing classic building materials, especially concrete and metals.
For several reasons (favorable application properties, simple and cheap production technology, investment savings, production costs), composite materials have become a very attractive group of building materials and will be irreplaceable materials in the future.
Figure 1 shows the basic components of a composite material, where it can be seen that by combining glass fibers and a matrix-resin a composite material is obtained. [1]

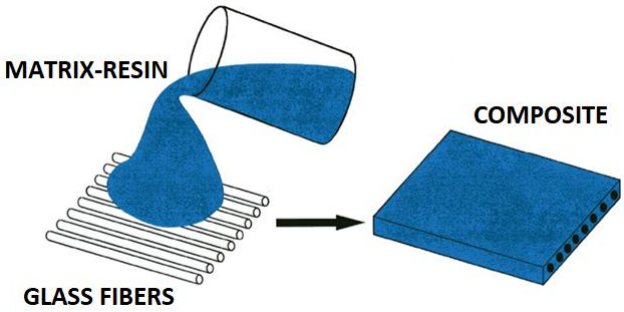


Figure 1: Composite material [1]

2. CHARACTERISTICS OF COMPOSITE MATERIALS

By polyester composite material we consider a material consisting of polyester resin, reinforced with glass fibers by adding certain fillers (chopped roving, continuous roving, quartz sand) in precisely defined scales, a material with a wide range of physical and chemical characteristics is produced.
Reinforced polyester, better known as fiberglass, is a composite material that allows a wide range of applications thanks to its good mechanical properties, water resistance, resistance to corrosive acids as well as to the action of basic substances. Compared to the second family of plastics, ie thermoplastics, reinforced polyester as a family of thermosets, allows the possibility of repairing physical damage. [2]
The following figure shows the possibility of influencing a composite material with a glass fiber percentage.

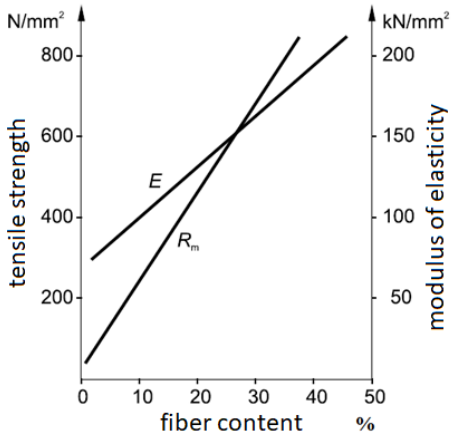


Figure 2: Influence of fiber content on modulus of elasticity and tensile strength [3]

The data given in the table below show the mechanical characteristics of the composite material made of long and short fibers as well as the characteristics of the PE material

Table 1: Mehanical characteristic composite material with short/long fibers and PE

Mechanical characteristics	Short fibers	Long fibers	PE (Polietylen)
Modulus of elasticity of MPa	6.210-6.950	16.650-17.680	1.100-1.500
Tensile strength MPa	130-140	295-335	23-35
Compressive strength MPa	89	143	
Flexural strength MPa	210-245	315-380	
Poisson's ratio	0,331-0,337	0,212-0,217	

The following figure shows the testing of the basic mechanical properties as well as the stiffness of the pipe rings used in the calculations of static stability of tanks made of composite materials

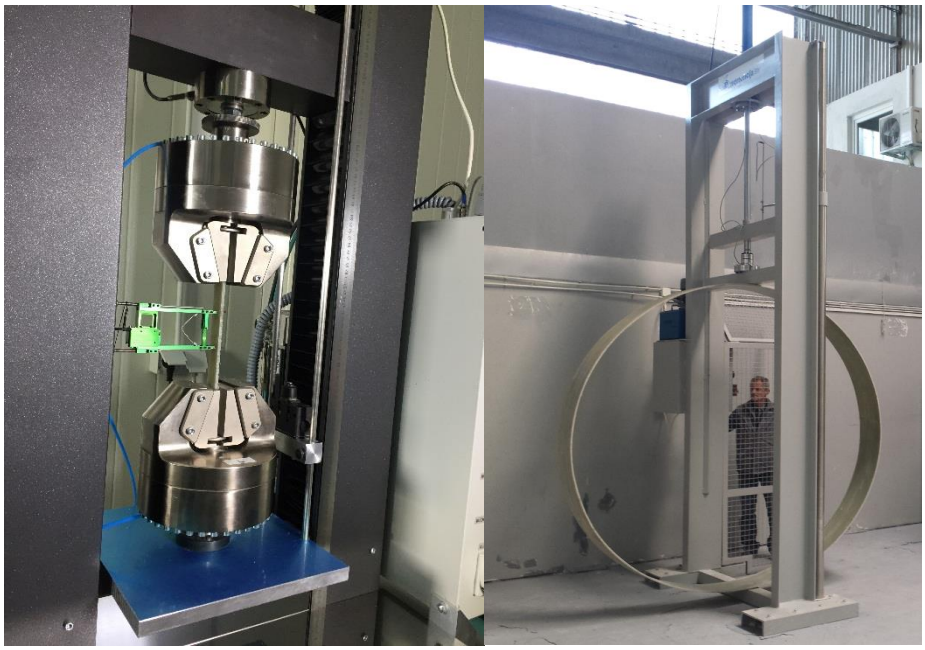


Figure 3: Review of testing mechanical characteristics in the laboratory

2.1. Advantages of using composite materials in practice

The advantages of composite materials over PE-polyethylene and PP-polypropylene are:
- higher load capacity,
- greater durability.

The advantages of composite material over metal are:
- it's lighter,
- does not corrode,
- faster installation.

The advantages of composite materials over concrete
- faster installation
- watertightness
- does not corrode

3. INSTALATION OF A TANK MADE OF COMPOSITE MATERIALS IN THE IRRIGATION SYSTEM

In this part of the paper, an example from the design solution to the installation of tanks made of composite materials will be presented. The following figure shows the areas covered by the irrigation system.

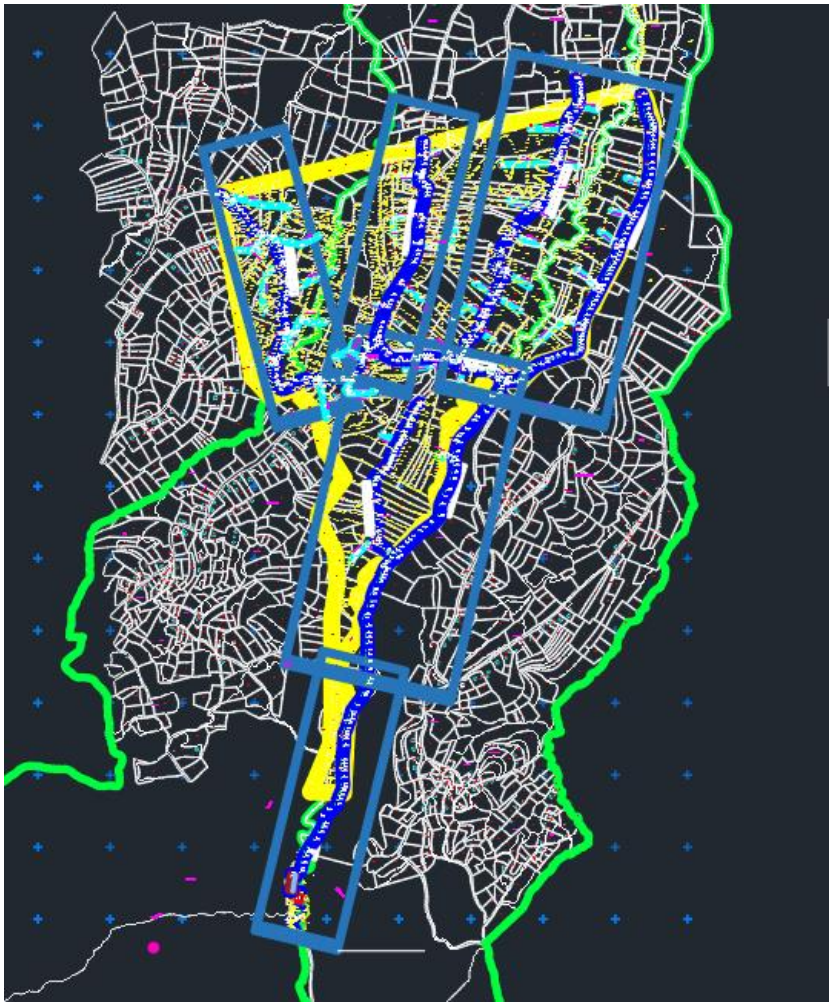


Figure 4: Areas covered by the irrigation system.

The project solution is involved the construction of four tanks with a diameter of 2.4 m and a length of 50 m, which ultimately amounted to 220 m3 of volume of one tank.
The first phase refers to the installation of the first two tanks while the second phase involves the installation of the remaining two tanks.

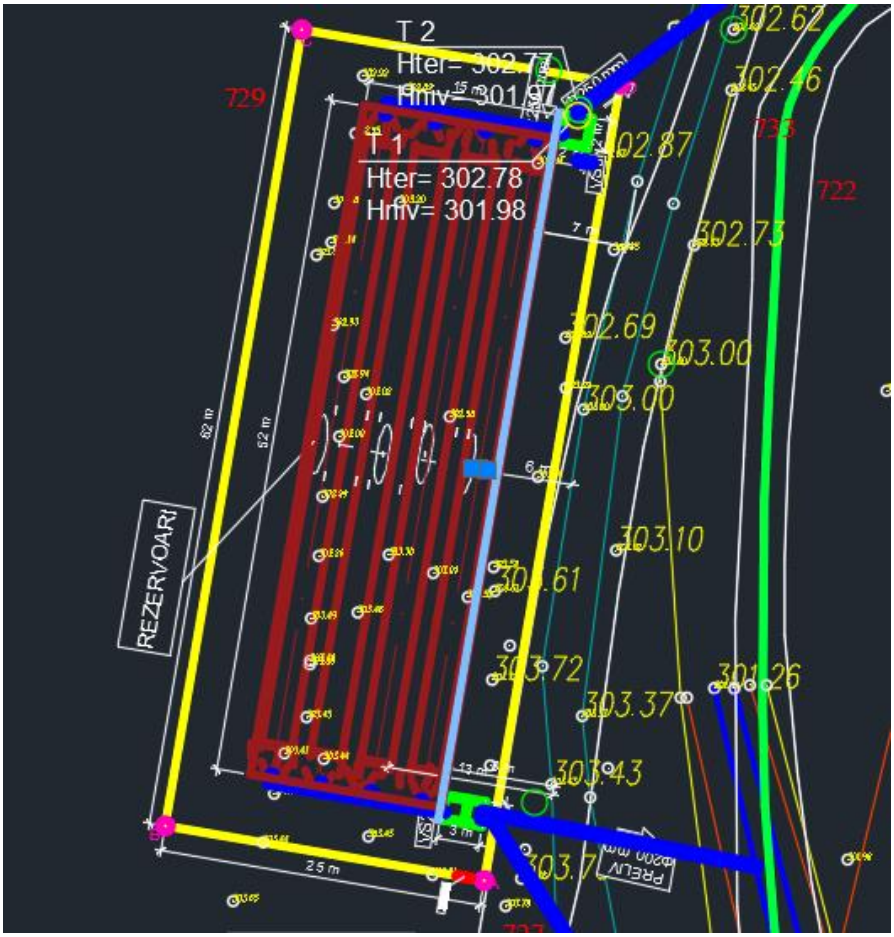


Figure 5: Showing four tanks on the situation

The following pictures show the installation of the first two tanks above mentioned dimensions. The total volume of the two tanks is 440m3. The second phase will include remaining two additional tanks so that the total volume will be 880m3.

Figure 5: Installation of two tanks with a total volume of 440m3

4. CONCLUSION

As shown in this paper, tanks made of composite materials have proven to be a very good choice. Practice has shown the main advantages over conventional materials in terms of water permeability, load-bearing capacity, installation speed as well as lower maintenance costs. Composite materials are already widely used in irrigation systems today, and far greater applications are expected in the future.

5. LITERATURA

[1] Beganović M.: *Doktorska disertacija „Eksperimentalno-numerička analiza i matematičko modeliranje kritične krutosti prstena cijevi od kompozitnih materijala*, Tehnički fakultet u Bihaću, 2016.
[2] Willems G, Lambrechts P, Bream M, V. Anherle G.: *Composite resins in the 21st century*, Quintessence Int, 1993
[3] Z. Schauperl, *Kompozitni materijali,* Predavanje 2007/08.

CONTRIBUTION OF INTERNATIONAL PROJECTS IN THE GEOINFORMATICS EDUCATION IN BOSNIA AND HERZEGOVINA

Slobodanka Ključanin, Suada Sulejmanović, Emina Hadžić
University of Bihać, Technical Faculty, slobodanka63@yahoo.com, University of Sarajevo Faculty of Civil Engineering, suada.sulejmanovic.gf@gmail.com, eminahd@gmail.com

ABSTRACT:

The development of information and communication technologies greatly affects everyday life, whether it is leisure activities and business life. The need for knowledge that accompanies the development and use of information and communication technologies came to the fore during the COVID19 pandemic when online communication and work from home were preferred.
Education in creating a framework for the possibility of using information and communication technologies is provided by educating staff on two fronts in parallel: in the business environment (public and private sector) and at universities (higher education). Assistance in implementing training provides by various international projects to transfer knowledge in geoinformatics that can apply in various industries. In this regard, the paper presents the primary goals and results of the following international projects: INSPIRATION, IMPULS and IPA DRAM, and ERASMUS + programs: BESTSDI and NATRISK.

Keywords: information and communication technology, geoinformatics, international projects

1. INTRODUCTION

The transfer of knowledge to teachers of higher education institutions, as well as professional staff in charge of collecting and processing spatial information to the users of this information is common to international projects in the field of geoinformatics, which are implemented in the Western Balkans (WB), and thus in Bosnia and Herzegovina. After implementing the project, the implementation of the reform is implied both in higher education institutions and in the public sector, which is responsible for spatial data of interest to different spectrums of users.

The INSPIRATION, IMPULS and IPA DRAM projects aimed to transfer knowledge to public administration staff, who need to create an efficient environment (laws, regulations, technical instructions, etc.) to share spatial information efficiently.

INSPIRATION – Spatial Data Infrastructure in the Western Balkans is an EU-financed multicountry project aiming to promote SDI and coordinate its further development in the West Balkans countries.

The EC supports the project through the IPA program. The duration of the project is January 2012 – December 2013. The budget of the project is 1,438 million €. [1].

The SIDA[1]-funded IMPULS project intends to create key national spatial data infrastructures (NSDIs) throughout the Western Balkans. The project had a budget of 38 million SEK (about 4 million Euro) and lasted from 30 May 2014 to 31 December 2019 (with a one-year no-cost extension granted on 31 December 2018).

The International Programme for Disaster Risk Assessment and Mapping (IPA DRAM) aims to reduce civilian casualties in Western Balkan and Turkey. The European Union recognized the need to further develop civil protection and risk management capacities in the region through special projects under the Instrument for Pre-accession Assistance (IPA). IPA DRAM had a budget of 2.999.25 euros [2].

Erasmus + is a European Union program that supports education, training, youth and sports for 2014-2020. It is believed that the development of these areas will help to address socioeconomic change positively, support the implementation of European policy programs for development, employment, equality, and social inclusion. The project intends to promote common European values, social integration, intercultural understanding, and a sense of belonging to the community's challenges, and promote common European values, social integration, intercultural understanding, and belonging to the community. [3].

The BESTSDI program Western Balkans Academic Education Evolution and Professional Sustainable Training for Spatial Data Infrastructures is a three-year project coordinated by the Faculty of Geodesy, University of Zagreb, with a total budget of € 978,166.66 [3].

NatRisk project with full name Development of master curricula for natural disasters risk management in Western Balkan countries is coordinated by the Faculty of Civil Engineering and Architecture, University of Nis. The total value of the project is € 1,245,746.00, and the duration is 36 months starting from October 2016 [3].

2. INSPIRATION project

The European Union is funding the multi-country INSPIRATION - Spatial Data Infrastructure in the Western Balkans project. The project's goal is to promote spatial data infrastructure (SDI) and coordinate its implementation across the Western Balkans better to prepare beneficiaries (national mapping and cadastral authorities) to satisfy the EU INSPIRE Directive's goals [4].
Another aim of this project was to establish a regional network of SDI professionals who could exchange challenges and technical solutions related to SDI implementation.

The project last from January 1, 2012, through December 31, 2013. The beneficiary countries are Albania, Bosnia and Herzegovina, Croatia, the former Yugoslav Republic of Macedonia, Montenegro, Serbia, and Kosovo*. The project leader was GFA Consulting Group GmbH in consortium with Conterra, Umweltbundesamt Austria, GisData [4].

INSPIRATION helped to raise awareness of the need for local, regional, and state administrative entities in the region to develop a legal and technical framework for accurate, up-to-date, high-quality, well-structured, and accessible spatial data.

The final European INSPIRATION Conference was held in Sarajevo, Bosnia and Herzegovina's capital and the country's biggest urban, cultural, and economic center. The cadastral agencies of Bosnia and

[1] Sida is Sweden's government agency for development cooperation.

Herzegovina - FGA Sarajevo and the Republic Authority for Geodetic and Property Affairs (RAGPA) Banja Luka - hosted the last regional event of the INSPIRATION Project.
The Memorandum of Understanding on Regional Cooperation in Spatial Data Infrastructure was signed by high representatives of all INSPIRATION beneficiary organizations prior to the Conference's formal start [6].

The Geoportal of the Federal Administration for Geodetic and Property Affairs (FGA) was launched at the final INSPIRATION conference. The FGA geoportal provides an overview of the B&H Federation's cadastral data [5].

3. IMPULS project

Following the completion of the INSPIRATION project, there was a need for further work to raise awareness of the importance of spatial data and to create a legal and technical framework for the establishment of national spatial data infrastructures in the WB countries. Donors have been sought by the WB nations' national mapping and cadastral authorities to continue the process of data adaptation in compliance with the INSPIRE regulation.

The IMPULSE project aimed to transfer knowledge about the processes and procedures necessary for the establishment and implementation of SDI to organizations responsible for the establishment and implementation of national spatial data infrastructures in the countries of the WB region. Since national mapping and cadastral authorities had different SDI development levels, the IMPULS project had a task to transfer knowledge on the establishment of SDI following the needs of national mapping and cadastral authorities. The project holders are the Lantmäteriet (Surveying and Mapping Authority of the Kingdom of Sweden) - the main partner, and the State Geodetic Administration of the Republic of Croatia - the junior partner. The project was funded by SIDA (Swedish International Development Cooperation Agency) and the Lantmäteriet [7].

The main goals of the IMPULSE project were:

1. reaching a certain level of knowledge to establish and implement SDI, based on the INSPIRE directive;
2. achieving efficient organization and business processes necessary for the development of SDI;
3. creation of interoperable technical solutions (e.g. software, services, etc.), which will enable the exchange of spatial data at the national and regional level and with the EU;
4. assistance in developing SDI strategies;
5. joint work plan, defining the way of work, maintaining spatial data, the inclusion of SDI entities (organizations responsible for certain data sets according to INSPIRE), development of specifications harmonized with the INSPIRE directive, etc.
6. Achieving the necessary competencies required for the establishment and maintenance of SDI [7].

The project has effectively achieved outcomes related to the increased understanding of SDI among Beneficiary Organizations (BOs). The production increased, used and provided data by BOs following SDI requirements and the promotion of NSDIs at national and regional levels. As the premier regional project on NSDI, the project has laid the foundation by helping BOs navigate their way around the implementation of the very complex and ambitious INSPIRE Directive The project has built capacity on all aspects of NSDI and provided initial support for implementation activities [8].

3. IPA-DRAM program

Albania, Bosnia and Herzegovina, the Republic of North Macedonia, Montenegro, Serbia, Kosovo*, and Turkey are all disaster-prone countries that confront a variety of natural disasters including floods,

earthquakes, landslides, wildfires, heat waves, and drought. Improved disaster risk management capacities would save lives, protect investments, and assure sustainable development.
In this context, the IPA DRAM contributes to strengthening the capabilities of its Partner Countries to manage disaster risk by providing an open platform for the development and improvement of national disaster loss databases, improving the coherence of national systems and methodologies, and ensuring compliance with existing EU regulations, guidelines, and best practices. Swedish Civil Contingencies Agency (MSB), in collaboration with the Italian Civil Protection Department (DPC), the Administration of the Republic of Slovenia for Civil Protection and Disaster Relief (ACPDR), the National Protection and Rescue Directorate of the Republic of Croatia (DUZS), and the International Centre on Environmental Monitoring, coordinated the IPA DRAM project (CIMA Research Foundation) [9]

The goals of this program were:

1. The Sendai Framework for Action and the disaster risk-informed approach for all EU policies (European Commission Staff working document) aiming to guide the multi-hazard management of disaster risk in development at all levels as well as within and across all sectors, will serve as a guiding theoretical framework for the implementation of the programme;
2. Continuity on existing national and regional structures and initiatives, taking into account national/ regional strategies when designing the country-specific plans of action, including the national disaster risk reduction platforms and former projects funded by the EU Instrument for Pre-Accession (i.e. IPA CP I and II, IPA FLOODS);
3. The perspectives of environment, gender and civil society involvement will be taken into consideration throughout the full programme cycle to achieve effective and sustainable results;
4. Local ownership and participation is a key principle for successful and sustainable results and will be ensured through the active involvement of partner agencies and experts from the outset of the project, starting with comprehensive dialogue in the inception phase and participatory fact-finding missions;
5. Having a multi-stakeholder and inter-agency approach to the planning, design and implementation of activities will ensure a holistic understanding of needs, capacities and assets, allowing for a comprehensive approach to developing disaster risk management capacities in the partners. both horizontally between sectors and institutions (including the private sector and civil society) and vertically between local, national, regional and global levels;
6. While ensuring a regional approach, the programme also recognises that each Partner is unique. The programme will adapt the support to the partner countries to the level of every country based on the progress made.

The achieved goals of the program are implemented through three technical components:

1) Disaster loss data (DLD),
2) Risk assessment (RA),
3) Risk mapping and Electronic Regional Risk Atlas (ERRA) [9].

4. BESTSDI project

The BESTSDI project and its idea are based on the findings of the EU IPA2010 project "INSPIRATION - Spatial Data Infrastructure in the Western Balkans" implemented in the period 2012-2013. and the accompanying project "Cooperation in the Western Balkans - Infrastructure for Spatial Information in the Western Balkans" (IMPULSE) [10].

The broader objectives of the BESTSDI project, which are fully in line with the priorities of Erasmus capacity building projects, can be grouped into the following: [3]:

1. improve the quality of higher education in the field of geosciences and technologies, SDI and geodesy, through the development, testing and adaptation of new curricula, courses, materials and tools in the field of SDI,
2. increase the competencies of future professionals and their importance in the labor market and in society / community, and improve the level of competencies and skills in higher education institutions by developing new and innovative educational programs within the field of SDI,
3. Introduce SDI and related concepts into undergraduate and graduate study programs at academic institutions whose profiles are well recognized as SDI beneficiaries, raising the awareness of students and professionals about the relevance of SDI and the benefits of well-organized spatial data. The BESTSDI consortium consists of 16 academic partners (and 3 associated partners) from the Western Balkans (Albania, Bosnia and Herzegovina, Kosovo, Montenegro and Serbia) and the program countries of Belgium, Croatia, Germany, S. Macedonia and Sweden [3].

The result of this project is the provision of teaching in new syllabus and study programs in accordance with European and other international standards.

4. NATRISK project

If we want to strengthen our risk reduction capacity, it is certainly necessary to develop mechanisms for managing the risks of natural disasters. Managing risks means thinking in advance about potential events that may occur, the effects and consequences that institutions may face in the future, and take timely measures to minimize risks, and thus avoid or reduce adverse effects. Recognizing the importance of studying this issue and the need to involve the academic community, in order for the effect of the activities to be long-lasting and accompanied by continuous development, the NatRisk project was launched.

The goals of the NatRisk project are fully aligned with the priorities of the capacity building projects, and can be summarized through groups:

1. Development and implementation of master study programs in the field of protection against natural disasters in the Western Balkans in accordance with European standards,
2. Education of teaching staff from the Western Balkan countries in this field in the EU countries,
3. Modern equipping of laboratories / procurement of equipment, which will help in the realization of planned activities and training of students;
4. Implementation of student and teaching staff mobility in EU countries;
5. Development and implementation of training for citizens and the public sector in the field of disaster risk management.

The project was implemented by 5 EU partners from Austria, Greece, Hungary, Italy, Great Britain, and 6 from the Western Balkans, and the Republic Hydrometeorological Institute of Serbia as an associate partner.

The achieved results can be measured through the fact that through the project:

1. 87 teachers were trained in the field of application of innovative methods in the implementation of teaching during 5 trainings in EU countries;
2. a survey of 3058 persons from the sectors related to this issue was conducted, at all levels of government and numerous sectors of the economy and society in order to identify acute problems in the field of disaster risk management,
3. four manuals for training of the civil sector in natural disaster situations have been created,
4. 14 multi-day trainings were held at higher education institutions in the Western Balkans and close to 500 participants from more than 150 institutions were educated,
5. six new master studies have been launched, as well as one specialist study, while one study program has been modernized with knowledge in this field,
6. more than 100 students are enrolled in accredited study programs,
7. three offices for international cooperation have been developed,

8. thirty students stayed on study internships for 12 days,
9. 115 mobility of teachers lasting over 1200 days and 25 student mobility lasting over 120 months were realized,
10. procured equipment in the amount of 254,000 euros and equipped 7 laboratories,
11. the project was promoted at more than 80 different events (conferences, seminars, workshops, info days), in more than 10 printed and online editions in several languages and 3 items were broadcast on national TV and radio channels [3].

6. CONCLUSION

After ten years of intensive implementation of projects in two fields (business and education), it can be emphasized that the projects achieved the set goals and contributed to raising awareness of the importance of spatial data sharing and development of geoinformatics in Bosnia and Herzegovina through modernization of study programs. The Western Balkans region has recognized the importance of joint action with the EU and other international actors, which is why a Memorandum of Cooperation between the national mapping and cadastral authorities of the WB countries has been signed, and a Regional Conference on Cadastre and SDI is held every year. The conference presents the results of investments in the development of each country in the implementation of international trends. A high level of understanding and comprehension of the concept of Spatial Data Infrastructure (SDI) and disaster risk management has been achieved between the project partners, who form different profiles of experts.

Comparing the dates of the initial implementation of regional projects funded by European institutions and countries, and the steps towards the establishment of SDI in B&H, it can be concluded that they are intertwined.

The greatest benefit from these international projects is the economy, which will receive new profiles of experts and thanks to participation in the presented projects, manifesting the multiple benefits of society as a whole, in the management of space and natural resources.

4. REFERENCES

[1] http://www.evropa.gov.rs/Documents/Home/DACU/5/28/161/AR%20Jan-June%202012%20final.pdf
[2] http://www.ipadram.eu/
[3] Hadžić, E., Bačić, Ž., Gocić, M. (2019). The Importance of ERASMUS + Projects in Strengthening Higher Education: Example NatRisk and BESTSDI Project. Proceedings of the Second B&H Water Congress. Association of Consulting Engineers Bosnia and Herzegovina. Sarajevo, B&H.
[4] http://www.evropa.gov.rs/Documents/Home/DACU/5/28/161/AR%20Jan-June%202012%20final.pdf
[5] https://www.katastar.ba/geoportal/preglednik/
[6] https://www.gfa-group.de/web-archive/inspire/www.inspiration-westernbalkans.eu/INSPIRE_-_Final-European-INSPIRATION-Conference_3679377.html
[7] http://www.fgu.com.ba/hr/978.html
[8] https://www.lantmateriet.se/contentassets/7377db13b7b7490ba023616082594a35/evaluation-of-impuls---final-report.pdf
[9] http://www.ipadram.eu/
[10] Bačić, Ž. And Poslončec-Petrić, V. (2016): BESTSDI projekt - modernizacija i standardizacija nastave iz IPP-a u regiji. XII međunarodna naučno-stručna konferencija "Savremena teorija i praksa u graditeljstvu, 7-8 decembar 2016, Banja Luka, Bosna i Hercegovina, pp 677-684.

APPLIED ELEMENTS OF BIOCLIMATE ARCHITECTURE AND CONSTRUCTION

Marija Mihajlović, Ljiljana Stošić Mihajlović
Faculty of Civil Engineering and Architecture, University of Nis,
e-mail: mmihajlovic1251997@gmail.com
Academy of Technical and Educational Vocational Studies, Nis - Department in Vranje
ljiljana.stosic.mihajlovic@akademijanis.edu.rs

ABSTRACT:

The main intention of the author of this paper is to present the bioclimatic architecture of buildings as an important determinant of energy efficiency of buildings. Therefore, the paper presents a house that was built according to the principles of passive solar architecture. Namely, the so-called passive houses consume very little energy, so it is possible to live in them without traditional heating and cooling systems, using renewable energy sources, primarily solar energy. Such interventions in energy use are based on spontaneous natural processes, which mainly use renewable energy sources, available in the local, natural environment, instead of expensive technological solutions. The paper is designed to point out the advantages of the bioclimatic architecture of a building that has already been built. Namely, the architectural experiences of a cottage in Pike district, intended for a married couple, were used as the first passive building built and a good example of passive solar architecture. By analyzing the technical documentation, it is obvious that the goal of saving energy and preventing heat release into the outdoor space, and partly to the detriment of the comfort of the users themselves, is to install insulation layers in the wall, foundation, mezzanine structure. By analyzing the available data related to the construction of this residential building, we came to the conclusion that innovative technological systems for ventilation and lighting were also used. With its form and logical placement in relation to the sides of the world, the building has contributed to the essence of passivity in the use of energy. In addition, with the clever use of tall greenery, which existed as part of the natural environment before construction, this facility is an example of bioclimatic architecture, which can be a model for future builders who prefer the principle of bioclimatic design in their work.

Keywords: passive house, energetic efficiency, energy saving, natural materials, ecological balance, renewable energy sources

1. INTRODUCTION

The intention of the author is to point out that at a time when climate change and irregularities are dominant in the world, we should turn to bioclimatic architecture, as a means of finding a lasting solution. Humanity is facing the disappearance of classical, non-renewable energy sources, large international stakes, strategic geopolitical moves, but often also the problems of a rational, although ecologically unsatisfactory way of building. [1] On the other hand, nature has confirmed that it represents an important part of the context in architecture and we must understand that man needs a connection with nature instead of a complete separation from it. The essence is in raising environmental awareness, restoring and preserving cultural heritage and re-establishing the dialogue between man and nature, and that would lead to great changes and solve the problems caused by global changes. Man should not disturb certain natural relations with his interventions in nature, but he should adapt to them. Today's buildings consume half of the energy produced from fossil fuels, and they are non-renewable and harmful. [2] Therefore, modern construction is increasingly turning to the so-called. passive

architecture, to build buildings from ecological materials with different possibilities of preservation and protection of the environment. Modern dynamic progress of technique and technology has a significant place in construction and architecture. That is why it is necessary for the architect to be up to date with the current possibilities of construction. [3] Responsible designers of the cottage in the area of Pike County, for this project said: [4] "It made sense to build a house that met the most advanced possible construction and energy standards. The design is perfect for enjoying the spectacular surroundings of the forest and the lake." Keffer Residence in Pike County is the first home in Pennsylvania, designed to meet the standard of a passive house. It is located in a historic private forest, and in order to be preserved, the design had to respect the view outside the location, the road and the lake. The site is densely forested, with excellent sun (solar energy), which allows access to free energy. It also overlooks the pristine mountain lake. The subject of the study of bioclimatic architecture is precisely the fight against current climate change, which can be heard more and more often. Namely, in the modern world, limit values are reached in a short time in terms of disturbing the environment and the natural balance of ecosystems. The amount of naturally produced carbon dioxide (CO2) is almost identical to the amount of carbon dioxide that disappears into the atmosphere, but even small changes caused by human activities can have a significant impact on this balance. Reducing greenhouse gas emissions is achieved by saving energy - the saved energy does not have to be re-produced. In this paper, we will talk about this specific example of a passive house, which leads to energy savings and nature protection, by merging with the natural environment. The subject of this paper is a description of all the applied passive characteristics of the house and how they would not function without the nature that surrounds them. [5] The aim is to present a general model of a residential building that supports renewable energy sources with its passive system. [6] This concept of sustainable construction reduces energy consumption to almost zero, while creating incomparable comfort in the home and virtually eliminating heating and cooling costs. Compared to the surrounding houses from Pike County, the house designed by architect Kefer proved to be practically the most efficient form for maximum energy savings with little investment in the entire construction process. The need for energy for cooling and heating according to the rules does not exceed 15kVh / m² per year, and the total energy consumption, which includes energy for space heating and cooling, hot water and electricity, does not exceed 42 kVh / m2 per year, which is about 10 times less from other objects. Design methods from the bioclimatic aspect go in the direction of proving that in order to consider an object ecological, all its possibilities in terms of environmental protection must be explored: The adaptation of the building to the existing climate changes was analyzed on two levels:

- The first level considers urban factors, which include the analysis of the influence of the local climate, landscapes on the positioning of the building and the definition of preliminary forms.
- The second level are architectural and technical-technological solutions whose application achieves energy-responsible design. Final analyzes indicate that a bioclimatic approach is necessary in the initial stages of design, from the installation of conceptual sketches of buildings, because the subsequent installation of technology in the building requires time and increases the cost of the whole process..

2. OBJECT LOCATION

The Keffer Passive House Residence is a weekend family resort located in the US state of Pennsylvania, Pike County. It was designed for a married couple from New York. The clients are retired older people, who wanted to replace the busy and noisy New York with a quieter area, with minimal later investment in the maintenance of the house itself. This building is located in a historical, private, forest reserve so that the design fits into the environment. At a distance of 100 meters north of the building, there is a road, and on the south side, 60 meters from the building is "Wolf" Lake. [7]

To the east and west of the building, at an equal distance of about 50 meters, there are neighboring buildings, which, like Kefer's passive house, are family holiday homes. Unlike neighboring buildings, Kefer passive house is the first and only so far designed and built in accordance with the principles of using locally available renewable energy sources. It is interesting to note that the use of renewable energy sources in Europe is widely used, as well as bioclimatic design, while in the United States this

type of construction is a novelty, regardless of the fact that it is the system with the highest performance according to building standards. The whole site is densely forested. As almost all the greenery was lost in the fire that broke out at the beginning of the twentieth century, it began with the systematic afforestation of the site, so that today's appearance of greenery is part of the tactics that the American government was implementing at that time. The dominant trees are resinous and red pine, larch, red maple and other trees.

Figure1: Keffer pasive house
Source: .architectmagazine.com/project-gallery/ke-passive-house keffer [8]

Project details: Project name - Keffer passive house; Location - pike county ; Architect - richard pedranti; Client/owner - Lynn & tom keffer; Project types - single family; Project scope - new construction; Size - 2,900 sq. Feet; Year completed - 2015; Project status- builte
Due to the natural environment, houses are a rarity in this part of Pennsylvania. Thus, within a radius of 200 meters around the house of Kefer, only 6 neighboring buildings were built, East of the building there is a park - lake forest. The greenery is dominant to the extent that the road that reaches the building is small in width and excludes active traffic. South of the building, there is a natural, large "Wolf Lake", one of many in the area. The surrounding forest is selectively pruned, to allow filtering of the lake view, improved solar gain and to allow natural light and air penetration. The new home meets the strict standard of a passive house, providing the most comfortable and healthiest environmental impact.

3. FUNCTIONAL ANALYSIS

In terms of the design of Kefer's house, it can be seen that the exterior is visually quiet and fits into the wooded environment. All the more so, it can be said that it meets the aesthetic standards of the community. The two-storey house is camouflaged in a natural environment with the dark colors of the facade. This stems from the fact that the building itself is covered with wooden paneling. The construction of the building itself is made of natural material. Built in a skeletal system, this building provides, above all, safety from possible earthquakes. Of the many ideas, the architect decided on a variant of maximum fit into the environment, because it was primarily the wish of the investor. Tom and Lynn Keffer found and contacted Richard Pedranti Architect, an energy-efficient design firm, and agreed to build the first passive house in Pike County, Pennsylvania. The goal of investing in this project is primarily a comfortable living space, which is compatible with the environment, economical to build and inexpensive to maintain over time. In the spring of 2016, they moved into a new vacation home. Construction costs were up to 10% higher per square meter than construction costs for a typical new house. Given the sustainability and passivity, with heating and cooling costs falling by about 80-90% per year, the return on investment in a short period of time has been proven.
The interior is modern, open type. Great attention is paid to energy saving systems. Wood, which is dominant in the environment, was used to make many parts of both the facade and the interior. Stairs, tables, chairs, window panes, shelves, wooden fences - are an example of good use of easily accessible

materials from the forest, which was reforested after that exploitation. All this has led to greater economy and less use of other materials such as plastic, PVC or plywood, which are available for sale but also harmful, both to the environment and to the health of tenants.

Figure 1 shows the base of the ground floor, and it is obvious that the efficiency of the passive house is reflected in the fact that the day and night zones are largely oriented to the south. Auxiliary rooms are correctly placed and oriented to the north side. The entrance is on the west side, but it is placed all the way in the upper part of the building, which again gives the possibility to form those rooms in the south that are in use throughout the day. One of the ideas could be to move the kitchen, which currently fully enjoys the very favorable south side, to the west, while there would be a dining room under it, which we would certainly not separate. In its place, the living room could have a better use of space and a complete advantage of the southern orientation. This would mean that the living room would have higher lighting and faster and complete heating during the winter, while the kitchen would get natural ventilation by being tied to the facade and generally there would be no need for any major partitioning.

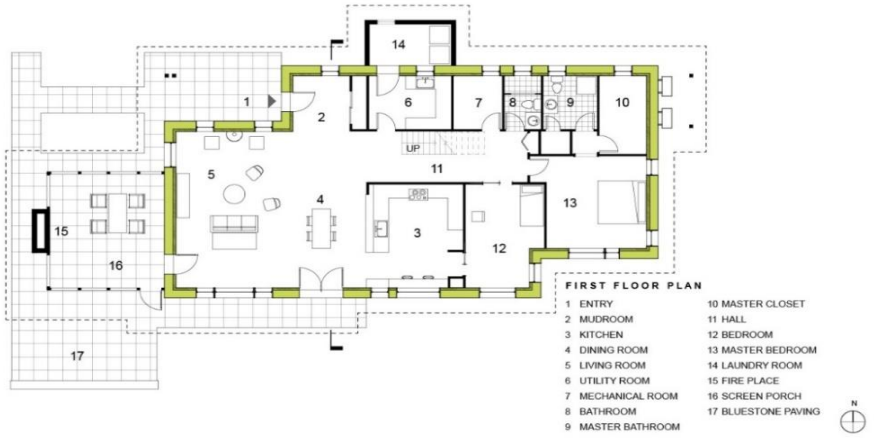


Figure 2: Ground floor of the building
Source: https://richardpedranti.com/projects/keffer-residence-passive-house, April 23,2021/16:48) [7]

On the other hand, the night zone, placed on the east side, is ideally integrated into the space, with the variant of placing the sleeping rooms to the north according to the design recommendations, again in the goal providing sunlight to the living room throughout the day. The technical rooms, in the north, are also well oriented and far enough away to remove any possible noise from the rest of the space. The shape of the building itself is largely compact and reduced, which contributes to the reduction of quotients when calculating the shape factor of the building. The western sun can be hard in the afternoon, which is prevented by the summer room, which is mostly made of glass, it is only a barrier to the sun, but also a fireplace is placed as a constructive element.

4. APPLIED ELEMENTS OF BIOCLIMATE ARCHITECTURE

Kefer's passive house applied, as the name suggests, exclusively a passive system of energy saving and environmental protection. Later, the architect included in the further elaboration of the project the possibility of introducing active elements of the sustainability of the house. He thought that the introduction of solar panels or solar collectors would be useful for several reasons. The house could almost completely not depend on the city's power supply network. Also, it would be the first house, which, in addition to the passive one, also uses the active energy production system. In a short time,

they would see a lasting benefit from the introduction of both systems, in the form of twice the production of electricity from consumption. Richard Pedranti explained which systems would work and how they would work when installed on Kefer's house.

The passive house conserves energy by creating a virtually hermetic, super-insulated compact building that uses the sun and heat emanating from people and equipment to achieve a comfortable interior space. Under the concrete slab of the foundation lies 30 centimeters of expanded polystyrene foam and 20 centimeters of Pennsylvania perlite, which completes the super insulated base. In addition to the thick layer of insulation under the foundation of the house, the walls and roof are wrapped with three times more insulation than today's standard home, reducing the loss of heating and cooling. Another key component in maintaining a hermetically sealed space are high-performance windows and doors, historically weak connections in the thermal defense of the building. RPA has appointed Intus Windows, a pioneering manufacturer and distributor of super energy efficient windows and doors. The triple window of Intus Windows works 3 times better than typical windows, while it captures the maximum solar energy from the Sun, and the space between the glasses is filled with gases krypton and argon. The heat transfer of these windows is slightly more than 0.85W / m^2 K

After installing the triple glazing and the door, the next step is to install all the mechanical components, including the heat recovery fan , or "lungs of the house". a constant supply of filtered, fresh air, while saving the owner money by restoring internal energy that would otherwise be lost. This achieves a major upgrade of indoor air quality, while maintaining constant comfort. During the construction process, the passive house will be tested several times by testing the door - a mandatory technique that ensures high performance of the building. "Ventilation doors" are fans that are mounted on the front door. A powerful fan draws all the air out of the house and detects leaks in the outer walls.

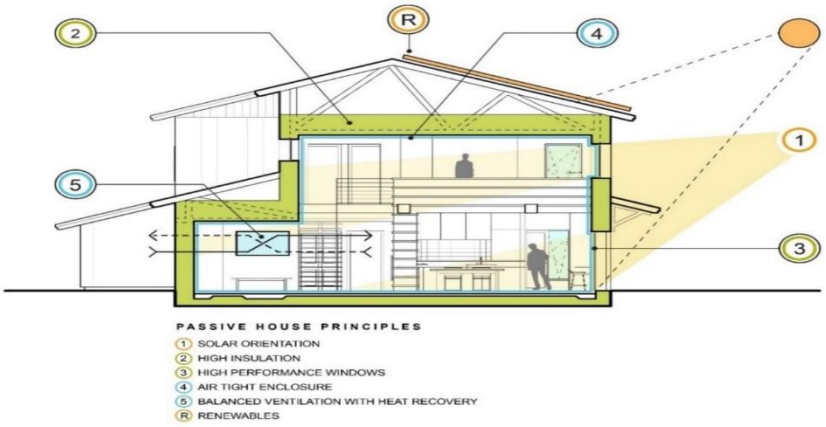


Figure 3: Overview of used passive and future active measures of facility sustainability .com/projects/keffer-residence-passive-house/ 14.5.2021./20:00)
(Source:https://richardpedranti.com/projects/keffer-residence-passive-house/ 14.5.2021./20:00)

Orientation to the Sun is a key factor that helps to heat the house. Then, the high insulation, as stated in the description, which reaches up to fifty centimeters in thickness, as well as the already mentioned high-performance windows, contribute to the house almost never leaking heat. The impermeable housing is placed on the inside of the building, Figure 2 shows how the functionality of passive and active energy sustainability measures is designed. The front part of the thermal insulation serves to prevent the passage of air through the walls, in order to prevent the release of heat. In addition to all that, it is necessary to somehow bring fresh air into the interior of the building, so a machine for balanced ventilation with the return of lost heat in that way is in charge of that. All other electricity

needs are handed over to active systems. Solar panels or solar collectors, depending on the needs of the users, would be placed on the roof of the building and oriented to the south side, in order to most easily collect the sun's rays, which convert them into electricity.

5. CONCLUSION

Today, our planet is a degree warmer than it was before the spread of industrialization. The global average temperature during all months of last year is a whole degree higher than the level from the nineteenth century, and this is due to human activity in terms of higher CO_2 emissions in the air. If today's civilization does not start with the massive application of active and passive energy saving systems, instead of traditional ones, the world will experience catastrophic changes - sea levels will rise, ocean temperatures will rise, and the food we consume will be in danger. The subject of the study of bioclimatic architecture is the contribution of architecture in the fight against current climate change and for living in harmony with the natural environment, while preserving the quality of life. In this paper, it is explained on an example how one passive house leads to energy savings and nature protection, through merging with the natural environment. In fact, a residential model is presented, which with its passive system supports renewable energy sources. This concept of sustainable building reduces energy consumption to almost zero, and at the same time creates incomparable comfort in the house and practically eliminates the costs of heating and cooling. The Keffer Passive House Residence is a weekend family resort located in the US state of Pennsylvania, Pike County. It was designed for the married couple Tom and Lynn Keffer from New York. Construction costs were up to 10% higher per square meter, but given the sustainability and passivity, with heating and cooling costs falling by about 80-90% per year, the return on investment in a short period of time was proven.
Unlike the neighboring buildings, Kefer Passive House is the first designed and constructed building in accordance with the sabioclimatic architecture. The very design of Kefer's house is visually quiet and fits into a wooded environment. The two-storey house with the dark colors of the facade fits into the natural environment, which was moved in in the spring of 2016. The interior is modern, open type. Kefer's passive house used exclusively a passive energy saving system in the conceptual design, later the architect included the possibility of introducing active elements of the house's sustainability in the further elaboration of the project. Since Kefer is the first house with such potentials in the entire Pike district, it can be considered a step towards smart and rational use of energy resources and an end to environmental threats. The fact that Kefer's passive house is the first in Pike district, and it was built in 2016, while this system has been in use in Europe for a long time, shows that the country that is the world's largest emitter of greenhouse gases is making little progress in terms of nature conservation.

6. REFERENCES

[1] Bere J. (2020). An Introduction to Passive House, RIBA Publishing, 10-17.
[2] Busalji, M.(2007) Vrhunski dometi arhitekture, Evro Giunti, 82-90.
[3] David Lloyd Jones,D. L. (2000). Architecture and the Environment: Contemporary Bioclimatic Buildings, Overlook Press, 23-40.
[4] Pedranti R., Living with Passive House Case studies in the human experience, dostupno na: https://issuu.com/richardpedranti/docs/naphc_rpa_living_with_passive_house
[5]Mihajlović, P., Đurić, S., Stošić-Mihajlović Lj. (2008). Upravljanje raspoloživim alternativnim energetskim resursima u urbanoj sredini. Održivi prostorni razvoj gradova, IAUS, Beograd
[6] Stošić-Mihhajlović, Lj., Mihajlović, M., Trajković, S. (2017). Bioclimatic urban design: General, Ecological and Economic aspect. ournal of Process Management. New Technologies 5(3), 17-27
[7] https://richardpedranti.com/projects/keffer-residence-passive-house
[8] https://*architectmagazine.com/project-gallery/keffer-passive-house*

RESISTANCE OF BOLTED TOP AND SEAT ANGLE FLANGE CLEATS CONNECTIONS

[1]Edvin Bolić, [2]Dženana Gačo
[1]University of Bihac, Tehnical faculty Bihac, Address: dr. Irfana Ljubijankića bb, edvinbolic@hotmail.com
[2]University of Bihac, Tehnical faculty Bihac, Address: dr. Irfana Ljubijankića bb, dzgaco@gmail.com

ABSTRACT:

This paper presents the behavior of the bolted top-seat flange cleat connections through laboratory tests on a generally accepted model of the T-stub.
The laboratory testing of T-stubs flanges performed on the samples with a variation of geometric characteristics such as m_1- distance between the axis of the screw and the free surface of the angle cleats, t_f - thickness of the T-subs flanges, d- diameter of the bolts. The results are expressed through the ratio of force and deformation F-Δ of the observed T-stubs flanges.
Based on the results of laboratory tests, analysis were performed and an expression for estimating the optimal ratio of parameters (m_1, t_f and d) was presented in order to achieve maximum resistance of the connection and maximum values of moment resistance and stiffness of bolted top and seat angle flange cleats connections.

Keywords: Bolted top-seat flange cleat connections, T-stub flanges, moment resistance, stiffness.

1. INTRODUCTION

Bolted beam to column joints with angle flange cleats used in steel frame structures can be classified as semi-rigid connections. Such kind of connections show greater ductility than welded joints and show a relatively high energy dissipation ability at seismic loads. Ductility of the connections reduces the risk of brittle and unannounced fractures in the structures. The characteristic of such connections to be prepared in workshops and their simple bolted mounting technology on site ensures an affordable price which ultimately makes such connections competitive in the market so that researchers become challenged to study their basic characteristics and behaviors through experimental, analytical and numerical analyzes.
Such connections can be noticed that in Europe they are significantly neglected compared to welded connections. Even a European standard, EC 3 does not process in detail with the construction and calculation of such joint. The analytical model is use to define the characteristics of the joints, presented through Eurocode [1], are based on the component method. The characteristic of a joint depends on the properties of its basic components, which should be among those identified in EC3 [1].

The basic joint components those identified in Table 6.1 Eurocode [1], together with the reference to the application rules are used for the evaluation of their structural properties. The load-bearing capacity

of the joints is based on the component that has the lowest load-bearing capacity, while the load-bearing capacity of the welds must not be the weakest component in the stress zone. The bolted top angle cleat in tension is usually the most significant source of deformation of the entire connection, and understanding of behavior of top angle cleat is key importance for understanding the behavior of the entire connection.

Eurocode 3 [1] did not directly present the failure mechanisms and resistance of the joints with flange angle cleats that is exposed to bending. As can be seen in Eurocode [1], in bolted connections an equivalent T-stub in tension is used to model the design resistance of the following basic components: column flange in bending, end-plate in bending, flange cleat in bending and base plate in bending under tension. Therefore, the joints with flange angle cleats that is in the tension according to Eurocode 3 is considered as a T-stub. The identification of the flange angle cleats in the tension and the equivalent T-stub is shown in Figure 1.

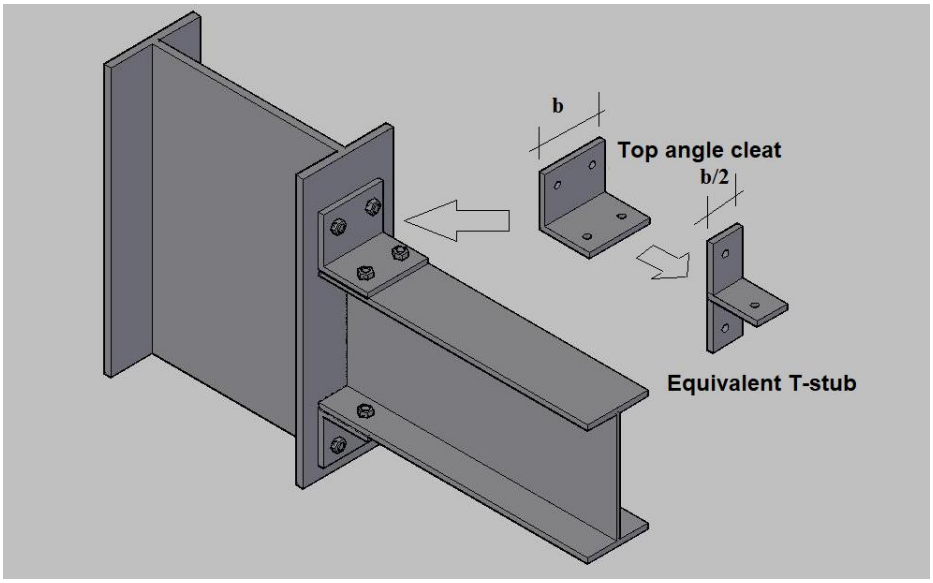


Figure 1: Equivalent T-stub (top angle flange cleat)

As can be seen, the design of the bolted connections according to Eurocode [1] is based on the equivalent T-stub model. This model is based on creating a full plastic mechanism in defining the resistance of connections. This behavior is modeled through the dependence of force and displacement curve F-Δ.

Therefore, it is necessary to purposefully design of the top angle flange cleats to achieve the desired moment resistance of the connection, but also to ensure the ductility of the entire structure.

Therefore, this paper attempts to clarify the behavior in these connections through laboratory tests through the behavior of the equivalent T-stub, which ultimately aims to better understand the connection itself and achieve optimal resistance of the connections.
Laboratory tests for the purposes of these analyzes were examined in the laboratory for testing building materials and structures at the Technical Faculty of the University of Bihać. Experimental tests were performed on the equivalent T-stub by changing the values of the parameters t_f-flange thickness of the

T-stub, d-diameter of the bolts and m-distance of the bolt axis and web of the T-stub. As a result of the test is Force versus Displacement Curves F-Δ of the all examined specimens. Therefore, the ultimate goal of this paper is to propose optimal relationships of these components to obtain the largest possible connection capacity.

2. FAILURE MODES AND PRYING FORCES

The resistance of the top angle flange cleats exposed to bending according to Eurocode [1] is estimated using the equivalent T-stub model and the assumption is adopted that the failure modes of the equivalent T-stub correspond to the failure modes of the top angle flange cleat.
By choosing the geometrical properties of tested T-stub specimens have been selected to obtain different collapse mechanisms. Bolted T-stubs can fail according to three collapse mechanisms.
Three collapse mechanisms of the bolted T-stub, are shown in Figure 2. Connection capacity of bolted T-stub is defined at the level of moment at which the bolted T-stub has reached its yield stress in any of elements.

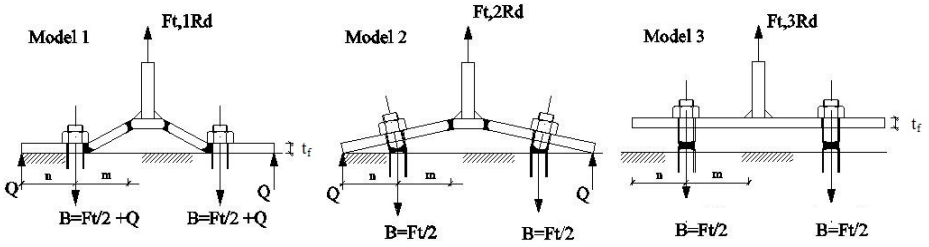


Figure 2: Design Resistance $F_{r,Rd}$ of a T-stub flange.$_{Rd}$

Design Resistance of the T-stub for three models FT,1,Rd , FT,2,Rd and FT,3,Rd are given by expressions (1),(2) i (3). B-axial resistance of the bolt.
Model 1, is characterized by the fact that the collapse of the connection occurs due to development of four plastic hinges. Two plastic hinges are formed along the bolts, on the side of the bolt to the flange in the area of the bolt head or washer. The other two plastic hinges are located at the connections of the flange with the web, on both sides of the web. The design capacity for such a model is given by the expression where is $M_{pl,Rd}$ -design plastic moment resistance:

$$F_{T,1,Rd} = \frac{4 \cdot M_{pl,Rd}}{m} \qquad (1)$$

Model 2, is characterized by complete yield stress within the connection caused by bolt fracture, which is accompanied by complete yield stress of the flange. In the connection, plastic hinges are formed in the flange of the element, but the failure occurs by tearing the bolt. The capacity of such elements is given by the expression where $F_{t,Rd}$ -design tension resistance of a bolt:

$$F_{T,2,Rd} = \frac{2 \cdot M_{pl,Rd} + n \cdot \sum F_{t,Rd}}{m + n} \qquad (2)$$

Model 3, describes collapse in the connection caused by bolt fracture. In this model, there is no formation of plastic hinges inside the flange of the T-element, but the collapse of the connection occurs by the bolt fracture. This mechanism should be avoided because it is a brittle fracture that is very

unfavorable in construction and is represented by expression where is $f_{y,b}$-yield strength of the bolt and $A_{s,b}$ - minimum cross-sectional area of bolt:

$$F_{T,3,Rd} = \frac{0{,}9 \cdot f_{y,b} \cdot A_{s,b}}{\gamma_{M2}} \qquad (3)$$

Obviously, the ultimate resistance is provided by the minimum value among $F_{T,1,Rd}$, $F_{T,2,Rd}$ and $F_{T,3,Rd}$ represents the relevant mode of failure, i.e. the resistance of the top angle flange cleats exposed to bending expression (4).

$$F_{T,Rd} = \min \begin{cases} \frac{4 \cdot M_{pl,Rd}}{m} \\ \frac{2 \cdot M_{pl,Rd} + n \cdot \sum F_{t,Rd}}{m+n} \\ \sum F_{t,Rd} \end{cases} \qquad (4)$$

As bolt action is not concentrated at the bolt axis, it is develops on a finite contact area. It is assumed that this action is uniformly spread on the area under the washer, bolt head, or nut, as appropriate. Actions formed on the contact on the flange from the bolt to the end of the flange of T-stub characterized as Q-prying forces as seen in Figure 2. This relationship is expressed through expression (5).

$$B = F_T + Q \qquad (5)$$

The increase of the prying force Q is reflected in the increase in the force in the bolts B so that it occurs to a decrease in the force that can be taken up by the angle cleat Ft.

2.1. LABORATORY TESTS AND ANALYSIS

The tests were performed in the laboratory for testing building materials at the Technical Faculty of the University of Bihać. Test are conducted with the aim of determining the influence of geometric properties on the resistance of the T-stub through the curve of load and displacement F-Δ. The influence of the flange thickness of the T-stub - **t_f**, the distance m from the bolt axis to the web of the T-stub and the diameter of the bolt **d_b**, which are presented in Figure 3, was considered.

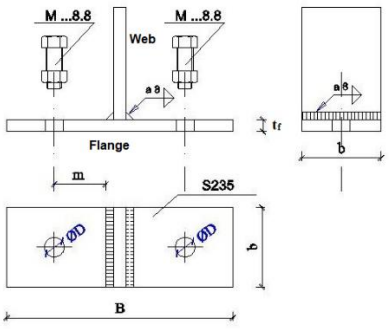


Figure 3: Structural Detail of Tested T-stub Specimens

The **B**-length of the T-stub is taken as a constant at a value of 254mm, and the **b**-width of the T-stub has a value of 80mm. The thickness of the web of the tested specimens is 12 mm steel plate welded to the flange of the T-stub.

The variable parameters t_f, d_b i m analized in experiments are shown in the above figure are considered in the values given in Table 1.

Table 1: The variable parameters of Tested Specimens

Variable		Value	
		Low [-1]	High [1]
A	t_f	8 mm	12mm
B	d_b	16mm	20mm
C	m	42mm	73mm

In order to vary all considered geometric parameters n = 3 which are the subject of consideration, ($2^n=2^3=8$) eight samples were prepared.
As the aim of the test is that the variations of these three parameters on the prepared T-stub influence each of the parameters on the rersistance of the equvalent T-stub, which should ultimately help to form the most optimal ratio of these parameters in the joints.
To determine the number of samples to test their geometric characteristics, we used design of experiment theory. The three-factor matrix of the experimental plan was used, and the geometric characteristics of the T-element samples on which the tests were performed and all variations listed in Tables 2 were determined.

Tabla 2 : Plan matrix

Samples	Plan Matrix							Variable velues			Constants	
	A	B	C	AB	AC	BC	ABC	t_f	d_b	m	b	B
T-1	1	-1	-1	-1	1	1	1	8	ϕ16	42	80	254
T-2	-1	-1	-1	1	1	1	-1	8	ϕ16	73	80	254
T-3	-1	1	-1	-1	1	-1	1	8	ϕ20	42	80	254
T-4	-1	1	1	-1	-1	1	-1	8	ϕ20	73	80	254
T-5	1	-1	-1	-1	-1	1	1	12	ϕ16	42	80	254
T-6	1	-1	1	-1	1	-1	-1	12	ϕ16	73	80	254
T-7	1	1	-1	1	-1	-1	-1	12	ϕ20	42	80	254
T-8	1	1	1	1	1	1	1	12	ϕ20	73	80	254

The following materials were used to make the T-stub on which the test was performed:

- Steel grade S 275: f_y= 275N/mm^2, f_u=430 N/mm^2, ε=0,92;
- Bolt M16 klass 8.8: $A_{v,b}$=201 mm^2, $A_{s,b}$=157 mm^2;
  Bolt M20 klass 8.8: $A_{v,b}$=314 mm^2, $A_{s,b}$=245 mm^2;

The connection of the web and the flange of the T-stub was made by welding with a weld thickness of 8 mm. All tests were performed on the Zwick Roell Z600 material testing machne, which can produce a maximum tensile axial force of 600KN during operation. Web of specements is fixed by top jaws by pressure of 50 Mpa. Bottom plate is absolutely rigid in comparison to the test specimens and fixed to the lower jaw without possibility of movement. Test specements are fixed to the bottom plate with a bolts. Axial tensile force is gradually introduced into the sample over the web of the T-stub until it collapse of sample. Process of testing is shown in pictures on Figure 5.

Samples bolted T-stub is designed to avoid a third collapse mechanisms in the T-stub by bolt fracture without development of plastic hinges in the T-stub flanges as shown through model-3 in Figure 2. Results of the test perform on the Zwick Roell Z600 material testing machine are expressed as the ratio of force and deformation F-Δ in details and presented on graph which shown on Figure 4.

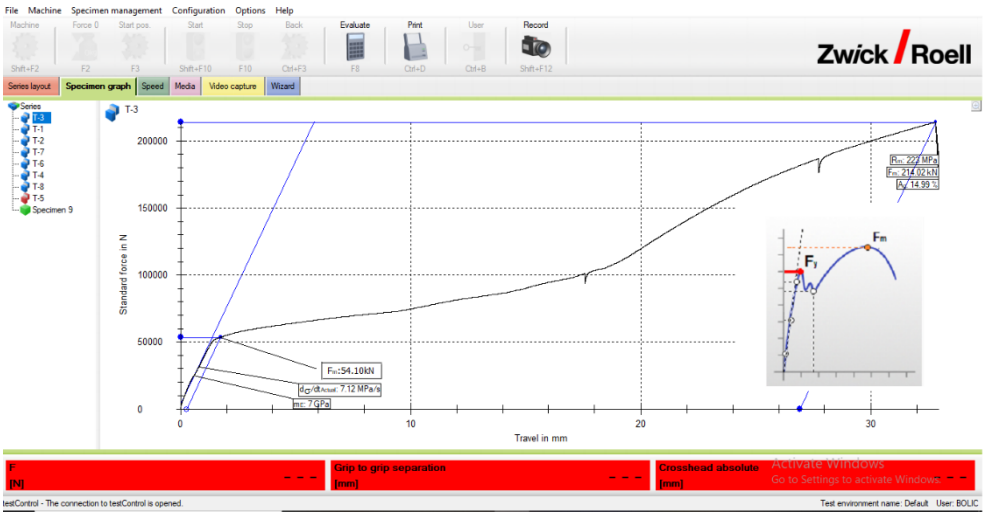


Figure 4: Structural Detail of Tested T-stub Specimens

The axial tensile force gradually increases up to welue of Fy -yield strength. Used testing machine to define the yield strength, a stress at the point of unloading that corresponds to a strain of 0.002 is used. This method of determining the yield strength is called the 0.2% offset method. Presented diagram on Figure 4 present linear relationship between Force versus Displacement up to point F_y-yield strength. Deformation in T-stub are small up to F_y-yield strength and with increasing of the t_f-thickness of flange the yield strength will be increased.

Table 3: Main results of test

Testing order	Variable velues			Experimental results		Computed values EC3
	t_f	d_b	m	F_y	F_m	$F_{t,Rd}$
	mm	mm	mm	kN	kN	kN
T-3	8	ϕ20	42	54.099	214.024	199.035
T-1	8	ϕ16	42	49.433	164.555	122.235
T-2	8	ϕ16	73	41.068	122.593	77.649
T-7	12	ϕ20	42	46.856	209.743	194.041
T-6	12	ϕ16	73	47.028	142.643	73.28
T-4	8	ϕ20	73	41.714	199.458	109.931
T-8	12	ϕ20	73	52.967	227.779	118.08
T-5	12	ϕ16	42	58.234	200.826	117.241

Next point measured during the test is F_m- maximum tensile force. Beatwin the two presented points plastic deformations ocured into the T-sub. Depending to the flange thickness of the T-stub - **t_f**, the

distance m from the bolt axis to the web of the T-stub and the diameter of the bolt $\mathbf{d_b}$, fracturing in the flange or bolts are occurring. Such collected results of the testing are presented in table 3 together with computed value of resistance of the T-stub as per expression (4). Deviations between experimental results and results obtained according to EC 3 su u rasponu od 7-45%.

Experiments confirm that in the initial stages of loading, stresses are concentrated at the connections of the flange with the web, on both sides of the web of the bolted T-stub and in the bolt area. Gradually from the bolt axis the stresses spread towards the ends of the T-stub flange up to fracture in on of the element. By further increasing the applied force, yielding occurs at the connections of the flange with the web and leads to the premature failure of the bolts.This behavior is characteristic of model 1, where a contact force Q appears on the part of the flange from the screw towards the end of the flange, which greatly increases to the capacity of the T-stud and thus the top angle cleat in tension. This force has no major influence and is not taken into account in the modeling of the type 1 mechanism.

After reaching the yielding stress inside the bolt that leads to its deformation as shown by experiments, the contact force Q decreases with increasing load. This behavior is characterized by Model 2, so that in modeling this type of fracture, the need to reduce the bearing capacity in relation to the value of the contact force Q is visible.

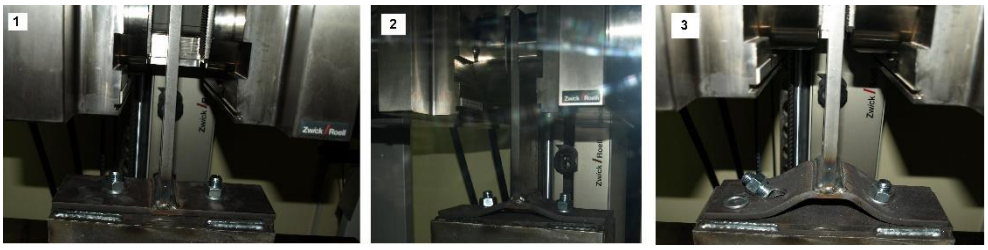


Figure 5: Process of testing T-stub

The experimental results are represented through diagrams Force versus Displacement Curves F-Δ.

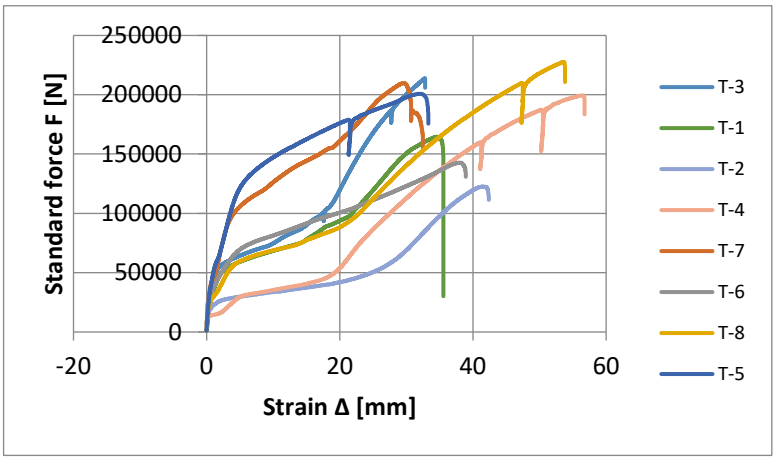


Figure 6: Force versus Displacement Curves F-Δ all of examined specimens

Figure 5 shows the sequence of events described above in Model 2, which shows the process of developing plastic hinges in Figure 5 (2) and the ultimate deformation of the T-element and the loosening of the screw in Figure 5 (3).

These diagrams clearly show the different behaviors of the examined T-stub depending on the varied values of t_f, d_b i m. The diagram shows the area up to the force level f_y where the stresses in the material reach the yield point f_y and large deformations develop in the flange of the T-stub. In the case of yelding stress in the flange of the column without large deformations in the bolt then such a T-stub behaves in accordance with Model 1 and there is a yelding in the flange of the T-stub as in the case of tested elements T-1, T-2, T-5 and T-6 . In the T-element samples T-3, T-4, T-7 and T-8 there is a large deformation in the flange but also in the bolt. The collapse occurs due to the bolt fracture.

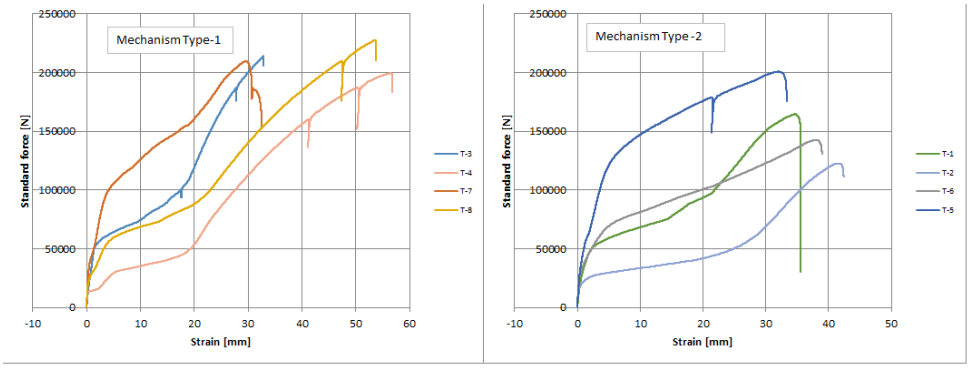


Figure 7: Force versus Displacement Curves F-Δ of Specimens Failing According to Mechanisms Type-1 and Type-2

As can be seen from the attached diagrams, the samples show stable behavior at small deformations and elastic behavior of the T-stub, while differences occur in the area of yield stress. In samples T-3, T-4, T-7 and T-8, it is visible after the yield stress occurred that there is a sudden increase in the capacity and extremely large deformations, after which there is flange yilding occurres in the T-stub. In contrast to this behavior, the T-1, T-2, T-6, and T-5 specimens in the elastic region show a calmer load increment to complete collapse by fracture in bolt.

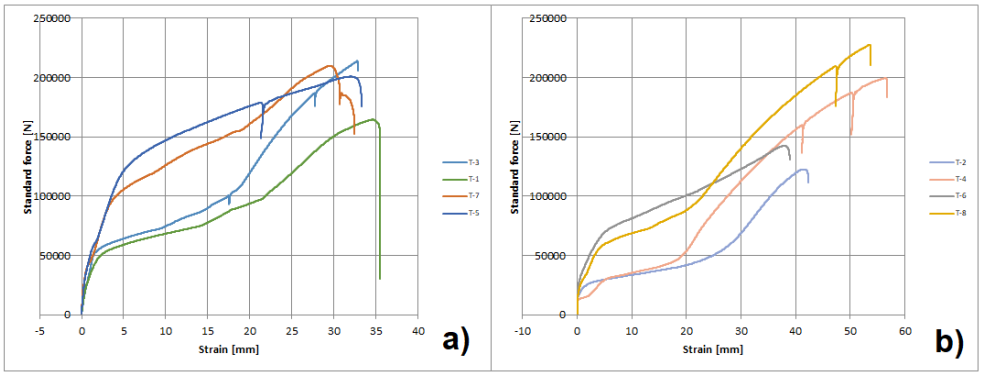


Figure 8: Force versus Displacement Curves F-Δ of Specimens with a) fixed m-42mm and b) fixed m-73mm

Figure 8 shows the behavior of T-stub specimens in which the distance from the bolt axis to the flange of the T-stub is constant and the other variables change. There is an increase in the prying force and

increasing capacity of the T-stub in the linearity area at lower values of m (distance from the bolt axis to the flange of the T-stub).

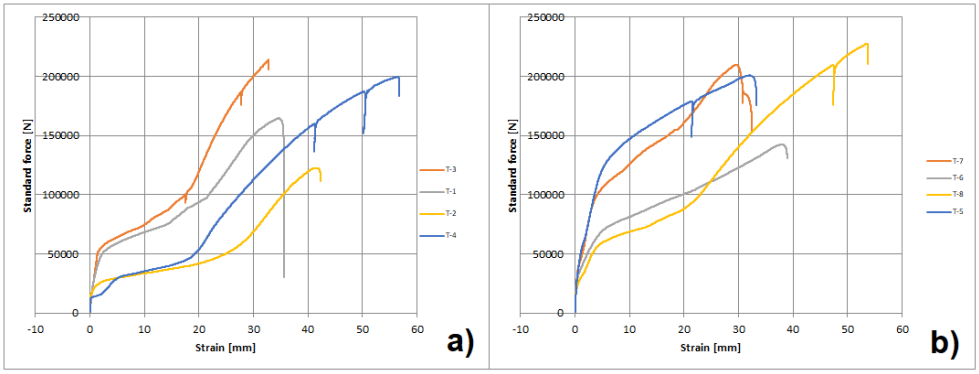


Figure 9: Force versus Displacement Curves F-Δ of Specimens with a) fixed f_t-8mm and b) fixed ft-12mm

Figure 9 shows the behavior of specimens in which the flange thickness of the T-stub is constant and the other variables change.
By planning the experiment as presented in Table 1 and Table 2 and the results obtained by the experimental test Table 3, we approached the search for an approximate function that would describe the capacity of the T - stub in relation to the variables m, t_f i d presented in Table 4 .

Table 4 : Planing of experiment for determination of the resistance

Testing order	Plan matrix							Variable velues			Experimental results
	A	B	C	AB	AC	BC	ABC	x1-t_f	x2-d_b	x3-m	Fm (kN)
T-3	-1	1	-1	-1	1	-1	1	8	ϕ20	42	214.024
T-1	1	-1	-1	-1	1	1	1	8	ϕ16	42	164.555
T-2	-1	-1	-1	1	1	1	-1	8	ϕ16	73	122.593
T-7	1	1	-1	1	-1	-1	-1	12	ϕ20	42	209.743
T-6	1	-1	1	-1	1	-1	-1	12	ϕ16	73	142.643
T-4	-1	1	1	-1	-1	1	-1	8	ϕ20	73	199.458
T-8	1	1	1	1	1	1	1	12	ϕ20	73	227.779
T-5	1	-1	-1	-1	-1	1	1	12	ϕ16	42	200.826

After analysis using Solver, we can see in which ratio each variable affects the capacity of the bolt T-stub. Approximation function for calculation of $F_{t,Rd}$-design tension resistance for flange cleat in bending presented at the expression (6).

$$F_{t,Rd} = 185+10{,}045A+27{,}548B-12{,}084C-4{,}034AB+2{,}047AC+12{,}951BC+6{,}103ABC \quad (6)$$

It can be seen from the above equation that increasing the thickness of the flange increases the capacity of the T-stub. Increasing the diameter of the bolt also increases the bearing capacity of the entire T-stub. The interaction of the thickness of the flange of the T-stub and the diameter of the bolt leads to a decrease in the load-bearing capacity of the total T-stub. It can be seen that increasing the distance between the bolt axis of the flange of the T-stub leads to a decrease in the capacity of the T-stub.

3. CONCLUSION

Knowing the capacity of the top cleat angle in tension in relation to the resistance of bolted top and seat angle flange cleats connections in the initial design phase is very important. Having such information is useful for choosing a suitable metod of analysis of a constructions. Therefore, a form that could help to easily come up with approximate initial data with which to enter the calculations are presented in this paper.
Comparing results according to the experimental test, standard method presented through EC 3 [1] and calculations be simplified formula showing accepted difference at results presented in Table 3.
For example with formula (6) calculation of $F_{t,Rd}$-design tension resistance for flange cleat in bending calculated for:
$\mathbf{t_f}$ - flange thickness 10mm (A=0)
$\mathbf{d_b}$- diameter of the bolt M 20 (B=1)
m-the distance from the bolt axis to the web is 42 mm (C= -1)
$F_{t,Rd}$= 211,883 kN as per formula (6)
For comparation used test presented in Semi-rigid connections handbook [2] Test Id. A2 has same characteristic as used in above calculation.
$F_{t,Rd}$= 193,569 kN as per Test Id. A2 in Semi-rigid connections handbook [2].
The Difference between two above results are 9 % which is within the differences between experimental results and results obtained according to EC 3 presented i Table 3.

4. REFERENCES

[1] Eurocode 3, Design of steel structures, Part 1-8: Design of Joints, European Committee for Standardization, EN 1993-1-8: 2005.
[2] Semi-rigid connections handbook / edited by Wai-Fah Chen, Norimitsu Kishiand Masato Komuro:Copyright © 2011 by J. Ross Publishing, Inc.

UNDERAWATER CONCRETE TECHNOLOGY

Hasib Torić
University of Bihać, Faculty of Technical Engineering, Ul. Irfana Ljubijankića bb
77 000 Bihać, hasib.toric.1993@gmail.com

ABSTRACT:

The paper describes a set of existing knowledge about underwater concreting technology. In the theoretical part of the paper, we give an overview of the existing methods of concreting and mounting concrete underwater. In the experimental part of the paper, we focus on the properties of concrete in order to perform underwater concreting. Also, we explain which procedure is the most common in relation to the need for such a way of installing concrete.

Keywords: underwater concrete technology, special concretes, self-compacting concrete

1. INTRODUCTION

Installation of a concrete mixture underwater, while not performing drainage works, is known as underwater concreting. Underwater concrete is one special type of high-performance concrete that was used in the past, present, and future as long as there is a need to construct facilities with foundations in soil with high water levels. This concrete is known as „UWC“ concrete and is mainly used for the construction of bridges and all off-shore or on-shore structures [1].

Underwater concrete is used for the construction of underwater parts of bridge columns, electricity columns, foundations, some hydraulic structures, etc. Underwater concreting is a difficult task and requires a lot of knowledge, experience, and patience. Placing concrete underwater can present a major problem for a constructor, and can have a great impact on the practicalities of site work. This is the reason why this way of building replaces precast concrete made in the plant, or dry on the construction site. Underwater installation is based on an important fact, that no air is required for curing. The key to successful placement is to avoid the segregation of the mixture or the washing out of the cement paste. Underwater-cast concrete must be proportioned to be highly flowable to spread into place without consolidation and must exhibit adequate stability to reduce segregation and water dilution.

There are two basic approaches to the problem of underwater placement of concrete. The concrete can be mixed conventionally and then placed by special methods, or the preplaced aggregate method can be used. In the first approach, placement can be made by pump, underwater bucket, or tremie. The lower end of the pipe, with an ejectable plug, extends to the bottom of the area to be concreted. This pipe is charged with concrete from the surface. Once the pipe is filled with concrete, it is kept full and its bottom should be kept immersed in the fresh concrete. The forms are filled with coarse aggregates in the second approach, which are then grouted so that the voids around the aggregates are filled. The grout is introduced at the bottom and the water is displaced upwards as the grout rises [1-2].

Underwater concreting is extensively studied in the papers [3-6] where authors try to obtain the best properties of the concrete. Authors in this paper try to introduce novel methods and ingredients into underwater concreting procedures.

In the next section, we will briefly introduce the main characteristics of underwater concrete. In the third section, we will introduce some of the most common methods of concrete installation and finally give a conclusion.

2. PROPERTIES OF UDERWATER CONCRETE

The composition of the underwater concrete mixture is different to the commonly used concrete. The composition of this concrete mixture must be such that concrete slowly passes through the pipe and enters the mass of fresh concrete and gradually raises it in the water. This movement is possible by the gravity effect. Concrete of this type must be cohesive not to segregate during transport. This concrete must compact well without vibration, and be able to not mix with water when installed.

Underwater concrete has a large number of particles smaller than 0.25 mm (fine sand, stone flour, cement). Chemical additives that are mostly used in this type of concrete are superplasticizers and aerants. The anti-washout admixtures can be made from various organic and inorganic materials. The two materials most commonly marketed are cellulose and gum. They act primarily by increasing the viscosity and the water retention of the cement paste. The increase in demand for the ingredients of concrete is met by partial replacement of materials by the waste materials, which is obtained utilizing various industries (slag is a byproduct of metal smelting) [2,4]. Properties of concrete that need special attention: fluid and ability to self-compress, extended installation time, the resistance of concrete to leaching, segregation and low water release, low heat of hydration, binding time, compressive strength, adhesion [7].

2. METHOD OF CONCRETE INSTALLATION

Different methods are used for underwater concreting: vertical movement of pipes (VPT), growing solution (BP), stacking with bunkers, stacking of concrete mix, placement of concrete mix in bags, etc [2].

There are several tried and tested ways of installing concrete [8]:

1. Concreting in the shallows
2. Crane rake
3. Concrete silo
4. Contractor
5. Hydrovalve
6. Movable tube
7. Colcrete (Grouted aggregates)
8. Skip
9. Concrete pump
10. Bags with a patent knot
11. Jute bags
12. Underwater injection bags and mattresses

2.1. Concreting in the shallows

Concreting on the shallows (up to 1 m deep) is performed by shaking the concrete on dry land (pile above the water) which then pushes the slope of the concrete forward with its pressure and so the

concrete mass gradually fills the entire profile. The surface of the concrete is always in contact with the water so that the remaining mass will not be washed away.

2.2. Crane rake

The crane rake can be used in cases of concreting of massive cross-sections when no great demand is placed on the quality of underwater concrete.

2.3. Concrete silo

Concrete silo with fresh concrete should be front finally pressed into the concrete. Just so the immersed vessel is shaken or opened so that the poured concrete does not come into too much contact with the sea, and the level of concrete in the formwork rises [8].

2.4. Contractor

It is based on a steel funnel welded to the vertical pipe, to the contractor, covering a certain surface (diameter of action) for concreting. The usual diameter of the contractor tube is 8 to 12 × the maximum grain diameter of the aggregate, which is usually 250mm. Concreting is done by pouring fresh concrete into the contractor funnel over water. Concrete from the funnel into the mold (formwork) travels by the action of its own weight. The contractor tube is always at its tip at least 0.5m immersed in a pre-installed mass of fresh concrete. At the first filling, the pipe at the lower end is sealed with a kind of "ball" which is pulled out with a chain at the beginning of concreting. Small sections are concreted with a single contractor, and large ones a group of contractors spaced 4-6m apart. The distance of an individual contractor from the formwork and the mutual distance of a group of contractors depends on the diameter of the spread of fresh concrete which is 3 - 4m [PM]. The slope of the fresh concrete surface is 1: 6 for an individual contractor and 1: 9 for a group of contractors. The spreading diameters must overlap so that the entire mold layout is covered by the spreading circles of fresh concrete. Concreting progresses in height by pulling the pipe slightly upwards (without horizontal displacements) as the concrete level rises in the formwork. Only the upper surface of the concrete mass is always in contact with the sea. When the concrete comes out above the water, the submarine concreting is completed, and after the bonding is completed, the upper weak (washed) layer of concrete is broken in order to continue the above-sea concreting on quality submarine concrete.

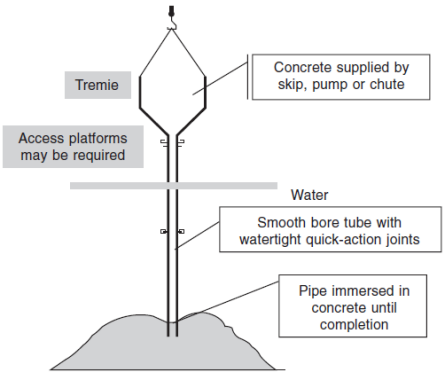


Figure 1: Contractor

2.5. Hydrovalve

It is used for concreting thin structures (a.b slabs up to 0.75 m thick) by horizontal guidance from left to right. The water valve under the steel funnel instead of the steel pipe has a flexible pipe made of woven material at the end of which is again a steel pipe. When there is no concrete in the funnel the pipe is flattened by water pressure, and when the concrete is flowing the pipe is always well adhered to the concrete and there is no leaching of the cement. Its lower end is not immersed in concrete but is at the desired level of the future upper surface of the concrete [8].

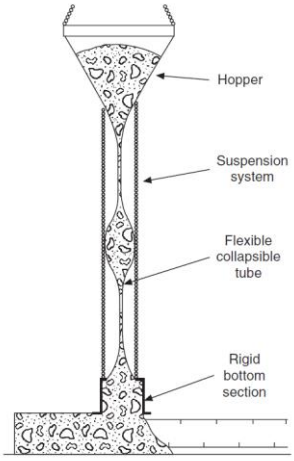


Figure 2: Hydrovalve

2.6. Movable tube

The movable tube works on the principle of Contractors and is used for underwater concreting of slabs in cases when there is no great demand on the quality of underwater concrete.

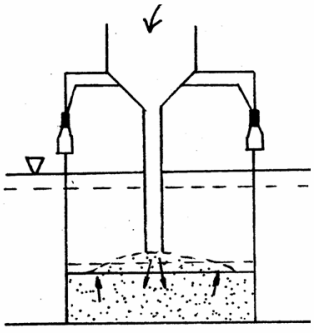


Figure 3: Movable tube

2.7. Colcrete (Grouted aggregates or Pre-placed aggregate concrete)

It involves the installation of aggregates (without cement) in the formwork and then the injection of cement mortar into the aggregate in order to connect the aggregate into the concrete mass. The aggregate is of uniform granulation (single-grain). Concreting begins by pouring the aggregate into the formwork. The total volume of aggregate concrete is 65 - 70%, and mortar 35 - 30%. Before pouring the aggregate, "wells" made of reinforcement are placed in the formwork at a distance 1.5 m, and when pouring the aggregate, the wells are not filled with aggregate. Then get through the well injects a suitable cement mortar into the aggregate cavities. The maximum ø of sand grains in mortar should be less than 1/10 of the minimum ø of aggregate grains. Injection equipment is based on vertical injection pipes (contractors of smaller diameter) which are immersed in "wells" of reinforcement. The wells cover a certain diameter of the concreting injection. The injection is done by pressing a column of cement mortar into the injection pipe. Concreting progresses in height so that the pipe is gently pulled upwards as the level of cement mortar in the formwork rises. A more modern variant is pump injection. Then, instead of reinforcement wells, vertical steel injection pipes are placed almost to the bottom of the mold, and the injection mixture is pressed into the unit through them by a pump. In doing so, the injection tubes (unlike contractor injection tubes) are not pulled upwards as the level the injection mass in the mold increases. The distance between the injection tubes is about 2m. A typical injection mixture (injection mortar) consists of a mixture of binder (portland and pozzolanic cement in a weight ratio of 2,5 : 1 to 3,5 : 1) and sand in a weight ratio of 1: 1 to 1,5: 1. The water-cement ratio of the injection mixture is v / c = 0,42 to 0,5. A chemical additive for injection (intrusion aid) can be added to the mixture, which improves flow, reduces segregation and increases cohesion. This one the additive slows down the setting a little, which allows a longer workability of the injection mixture, and also contains a little aluminum powder which slightly increases the volume before the end of hardening. This method of concreting gives higher concrete strength than others; regularly over 40 Mpa [7-8].

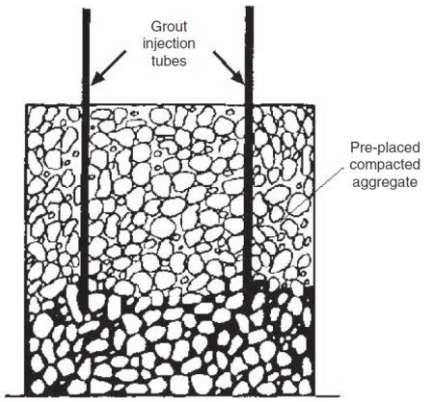


Figure 4: Installation of concrete under water

2.8. Skip

The skip is used for concreting thin construction. It can work even thicker if the mouth of the lattice elevator is buried in previously placed fresh concrete. The elevator consists of two halves of a large tin mold (like two halves of a "baking sheet") that is filled and leveled dry, and covered with two halves of PVC foil that is glued to the concrete and protrudes over the edge mold. Foils prevent the concrete from leaching out because they remain stuck to the concrete when the mold is submerged, but also when the concrete is shaken out. Shaking is done by lowering the mold to the bottom and then lifting the ends while the split in the middle remains at the bottom. This tilts each half of the mold and the

concrete begins to leak along the bottom. At the same time, the halves of the mold are spread so that the concrete is spread along the bottom in a uniform thickness. The best variant is a lattice elevator with vertical guides and a “skirt” that minimizes the mixing of concrete with water.

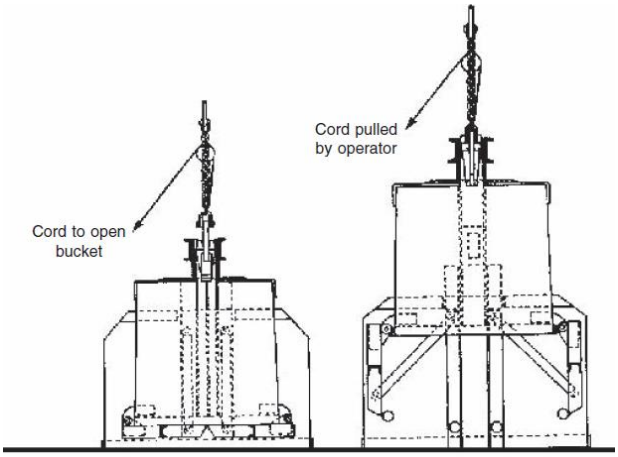


Figure 5: Skip

2.9. Concrete pump

The concrete pump is ideal for installing concrete under the sea because the composition and consistency of submarine concrete is similar to pumped concrete. Concreting depth is about 30m. The principle of concreting is like with a contractor; but the pump operator is not so good feeling like a contractor operator. The underwater pump pipe is at an angle to horizontal, and therefore not as controllable as the contractor tube. Prevention is important of its horizontal displacement.

2.10. Bags with a patent knot

Bags with a patent knot are used when a little concrete is needed such as e.g. code repairs of subsea concrete. The impermeable bag is filled with dry concrete and tie with a rope one patent knot. The bag came down on the rope installation, with a stroke of a rope untie the knot and then squeeze the concrete like toothpaste into a previously prepared cavern in old concrete. All this is done by an underwater diver, with an expensive diving hour.

2.11. Jute bags

Jute bags (10 to 20l) are filled halfway with plastic concrete, tied unbreakable and laid in the desired place by a diver. Half full jute bags they can adapt well when stacking or filling a shape with each other. Cement paste penetrates through the jute into another bag and concrete before the concrete hardens connects. This is convenient when making submarine supports for hollow concrete blocks, because the bags can be leveled well to the desired height. Divers prefer handle a dry mix of cement and aggregates (dry mix concrete), and code installation to connect the bags by placing the plaster between the bags. It doesn't give good results, because dry-mixed concrete is never completely soaked by breaking through

enough amounts of water to hydrate the cement so it does not harden completely, and the contact surfaces among the bags are minimal.

2.12. Underwater injection bags and mattresses

Underwater injection bags and mattresses are used as elements of erosion protection, shipwreck flushing and water penetration. They consist of a two-layer permeable woven material connected by a thread. The sections are joined together, laid empty on a slope below and above the water and then filled with pumped concrete. To strengthen the bags can be stitched with steel cable or rope to ensure integrity after settling and cracks from shrinking concrete [8].

4. CONCLUSION

Normally, underwater concreting pose a challenge to the contractor for various reasons, including the need to minimize washout of cement and fines during concrete placement. Dewatering is a solution, but it is costly. The cost of dewatering averages more than 40% of the total costs. An alternative to dewatering is placing concrete underwater, using a mix proportion containing higher amounts of cement, pozzolans such as silica fume, or (AWA). The hardening of concrete is equal or better under water. However, since vibration is not possible under water (due to rinsing the cement with water), fresh concrete for underwater concreting must be sufficiently liquid and self-compacting to completely fill the mold. Therefore, special attention should be paid to the main stage of concreting: concrete installation. The concrete must not be mixed, separate with water and rinse. In order for this not to happen, the basic rule is that concrete must not fall freely through water: i.e. the concrete mass on the installation path must not come into direct contact with water. If the concrete were poured freely directly through the water, the rapid sinking of the concrete would wash away the tiny particles of the concrete mass, primarily cement, disintegrated fresh concrete into aggregate and cement. The largest granulation would then be deposited on the bottom of the mold first; a clean aggregate would remain at the bottom of the mold. After a relatively long period, loose cement would settle on it. The most common underwater concreting procedure is Contractor where small sections are concreted with a single contractor, and large ones a group of contractors.

5. REFERENCES

[1] Ashraf Mohamed Heniegal, Alsaeed Abd El Salam Maaty and Ibrahim Saad Agwa (2015). Underwater concrete properties with steel slag as the coarse aggregate, - Civil Structures Dept., Faculty of Industrial Education, Suez University, Suez, Egypt.
[2] Ali ,E. E.,and Kattab E. A. (2013). Self Flowing Under-Water Concrete Mixtures With and Without Anti-washout Admixture. Engineering Research J, Azhar University Egypt, Jan.
[3] Grzeszczyk, S., and Jurowski, K. (2021). Underwater Concrete—Impact of Fine Particles in Cement on Washout Resistance of the Concrete Mix. Lecture Notes in Civil Engineering, 129–137. Springer International Publishing. doi: 10.1007/978-3-030-63879-5_10
[4] Ahmad Zaidi, F. H. et.al. (2021). Geopolymer as underwater concreting material: A review. Construction and Building Materials 291, 123276. doi: 10.1016/j.conbuildmat.2021.123276
[5] Nasr, A. A., Chen, S. and Jin, F. (2021). Washout resistance of self-protected underwater concrete in freshwater and seawater. Construction and Building Materials 289, 123186. doi: 10.1016/j.conbuildmat.2021.123186.
[6] Wang, Y. et al. (2021). Beneficial effect of nanomaterials on the interfacial transition zone (ITZ) of non-dispersible underwater concrete. Construction and Building Materials 293, 123472. doi: 10.1016/j.conbuildmat.2021.123472.
[7] Special technologies of concrete installation (grad.unizg.hr/_download/repository/PBT__-_Podvodno_betoniranje.pdf), Accessed: 20.7.2021.
[8] Lectures-Construction technology II, Faculty of Civil Engineering, Osijek 2015. Croatia

REDUCTION OF HEAT TRANSFER COEFFICIENT THROUGH ALUMINUM FRAMES IN CASE OF GLASS REPLACEMENT

Aldin Mahmutović[1], Lejla Bašanović Mahmutović[2]
Univerzitet u Bihaću, Tehnički fakultet Bihać, aldinn93@gmail.com
Univerzitet u Bihaću, Tehnički fakultet Bihać, lejlabasanovic@gmail.com

ABSTRACT:

It is a well-known fact that aluminum windows have an increased heat transfer coefficient compared to newer PVC profiles. Bosnia and Herzegovina is divided into two climatological categories, North and South. During the development of energy projects, it is common to encounter openings with aluminum frames dating from the period 2000-2010. year, and their characteristics do not meet today's criteria that limit the coefficient of heat transfer to 1.4-1.6 W/m^{2}K., depending on the region in which they are located. The aim of this article is to use the calculation method to show how it is possible to obtain the required heat transfer coefficient on this type of window with more optimal solutions and thus greatly reduce the costs of reconstruction of the building.

Keywords: metal frames, heat transfer coefficient, reconstruction, energy projects

1. INTRODUCTION

This article discusses the energy reconstruction of the Clinic for Internal Medicine in Mostar Bijeli brijeg. Windows and doors on the building in 1998 replaced with windows made of aluminum frame, but without interrupted thermal bridge. The glazing was mostly made of thermal insulation glass, but the current glazing is single on many openings. Only a few openings in the extended part of the annex have windows made of five-chamber PVC profiles and with thermal insulation glass with good thermal characteristics. The glazing of these windows is made of thermal insulation glass 4 + 16 + 4 with noble gas filling and low-e coating on the outer glass. The considered type of window in this article is an aluminum frame window with single glass and poor energy characteristics.

2. THERMAL CHARACTERISTICS OF ALUMINIUM FRAME

The building windows is mostly made of aluminum frames by the manufacturer FeAl from the Thermo 50 series. Figure 1 shows the thermal coefficients of this system for double glazing filled with flammable gas. A detailed energy audit included the data that heat transfer coefficient is 3.4 W / m^{2}K for such a system. The facility is located in the South region, which has a problem of excessive space heating, or a large inflow of heat gains in the summer period when we do not need them.

DIMENSIONS	L	[m]	1,23
	H	[m]	1,48
A – frame + wing	U_A	[W/m²K]	3,4
S - glass	U_S	[W/m²K]	1,1
A combination of glass and profile	U_W	[W/m²K]	1,9

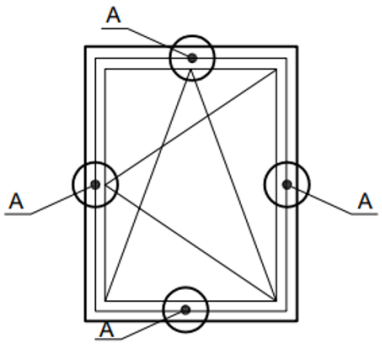


Figure 1: Thermal characteristic of observed Aluminium frame [1]

The window assembly (Figure 2) is divided into three basic areas: glass, which occupies 95% of the total window area, the frame and the connection of the window with the surrounding wall. Most windows contain several glass surfaces, most often two. The window frame can be made in many ways. There are usually two window sashes, sometimes multiple, each with its own frame. In residential buildings, windows can also be found with inserted frame elements that divide the glass surface into several parts, usually two or four. When the window, looking from the room, is "recessed" into the wall, window sills and planks are placed on the inside of the window on the untreated surface of the wall, which, in addition to aesthetic reasons, also serve for better insulation. The glass with the frame and the various elements of the frame are connected to each other by hinges which, along with the handles, are the moving parts of the window assembly. Window connection means the way of installing the window assembly in the wall construction.

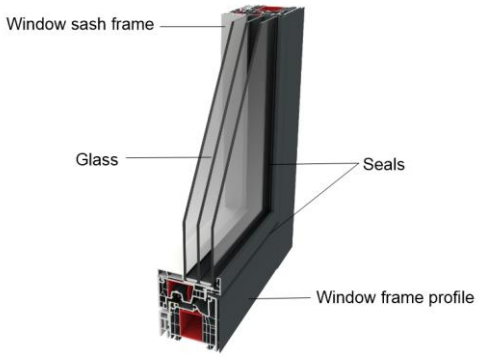


Figure 2: Window elements

The frame transfers heat by convection, conduction and radiation. A large amount of heat can be lost through the window frame, so the U-frame of the window frame (U frame) greatly contributes to the total U-coefficient of the window assembly. Therefore, reducing the U-frame ratio is one of the key problems when calculating windows. With a typical 2-sash window, the frame can occupy up to 30 percent of the total area of the window assembly, which is why the frame has such a large impact on the energy performance of the window. What is important to emphasize in calculation is that it is necessary to take into account the area of the frame covered by the treated window frame provided by

the newly designed condition. This approach leads to results that correspond to the real state of the opening in the structure.

3. CALCULATION OF HEAT TRANSFER COEFFICENT THROUGH A WINDOW ASSEMBLY – EMPIRICAL METHOD

On the observed object we will observe a characteristic window measuring 150 x 148 cm double with an existing aluminum profile Feal Thermo 50 for which are attached all the declaration documents from the manufacturer with which calculation was approached and the newly installed glass IZO CLIMAGUARD SOLAR 4/16 AL NATUR + Ar / 4 FLOAT Ug = 1.0 W / m^{2}K, g = 42.4%, Rw = 30 dB.

Table 1: General window data

Window dimensions	Width:	1,50 m
	Height:	1,48 m
Window material:	FEAL THERMO 50	
Glazing:	IZO CLIMAGUARD SOLAR	
Seals:	Ethylene propylene rubber EPDM	

The calculation of the heat transfer coefficient was declared by the manufacturer and the testing of the window frame and sash performed by the Croatian Institute of Civil Engineering is presented.

Table 2: Measurement results for the Window frame profile of the tested sample [1]

Window specification	**Measure unit**	**Measuring point**		
		1	2	3
Mean temperature of the warmer side of the test sample	℃	14,3	24,9	34,7
Mean temperature of the colder side of the test sample	℃	7,0	17,3	26,8
Mean temperature of the tested sample	℃	10,7	21,1	30,8
Mean temperature difference	K	7,3	7,6	7,9
Heat flux density	$W \cdot m^{-2}$	27,7	29,6	30,8
Thermal resistance	$K \cdot m^2 \cdot w^{-1}$	0,264	0,258	0,254
Thermal resistance at +10.0℃	$K \cdot m^2 \cdot w^{-1}$	0,264		

In accordance with the prescribed norms and laws [4], the heat transfer coefficient for the window profile of the tested sample is:

$$k = \frac{1}{\frac{1}{\alpha}+R_{10}+\frac{1}{\alpha}} = 2{,}3\ W \cdot K^{-1} \cdot m^{-2}\ . \quad (1)$$

Table 3: Area of the observed window frame

The observed part	Width [**m**]		Heigth [**m**]	Frame area [$\mathbf{m^2}$]
Sides x2	0,112 - 0,02 =	0,092	1,256	0,2311
Middle bar		0,142	1,256	0,1784
Lower bar	0,112 - 0,02 =	0,092	1,5	0,1380
Upper bar	0,112 - 0,02 =	0,092	1,5	0,1380
Total frame area:				**0,6855**

The heat transfer coefficient of the glass declared by the manufacturer is 1.0 $W \cdot K^{-1} \cdot m^{-2}$. If PVC joining strips is used instead of metal joining strips, this coefficient is reduced by 10%.

Table 4: Window specification

Glazing width	0,567 m
Glazing height	1,256 m
Glazing surface	1,424 m^2
Total opening area	2,20 m^2
The proportion of glazing in the opening	64 %
Glass / joint edge length	(0,567+1,256)x2x2= 7,29 m

The heat transfer coefficient of increase in the case of well-resolved thermal bridges is Ψ_g = 0.05 W/m^2K. The calculation of the total heat transfer coefficient U_w [5] is calculated according to the expression

$$U_W = \frac{A_f \cdot U_f + A_g \cdot U_g + l_g \cdot \Psi_g}{A_w} . \quad (2)$$

Where is:

Uw - factor of the built-in window, W/ m^2K
Aw - built-in window area, m^2
Uf - U-factor of the frame, W/m^2K Af - surface of the frame, m^2
Ug - U-factor of glass, W/m^2K Ag - surface of glass, m^2
Ψg - heat losses caused by thermal bridges of the glass edge, W/m^2K
lg - length of glass edge, m

After all the necessary data have been entered, the calculation of the heat transfer coefficient is approached:

$$U_w = 1{,}49\ W/m^2K$$

If we observe that a system of external aluminum blinds has been applied to the building windows, the heat transfer coefficient is additionally reduced by 10% and the real total heat transfer coefficient is:

$$U_{real} = U_w\ x\ 0{,}9 = 1{,}34\ W/m^2K$$

A detailed energy audit envisages the replacement of the existing windows and the financial indicators are given in detail energy audit [2].

The installation of blinds is not planned, nor the processing of internal and external joists, which is significant in terms of price, and windows without blinds are unacceptable for the user of the facility,

having in mind the purpose of the institution and the geographical position of the facility - Mostar, south region.

If we consider only the replacement of glass with high quality IZO CLIMAGUARD SOLAR 4/16 AL NATUR + Ar / 4 FLOAT Ug = 1.0 W / m2K g = 42.4% Rw = 30Db which absolutely satisfies the needs of users and we keep the much needed blinds. Energy consumption remains as predicted through a detailed energy certificate as well as energy savings while reducing investment and its payback period. It is necessary to replace the sealing tires and make the connection between the glasses with a PVC strip in order to further reduce heat loss. The calculations performed above show that the total heat transfer coefficient is less than 1.6 W / m^2K required by the regulations for the envisaged region. Since all external slats will be additionally insulated and cover part of the Al profile, this will also significantly reduce air infiltration. This way everything will remain the same in energy consumption but the investment as well as the repayment time will be reduced.

After replacing the glass with new IZO glass, PVC moldings and filled with argon and replacing the seals, the investment reduces the repayment period of the measure from 18.18 years to 10.23 years with the same comfort and.

3. CONCLUSION

The calculation proved that by replacing the existing glass with IZO CLIMAGUARD SOLAR 4/16 AL NATUR + Ar / 4 FLOAT *Ug* = 1.0 W/m^2K, g = 42.4%, *Rw* = 30 dB, we achieve a heat transfer coefficient of 1.49 W/m^2K without the use of blinds with which we meet the heat transfer conditions for openings for the South region are 1.60 W/m^2K. In addition, the originally planned investment was reduced by 56% as well as the payback period from 18.18 years is reduced to 10.23 years, which is 44% faster return.

4. REFERENCES

[1] Feal Thermo 50 Catalog
[2] Detailed energy audit, ENOVA d.o.o. , Sarajevo 28.05.2020.
[3] Thermal performance of windows, doors and sun protection systems - Calculation of heat transfer coefficient - Part 1: General (EN ISO 10077-1:2006, IDT; ISO 10077-1:2006, IDT)
[4] Thermal performance of windows, doors and associated elements - Calculation of heat transfer coefficient - Part 1: General (EN ISO 10077-1:2006/AC:2009, IDT; ISO 10077-1: 2006/AC:2009, IDT)
[5] Thermal performance of windows, doors and associated elements - Calculation of the heat transfer coefficient - Part 2: Numerical method for frames (EN ISO 10077-2:2012/AC:2012, IDT; ISO 10077-2:2012/AC:2012, IDT)

OVERVIEW AND COMPARISON OF TYPES OF RETAINING WALLS IN ROAD HULL REMEDIATION

Sanel Grgic, Mirza Memic
University of Bihać, Technical Faculty, Irfana Ljubijankića bb,sanel_grga@hotmail.com
Public Institution Directorate of Regional Roads TK, A. Herljevića 43 Tuzla,
mirza.memic@bih.net.ba
University of Bihać, Technical Faculty, Irfana Ljubijankića bb,edis.softic@bih.net.ba

ABSTRACT:

In everyday modern construction practice, very often apply supporting structures of various types and shapes. It is use them to secure the slopes of cuts or notches in the construction of roads or railways, piers, coastal bridge piers and the rehabilitation of road hulls or increase stability in the event of landslides and mudslides or due to any need for terrain denivelation. This immediately raises the question of which type of retaining wall to choose. In addition to the spatial constraints and geostatic conditions that each wall needs to meet, it is also necessary for such a facility to be ultimately the most economically acceptable technical solution. In order to make it somewhat easier for engineers to make such decisions, this paper analyses and compares the results of calculations and construction values for different types of retaining walls.

Keywords: retaining structures, variant solutions, rehabilitation

1. INTRODUCTION

Today's demanding market poses various challenges to engineers in order to solve problems in geotechnical practice as efficiently and quickly as possible. When it comes to infrastructure, especially traffic, we are witnessing very frequent landslides, or mudslides that result in various damage to the road hull. As one of the basic remediation measures, along with other interventions to address the issue of drainage, the construction of a retaining wall is usually applied. The individual geometric elements of the remediation cross-section are mostly determined. This refers to the height of the retaining wall. The crown of the wall is directly determined and tied to the elevation of the road (usually 20-30 cm higher). As it is a matter of remediation, after performing all works and asphalting, the levels must return to the level before the damage occurs. It is similar with the foundation level because it is necessary to fulfill the condition that the wall must be based in stable soil. This refers to the position of the sliding plane and the line of the substrate. But there is a dilemma about the adoption of other elements of the wall (wall thickness, height and width of the foundation, the place of clamping the wall in the foundation foot, or the dimensions of the "heel" and foundation footing in front of the wall, etc.). The determination of the mentioned geometrical elements directly affects the value of the total remediation works on the road hull, which is a limiting factor when choosing the type of retaining wall. In this paper, various researches have been done on a large number of different calculation models in order to get a more realistic picture in forecasting and solving the above mentioned geotechnical problems. Based on the results of the calculation, a recommendation has been given regarding the selection of the optimal design solution, ie the selection of the type of retaining wall. Theoretical bases, the method of modeling with a kind of instructions have been described in [2,3,4,5,6]. The analysis was

done on a specific example, where we had all the data on the soil and comparisons of different retaining walls were made.

2. RESEARCH PAPERS

Prior to the remediation of the road hull, the exact cause of instability or landslides must be determined. Appropriate geomechanical investigations are needed to determine these causes. In order to draft proposals for landslide remediation measures, it is necessary to collect and analyse engineering geological, hydrogeological and geotechnical research data as follows:

- define the geometry of landslides and soil layers (situational and altitude);
- define soil layers with their physical-mechanical layers;
- determine the depth of the sliding surface;
- determine the groundwater level;
- determine the direction, intensity and speed of landslides.

In this paper, we will not deal with the causes of landslides, but we will analyse and compare the results based on the parameters from the real example of hull remediation that occurred on the regional road R-461a Srebrenik - Orahovica.
For the needs of the remediation project, detailed geodetic surveys have been performed and engineering-geological and geomechanical research works and tests have been done in order to obtain relevant data, [8].

Figure 1: Footage from the spot, [8]

To determine the geomechanical properties of the soil, two exploratory excavations marked R-1 and R-2 have been performed. Samples for laboratory tests have been taken from the research excavations, [7].

Table 1: Geomechanical characteristics of soil-taken from [7]

No.	Layer	γ_{sat}	C_{ref}	φ
		[kN/m^2]	[kN/m^2]	°
1	Clay sand	22,0	22,6	32,0
2	Stable terrain (substrate)	19,2	8,0	22,2
3	Compacted limestone (backfill)	20	0	32

Based on the previously described engineering-geological characteristics of the terrain and comparison of laboratory results conducted during these researches, comparisons and experiences with similar materials, the geotechnical profile of the terrain with parameters for calculations has been adopted, Figure 2, [7].

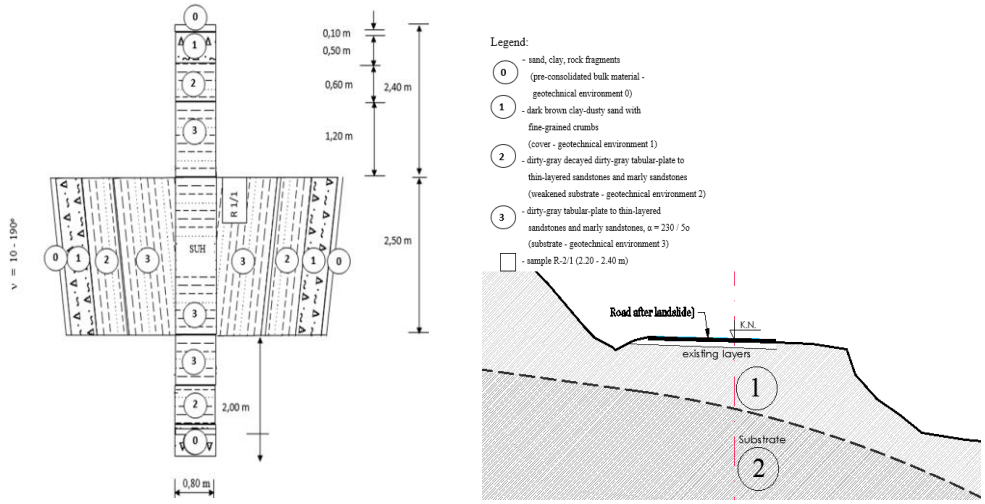


Figure 2: a) Engineering-geological terrain profiles, b) existing condition profile [7]

3. BUDGET MODELS

After a thorough analysis of all the above factors, calculations and simulations on budget models, three types (models) of remediation are proposed for comparison: reinforced concrete cantilever retaining wall, reinforced concrete "L" shaped retaining wall, massive retaining wall.
For the purposes of analysis, it is necessary to adopt certain assumptions or criteria. A criterion has been adopted where the transverse profile, for each type of wall, has the same geometric and geomechanical parameters (height of soil leveling, elements of road construction, traffic load, soil parameters, etc.) which do not change during the analysis.

The terrain model is made of horizontally layered soil with two layers (backfill and substrate). Each layer is associated with the following parameters: (unit volume weight, internal friction angle, cohesion). The surface of the terrain (road) is horizontal with the adopted equally divided surface load of 20 kN / m^2. No groundwater has been registered.

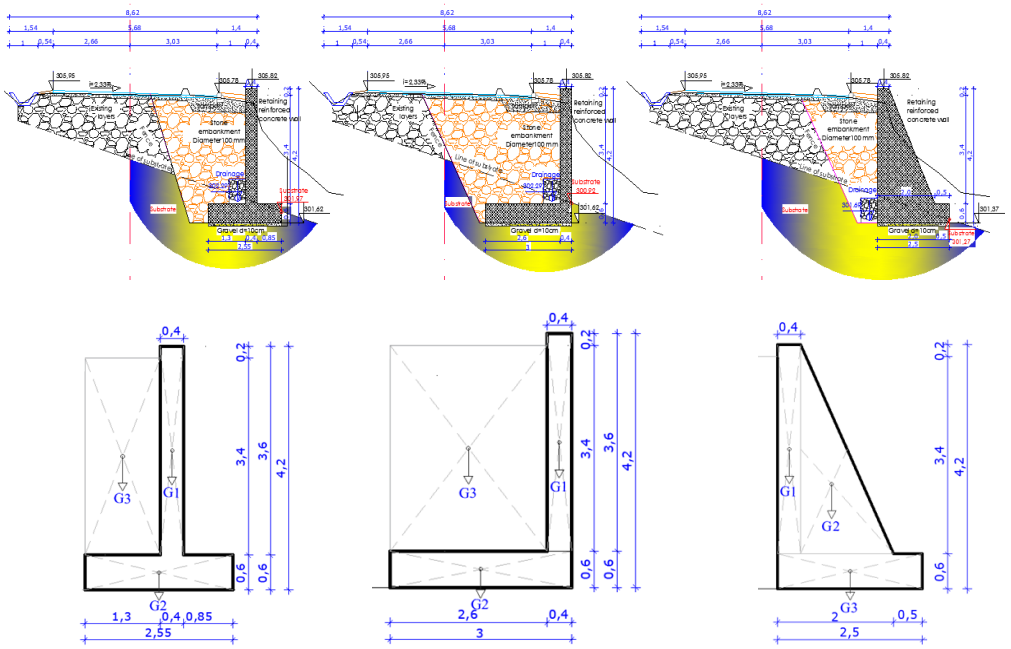


Figure 3: Display of variants on the most loaded profile and geometric characteristics

4. RESULTS AND DISCUSSION

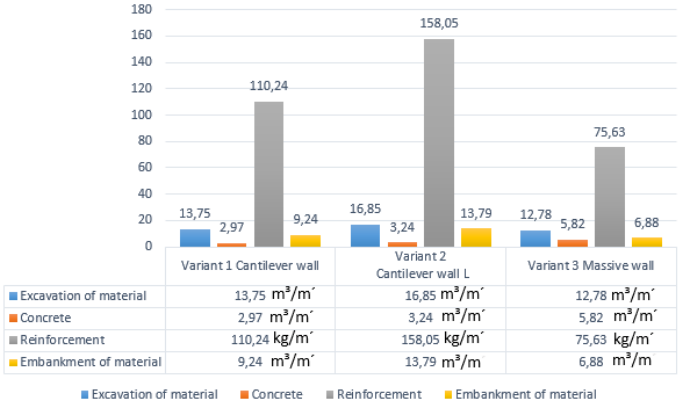
The entire budget has been made according to the Ordinance on Technical Standards for the Foundation of Buildings, [1]. Iterative geostatic calculations, on all types, have led to the minimum cross-sectional area of the adopted type of retaining wall on the basis of which the estimated value of the wall and remediation works has been established and acompared with the others.

Table 2: Display the results of variants

Variants	G[kN]	Fsk≥1,50	Fsp≥1,50	M[kNm/m´]	σ1[kN/m²]	σ2[kN/m²]
Cantilever wall	162,65	1,68	2,22	67,92	126,12	1,45
Cantilever wall L	256,80	2,34	2,27	125,89	169,53	1,68
Massive wall	145,50	1,57	2,12	53,61	109,75	6,65

The following results of the calculations have been analysed: stability factors, stresses on the foundation soil and the amount of work and materials necessary for the construction of a particular type of wall. Only the results of the calculation have been taken into account, where the selected wall satisfies all the conditions of structural and soil stability. The stability of an individual case is satisfied if the tests for overturning and sliding (Fs≥1.5) and stress values on the foundation soil with a positive sign (σ1 and σ2> 0) are satisfied, ie that the resulting force is inside and as close as possible to the core boundary.
The analysis of the calculation results have led to important conclusions related to the selection of the type of retaining wall that is the most rational or most economical for the remediation of the landslide in this case. In order to determine which type is the most economical, the positions of the works that are characteristic and crucial for each selected type of wall have been taken into consideration. The

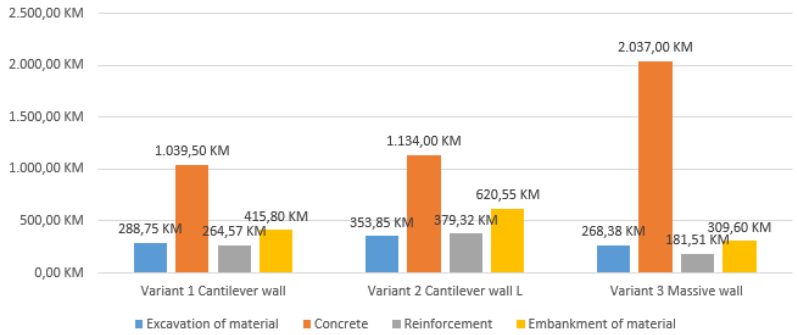
works that we observed in the selected models are: the required excavation for each variant, the amount of installed concrete, the amount of reinforcement and the amount of embankment for backfilling. Considering that other works on road hull remediation are mostly the same for all types, and their scope does not significantly affect the final difference in the value of repair works, it was adopted that they are constant. For all types, the same unit price of the works for which the comparison is made has been taken into account.



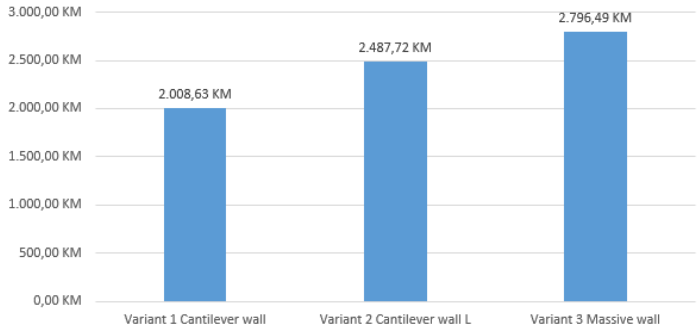
Graph 1: Display of material consumption by variants for m´ reinforced concrete wall

Table 3: Display of the value of wall construction works taken into consideration

Copared parameters	**Variant 1** Cantilever wall	**Variant 2** Cantilever wall L	**Variant 3** Massive wall
Excavation of material	288,75 KM	353,85 KM	268,38 KM
Concrete	1.039,50 KM	1.134,00 KM	2.037,00 KM
Reinforcement	264,57 KM	379,32 KM	181,51 KM
Embankment of material	415,80 KM	620,55 KM	309,60 KM
TOTAL	**2.008,63 KM**	**2.487,72 KM**	**2.796,49 KM**



Graph 2: Display of the value of wall construction works taken into consideration



Graph 3: Total cost of construction of the retaining wall by variants for m´

5. CONCLUDING REMARKS AND CONCLUSIONS

Analyses of this type have recently become a very desirable process in the design and optimization of retaining walls. They enable designers of geotechnical structures to quickly find the most economical technical solution for a specific case.
Based on the conducted analyses, we come to the conclusion that the offered model is rational and the most economical of the selected three types of wall for a specific case.
The proposed model can serve as an example for solving similar cases in practice.
It is necessary to perform further research on similar examples and to compare the obtained results. It is recommended to perform numerical analyses and compare the obtained results.

6. BIBLIOGRAPHY

[1] Rulebook on Technical Norms for the Foundation of Buildings ("Official Gazette of the SFRY" 15/90).
[2] Memić M., Folić R. (2012): Theoretical Foundations and Numerical odeling in Plaxis, SGIT Serbia: Collection of Works "Earthquake Engineering Engineering Seismology", Divčibare, 239-250
[3] Roje-Bonacci, T. (2003): Soil Models, IGH d. D, Zagreb, Split.
[4] Memić M., Folić R. Ibrahimović A. (2013): Influence of Soil Parameters Change on Displacement of Reinforced Concrete Diaphragms, Collection of Works -Geotechnical Aspects of Construction, Soko Banja, 93-102
[5] Memić M., Folić R. Ibrahimović A. (2013): Comparative Analysis of Methods for Estimating the Displacement of Flexible Anchor Concrete Diaphragms, Building Materials and Structures 56, Belgrade, 19-43.
[6] Memić M., Folić R. (2018): Remediation Model of RC Support Structure - Case Study, DGKS 15, Zlatibor, 209 - 218.
[7] Study on Engineering-Geological and Geotechnical Characteristics of the Terrain, "Barel" doo Tuzla, November 2015.
[8] Main Project for the Remediation of the Regional Road Hull R-461a Srebrenik-Orahovica, at the station km. 12 + 270, "ARTING BH" doo Sarajevo, February 2015

OPTIMALIZATION OF CANTILEVER REINFORCED CONCRETE RETAINING WALLS

Sanel Grgic, Mirza Memic, Edis Softic
University of Bihać, Technical Faculty, Irfana Ljubijankića bb,sanel_grga@hotmail.com
Public Institution Directorate of Regional Roads TK, A. Herljevića 43 Tuzla,
mirza.memic@bih.net.ba
University of Bihać, Technical Faculty, Irfana Ljubijankića bb,edis.softic@bih.net.ba

ABSTRACT:

Weather conditions and rains with their intensity cause problems and damage various structures, especially in construction. In some cases it is necessary to react quickly, build a supporting structure to prevent damage to buildings and roads.Due to the fact that cantilever reinforced concrete- retaining walls (T Type) are one of the most economical and most commonly used types of walls, the paper analyses its basic geometric elements with the aim of optimizing and rationalizing their construction.

Keywords: retaining structures, variant solutions, rehabilitation

1. INTRODUCTION

The goal of every company that deals with construction is to optimize the consumption of materials and other resources during the construction of a facility, with the goal to meet all quality and safety requirements. In order to meet such goals, a comprehensive analysis of all factors that may affect them is necessary. When it comes to the construction of cantilever RC retaining walls, there are several dilemmas about defining the geometry of its structural elements and the cross section as a whole. First of all, it refers to determining the height and thickness of the wall, the height and width of the foundation, the place of clamping the wall in the foundation foot, or the dimensions of the "heel" and part of the foundation foot in front of the wall, etc .
With reference to all the above, it is of interest to determine which ratio of geometric elements gives the most rational cross section, and which will ultimately give the minimum necessary value of works in order to build such a structure. In this regard, an analysis has been made on a large number of different rational models that are presented in the paper.
Through the consideration of the calculation results, a framework and recommendations have been given to the designers regarding the selection of the optimal cross-section of the cantilever RC retaining walls. Theoretical bases, the method of modeling with a kind of recommendations are described in papers [3,4,5,6]. The analysis was done on a specific example, where we had all the data on the soil.

2. RESEARCH PAPERS

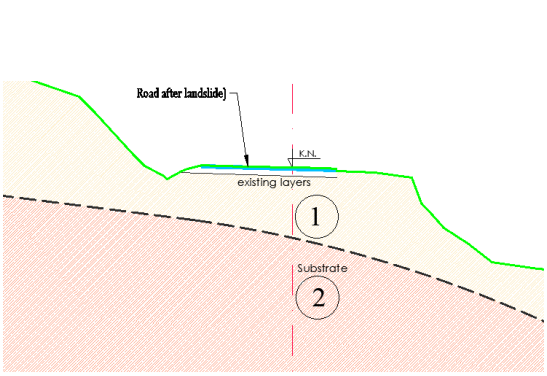
Analyses and comparison of results in this paper have been made on the basis of parameters from a real example of hull rehabilitation on the regional road R-461a Srebrenik - Orahovica. For the needs of the rehabilitation project, detailed geodetic surveys have been performed and engineering-geological and geomechanical research works and tests have been done in order to obtain relevant data, [1,7].

To determine the geomechanical properties of the soil, two investigative excavations marked R-1 and R-2 have been performed. Samples for laboratory tests have been taken from the research excavations [2].

Table 1: Geomechanical characteristics of soil-taken from [2]

No.	Layer	γ_{sat}	C_{ref}	φ
		[kN/m^2]	[kN/m^2]	°
1	Clay sand	22,0	22,6	32,0
2	Stable terrain (stubstrate)	19,2	8,0	22,2
3	Compacted limestone (backfill)	20	0	32

Based on the previously described engineering-geological characteristics of the site and the comparison of laboratory results conducted during these researches, comparisons and experiences with similar materials, the geotechnical profile of the site with parameters for calculations has been adopted, Figure 1, [2,7].



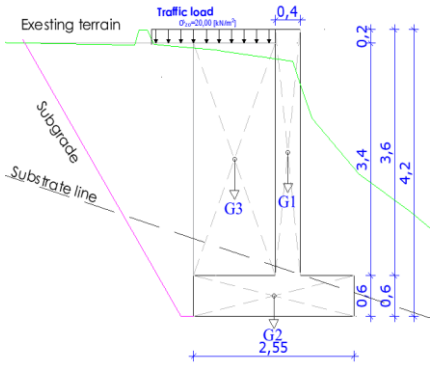


Figure 1: a) Profile of the existing condition [1] *b) calculation model of the retaining wall*

3. RATIONALE MODELS

One of the basic dilemmas is how to determine the geometry of the structural elements of the wall as well as the position of the wall in relation to the foundation rate. Through further research, models have been set up and facts and indicators have been established that can give guidance in design of the geometry of the retaining wall.

For the purposes of analysis, it is necessary to make specific assumptions or criteria. A criterion has been assumed where the transverse profile, for each calculated wall model, is with the same geometric and geomechanical parameters (height of soil denivelation, elements of road construction, traffic load, soil parameters, etc.) which do not change during the analysis. [7].

The model is made of horizontally layered soil with two layers (backfill and substrate). Each layer is associated with the following parameters: (unit volume weight, internal friction angle, cohesion). The surface of the road is horizontal with the adopted equally divided surface load of 20 kN / m^2. No groundwater has been registered. [7].

The initial basis or initial model with all parameters for analysis has been taken from the work of the same authors [9], where it has been proved that the selected geometric elements of the cantilever RC retaining wall provide the most rational technical solution. In the calculation models, the geometric elements are constant: the height of the cantilever wall H = 4.2 m, the width d = 0.4 m, and the width of the foundation B = 2.55 m.

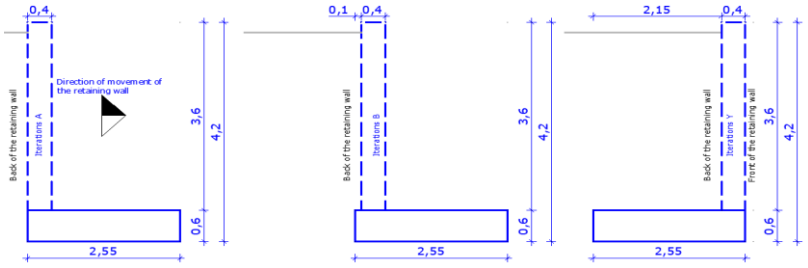
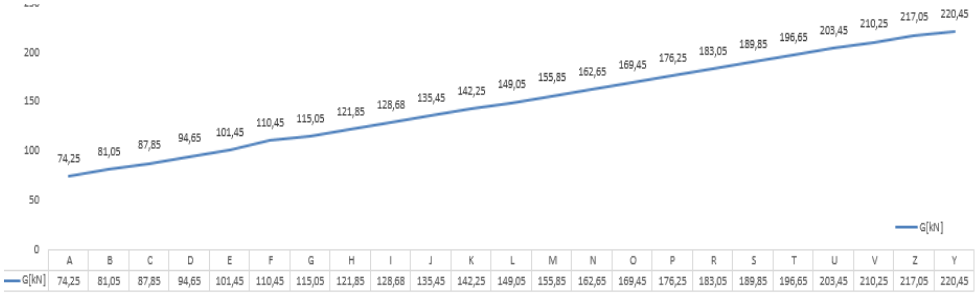


Figure 2: Direction of the displacement of retaining wall

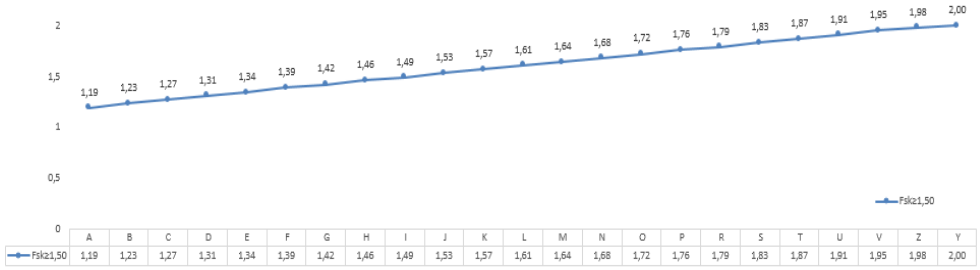
4. RESULTS AND DISCUSSION

When determining the geometry of the cross section of the wall, special attention should be paid to determining the place of clamping the wall in the foundation footing. In this paper, an analysis has been done where the iteration has been performed from point A to point Y and the displacement interval has been 10 cm. Point A is located on the inner (back) side of the foundation and point Y is on the front. It is of interest to determine in which position of the wall the most rational cross section is obtained.
The stability of an individual case is satisfied if the checks on overturning and sliding (Fs≥1.5) and stress values on the foundation soil with a positive sign (σ1 and σ2> 0) are satisfied.
An overview of the results of geostatic calculations of stability factors and bending moments and stresses in the foundation joint is given in tabular and graphical form. The connection between the RC retaining wall and the substrate.
Table 2: Display of results A-Y

	Iterations [m]	G[kN]	Fsk≥1,50	Fsp≥1,50	M[kNm/m´]	σ1[kN/m²]	σ2[kN/m²]
A.	0,0	74,25	1,19	1,16	-76,00	99,25	-41,02
B.	0,1	81,05	1,23	1,28	-71,30	97,56	-33,09
C.	0,2	87,85	1,27	1,39	-67,20	96,49	-27,58
D.	0,3	94,65	1,31	1,50	-63,90	96,04	-21,81
E.	0,4	101,45	1,34	1,59	-61,20	96,23	-16,66
F.	0,5	110,45	1,39	1,73	-57,30	96,23	-9,6
G.	0,6	115,05	1,42	1,77	-57,80	98,48	-8,24
H.	0,7	121,85	1,46	1,86	-57,20	100,55	-4,98
I.	0,8	128,68	1,49	1,93	-57,20	103,24	-2,34
J.	0,9	135,45	1,53	2,00	-57,90	106,56	-0,33
K.	**1,0**	**142,25**	**1,57**	**2,06**	**-57,30**	**110,51**	**1,06**
L.	**1,10**	**149,05**	**1,61**	**2,12**	**-61,40**	**115,09**	**1,81**
M.	**1,20**	**155,85**	**1,64**	**2,17**	**-64,10**	**120,29**	**1,94**
N.	**1,30**	**162,65**	**1,68**	**2,22**	**-67,60**	**126,12**	**1,45**
O.	**1,40**	**169,45**	**1,72**	**2,26**	**-71,70**	**132,58**	**0,32**
P.	1,50	176,25	1,76	2,29	-76,50	139,67	-1,43
R.	1,60	183,05	1,79	2,32	-81,90	147,38	-3,81
S.	1,70	189,85	1,83	2,34	-88,10	155,72	-6,82
T.	1,80	196,65	9,87	2,36	-94,90	164,69	-10,46
U.	1,90	203,45	1,91	2,37	-102,40	174,29	-14,72
V.	2,00	210,25	1,95	2,37	-110,60	184,51	-19,61
Z.	2,10	217,05	1,98	2,37	-119,50	195,36	-25,13
Y.	2,20	220,45	2,00	2,37	-124,20	201,03	-28,12

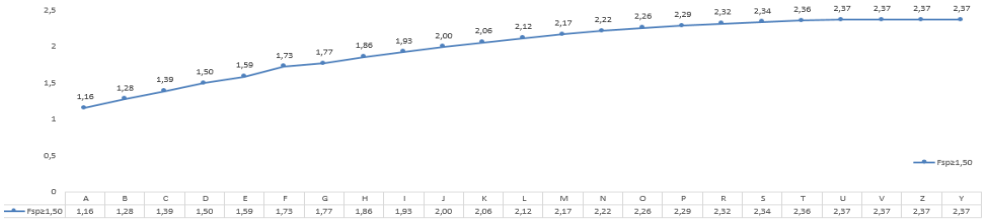


Graph 1: Wall weight - sections A-Y



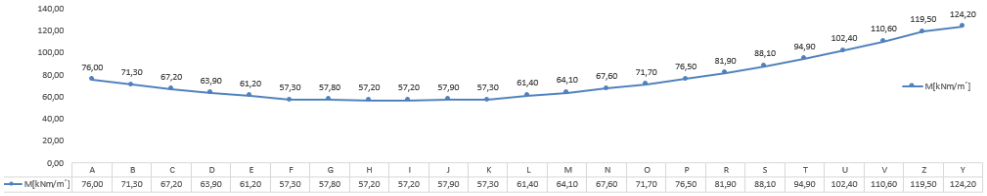
Graph: Slip stability - sections A-Y

If look at the weight of the retaining wall (G), can see that by increasing the interval and forming the "heel" of the wall, a higher own weight is mobilized, which certainly has a positive effect on the stability of the wall.The increase in the weight directly affects the increase in the slip stability factor, which is expected because the force of active soil pressure is constant for all models. It can be noticed that the condition Fsk is satisfied only after the interval of moving the wall 0.9 m ("heel" 0.9 m) or about 0.35B. The Fsk magnification function has a linear character.



Graph 3: Stability on overturning - sections A-Y

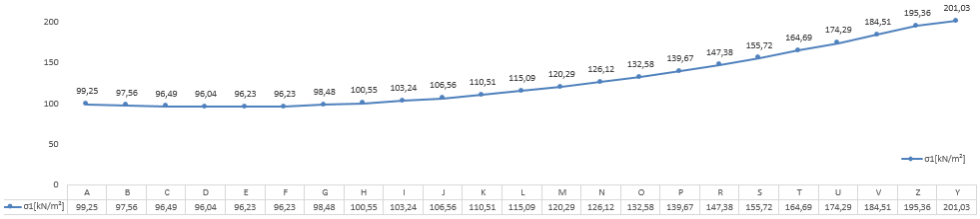
It is similar with the overturning stability factor. Increasing the "heel" increases the Fsp. The same factor is satisfied, already after 0.3m or about 0.12B. According to the shape of the curve, it can be concluded that the increase in Fsp in the initial iterations is more intense, has a tendency to grow, while in the final ones the difference between iterations is insignificant (from T-Y), that is, it can be said that it has reached the maximum value for the adopted rationale model.



Graph 4: Bending moment in relation to the centre of gravity of the cross section of the foundation joint – sections A-Y

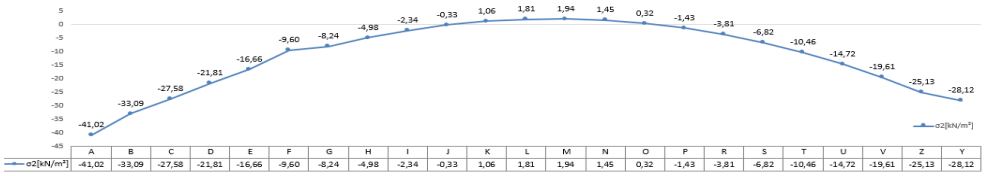
The bending moment at the point of wall clamping in the foundation is the same for all iterations. By analysing the bending moments in the foundation joint, it can conclude that as the wall moves towards the centre of the foundation joint, its intensity decreases, which is expressed in the first quarter of the foundation width. From the beginning of second quarter foundations of the wall, all the way to the middle of the foundation, we read minimum values of moments that are approximately of the same intensity. This indicates the fact that, viewed from the aspect of bending moments, the most favourable position is in zone of connection of the foundation with the substrate. By further moving the wall, the intensity of the moments increases, and at the end it is higher than the initial position by 63%. Compared to the minimum value of moments, it is higher by as much as 117%. It can be stated that the lowest consumption of reinforcement is in cases when the wall is located in the part of the second quarter of the foundation.

Observing the intensity of edge stresses, it can conclude that with the increase of the "heel" of the wall, the stress σ1 in the foundation joint increases, which is expected because the part of the backfill that stabilizes is also mobilized but it increases the stress.



Graph 5: Stress representation in the basic connector σ1 A-Y

With stress σ2, the situation is much more complex, since the condition is set that the stress must have a positive intensity, ie there must be no occurrence of tensile permissible stress. It can be concluded that only the position of the wall in the central quarter of the foundation width (from sections K to O) or from 0.4B to 0.55B is acceptable.



Graph 6: Stress representation in the base connector σ2 – sections A-Y

5. CONCLUDING REMARKS AND CONCLUSIONS

The primary goal of this paper is to provide guidance to engineers in the construction of cantilever RC retaining walls. The geometric position of the wall in relation to the foundation rate has been analysed. By analysing the obtained calculation results, shown in the table and diagrams, it can conclude that only the position of the wall at the base rate in the range of sections K to O, or from 0.4B to 0.55B, satisfies all stability conditions.

The position of the wall in the range of A-I does not satisfy mainly the stability to overturning and sliding, nor the permissible stresses in the foundation joint and as such are not acceptable.

The design values in the range of sections P-Y meet the conditions of stability to slip and overturning, but do not meet the set conditions for the permissible stresses in the foundation joint. Of course, in such cases there is a possibility of conducting additional analyses and checks for each specific case where a comparison of the stress with the permissible bearing capacity of the foundation soil should be performed.

Based on the performed analyses and the conclusions drawn, specific geometric ranges for placing the wall at the foundation rate are proposed. The proposed ranges have been made for a specific case and can serve as an example for solving similar cases in practice.

It is recommended to perform further research on similar examples and other dimensions of the cross sectionof the wall and to compare the obtained results.

The entire has been made according to the Ordinance on Technical Standards for the Foundation of Buildings.(The official Gazette of SFRY) It is recommended to perform similar analyses according to EC7.

6. BIBLIOGRAPHY

[1] The Main Project for the Remediation of the Hull of the Regional Road R-461a Srebrenik-Orahovica, at the station km. 12 + 270, "ARTING BH" doo Sarajevo, February 2015

[2] Study on Engineering-Geological Characteristics of the Terrain, "Barel" doo Tuzla, November 2015.

[3] Memić M., Folić R. (2012): Theoretical Foundations and Numerical Modeling in Plaxis, SGIT Serbia: Collection of Works "Earthquake Engineering Engineering Seismology", Divčibare, 239-250.

[4] Memić M., Folić R. Ibrahimović A. (2013): Influence of Soil Rarameters Change on Displacement of Reinforced Concrete Diaphragms, Collection of Works-Geotechnical Aspects of Construction., Soko Banja, 93-102.

[5] Memić M., Folić R. Ibrahimović A. (2013): Comparative Analysis of Methods for Estimating the Displacement of Flexible Anchor Concrete Diaphragms, Building Materials and Constructions 56, Belgrade, 19-43.

[6] Memić M., Folić R. (2018): Remediation Model of RC Support Structure - Case Study, DGKS 15, Zlatibor, 209 - 218.

[7] Grgić S., Memić M., Softić E .: Review and Comparison of Types of Retaining Walls in the Remediation of Road Hulls - Scientific Research, University of Bihać, Technical Faculty, Conference RIM 2021, Sarajevo.

SECTION/SEKCIJA
E

DESIGN OF MULTIFUNCTIONAL JACKET

Blaženka Brlobašić Šajatović, Ivan Mihaljević, Ksenija Doležal, Darko Ujević
Faculty of Textile Technology University of Zagreb
blazenka.brlobasic@ttf.unizg.hr

ABSTRACT:

The topic of the paper is the design of a multifunctional jacket. The jacket primarily has all the properties of an upper garment, but in exceptional situations (earthquakes, floods, fires) it can also serve as a sleeping bag. The aim of this paper is to design a functional, anatomical and structurally acceptable multifunctional jacket. The theoretical part of the paper summarizes the structure and anatomy of the human body and the specifics of sleeping bags. The experimental part of the paper consists of conceptual solutions related to the design of the multifunctional jacket collection, selection of conceptual solutions for the realization of the model, selection of materials (basic and auxiliary), construction, modeling and prototyping. Given the natural disaster of the earthquake that hit the whole of Croatia in 2020, there is a need for analysis of individual phases and technological operations of the industrial method of production of this type of multifunctional clothing.

Keywords: multifunctional jacket, construction, modeling

1. INTRODUCTION

From ancient times the clothes are used as a means of protection from external influences. According to the online edition of the Croatian Encyclopedia, clothing is the protection of the human body or individual parts of the human body with blankets made of natural and artificial materials, and clothing is created from the need to protect the human body from harmful external influences, especially climatic: cold, heat, humidity and rain. As one of the reasons for the appearance of clothing, according to the Bible (the concept of the first sin), shame is also stated. Historically, the concept of protection has had different connotations for different cultures in different periods [1].
Research has shown that in early peoples, bodies were adapted to weather conditions, they were adapted to extreme heat and cold without the use of clothing, so clothing was not used as physical protection [2].
Until the 20th century, protective clothing served one of two functions - as a shelter from climatic conditions or as protective armor. The materials used in the production of clothing with the function of shelter varied according to the regions in which people lived as well as the natural resources that were found in their regions. The change and development of such clothing was more influenced by social customs, traditions and beliefs than by the actual climatic conditions due to which they provided protection. Clothing used as shelter changed with the fashion of the time, and to some extent, the same goes for the development of protective armor. "European suits - armor and elaborate kimonos for samurai warriors are symbolic. Armor or shield has evolved throughout history. Mostly in response to the evolution of weapons "[2].

2. FUNCTIONALITY OF PROTECTIVE CLOTHING

EN 240: 2003, "Protective clothing, general requirements", protective clothing is clothing that is worn over or replaced by personal clothing and is designed to provide protection against one or more danger. It is also an important hygienic factor. The term “protective clothing” is generally used today to denote clothing and accessories that focus on physically protecting the body from endless physical threats. In everyday life, we use clothes as protection from weather conditions such as heat, sun, cold, rain, sun, snow and other weather disasters. Protective clothing allows the body to survive in different spaces and to protect individually in different dangers environments (such as war zones, dangers toxic chemicals, etc.) and provides protection in sports and recreation.
Very often, protective clothing must provide more protective functions and at the same time ensure the natural respiration of the skin. "In addition to high material production costs, important parameters are wear resistance, resistance to chemicals, resistance to static electricity generation, washability and all aspects of thermal behavior, moisture absorption and the ability to create material comfort. Personal protective equipment for body protection should be made of appropriate materials so that they are comfortable, light and comfortable, and do not interfere with movement "[3].
In case the employee is exposed to the harmful effects of dirt, moisture, high temperature, to work with various means of work (machines, installations, etc.) and to work in dirt and dust, the uniform must be made of cotton or twill in one or two pieces (jacket and pants). For communal activities (work in the sewerage network, garbage collection, street cleaning), navigation, fishing, etc. activities, the work uniform must be made of impregnated material, and of material that is resistant to toxic and corrosive substances [3].
Due to various climatic and other natural disasters (earthquakes), there is a need for multifunctional clothing. The paper will show a jacket, which is used as protection against cold, fire, but also as a sleeping bag.

1.2. Croatian standards for protective clothing

The main task of protective clothing is to protect the human body from harmful influences. Such clothing must meet the highest safety standards and comply with the requirements of the working environment in which it is used.
In order for protective clothing to be effective and functional, it is important that it has the following characteristics:

- That it is made in several clothing sizes to allow use in a wide range of anthropometric scales.
- That it is ergonomically designed in accordance with the dynamic anthropometric conditions of use. When performing activities, it is important that it ensures comfort when wearing and freedom of movement of the wearer.
- That it is specially designed, but that all possibilities of wearing conditions that may arise when wearing tools, accessories, breathing apparatus, etc. are considered [4].

3. MULTIFUNCTIONAL FASHION PRODUCTS

Clothing has always had at least two main functions, especially in modern societies, the protective function and the social function. The main purpose of clothing is to protect the human body against the environment, such as cold or heat. Also, the social function of clothing, which has the function of communicating social status, should not be neglected. Today's clothing we play an important role in the communication of our lifestyle between cultural, which manifests another function important for clothing [5].

The last decade can see a significant increase in demand for high-end multifunctional products with significant added value that are taken into account at the same time due to ease of use, comfort, flexibility in wearing and modern appearance. In this paper, multifunctional objects that fall into the category of fashion clothing / clothing are observed [5].
Multifunctional fashion clothing can be defined as a clothing system that can be used in different conditions, adapt (dynamic or not) to different social situations or weather conditions, or it can be clothing that has different characteristics in different areas of the body to have different functional features, such as different bending properties on different parts of the body [5].

4. DESIGN IN TERMS OF MULTIFUNCTIONAL FASHION

When dealing with the topic of fashion design, it is common to consider traditional fashion and the design process, if design research focuses on fashion and market trends analysis, consumer study (lifestyle, ambitions, worries, tastes, desires), brand concept (when there is one) , in observation, inspiration, innovation and finally in researching innovative methods and procedures of clothing production. For the development of multifunctional fashion products, there are a significant number of key elements that need to be considered in the design process, such as:
• Textile materials and technologies, especially emerging materials and technologies that can contribute to the development of truly multifunctional garment products;
• Comfort in the garment, a feeling of complete comfort;
• Design research;
• Concept test and evaluation;
• Inclusive approach to design;
Psycho-aesthetic comfort does not seem to have much to do with the technical properties of the fabric and is mainly related to the aesthetic appeal and fashion trend prevalent in society. It is the subjective perception of clothing by the wearer or observer, which contributes to the wearer. Ergonomic comfort is associated with the comfort of body movement, the ability of clothing that allows freedom of movement, has to do with body shaping, making and sewing.
According to Clarkson et al., Inclusive design or design for all is an approach to design that aims to ensure that most products are available to the largest number of users. That would mean that inclusive design is better design. An example is the attitude towards the elderly and allowing them a special kind of design as well as other vulnerable groups. Growing awareness of an inclusive design approach is responsible not only for increasing life expectancy resulting in an aging population, but also for increasing dissatisfaction associated with the lack of integration of people with disabilities into most designs. This awareness brings new challenges to fashion designers such as: how to design products to be able to meet the needs of the majority? The answer may lie in accepting the consideration of comfort and multifunctional capabilities as a further development of fashion clothing [6].

5. MULTIFUNCTIONAL JACKET DESIGN, CONSTRUCTION AND MODELING

Within the collection, there are five multi-functional jackets that differ in shape, structure, various accessories such as pockets, hoods, zippers and accessories. Functionally, each of them has the purpose of wearing for everyday purposes or in case of natural disasters, where each of the jackets takes on a new shape, figure 1.

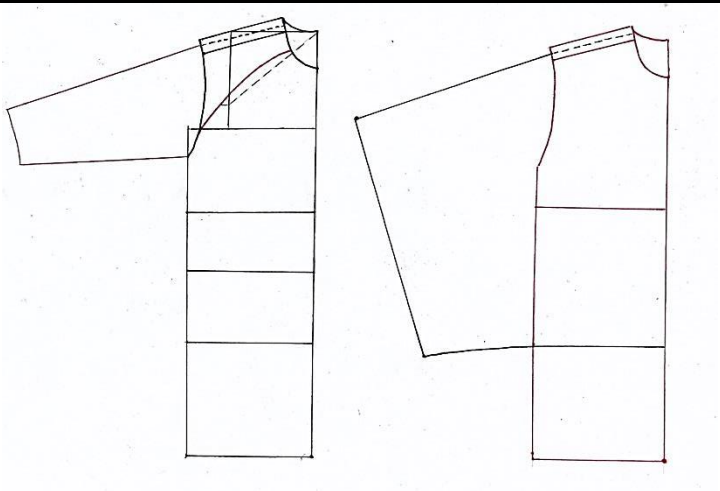
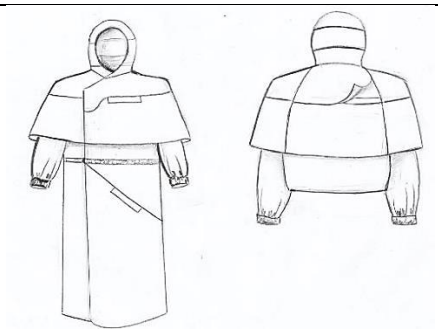
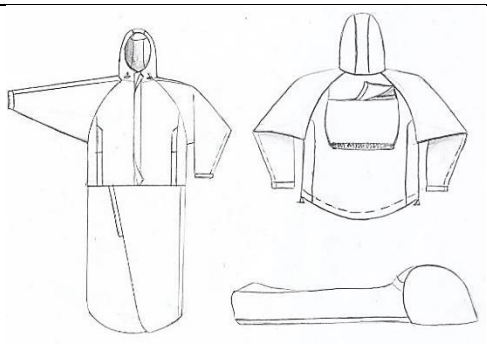
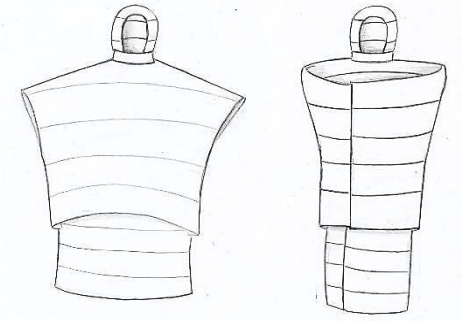
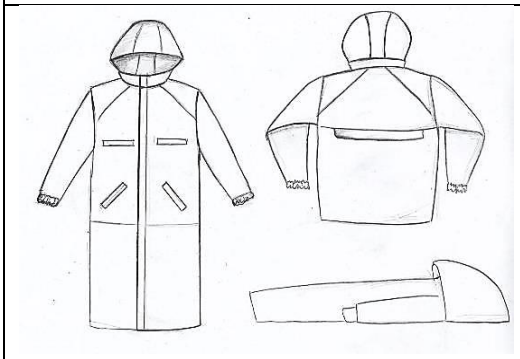
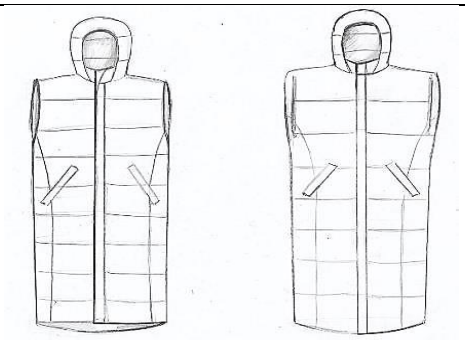


Figure 1: Basic constructino of collection containing five variations of multifunctional jackets

Table 1: Display of five variations on a multifunctional jacket

	**Model 1.** The first model features a cape and a hood at the top. The lower part of the jacket is connected to the upper part of the jacket by means of a zipper. The lower part of the jacket, if not used, can be folded into the back of the jacket, where a special pocket has been cut for the specified part of the jacket. The jacket has two pockets on the front. The idea is for the jacket to be made of polyester fabric that is filled with polyacrylonitrile fibers for heat.
	**Model 2.** The second jacket is also made on the principle of the first model, but does not contain a cape and has raglan sleeves. The lower left corner shows a sketch of what a person who would sleep in such a multifunctional jacket looks like. It is important to note that there is a zipper on the lower part of the jacket, the closure of which protects the feet from the cold. The jacket has three pockets on the front.

	**Model 3.** The third jacket is shaped like a sheath that rounds out the body. The front of the jacket is shorter than the back. On the right side of the picture you can see the way in which the jacket would fold to cover the entire surface of the body and thus retain heat.
	**Model 4.** The fourth model of the jacket was made as well as the first two listed models. The lower part of the jacket has the possibility of separation and connection by means of a zipper. The bottom of the jacket can be tucked into the back pocket of the jacket if not in use. In the lower left part of the picture, the lying position of the person who would use the jacket is shown. The jacket has four pockets on the front
	**Model 5.** The fifth model of the jacket does not contain sleeves, but there are zippers on the sleeve of the jacket. The jacket has the possibility of closing at the hem with a zipper. The jacket at the front contains two pockets and contains a hood.

6. CONCLUSION

The concept of functional design explains to us the importance that the designed system of protective clothing, in addition to its appearance, must support function and usability. This paper shows how the design and construction of the systems themselves with functional and additional solutions allows end users ergonomic and comfortable multifunctional jackets that provide safety and comfort in natural disasters or colder climates. Accessories on the back allow for smooth arm mobility and ensure the use of a multifunction jacket accessory as needed.

The jackets are three-dimensionally shaped and allow the unobstructed flexibility of the main joints, which is necessary for crawling, squatting and kneeling. Pockets that are designed in such a way that private things are safe and secure and easily accessible. Functional solutions of the jacket zipper enable dressing, and the user is protected from cold conditions. Based on the researched theoretical bases, it

can be concluded that in addition to an important factor in the choice of materials, special attention should be paid to the functional design of multifunctional clothing.

7. LITERATURA

[1] http://www.enciklopedija.hr/natuknica.aspx?id=44736

[2] Lovrić, L. (2013) Oblikovanje modne kolekcije na principu dekonstrukcije zaštitne odjeće; Tedi, 1, 3, pp. 33-45

[3] Dugac, Ž.; Horvat,K. (2013), Službeno, praktično i elegantno: O uniformama sestara pomoćnica – medicinskih sestara od 1920-ih godina u Hrvatskoj, Acta Medico-Historica Adriatica, 11, 2, pp. 16-23.

[4] Popović T.; Istraživanje stanja zaštitne odjeće u vatrogasnim postrojbama u Republici Hrvatskoj, Sveučilište u Zagrebu, Tekstilno-tehnološki fakultet, diplomski rad, Zagreb, 2013.

[5] https://www.geraldinewharry.com/getinspired/thefutureofconsciousfashion-irinadzhus

[6] https://wesustainabletextileforum.com/2020/08/01/multifunctional-garments-a-sustainable-fashion-design-strategy/

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WORKPLACE RISK ASSESSMENT IN THE TECHNOLOGICAL PROCESS OF SEWING USING THE SMART METHOD

Snježana Kirin[1], Anica Hursa Šajatović[2]
[1]University of Applied Sciences, Department of Safety and Protection, Trg J.J. Strossmayera 9, 47000 Karlovac, snjezana.kirin@vuka.hr
[2]University of Zagreb Faculty of Textile Technology, Department of Clothing Technology, Prilaz baruna Filipovića 28a, 10000 Zagreb, anica.hursa@ttf.unizg.hr

ABSTRACT:

In order to achieve the highest possible productivity and quality of workmanship in modern garment production processes, work should take place under optimal working environment conditions in regulated and ergonomically designed workplaces, which increases workers' efficiency and reduces their load and fatigue. The technological process of sewing is performed in a sitting position with the repetitive execution of technological operations in a short time interval which can lead to diseases of the musculoskeletal system. The paper presents the results of risk assessment research using the SMART (Scoring Method for Assessment of Repetitive Tasks) method. Investigations were carried out at ten workplaces in the technological process of sewing and an increased risk of damage to the health of workers was found.

Keywords: technological sewing process, SMART method, risk assessment

1. INTRODUCTION

In the technological sewing process, work is carried out on production lines that contain a large number of workplaces where individual technological operations are performed [1]. Technological operations have short execution cycles of 15 to 60 sec, thus causing a high degree of repetitiveness with a considerable psychophysical load due to sitting, the required high degree of concentration of the eyes, short hand movements in the execution of combined and simultaneous movements [2]. Due to the necessary dynamics and coordination of hand and whole body movements with repetitive execution of technological operations, musculoskeletal diseases often occur, resulting in a decrease in productivity and quality of work. The load of musculoskeletal disorder depends on the characteristics of the work task, statodynamic load, work environment and individual factors [3, 4].
In order to prevent or reduce the risk of disease, the employer is obliged to continuously assess the risks to the life and health of workers. In this context, there is a legal basis that provides basic guidelines for the protection of workers, such as Council Directive 90/269/EEC, the Occupational Safety and Health Act [5], Ordinance on Health and Safety Requirements for the Manual Handling of Loads at Work [6] and the Occupational Safety and Health Regulation for the Workplace [7]. To protect workers in the workplace, a risk assessment of the load resulting from the load handling is carried out, taking into account the characteristics of the load, the workplace, the working environment and individual factors. The task of risk assessment is to identify hazards, assess the extent of the risk and propose measures to reduce the risk at the workplace. There is a need to constantly improve work processes and bring them

into line with changes and advances in technology, ergonomics, health care and other related scientific fields.

In this work, risk assessment in manual handling of lighter loads with a high frequency of repetition of the technological operation called risk assessment method for repetitive work tasks, i.e. SMART (Scoring Method for Assessment of Repetitive Tasks) method was used.

2. SMART (Scoring Method for Assessment of Repetitive Tasks) method

The SMART method is used in risk assessment in technological operations with a high number of repetitive technological suboperations. Work tasks that involve a large number of repetitions of technological suboperations mainly involve movements of the upper extremities in conjunction with non-physiological body posture, which ultimately leads to damage to the musculoskeletal system [8, 9]. The assessment identifies the numerical values of each risk factor leading to the development of musculoskeletal diseases, namely: the duration of the work task, the number of repetitive movements (repetitions), the power required to perform the work task, and the position in which the body is located while performing the work task. A series of repetitive movements can lead to muscle and tendon fatigue, i.e. overload. The load estimation procedure for repetitive work operations is performed according to the following steps:

Step 1: Scoring according to the duration of the work task, which implies the total time in the working day during which the worker performs tasks with repetitive work operations or repetitive movements (Table 1).

Table 1: Scoring (T1) according to the duration of the work task [8]

Duration of the work task (total time in one working day during which the worker performs repetitive movements)	**Point value (T1)**
up to 60 minutes	1
from 61 minutes up to 120 minutes	2
from 121 minutes up to 240 minutes	3
more than 240 minutes	4

Step 2: Load scoring according to the number of repetitions (Tab. 2), physical power (Tab. 3) and body posture (Tab. 4).

Table 2: Determination of the point value (T2) according to the number of repetitive movements [8]

Number of repetitive movements during one shift	**Point value (T2)**
up to 1000	1
1000 to 4800	2
4801 – 10 000	3
10 001 – 12 000	4
more than 12 000	5

Table 3: Determination of the point value (T3) by the power required during work [8]

Power required during work	**Point value (T3)**
Low	1
Moderate	2
Quite high	3
High	4
Very high	5

Table 4: Determination of the point value (T4) according to body posture [8]

Body posture			**Point value (T4)**
a	Head and neck	Head/neck bent or tilted ≤ 50% of working time	0.5
		Head/neck bent or tilted > 50% of working time	1
b	Back	Back bent forward, sideways or twisted ≤ 50% of working time	0.5
		Back bent forward, sideways or twisted ≤ 50% of working time > 50% of working time	1
c	Shoulder	Arms raised above the shoulders ≤ 50% of working time	1
		Arms raised above the shoulders > 50% of working time	2
d	Elbow	Elbow away from the body ≤ 50% of working time	1
		Elbow away from the body > 50% of working time	2
e	Wrist	Wrist rotated to the extreme possible limit of the wrist ≤ 50% of working time	0.5
		Wrist rotated to the extreme possible limit of the wrist > 50% of working time	1
f	Fingers	Holding the object with only two fingers or in a wide grasp ≤ 50% of working time	0.5
		Holding the object with only two fingers or in a wide grasp > 50% of working time	1
Total scoring value for all body parts T4 = a+b+c+d+e+f			

Step 3: Calculation of the final value and assessment of the overall risk

Each of the above-mentioned factors relevant for the assessment is presented in the evaluation table as a separate part with the corresponding points. Once the numerical values of each individual risk factor have been determined, they should be included in the equation that leads to the final result, i.e. the value of the total risk for the development of overload syndrome. The calculation of the total load is carried out according to the expression:

$$\textbf{Total load} = (T2 + T3 + T4) \times T1 \quad (1)$$

where:

- T1 – Duration of the work task
- T2 – Number of repetitive movements during one shift
- T3 – Power required during work
- T4 – Body posture

The final result of the total load or risk level can be read from Table 5.

Table 5: Explanation of the determined values of the total load [8]

Risk level	**Total load**	**Explanation of the determined values of the total load**
1	< 10	***Low risk level:*** there is no risk of worker overload and health damage
2	10 to 45	***Increased risk level:*** there is a possibility of overloading less resistant workers (older than 40, younger than 21, inexperienced patients)
3	46 to 65	***High risk level:*** there is a risk of overloading all workers with the likely occurrence of musculoskeletal injuries and diseases, it is recommended to redesign the workplace
4	> 65	***Very high risk level:*** there is a significant risk of worker overload and a serious risk of injury and illness, it is necessary to redesign the workplace using appropriate work equipment and to change the methods and organisation of work in order to reduce workload.

The final result obtained indicates whether the workload is acceptable or not. If test results show an increased risk, the employer is then obliged to undertake appropriate technical or organisational corrections to workplaces, depending on the level of workload, with the aim of ensuring a healthy workplace and reducing the possibility of occupational diseases among workers.

3. EXPERIMENTAL PART

In the experimental part of the work, a risk assessment using the SMART method was carried out in the real production process at ten workplaces where different technological operations of sewing a men's jacket are performed. For individual workplaces, the execution time of certain technological operations was determined according to the REFA method and thus the number of repetitions during the work shift was determined (Tab. 6).
Technological sewing operations are performed by female workers of different body heights with differently adjusted sitting height depending on the subjective assessment of the workers for a comfortable working position. The height and size of the work surface are designed in accordance with the needs of performing technological operations with regard to the size of the work piece. In the technological operations examined, the work pieces belonged to the group of large products.

Table 6: List of technological operations with execution time and number of repetitions

Designation of the technological operation	Name of the technological operation	Execution time of the technological operation [s]	Number of repetitions of the technological operation
1TO	Sewing the back seam	43.2	625
2TO	Sewing the front and back part	69.6	775
3TO	Sewing the back seam of the sleeve	55.2	978
4TO	Sewing the lining in the length of the sleeve	60	450
5TO	Sewing the lining to the underlay of the front part	58.8	918
6TO	Closing the sleeve opening	51.6	1047
7TO	Closing the sleeve and the lining leaving the opening	78.6	687

8TO	Sewing the shoulder seam	42	1286
9TO	Sewing the seam lining of the sleeve	41.4	1304
10TO	Sewing the side seam of the front piece	49.8	1084

The recording was done using the EOS 750D camera with a built-in EFS 18-135 mm lens, which has video recording capability. The workplaces were recorded for 20 minutes, which meant on average between 15 and 25 executions of each technology operation. The workers were filmed in the sagittal plane on the left or right side, depending on the type of the technological operation and the design of the workplace.

4. RESULTS AND DISCUSSION

Determining the risk level by the SMART method is shown for the position of the body in the Tab. 7. Tab. 8 shows the values of the duration of the work task (T1), the load by number of repetitions (T2), the required power (T3), the values of the body position (T4), the total value of the load and risk level.

Table 7: Load in relation to the body position

Designation of the technological operation	Body posture						T4
	a	b	c	d	e	f	
1TO	1	1	0	2	0.5	1	5.5
2TO	1	1	0	2	0.5	1	5.5
3TO	1	1	0	2	0.5	1	5.5
4TO	1	1	0	2	0.5	1	5.5
5TO	1	1	0	2	0.5	1	5.5
6TO	1	1	0	2	0.5	1	5.5
7TO	1	1	0	2	0.5	1	5.5
8TO	1	1	0	2	0.5	1	5.5
9TO	1	1	0	2	0.5	1	5.5
10TO	1	1	0	2	0.5	1	5.5

Table 8: Presentation of the values for the duration of the work task (T1), load according to the number of repetitions (T2), required power (T3), values for body posture (T4), total load and risk level.

Designation of the technological operation	T1	T2	T3	T4	∑ T	Risk level
1TO	4	1	1	5.5	34	2
2TO	4	1	1	5.5	34	2
3TO	4	1	1	5.5	34	2
4TO	4	1	1	5.5	34	2
5TO	4	1	1	5.5	34	2
6TO	4	2	1	5.5	38	2
7TO	4	1	1	5.5	34	2
8TO	4	2	1	5.5	38	2
9TO	4	2	1	5.5	38	2
10TO	4	2	1	5.5	38	2

The research has shown that considering the duration of the work task (T1), the female workers spend more than 240 minutes (score 4) to carry out the technological operations. The analysis of the load by the number of repetitive movements during the work shift (T2) for technological operations 1TO, 2TO, 3TO, 4TO, 5TO and 7TO shows that the worker performs up to 1000 repetitive movements (score 1),

while for technological operations 6TO, 8TO, 9TO and 10TO the workers perform more than 1000 repetitive movements during the shift (score 2). With the load according to the force required during work (T3), it was found out that female workers handle low-weight work pieces (score 1). Table 7 provides an overview of the load with a total score of 5.5, for all ten technological operations. The load analysis shows that the head/neck was bent more than 50% of the working time (a = 1), the back more than 50% of the working time (b=1), the arms were not raised above the shoulders (c=0), while the elbow was far away from the body more than 50% of the working time (d=2). The wrist was rotated less than 50% of the working time (f =1). Table 8 shows the total workers' load, which determines the risk level of all technological operations (score 2). The presented research results show that there is a possibility of overload. Determining the risk level by the SMART method requires additional analyses in relation to determining the level of the workers' workload in the technological sewing process. The employer is obliged to make appropriate technical and organisational corrections to workplaces in order to reduce the possibility of musculoskeletal disorders and to ensure work in a healthy workplace, while reducing the possibility of occupational diseases.

5. CONCLUSION

Performing technological sewing operations on sewing machines in the technological sewing process requires from workers to have good psychomotor skills, such as high mobility and coordination of body movements, legs, arms, hands and fingers. Based on the analysis by the SMART method at ten characteristic workplaces where technological sewing operations are carried out, it was found that there is a load or increased risk level (score 2). The analysis of workplaces revealed increased anterior flexion of the spine and head. While working at the sewing machine, workers load their arms and hands considerably. In order to determine the level of workload, it is therefore necessary to carry out an additional analysis of the workplaces, such as redesigning the workplaces and determining a suitable working method that would reduce the workload. Risk assessment is of great importance because it allows the employer to identify the level of load or danger in individual workplaces. It is the obligation of the employer to continuously create safe working conditions in order to reduce the occurrence of diseases of the musculoskeletal system and other work-related diseases.

REFERENCES:

[1] Kirin, Snježana; Hursa Šajatović, Anica: (2020): Research on Workload in the Technological Sewing Process using ANSI Z 365 Standards , *Book of Proceedings 13th International Scientific – Professional Symposium Textile Science and Economy - Chinese-Croatian Forum: Innovation, Design and Digitalization in the Textile and Leather Sector*, Petrak, Slavenka; Zdraveva, Emilija; Mijović, Budimir (ur.), Zagreb: University of Zagreb Faculty of Textile Technology, 226-231

[2] Kirin, S.; Hursa Šajatović, A(2020), Determination of Working Methods and Normal Times of Technological Sewing Operation using MTM System , Tekstilec**, 63**, 3; 203-215

[3] Kirin, Snježana; Dragčević, Zvonko; Firšt Rogale, Snježana, (2014) Workplace Redesign in the Computer-Aided Technological Sewing Process, Tekstil 63, 1-2; 14-26

[4] Kirin, Snježana (2020):Ergonomska istraživanja opterećenja radnika u procesu šivanja odjeće, Sigurnost 62, 3; 239-249

[5] Zakon o zaštiti na radu, NN 71/14,118,14,94/18

[6] Pravilnik o zaštiti na radu pri ručnom prenošenju tereta NN 41/05

[7] Pravilnik o zaštiti na radu za mjesto rada NN 29/13

[8] Bubaš, M., Bradvica, K. (2018): Nova metodologija za procjenu rizika statodinamičkih napora-SMART metoda, Sigurnost 60, 1, 37-48

[9] Praktična smjernica za ocjenu rizika pri ručnom rukovanju teretom, HZZZSR,2011, http://www.hzzzsr.hr/wpcontent/uploads/2016/11/Prakticna_smjernica_za_ocjenu_rizika_pri_rucnom_rukovanju_teretom.pdf, accessed 22.03.2021

THE IMPACT OF THE CRISIS OF DESIGN FROM FIRST WORLD WAR TO WAR IN BOSNIA AND HERZEGOVINA

Elvedina Ramić, Irfan Hošić
Faculty for Technical Engineering, University of Bihać, ramicelvedina037@gmailcom, irfan.hosic@unbi.ba

ABSTRACT:

This research elaborates the impact of the crisis on design production starting from the World War One in a broader perspective, to the War in Bosnia and Herzegovina and design issues in a local perspective. Among the most significant, this research processes the period around the World War One; the Great Depression in the USA in the 1920s; the period of the World War Two; concluding with the War in Bosnia and Herzegovina in the early 1990s. The aim of this research is detection of the most prominent design production examples, and their contextualization within political, social and cultural frame. It intends to point out to the power of the human spirit, creativity and often resistance against unforeseen circumstances of the time. In doing so, design becomes a societal testimony and reflection of individual and collective consciousness at the particular moment of its origins.

Keywords: crisis, design

1. INTRODUCTION

When looking at the consequences of political and social changes on the economy, statistics clearly indicate production decline and market supply shortages. However, within these and similar mathematical analyses and less-than-encouraging projections, history reveals a production of creative solutions as reflections of invincible spirit freed from chronologically, geographically, and socially conditioned limitations. Representatives of avant-garde movements, which marked the early 20th century made significant contributions to textile and clothing design. They were heralds or predecessors of contemporary fashion design intuitively laying the foundation of new ways of creative thinking about the role and meaning of clothes in the period of economic crisis. In Italy, the cultural movement of Futurism, established in the early 20th century, aligned itself with fascist ideology. The Futurists considered war to be the world's only hygiene; they celebrated militarism, patriotism, destructive gestures of anarchists, beautiful ideas worth dying for, and scorn of women. Unlike the regime, Futurism advocated breaking all ties with tradition, especially with Italy's historical and cultural heritage. These affinities manifested most considerably in fashion design, especially through the choice of unconventional colors. After World War One, in the midst of poverty and crisis, Ernesto Michahelles - Thayaht created in 1919/1920 the TuTa - the most innovative Futurist garment in the history of Italian fashion. The TuTa was a T-shaped coverall made of 4.5 meters of fabric. It was a simple, functional garment primed of mass production and designed to encourage the spirit of equality by being intended for use by men and women. In 1920, Thayaht mass-marketed the TuTa by publishing the design sketches and patterns for its creation in La Nazione magazine. However, the form of the garment never took root on the market but was primarily used by members of Florentine high society. With time, it became synonymous with a modern, revolutionary style, common especially in contemporary male clothing.

2. CLOTHING DURING THE WORLD WAR TWO

In 1939, the attack on Poland by Germany marked the beginning of World War Two. It lasted for six years; it was waged on three continents, involved the majority of the world's nations, and ended with Japan's capitulation. Clothing habits in the period prove that war and fashion do not go well together; world-scale destruction, on the one hand, a creation of beauty on the other. Shortly before the German occupation in France in 1940, Parisian tailors created garments with suggestive titles such a False alarm and Attack. Collections influenced by warfare atmosphere include simple silk blouses, long woolen skirts, jackets with silk epaulets, and handbags comprising gas masks. Pierre Balmain (1914-1982) designed two evening dresses symbolically called Occupation and Underground, while Mainbocher (1891-1976) created uniforms for the U.S. Navy and women's Red Cross uniforms.

Figure 1: Mainbocher, uniforms for U.S army (1942)

This was a period of wide-ranging rationing. However, the imposed system of restrictions flourished with a resourceful spirit that helped creative ideas expand. Clothes, especially female, became a form

of subversive language - in Paris they were a symbol of resistance to occupiers, and in London an act of solidarity with soldiers fighting on battlefields. Parisian tailoring workshops were active until the end of the German occupation.

Some of the couturiers closed their stores while the rest changed their locations, such as Mainbocher who continued with his production in New York. Before the onset of World war two, Parisian haute couture had remarkably contributed to the economic growth of the country, and for this reason not surprisingly, Goebbels attempted to move production from Paris to Berlin. In addition to its economic contribution, French haute couture was also synonymous with national cultural identity. While English women took it as their "obligation" to dress inconspicuously and modestly, French women did not follow the same behavior pattern when it came to clothing. Fashion, that is, wearing clothes was,for them, a means to express resistance under the occupation, and then became a symbol of unbreakable and unoccupiable spirit. In spite of shortages and restrictions, they justified the reputation of being of most exquisitely dressed woman by taking care of how they looked and wearing clothes with patriotic colors- red, white and blue. In 1942, the French government decreed the collection of hair from Paris hair salons and barbershops to be made into slippers and sweaters. Men were encouraged to their hair short. The decree, together with Jewish persecutions, triggered the zazou youth movement to oppose to new political regime with their clothing style and image. They let their hair grow long and promoted the zazou style based on the culture of swing, jazz and bebop. This movement, inspired by American music and the culture of swing was characterized by a particular fashion rhetoric, the so-called zoot suit, which was composed of wide trousers and long jackets. Female members of zazou subculture wore their long, typically blond hair down. They also wore lipstick, sunglasses, shoes with thick wooden soles, jackets with wide shoulders and short pleated skirts. Men's habit of having long hair was often a cause of street fights with the military police.

2.1. Design during the great depression in USA 1930s

The outward appearance- mass, shape, finish- of a wide range of products underwent significant change during the 1930s. The decade started with the angularity and application of ornaments from the Art Deco serving as the last word in modernism; it ended with the sinuous curves and sleek surfaces of Streamlining leading the way. Between 1929 and 1940, big changes occurred in American design, from humble appliances to airliners, from pencil sharpeners to complex machines.

The public witnessed these ongoing changes through popular culture. Art directors and set designers made Americans visually aware of the very latest ideas in architecture and interior decoration through movies since movie theatres were popular among the public at the time. At the time popular set designs for Hollywood movies were classy cocktail lounges and elegant nightclubs in many of the nation's larger cities. A white lacquered piano was used as a centerpiece, its traditional curves were used to cover the absence of any applied decoration, and the bar could be polished black Bakelite (which was a popular plastic of the day) with chrome highlights. Even the crystal stemware would reflect the latest in innovative design. It all represented the new modernism rather than the old one, and it had its place in fantasy and glittering restaurants and night spots. Despite these constant advertisements, it would be many years before these expressions of modernity found wide acceptance in most people's domestic lives since the American home kept a bastion of tradition.

Figure 2: The living room at American home in the great depression 1930s

A case in point: shiny plastics, chromed tubular steel, luxurious accessories, and glass curtain walls characterize the bathroom seen in many films. By the application of Hollywood Production Code restrictions, these luxurious pleasure palaces always lack visible toilets, and they exist mainly in the imagination, service spaces served the same purposes in most homes.

During a time of economic unrest, for most people, a typical middle-class home mixed the old with the new (but not too new), a sprinkling of colonial, Victorian, utilitarian, and maybe an occasional Art Deco Streamlining accent. Maroon, mauve. cream, tan, and Depression green, a medium grey-green particularly favored for kitchens, led the way for interior colors, with blues and peach popular for accents. Flowered draperies and wallpapers and patterned linoleum or rugs could be found in most rooms. Inspired by the movies, a courageous homeowner might have an end table constructed of chromed tubing and black lacquered surfaces, but most of the furniture would be bulky and traditional. A large simple chair or two dominated the living room, and bore the name "Bumstead". The named chair got the name "Bumstead" as Dagwood Bumstead, (the main character in Chic Youngs (1901-1973) newspaper comic strip Blondie), enjoyed relaxing in such a chair, furniture makers profited on the series popularity.

2.2. Design and art in period of the siege Sarajevo

Design products in surrounded Sarajevo is certainly a topic that was discussed to great lengths in the past but which has still not been thoroughly and critically examined. Superficial analyses have been

made due to a lack of a comprehensive academic approach with which to study local history and theory of design. In addition to an inventory of design products and their contextualization, it would be desirable to conduct a theoretical analysis, including a historical retrospection, because a critical reflection of design as a practice of "capitalist self-reflection" in the social and economic circumstances of the surrounded city would yield completely different results and conclusions. This is an extremely problematic situation because design develops concurrently with industry and new production technologies. The case of Sarajevo, however, requires a different approach because of the circumstances in which the city found itself during the siege (1992-1995). Not only did the pre-war economic activities come to a halt but the basic standards of civilized life at the threshold of the 21st century were sophisticated, progressive, and developed society. Moreover, it is the case of the "image of the crisis" constructed through the language of design.

The most productive designers were those forming the Trio group, namely, Bojan Hadžihalilović, Dalida Hadžihalilović, and Lejla Mulabegović. Their design managed to articulate a visual statement whose symbolic strength, reinforced with cynism and reduced typography, created an original and iconic image of surrounded Sarajevo, A number of the Trio s visual solutions in the form of postcards, realized by using redesign strategies and recognizable visual references from the popular culture and art history, as well as their wartime works, constitute an important element in the formation of the image of the war crisis in Sarajevo and Bosnia and Herzegovina. In the period between 1992 and 1995, the socially engaged graphic design took over the role. of a mass medium and mediator, witnessing a unique historical moment, but also being torn between the most extreme influences of the environment in which it originated.

Figure 3: Trio group "Greetings from Sarajevo"

The works of the Trio group represent an isolated entity of Sarajevo s material culture, which would not have been achievable in that particular format if it had not been the former and completed accomplishments of the industrial revolution in Bosnia and Herzegovina, envisaged from the perspective of Gropius Bauhaus. Therefore, Trio s graphic design acquired a certain status in the context of the "revolution of the object" in the society vanishing of the ashes of a brutal war. In the period of all-around destruction, these posters had a unique power to stop for a moment the devaluation of the meaningfulness of a living environment, which conventional industrial design, among others, commonly generates and develops in peaceful times and societies and within normal living circumstances. In times of shattered and sense, Trio managed to create a comprehensive synthesis and initiate rejuvenation of broken ties between form and function, the beautiful and the useful, even between art and technology.

3. CONCLUSION

History was shown that impact of the crisis on design production and human creativity ubiquitous. Starting from the World War One to the war in Bosnia and Herzegovina, the power of the human spirit and creativity sent to the world a message through with design. Most often using a language of propaganda, that meaning using redesign and designing a new design. Design production as such is a language trough which designer communicate and sent a message on the state of society. Because of that detection of the design production as such is very important and put in context political, social and cultural frame.

4. REFERENCES

[1] Irfan Hošić, Design and crisis (2019). buybook, Radićeva 4, Sarajevo, buybook, Turinina 7, Zagreb
[2] William H. Young, Nancy K. Young, The Great Depression in America (2007), Greenwood Press, 88 Post road West, Westport

CAPITALIST INTERPRETATION OF A SOCIALIST PRODUCT – THE CASE OF BOROVO SHOE FACTORY

Aida Hodžić, Irfan Hošić
Faculty for Technical Engineering, University of Bihać, h.aida1998@gmail.com

ABSTRACT:

Borovo is a Croatian shoe company whose tradition dates back to the Second World War. From 1945 to 1991, the company was nationalized, after which it continued to operate in free trade economy as a largely state-owned company. Today, Borovo operates in the Croatian and international market as a result of the management's strategic decision aimed at finding new regions for growth and development. The objective of this paper is to analyze the rebranding process of one of the most recognizable products of Borovo – the iconic Borosana shoes and Startas sneakers, that have been produced in the same way ever since 1976. The life of these brands was marked by the cycle of introduction, growth and decline. The change of political and economic circumstances of the 1990s, from socialism to capitalism, caused radical changes in market economy and consumer culture leading to new needs, desires, and capabilities of buyers. Following the decline of everything inherited from socialism, Borovo started producing old brands in a new concept and design based on the rebranding practices. The example of analyzing these two brands suggests the importance of brand characteristics such as logos and symbols, as well as those characteristics that evoke sentiment and memories.

Keywords: Borovo, redesign, socialism, capitalism

1. INTRODUCTION

Amid the big industrial crisis of 1931, near the village of Borovo, Czech industrial Tomáš Baťa built a large industrial complex – Bata Borovo factory. The shoe factory radically changed the entire Vukovar region – its economic and social concept. The central Bata factory was located in the small town of Zlin in Czechoslovakia, a country with a democratic political system and free-trade economy. Politics largely influenced the factory in Vukovar and it largely shaped its capabilities. At first, one large investment was thoroughly changed and its existence was left to turbulent political changes. The factory was established during the Kingdom of Yugoslavia that stimulated mostly free international capital. From 1941, the factory had been working under the fascist autocracy of the Independent State of Croatia and strictly within the war economy.
In 1945, the factory changed its name and owner and operated in the socialist economy of Yugoslavia. Within a short period, 1990-1991, the factory was drastically changed and it occupied its war positions. Each Yugoslavian state and system had its own political primary goal that reflected on the factory operations.
The story of Bata's factory is an economic and political story, as well as a symbol of a new era in the fashion industry of this region. The investment project itself was primarily driven by economic motives, but political priorities entirely influenced the factory operations. The Bata Borovo factory, therefore,

operated in a respectable correlation with its environment: it changed its surroundings economically, politically, and socially. The surroundings undoubtedly influenced the factory as well, considerably more than if there had been only economic regulations.

Under current conditions of unstoppable technological development, continued market struggles, and competition, each group is forced to strive for changes and flexibility. As with the majority, this industry was affected by the crisis caused by national divisions, the Croatian War of Independence, and the breakup of Yugoslavia. Political instability caused business problems, but problems sparked changes. The decisive factor was the change where the focus was on the implementation of a production revitalization plan, redesign strategy, and developing high-quality brands, as well as the development of the company and the city of Vukovar.

Although the focus on socialist and planned business operations instead of market operations was mostly conditioned by the lack of brands and own design, iconic brands Startas and Borosana managed to make their way through with the help of their intangible characteristics such as feelings and memories.

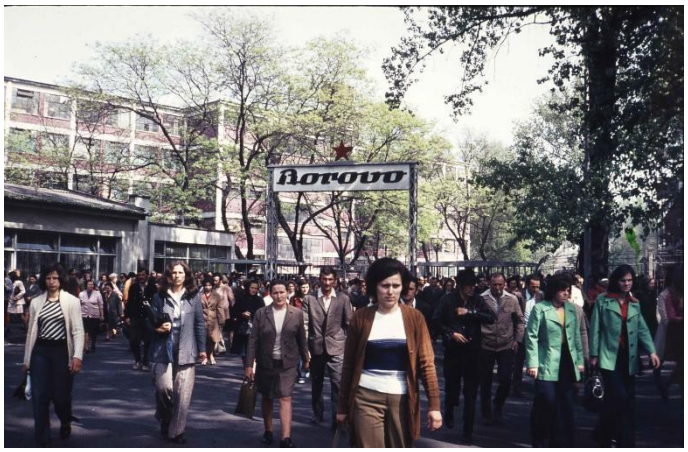


Figure 1: Borovo factory in 1980.

2. WORKING SHOES, HALF A CENTURY LATER

Women's working shoes Borosana appeared on the socialist market with the advertising slogan "Working feels like vacation while wearing Borosanas all day". The slogan presented Borosanas as working shoes for women who perform manual labor (nurses, cleaning ladies, waitresses, etc.), focusing on their orthopedic characteristics and creating a balance between the two opposing aspects of life – work and leisure. The social identity of a female worker wearing Borosana shoes mostly represented a modest woman who worked as a barista, seller, some type of iconic element, archetypal. Borosana shoes primarily had a practical purpose: comfort, quality, and functionality were the most important elements, whereas their esthetical value was neglected in presentation. Borosana shoes were made of canvas or leather, most often white or blue, and they were ridiculed in fashion circles. In the country where the working class was officially in power, working symbols were not valued. Aesthetics was on the rise in the working environment, uniformity by choice; no one normalized the uniform, it was chosen under the principle of functionality. Borosana shoes were the symbol of the development

of Yugoslavia that rested on the working class, and wearing them was a clear sign of social background and led to social differentiation among the working and upper class.

An important requirement of high consumption and popularity of Borosana shoes was the lack of competition in the shoe market, so Borosana shoes quickly became the Yugoslavian brand. A new advertising slogan underlined the authenticity of the product and its uniqueness: "If it's not Borovo, it is not Borosana". The significance of Borosana shoes in the aspect of socialism was marked by the labor ethics, as hinted in the *Lexicon of YU Mythology*: authors emphasized how the product was marked by gender and functionality but unpopular because of its "social component".

Today, Borosana shoes have undergone fashion redesign and repurpose from working shoes to shoes for young people, and they are presented as a popular product in retro style. The intuitiveness of Borosana shoes reflected the socialist ideal of equality, whereas today, the myriad of patterns, materials, and colors emphasize the complete opposite – powerful individuality.

Borosana shoes have survived socialism and became trendy shoes that came out of an anonymous world of uniforms and became the symbol of individuality and unconventional character of a new street style and it was reincarnated as Boromina. In 2012, Borovo announced the new product with the slogan "It's not a heel, but it has a height; it's not a slipper, but it is comfortable for everyone; it is not too rude or too nice; Borovo presents the beautiful Boromina!" Focusing on Borosana shoes and the existing production technologies in Borovo factory plants, product designer Iva Čurković has created a light canvas sandal, and fashion designer Ivana Popović hand-painted the Boromina series and presented it with her *Organica* collection. The new product no longer has worker connotations as the original Borosana, but its design is reminiscent of it.

The collection consists of six models: Pivce za živce, Nafrizirani, Verde tropico, Artičoke, Cvijeće 80-ih, and Ruže.

Figure 2: Organica collection

Startas sneakers, another Borovo product, have undergone the same cycle of meaning – from socialist footwear to popular modern shoes. These sneakers were created in the 1970s and were transformed into the biggest sports brand of Yugoslavia, while today it is targeted at young consumers. The social identity of consumers is marked by freedom, creativity, leisure, and sports. The product is commonly presented by a young person enjoying a sports activity.

Startas sneakers were made in 1976 and they were originally designed for playing table tennis. These low-top canvas sneakers with rubber soles were made of natural materials, often monochrome. In the 1970s, Startas product family consisted of the basic model line – monochrome canvas shoes in 12 different colors with blue and white rubber soles; imaginative colorful models – rubber soles with matching color or purposefully contrasted with the model, depending on the print or the color combination, and each pair came with two pairs of shoelaces in different colors; "luxury" Startas

sneakers – models made of brushed leather in 7 colors and came with a big bow of the same material that can be removed from the shoelaces if necessary.

Figure 3: Redesigned collection of Startas models

Startas sneakers very quickly became an iconic cultural heritage of former Yugoslavia. Today, many years later, after almost becoming "a thing of the past", Startas sneakers are revolutionized – they are revamped and redesigned thanks to designer Mauro Massarotto and the creative studio Sheriff&Cherry. Mauro Massarotto, the director of the creative studio Sheriff&Cherry, began the project of revival of Startas sports brand in mid-2007. In the spring of 2008, the redesigned sport sneakers were premiered at the world fair of men's fashion Pitti Immagine Uomo in Florence, as the first step in the business redevelopment and rebranding of this sports giant. Promotions around the world followed – Barcelona, Zagreb, Milan, Paris.

In keeping with the era, colors, and trends, Mauro has shaped the product destined to succeed on the global level. So far, three series of Massarotto's Startas sneakers have been presented in Croatia and worldwide, of which 50 models are made of canvas and leather. There are eleven colors in the basic line, around 30 prints, and ten leather models in different colors.

Ante Tonči Vladislavić, one of the project selectors, commented on the inclusion of Startas sneakers in the Exhibition of Croatian Design in the catalogue preface: "Startas shoes designed by Mauro Massarotto is an entirely unusual design product. By purchasing Startas trademark and redesigning the existing Startas tennis shoes, the designer redesigned the product and the symbolic value of these iconic shoes. Instead of novelty as the premise for the fashion message, the design process created a sort of an inversion. Therefore, this "aged" product emerged from the "socialist memory" retaining an unspeakable semantic vitality. The inclusion of present-day view on the past with the addition of redesign (visible in new colorful patterns with equally "colorful" names) is the secret for success: semantic, meaningful layer is the value of this product. Fashion and ideological dimensions of a *ready-made* product were mastered and redesigned to create a new design. As if fashion confirms that communication layer stands above all design layers, where there are values of time, present and distant pas, subjected to the current moment."[1]

[1](Text originally published in Pregled hrvatskog dizajna 0708).

Figure 4: designer Mauro Massarotto

3. CONCLUSION

The process of production, circulation, and consumption of Borovo products is shown in movements between the public and private spheres. The public sphere is presented by state institutions, legal norms, and the world of labor, whereas the private sphere is private home space and intimate and personal elements. The presentation and elements depend on the product and the consumer they are intended for; they include marketing strategies, and their only purpose is making profit while being the cultural practice of structured meaning. On one hand, goods are made by industry, but on the other hand, it belongs to common people who create and transfer their own meaning by using these goods, and they often fail the initial ideology of their manufacturers.

The paper analyses typical socialist products, beginning from how they were presented in the original context, who were the intended social groups, how they were consumed, and how they are consumed today.

Startas shoes, as well as Borosana shoes, are not only a cultural product made for young people, but they are a recognizable symbol reminding them of an everyday Yugoslavian experience. We should not neglect the thought that Yugonostalgia could be the key element in the presentation of these brands creating a deeply paradoxical situation: can a Yugoslavian brand in this context be intended for a social group whose life experience in socialism encompasses only a few years. How the phenomenon of Yugonostalgia was used in recycling the past should be analyzed taking into consideration its ideological and political connotations.

4. REFERENCES

[1] Adrić, I. i dr. ur. (2004) Leksikon YU mitologije, Beograd: Rende; Zagreb: Postscriptum

[2] Todorović T, Pavko-Čuden A 2016 The development of fashion design in Yugoslavia compared to centers of fashion Proceedings of 16th World Textile Conference AUTEX 2016 8-10 June Ljubjana ed Simončič B, Tomšič B and Gorjanc (Ljubljana: Faculty of Natural Sciences and Engineering, Department of Textiles, Graphic Arts and Design)

[3] Cvek, S. et al. 2015. Jugoslavensko radništvo u tranziciji: Borovo 1989. Politička misao, 52 (2): 7–34.

[4] Jović, D. 2003. Jugoslavija: država koja je odumrla. Zagreb: Prometej.

[5] Žebec, I. 2008. Utjecaj češkog kapitala na razvoj Vukovara između dva svjetska rata. Društvena istraživanja, 17 (1/2): 101–124.
[6] Palaček V: Moda za mene ne postoji jer je odvratna: Ivana Popović, modna kreatorica o svojoj reviji Standard konfekcija, Slobodna Dalmacija 59 (2001.) br. 18130, 13.7.2001. str. 34

THE ISSUE OF FASHION-WASTE TOWARDS THE CONCEPT OF CIRCULAR ECONOMY AND SUSTAINABILITY

Belma Gutlić, Irfan Hošić
University of Bihać, Faculty of Technical Engineering, belma-gutlic@hotmail.com, irfan.hosic@unbi.ba

ABSTRACT:

This paper deals with the analysis of fashion-waste, giving suggestions for optimizing the social model of sustainability and addressing the fundamental issue of overproduction. The accumulation of unsold clothing in fashion industry, often as a result of maintaining an ambitious strategic intent of manufacturing goals and whole new market demands, is in fact a condition and a sign that sale-results do not match the planned turnover. Unsold clothing ultimately has a final destination most commonly marked as a landfill, causing major financial losses. The problem of accumulation of unsold clothing is further exacerbated by the fast-paced fashion cycle in order to protect the image and integrity of the fashion brands. A complete halt to supply chains within the restrictive fashion calendar, offered deeper insights on the effectiveness of diverting waste, towards the concept of circular economy and environmentally friendly economies. Following the design process in determining the most suitable method, the aim of this paper is to point out the problems of large quantities of unsold clothing in fashion industry and consider them in the direction of sustainability and responsibility.

Keywords: fashion-waste, sustainability, circular economy

1. INTRODUCTION

The textile industry faces some of the most important challenges, producing clothes that consumers buy for reasons of desire rather than need. In the earlier period of the 20th century, the appearance of a clothing was a secondary issue to be met in production. The fashion industry effectively only had two seasons a year. With lower prices at clothing shops, thanks to easier access to cheap labor, fashion brands, with positive consumer response, began to stimulate production. The term "fast fashion" was quickly created, making clothes disposable. The concept of "fast fashion" is focused on low-quality production with the lowest price, which cannot be produced sustainably. The key to managing “fast fashion” and avoiding the accumulation of unsold clothing is recognizing consumers preferences to anticipate fashion trends [1]. Fast fashion is not conceived as high fashion, but it is more or less a copy of high fashion design where an obvious difference is noticed due to the use of cheap materials, production of the same product in several different colors and sizes [2].

As public awareness of the problem of fashion and textile waste grows, so does the pressure on fashion brands to rethink their operating models to minimize material use and take responsibility to ensure that as much of what they sell can be recycled [3]. Reducing the amount of waste becomes a business opportunity. It is a devastating fact that less than 1% of the amount of textile and fashion waste is

recycled [4]. Most of the unsold clothing from the warehouse ends up in the landfill. Luxury fashion brands, in order to avoid devaluing the brand image, burn unsold clothing out of season and thus prevent sales at a reduced price. The financial year that ended in March 2018, Burberry destroyed more than $ 38 million in clothing and cosmetics. H&M is another example of a company that produces more than it sells. Despite around $ 4.3 billion of unsold inventory in 2018, the company did not stop or reduce production, continuing to produce new clothing [5].

In the initial stage, clothing can be designed in a way that will ensure its longevity. One of the key ways to respond to this is to develop a "value-based business" that includes developing business models that allow them to use natural resources more sustainably and producing clothing made from fabrics originating from overproduction or consumer waste, or both [6]. Often designers are not aware of the negative impact of the textile industry on the environment or are not well educated in the field. In recent years, however, design schools have paid more attention to the problems of fashion waste, where resources come from and under what conditions they are created.

The study focuses on understanding the conditions and challenges that enable the transition to a circular model by adopting unsold clothing redesign activities, identifying values that are crucial in consumer interest for redesigned clothing, and examining the economic viability of such a business strategy. In addition to assessing feasibility, the study identifies key success factors toward moving to a circular model [7].

2. THE GROWING PROBLEM OF FASHION-WASTE

The fashion industry has extremely complex supply chains. In the fashion industry, multinational companies have joined forces, defined infrastructure, and implemented major initiatives. To compete, fashion brands rely heavily on future trends, rather than using real-time data to assess consumer needs and desires. The production strategy until the 1980s focused more on the demands of consumers who were less sensitive to fashion changes and cared more about functionality. In the late 1980s, the fashion industry was dominated by several brands, intensifying market competition. Since the 1980s, clothing has gone through stages of introduction and adoption by fashion leaders, then public acceptance, maturation, and finally decline and obsolescence. Business strategies in the 1990s began to focus on expanding the range and responding more quickly to consumer preferences [8]. To increase the diversity of fashion clothing on the market, more phases were added to the existing seasons, ie the mid-seasons in the fashion calendar. These changes in the number of mid-seasons are partly due to lifestyle changes, and also the need to satisfy consumers with clothing for various occasions. Adding 3 to 5 mid-seasons created a lot of pressure on suppliers as they had to deliver clothes in smaller batches, but with reduced delivery times. Complicated supply chain due to challenges produced by the geographical dispersion of partners, inconsistency in delivery deadlines, inefficient communication has led to reduced profitability. To improve its operational performance, existing strategies needed to be restructured. Some examples of restructuring that emerged around the 1990s include the development of new strategies to respond quickly to current market needs with shorter delivery times. The challenges facing the fashion industry are the result of the introduction of strategies such as Just in Time (JIT) [9], Computer Integrated Manufacturing (CIM) [10], and Total Quality Management (TQM) in manufacturing [11].

The fashion clothing industry developed significantly in the late 1990s. Fashion shows have become a public phenomenon, resulting in the development of consumer awareness of fashion. As fashion-conscious consumers were exposed to an exclusive design inspired by the catwalk look, their needs became far more demanding [12]. Consumer needs and desires have changed at a much faster pace than before. Today, successful brands like Zara, H&M and Forever 21 have taken over the fashion industry [13]. With "fast fashion", new styles quickly replaced the old ones, and so did the constant definition of consumer desires and the search for one's own style. "Fast fashion" consumers are usually between

15 and 29 years old [14]. These young consumers have limited disposable income that allows them, almost exclusively, to buy fast fashion clothes. Fast fashion manufacturers are influencing this target group by offering the latest designs and instant gratification of evolving temporary identities, at affordable prices. Identity changes with the accelerated way of life and in the context of fashion, with new looks replacing the old ones [15].

The result is a supply chain that can handle low costs and have high flexibility and deliver the product to the market at high speed. The scale at which production takes place is enormous and growing [16]. Innovation in this type of production is difficult to push, because the production process is stuck within a short time frame and the current business model of "fast fashion". Multinational companies respond to the concept of "fast fashion" and focus on producing as fast and cheap as possible, in line with the latest trends, because the consumer demands it, and are often more exposed to the media, which can be both beneficial and unfavorable for them in terms of engagement in creating a sustainable business model. They have a business model that pays off, and they have little incentive to change that model.

3. TRANSITION OF FASHION INDUSTRY TO THE CIRCULAR BUSINESS MODEL

For the fashion industry to become circular, the entire infrastructure and supply chain must be changed and made circular. Some interesting innovations have already been developed that differ from conventional models of the circular economy [16]. Figure 1 shows the business model of the circular economy, including the redesign of unsold clothing for a more sustainable approach. After the market use of clothing, clothing can be recycled. The problem arises with overproduction and a huge amount of unsold clothing in the warehouse that could be redesigned next season according to new market demands.

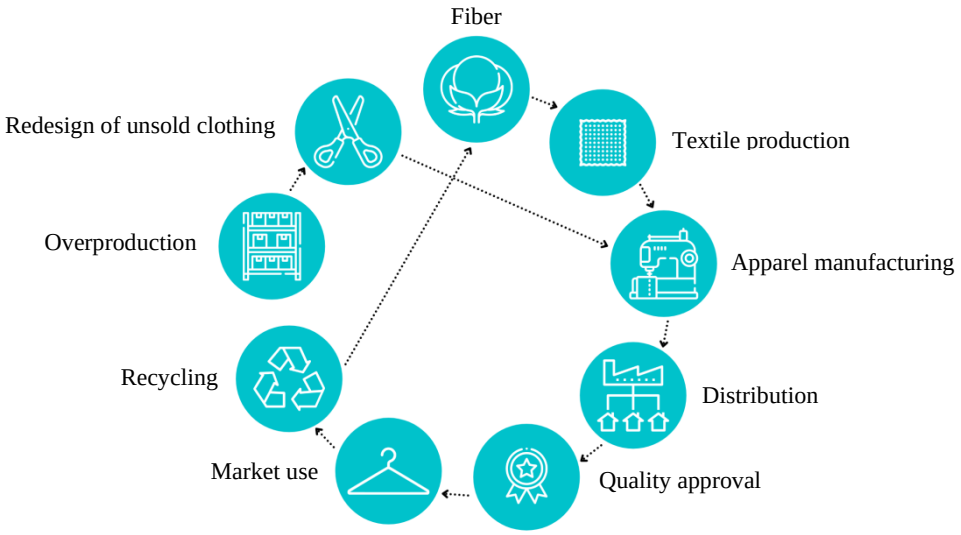


Figure 1: Circular economy business model, including a redesign of unsold clothing from warehouse

Recognizing these business opportunities is the reason why companies are willing to move to a more sustainable approach. The primary reasons are improved reputation and competitive advantage in the market. However, especially in start-ups, many initiatives have been developed out of employees' personal concern for the environment and the realization that society cannot continue to operate in the

way the current economy works. Increased employee participation in environmental engagements has the power to change the business vision. Leading positions within the company must be aware of the benefits of a sustainable business model, as their attitude and willingness to adapt are important variables for achieving change. Also, consumer demands increasingly require an environmentally "conscious" design approach. Examples of increased consumer propensity to participate are shown in sustainable fashion initiatives [17].

In this paper, the transition to a circular business model is facilitated by the closed-loop supply chain concept, which refers to a supply chain system in which the production and redesign of unsold clothing and clothing from consumer use coexist. The processes of redesign and reverse logistics activities include the steps shown in Figure 2. The redesign takes a step backward and adds value to the use of clothing and is an advanced form in which refurbished parts retain their original function and look in line with seasonal market requirements. The redesign has several advantages for sustainable production and waste management. By reducing the production of new textiles, the use of water, energy, and chemicals has been reduced, leading to a reduction in greenhouse gas emissions.

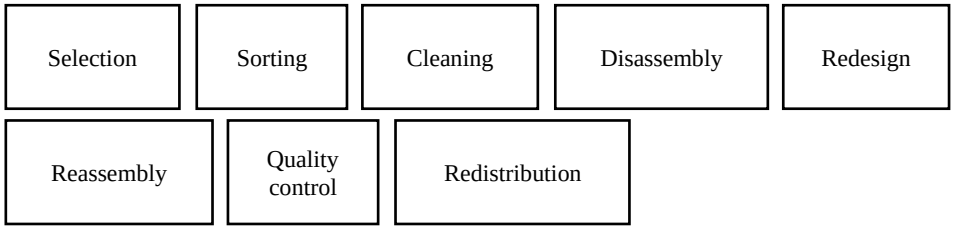


Figure 2: Steps in the processes of redesign and reverse logistics activities

Furthermore, the more clothing components used as raw materials in the redesign still function, the cheaper the process becomes. In addition, the quality and performance of redesigned products can be compared to a new product, with the added benefits of shorter processing times and reduced negative environmental impacts [18]. However, there are still many uncertainties, especially related to reverse material flow, delivery time, quality, and market demand. All steps and their sequence in the redesign process affect the quality and feasibility of the activities carried out to the final product. The quality standard and the new product depending on the quality of the waste material, the level of complexity of the required activities, and the available technologies. For example, the value of waste material depends on the market demand, and supply of materials, legislation on redesign activities, and technologies used. In addition, the disassembly phase of clothing components has a direct impact on the quality of newly created clothing, because the process is labor-intensive, so it is exposed to a higher risk of human mistakes.

Because of challenges, such as a lack of adequate experience and infrastructure, most companies are reluctant to explore the potential for redesign. This can be attributed to a lack of motivation for increased collaboration due to ignorance of redesign operations, along with globalization and cheap sources from overseas production and misunderstanding of consumer perception and consumer behavior towards redesigned products. In conclusion, while there are numerous advantages and challenges of the redesign in the textile and fashion industry, success requires a comprehensive understanding and increased redesign activities in transition to a circular business model explained in Figure 1. A combination of integrated business activities and cooperation is needed.

The main variables that affect the economic feasibility of redesigned clothing are the retail price and the costs associated with the redesign process. Redesign activities are cost-effective, and their goal is

to serve as an indicator of the feasibility of moving towards a circular business model [19]. Given the lack of policy incentives, such as tax cuts on product standards, interest in moving to a circular business model may be inhibited. The design within the circular business model of the textile and fashion industry is becoming more complex, as it is necessary not only to anticipate the initial sales but also the circulation of the offer. To arrive at a suitable revenue model, visualizing the economic value created by the redesign is a greater challenge as revenue models become increasingly complex [19].

Within this business model, a lack of consumer demand and awareness of sustainable products, along with limited sales arguments, including the sustainability of redesigned products, can lead to weak and uncompetitive sales. Fluctuating consumer demand poses a challenge to market redesigned products [20]. Limited knowledge of aspects related to designing redesigned products puts designers in a challenging position. Also, the exchange of information and knowledge related to the circular economy of enterprises is quite rare, which could potentially lead to a lack of awareness of the impact of waste generation and disposal [21].

4. CONCLUSION

Issues related to the availability, demand and technical capacity to redesign unsold clothes that meet market demands, together with uncertainties regarding the potential for redesign due to quality and function, point to a lack of redesign regulations. Redesign activities depend heavily on manual labor which means labor-related costs are higher compared to mass production. Additional costs may arise due to the additional use of materials leading to the challenges associated with pricing redesigned products. In order to attract more consumers to redesigned products, companies need to understand the factors that influence the acceptance process as well as communicate their environmental initiatives. The transition to a circular business model by redesigning unsold clothing requires the implementation of strategies and policies that question consumerism and the behavior of the fashion industry. Companies can influence the adoption and transition to redesign activities; fashion brands need to take steps to influence policymakers to enact regulations, such as tax cuts. The integration of several business activities has been described as essential to the success of the redesign implementation. In addition, rethinking business strategy allows a company to increase sales, spread brand awareness, identify new sales opportunities along with reduced environmental impact, and create new jobs, and increase revenue and reduce environmental impact by focusing on the product rather than the quantity.

5. REFERENCES

[1] Sull, D. and Turconi, S. (2008). Fast fashion lessons. Business Strategy Review 19(2), 4–11. doi: 10.1111/j.1467-8616.2008.00527.x.
[2] Mrad, M. et al. (2020). Brand addiction in the contexts of luxury and fast-fashion brands. Journal of Retailing and Consumer Services 55, 102089. doi: 10.1016/j.jretconser.2020.102089.
[3] Bick, R., Halsey, E. and Ekenga, C. C. (2018). The global environmental injustice of fast fashion. Environmental Health 17(1). doi: 10.1186/s12940-018-0433-7.
[4] The impact of textile production and waste on the environment (infographic), European Parliament, https://www.europarl.europa.eu/news/en/headlines/society/20201208STO93327/the-impact-of-textile-production-and-waste-on-the-environment-infographic, Accessed (01.07.2021)
[5] The destruction of unsold clothes shows the dark side of fast fashion, Lifegate, https://www.lifegate.com/fast-fashion-overproduction, Accessed (04.07.2021.)
[6] Pookulangara, S. and Shephard, A. (2013). Slow fashion movement: Understanding consumer perceptions—An exploratory study. Journal of Retailing and Consumer Services 20(2), 200–206. doi: 10.1016/j.jretconser.2012.12.002.
[7] Koszewska, M. (2018). Circular Economy — Challenges for the Textile and Clothing Industry. Autex Research Journal 18(4), 337–347. doi: 10.1515/aut-2018-0023.

[8] Mellahi, K., Jackson, P. and Sparks, L. (2002). An Exploratory Study into Failure in Successful Organizations: The Case of Marks & Spencer. British Journal of Management 13(1), 15–29. doi: 10.1111/1467-8551.00220.
[9] Voss, C. A. and Robinson, S. J. (1987). Application of Just-in-Time Manufacturing Techniques in the United Kingdom. International Journal of Operations & Production Management 7(4), 46–52. doi: 10.1108/eb054799.
[10] Bi, Z. (2021). Computer Integrated Manufacturing (CIM). in Practical Guide to Digital Manufacturing. Springer International Publishing, 321–388. doi: 10.1007/978-3-030-70304-2_5.
[11] Zainal, M. I. et al. (2021). ANALYSIS ON THE TOTAL QUALITY MANAGEMENT (TQM) PRACTICES TOWARDS BUSINESS PERFORMANCE; A CASE STUDY. Jurnal Aplikasi Bisnis dan Manajemen. doi: 10.17358/jabm.7.2.306.
[12] Vrontis, D. and Vronti, P. (2004). Levi Strauss: an international marketing investigation. Journal of Fashion Marketing and Management: An International Journal 8(4), 389–398. doi: 10.1108/13612020410559984.
[13] Not Forever 21...Why Zara And H&M Still Dominate In The Fast Fashion Relevance War, Forbes, https://www.forbes.com/sites/scottdavis/2019/10/02/not-forever-21-why-zara-hm-dominate-fast-fashion-relevance-war/?sh=26820e18206e, Accessed (07.07.2021)
[14] Gupta, S. and Gentry, J.W. (2018). Evaluating fast fashion: Fast Fashion and Consumer Behaviour. In book: Eco-friendly and Fair 15-23. doi:10.4324/9781351058353-2.
[15] Bhardwaj, V. and Fairhurst, A. (2010). Fast fashion: response to changes in the fashion industry, The International Review of Retail, Distribution and Consumer Research 20(1), 165–173. doi: 10.1080/09593960903498300.
[16] Wang, B. et al. (2020). Blockchain-enabled circular supply chain management: A system architecture for fast fashion. Computers in Industry 123, 103324. doi: 10.1016/j.compind.2020.103324.
[17] Zamani, B., Sandin, G. and Peters, G. M. (2017). Life cycle assessment of clothing libraries: can collaborative consumption reduce the environmental impact of fast fashion?. Journal of Cleaner Production 162, 1368–1375. doi: 10.1016/j.jclepro.2017.06.128.
[18] kamel, M. (2021). Suggested Methodology for Designing According To the Concept Of Fast Fashion. Journal of Design Sciences and Applied Arts 2(2), 162–172. doi: 10.21608/jdsaa.2021.64533.1098.
[19] Palm, C., Cornell, S. E. and Häyhä, T. (2021). Making Resilient Decisions for Sustainable Circularity of Fashion. Circular Economy and Sustainability. doi: 10.1007/s43615-021-00040-1.
[20] Grazzini, L., Acuti, D. and Aiello, G. (2021). Solving the puzzle of sustainable fashion consumption: The role of consumers implicit attitudes and perceived warmth. Journal of Cleaner Production 287, 125579. doi: 10.1016/j.jclepro.2020.125579.
[21] Miotto, G. and Youn, S. (2020). The impact of fast fashion retailer, sustainable collections on corporate legitimacy: Examining the mediating role of altruistic attributions. Journal of Consumer Behaviour 19(6), 618–631. doi: 10.1002/cb.1852.

CONGRUENCES AS A DESING TOOL

Melisa Haurdić, Dejla Ramić
Faculty of Tehnical Engineering, Bihać
melisa.haurdic@unbi.ba, dejla.ramic@unbi.ba

ABSTRACT:

This paper defines the concept of congruence, describes its basic properties and its application in other sciences, which at first glance are not related to mathematics. As a special application of congruence, we have singled out the shaping and design of surfaces related to ambient textiles.

Keywords: congruence, residual system, repetition, textile pattern, rhythm.

1. INTRODUCTION

This paper analyzes the role and importance of congruence, but also its application in creating a modular design. A mathematical apparatus was developed with the the introduction of congruence, that over time played an important role in science. They have found application in other sciences, which at first sight are not connected with mathematics. The theory of congruence was introduced in the work Disquisititiones Arithmeticae by Carl Friedrich Gauss, one of the greatest mathematicians of all time.

2. CONGRUENCE

As to its conveyance, congruences were used for military purposes when counting how many soldiers survived after a battle. Namely, instead of unnecessarily waisting time on long counts, the surviving soldiers would simply stand in rows of 3,4,5,7,11 and possibly 13 soldiers (if there were a larger number of survivors), and then with the help of the number the soldiers remaining in the back row received a system of congruence. By solving that system, they would get the exact number of surviving soldiers. Of course, the number of soldiers in a particular order could change, but one always had to make sure that the numbers were relatively simple and their product was large enough to be able to read the exact number of surviving soldiers from the final congruence.
Congruences are used in order to check certain errors in a series of numbers, whether it is the detection of an error in a series of bits or in a series of decimal numbers used to identify JMBs, books, postal codes, food products, banknotes and similar. They have also found their application in sports, when scheduling matches in a tournament consisting of n teams, and is held on the principle that each team plays with each other team exactly once.
Definition 1.1. If the integer $m \neq 0$ divides the difference $a - b$, then we say that a is congruent b modulo m and write $a \equiv b \ (mod\ m)$.

Since $a - b$ is divisible by m if and only if it is divisible by $-m$, without reducing the generality we can observe cases with positive modules and in further consideration modulo m will be a natural number.

When applying congruences, it is often necessary to translate them into equality, which the following theorem allows us to do.

Theorem 1.1. Let a and b be integers. $a \equiv b \pmod m$ if and only if there exists an integer k such that $a = b + km$.

The consequence of this theorem is that $a \equiv 0 \pmod m$ if and only if $m \mid a$.

The relation "to be congruent modulo m" is reflexive, symmetric and transitive, which means that it is a equ - From $m \mid 0$ follows $a \equiv a \pmod m$.

- If $a \equiv b \pmod m$, then there exists $k \in \mathbb{Z}$ such that $a - b = mk$. Now $b - a = m \cdot (-k)$, so $b \equiv a \pmod m$. equivalence relation on the set $\mathbb{Z}$:

- From $m \mid 0$ follows $a \equiv a \pmod m$.
- If $a \equiv b \pmod m$, then there exists $k \in \mathbb{Z}$ such that $a - b = mk$. Now $b - a = m \cdot (-k)$, so $b \equiv a \pmod m$
  - It follows from $a \equiv b \pmod m$ and $b \equiv c \pmod m$ that there exist $k, l \in \mathbb{Z}$ such that $a - b = mk$ and $b - c = ml$. By adding these two equations we have $a - c = m(k + l)$, which entails $a \equiv c \pmod m$.

Some of the simple properties of congruences are given in the following proposition.

Proposition 1.1. Let $a, b, c,$ be integers.

1. If $a \equiv b \pmod m$ and $c \equiv d \pmod m$, then $a + c \equiv b + d \pmod m$, $a - c \equiv b - d \pmod m$, $ac \equiv bd \pmod m$.
2. If $a \equiv b \pmod m$ and $d \mid m$, then $a \equiv b \pmod d$.
3. If $a \equiv b \pmod m$, then $ac \equiv bc \pmod{mc}$ for every $c \neq 0$.

The relation "to be congruent modulo m" on the set $\mathbb{Z}$ is the equivalence relation on the set $\mathbb{Z}$, so the set $\mathbb{Z}$ is split into equivalence classes according to the relation "to be congruent". The class of equivalence of elements a, in the notation $[a]_m$, is called the class of residues modulo m and represents a set of integers that are congruent with a per module m, ie.

$$[a]_m = \{x : x \in \mathbb{Z} \wedge x \equiv a \pmod m\} = \{a + km : k \in \mathbb{Z}\}$$

For example: The residue classes of module 4 are:

$$[0]_4 = \{\dots, -16, -12, -8, -4, 0, 4, 8, 12, 16, \dots\}$$
$$[1]_4 = \{\dots, -15, -11, -7 - 3, 1, 5, 9, 13, 17, \dots\}$$
$$[2]_4 = \{\dots, -14, -10, -6, -2, 2, 6, 10, 14, 18, \dots\}$$
$$[3]_4 = \{\dots, -13, -9, -5, -1, 3, 7, 11, 15, 19, \dots\}$$

Definition 1.2. Let $m \in \mathbb{N}$. A set of m integers $\{x_1, x_2, \dots, x_m\}$ is called a complete system of modulo residues m if it does not contain any pair of numbers of congruent modulo m, ie if it contains exactly one element from each class of modulo residues. In other words, that set will be a complete system of remainders if for every integer x there is exactly one element of that set x_j such that $x \equiv x_j \pmod m$.

It is obvious that there are infinitely many complete systems of modulo m residues. One of them is the so-called system of least nonnegative residues modulo

$$\mathbb{Z}_m = \{0, 1, \dots, m - 1\}.$$

In addition, a system of absolutely smallest modulo residues is often used. If m is an odd number, it is the set $\left\{-\frac{m-1}{2}, -\frac{m-3}{2}, \dots, -1, 0, 1, \dots, \frac{m-3}{2}, \frac{m-1}{2}\right\}$ and if m is even, it is the set $\left\{-\frac{m-2}{2}, -\frac{m-4}{2}, \dots, -1, 0, 1, \dots, \frac{m-4}{2}, \frac{m-2}{2}\right\}$.

Theorem 1.2. Let $\{x_1, \dots, x_m\}$ be a complete system of residuals modulo m, and let $nzd(a, m) = 1$. Then $\{ax_1, \dots, ax_m\}$ is also a complete residual system of modulo m.

3. MODULAR DESIGN OF TEXTILE PATTERNS

Modular design is deeply rooted in design theory and has been used by many designers for a long time. The advantages of modular design are clear space and organization, a network that works in almost any style and easy use to make patterns in ambient or clothing textiles. DESIGN (French: Dessin - drawing) pattern, print, swatch on textile is woven, knitted, or printed on a smooth, hairy or embossed surface. It represents a degree towards the enrichment of textile material. The pattern is a larger or smaller motif, which is rhythmically repeated. However, the pattern may be shaped as a border along the edges of the garments or represent a stand-alone composition according to the shape of the body and garments. According to the motif, the patterns can be: striped, checkered pepita, stylized plant, animal or human figures, various abstract patterns. One of the ways to create a pattern is modular arithmetic. There are three types of such design: (m, i) -star, design (m, n) –residue design and quilt design.

3.1.Design (m,i)-star

In order to construct this type of design, first we construct a circle and mark m equally spaced points on it. We denote these points by the elements of the set $\mathbb{Z}_m$. We choose $i \in \mathbb{Z}_m$ such that $nzd\ (i,\ m) = 1$. Connect each point x on the circle with the point $(x + \mathrm{i})\ mod$. (For example, to construct a $(17,6)$ -star, we construct a circle and mark 17 equally spaced points on it. Connect each point x on the circle with the point $(x + 6)\ mod\ 17$.

Table 1: (17,6)-star

x	$(x+6) mod 17$	x	$(x+6) mod 17$	x	$(x+6) mod 17$
0	6	6	12	12	1
1	7	7	13	13	2
2	8	8	14	14	3
3	9	9	15	15	4
4	10	10	16	16	5
5	11	11	0		

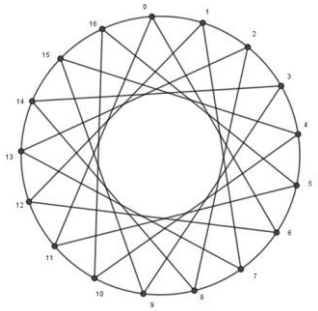


Figure 1: (17,6)-star

3.2.(m,n)-residue designs

For the construction of the design (m, n) –residue design, where $1 \leq n < m$ and $nzd\ (m, n) = 1$, we select $m - 1$ equally spaced points on the circle and denote them by numbers from 1 to $m - 1$. After that, we

connect each point s with the point $nx \ mod \ m$. Using different colors in certain regions we come to the design.
For example, to construct a design (21,10), we construct a circle and mark 20 equally spaced points on it. Multiply the number 10 by each nonzero remainder of modulo 21.

$10 \cdot 1 \ mod \ 21=10$	$10 \cdot 8 \ mod \ 21=17$	$10 \cdot 15 \ mod \ 21=3$
$10 \cdot 2 \ mod \ 21=20$	$10 \cdot 9 \ mod \ 21=6$	$10 \cdot 16 \ mod \ 21=13$
$10 \cdot 3 \ mod \ 21=9$	$10 \cdot 10 \ mod \ 21=16$	$10 \cdot 17 \ mod \ 21=2$
$10 \cdot 4 \ mod \ 21=19$	$10 \cdot 11 \ mod \ 21=5$	$10 \cdot 18 \ mod \ 21=12$
$10 \cdot 5 \ mod \ 21=8$	$10 \cdot 12 \ mod \ 21=15$	$10 \cdot 19 \ mod \ 21=1$
$10 \cdot 6 \ mod \ 21=18$	$10 \cdot 13 \ mod \ 21=4$	$10 \cdot 20 \ mod \ 21=11$
$10 \cdot 7 \ mod \ 21=7$	$10 \cdot 14 \ mod \ 21=14$	

Now we connect the dots 1 i 10.2 i 20.3 i 9,… 20 i 11 in order.

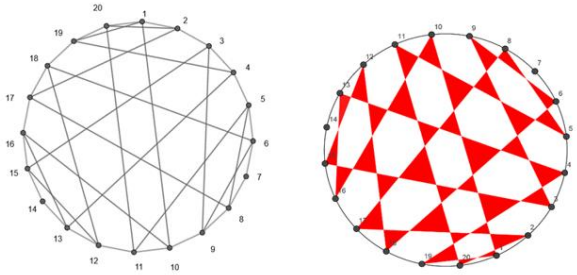


Figure 2: (21,10)-residues

3.2.Quilt designs

This type of design is easiest to explain with the following example. We choose m = 7, and apply the addition operation on the set of smallest remainders of modulo 7.

Table 2: Addition operation on the set of smallest remainders of modulo 7

+	0	1	2	3	4	5	6
0	0	1	2	3	4	5	6
1	1	2	3	4	5	6	0
2	2	3	4	5	6	0	1
3	3	4	5	6	0	1	2
4	4	5	6	0	1	2	3
5	5	6	0	1	2	3	4
6	6	1	2	3	4	5	6

We choose seven basic elements of design, so that each of them represents the numbers from 0 to 6 as in the picture.

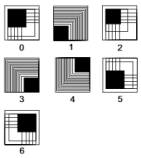


Figure 3: Basic design elements

If we now replace each number in the table with the corresponding element we get the following design.

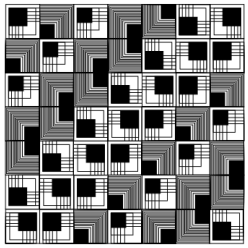


Figure 4: Quilt design mod 7

If we fill a 4 × 4 square grid with this design, and the resulted design can be copied in a relation to the vertical or horizontal line, and by that we can get the following design

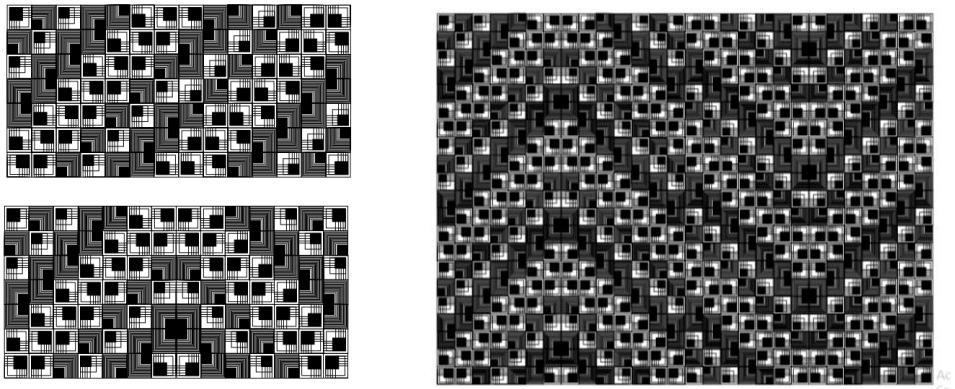


Figure 5: Quilt design mod 7

If we place the obtained design in non-standard grid and expand the design by mapping or rotation, we get the following design.

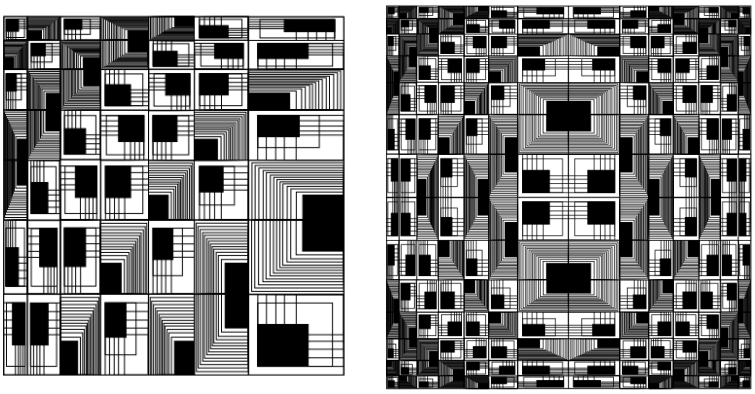


Figure 6: Quilt design mod 7

By using this we can get different designs if we use multiplication mod *m*. For example use *m=7*. We apply multiplication operation at the set of the smallest residues in multiplication of mod 7 .

Table 3: Multiplication operation on the set of smallest remainders of modulo 7

·	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	1	2	3	4	5	6
2	0	2	4	6	1	3	5
3	0	3	6	2	5	1	4
4	0	4	1	5	2	6	3
5	0	5	3	1	6	4	2
6	0	6	5	4	3	2	1

We leave first row and column and fill the grid with wanted designe.

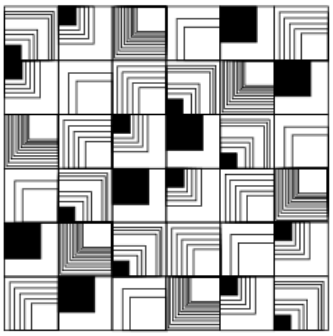


Figure 8: Quilt design mod 7

3. CONCLUSION

The theory of congruence finds wide usage in everyday life. We do not encounter at it only in mathematics but also in economics (e.g. game theory), visual arts, music, computing and many other sciences. Modern cryptography is also based on this theory, while some ideas that can realte to congruences dating, originate from the time of the Gallic wars. In design theory, congruences allow the

creation of modules that are often an inspiration to visual artists to create artwork, but also to textile designers to create designs. There is a close connection between mathematics and art,as it is described in the following.

4. REFERENCES

[1] Ibrahimpašić, B., (2014). Uvod u teoriju brojeva.Pedagoški fakultet. Bihać.
[2] Rosen, K., H., (1993). Elementary Number Theory and Its Applications. Reading.
[3] Koshy, T., (2007). Elementary Number Theory with Applications. Press.

INFLUENCE OF FINISHING ON THE PROJECTING STRUCTURE OF SIGNLE JERSEY COTTON WEFT KNITTING

Edin Fatkić, Ena Jajalo, Belma Gutlić
Faculty of Technical Engineering, University of Bihać

ABSTRACT:

Consumer demands for quality knitted products are growing. In this sense, the knit must be designed, which, among other things, implies an optimal knit structure. The paper investigates the influence of knitting finishing on the designed parameters of the structure of the right-left cotton cool knit. The results showed that the designed structure can be knitted on a machine with a cooling depth of 1.45 mm. By bleaching the knits the parameters change significantly. By bleaching the step of the eyelet increases in all samples, the height of the eyelet and the length of the eyelet decrease. The surface mass also increases significantly. Surface mass is not an indicator of quality but only a trade parameter.

Keywords: cotton knitwear, knitting design, structure, finishing

1. INTRODUCTION

Modern knitting requires the design of knits as an element of a systematic approach to quality assurance whose goal is to achieve a quality product, proper use of materials and maximum efficiency of knitting machines. Many knitters today produce knitwear without knowing the basic rules of knitting design [1]. Knitting design today involves selecting the most optimal parameters in terms of product selection, raw material selection, knitting machine, matching the fineness of yarn and machine, determining the optimal structural parameters of the product, etc. In practice, the art of knitting often comes down to achieving Dh and Dv satisfactory surface mass of the knit, which is justified only as an economic indicator. In order to obtain quality knitwear, it is necessary to design before mass production. The initial data for designing the basic characteristics of knitting structure is the type and raw material and fineness of knitting yarn. From this data it is necessary to determine the thickness of the yarn, which is not easy due to the variability of fiber and yarn properties, yarn length and stitch shape, ie stitch steps Ao and stitch height B. For different types of knits there are different values and relationships between yarn length in stitch yarn and stride and eyelet height. It is of great importance to determine the optimal parameters of the structure of the knit (lo, Ao and B) that will ensure the smallest deviations in the predetermined quality of the knitted product after wearing and maintenance. The shape of the eyelet with such parameters has maximally rounded needle and platinum heads, which ensures a state of minimum energy. The aim of this work is to achieve the designed parameters and the impact of finishing on the designed structure of right-left cotton, and the same such bleached knits.

2. DESIGN OF STRUCTURAL PARAMETERS OF RIGHT-LEFT COOL KNITTING

Considering the purpose of the knitting and the chosen fineness of the yarn, the design of the structural parameters of the right-left cotton knitted knitting was performed [1].
The structural parameters of the designed knit are shown in tab. 6. A value of 1.4 is chosen for the density factor K. The yarn thickness was calculated from the fineness of the yarn taking into account the raw material composition with the assumption that the cross section is perfectly circular in shape. Because in reality, in addition to a number of other factors, the cross-section of the yarn is not a perfect circular shape, the theoretical calculations differ from the practically measured parameters of the knit.

Table 1: Structure parameters of the designed knit

Ordinal no.	Parameter name	Label	Units	Value
1.	The fineness of the yarn	$\mathbf{T_t}$	tex	16,81
2.	Yarn thickness	$\mathbf{d_{pr}}$	mm	0,16
3.	Loop step	**Ao**	mm	0,72
4.	Loop height	**B**	mm	0,61
5.	Density factor	**K**	$tex^{0,5}\,mm^{-1}$	1,4
6.	Loop lenght	$\mathbf{l_o}$	mm	2,92
7.	Horizontal compaction	$\mathbf{D_h}$	$(10\ mm)^{-1}$	13,89
8.	Vertical compaction	$\mathbf{D_v}$	$(10\ mm)^{-1}$	16,39
9.	Surface mass	**m**	$g\ m^{-2}$	111,4

3. EXPERIMENTAL PART

In order to examine the possibility of achieving a knitted structure of predetermined optimal quality, which means the designed parameters of the structure shown in table no. 1, samples of right-left knitting were made of cotton yarn of fineness Tt = 16 tex, in 5 cooling depths. After that, the causes were relaxed 48 sti in a climate chamber with standard conditions. The structure parameters were experimentally determined according to the standards. Samples are marked with A1, A2, A3, A4 and A5 marks. The same samples of cotton knits were bleached according to the recipe to see how the finishing affects the raw knits of the designed structure. Such causes are designated A1B, A2B, A3B, A4B and A5B. Tests of the structural parameters of the knits were performed after the relaxation of the knits. For the purpose of testing, the basic parameters of the knitting structure were experimentally determined:
• Compaction of meshes in row Dh and row Dv according to DIN 53883, [2, 3].
• The length of the yarn in the loop is practically determined according to DIN 53852 [4, 5],
All measurement results were processed by standard statistical methods [6].

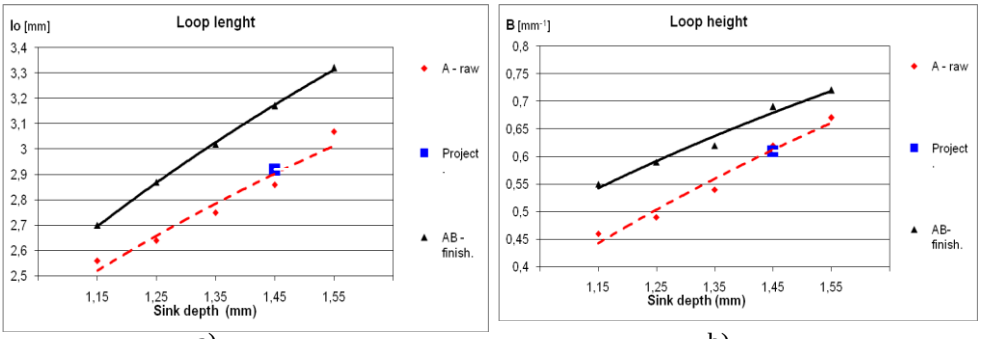
4. TEST RESULTS

The measured parameters of the structure of horizontal and vertical compaction and the length of the yarn in the stitch are shown in tab. 2 and in the figures: Fig. 1, Fig. 2 and Fig. 3. The results of the experiment, ie the change of structural parameters of the knitting are shown in Table 2, and graphically presented by diagrams of the change of parameters of knitted knitting patterns with respect to the depth of cooling and finishing of knitting, [7].

Table 2: Measured parameters of the structure of the right-left cotton knit

Param.	Units	Sample mark									
		A1	A2	A3	A4	A5	A1B	A2B	A3B	A4B	A5B
Dh	cm^{-1}	12,05	12,3	12,36	12,78	12,95	15,52	15,65	15,95	15,78	15,82
σ	cm^{-1}	0,09	0,063	0,150	0,147	0,05	0,133	0,092	0,081	0,087	0,172
Cv	%	0,746	0,514	1,211	1,149	0,386	0,855	0,589	0,505	0,552	1,088
A_o	mm	0,81	0,81	0,78	0,73	0,78	0,65	0,65	0,67	0,67	0,66
Dv	cm^{-1}	23,06	21,98	20,28	18,56	16,25	29,49	27,15	26,15	24,66	24,56
σ	cm^{-1}	0,066	0,04	0,06	0,136	0,120	0,318	0,112	0,180	0,448	0,326
Cv	%	0,288	0,182	0,296	0,731	0,741	1,077	0,412	0,690	1,815	1,328
B	mm	0,46	0,49	0,54	0,62	0,67	0,55	0,59	0,62	0,69	0,72
l_o	mm	2,56	2,64	2,75	2,86	3,07	2,56	2,65	2,79	2,98	3,18
σ	mm	0,016	0,025	0,027	0,013	0,,012	0,019	0,023	0,026	0,014	0,021
Cv		0,930	0,996	0,442	0,581	0,850	0,508	0,776	0,565	0,329	0,660
m	gm^{-1}	116,1	114,6	111,3	104,4	102,4	106,5	105,9	107,0	99,00	96,02
σ	gm^{-1}	0,008	0,008	0,006	0,006	0,009	0,010	0,013	0,007	0,014	0,614
Cv	%	0,750	0,706	0,580	0,581	0,850	0,906	1,233	0,565	1,392	0,639

Figures 1 and 2 show the changes in the structure of the knit with respect to the depth of cooling and finishing



a) b)

Figure 1: Influence of cooling depth on compaction of raw and finished knits

4. DISCUSSION

The increase in the length of the yarn in the stitch from the minimum to the maximum cooling depth is about 24%. With the relaxation time, the yarn length in the stitch decreases also in all samples (results not shown). The reason for this is the release of internal stresses that the yarn received during knitting, ie relaxation phenomena in the yarn in terms of contraction or reduction of the length of the yarn in the stitch. The reduction in yarn length in the stitch during relaxation from the first to the twentieth day of relaxation is up to 2% for all samples. As for the length of the yarn in the mesh of Fig. 1, due to the contraction of the yarn during wet processing and drying, ie bleaching, it decreases by about 4% at the same cooling depth. Bleaching the knits results in a significant reduction in the length of the yarn in the stitch for all samples. Bleaching causes swelling and contraction of the yarn in the knit, thus reducing the length of the yarn in the stitch. When bleaching, cotton fibers swell, the cross-section of the fibers increases and thus the yarn, and the length of the bleached yarn is

significantly reduced. The reduction in the length of the bleached yarn compared to the raw knit patterns is up to 3.1%. With 100% cotton raw knitwear with increasing cooling depth, the stitch pitch Ao decreases, Tab. 2. This phenomenon is also explained by the increase in stitch height with increasing cooling depth. At a greater depth of cooling, the stitch is larger and therefore there is more space for bending the yarn and its relaxation. In this sense, there is a smaller increase in eyelet steps during relaxation in the sample marked A5. The same trend is for bleached specimens marked, Fig. 1. As the cooling depth increases, the height of stitch B increases in raw and bleached cotton knits marked A and AB. The reason for this is an increase in the length of the yarn in the stitch. There is a greater trend of increasing the height of the eyelet with increasing depth of cooling in raw samples compared to bleached samples. The bleaching of the yarn, ie the knitting, relieves the internal stresses created during knitting, so there are minor changes in the dimensions of the knitting. The surface mass decreases with greater cooling depth. It is a function of horizontal and vertical compaction, the length of the yarn in the stitch and its fineness. By bleaching the knits, the surface mass is reduced by reducing the vertical and horizontal compaction.

5. CONCLUSION

According to the test results, the designed values of the knitted structure can be achieved with a cooling depth of 1.45 mm. However, with the bleaching of the knit, the parameters of the structure change significantly. The length of the yarn in the stitch determines the structure and properties of the knit. Different lengths of yarn in the Loop also give different properties. After relaxation, the length of the yarn gained a value of 2.86 mm at the cooling depth, which is a decrease of 2.1% compared to the projected value of 2.92 mm. which is a very good result for the designed structure that will behave best in the knit during wearing and maintenance. However, after bleaching the knit, the stitch acquires a value of 2.98, which is 2.1% more than the value of the designed stitch. This must be borne in mind by knitters in the plants in achieving the designed length of yarn in the stitch as the most important parameter of the structure of the knit. Surface mass is a parameter of the structure of the knit that does not speak about its quality but serves commercial purposes. The customer requires a certain surface mass that often does not correspond to the optimal designed surface mass, so it takes the experience of the knitter to adapt the designed structure to the requirements of customers. During relaxation, the surface mass of the knit grows. The biggest changes are visible after removing the knit from the machine. The longer the length of the yarn in the stitch, the lower the density of the knit, the smaller the number of loops on the surfaces, ie the lower the surface mass of the knit.

6. LITERATURE

[1] Vrljičak Z.: Načelo projektiranja glatkog kulirnog desno-lijevog pamučnog pletiva, Tekstil 43 (1) 26-31 (1994)
[2] DIN 53883: Bestimmung der Maschenreihenantahl, Maschenstabchenanzahl and Machendichte von Gewirken und Gestricken, Dezember, 1983
[3] Tekstilni priručnik : Društvo inženjera i tehničara tekstilaca DITT, Maribor (1986)
[4] Čunko R.: Ispitivanje tekstila, Sveučilišna naklada Liber, Zagreb, 1995
[5] DIN 53852 Testing of textiles; determination of yarn length ratios in woven and knitted fabrics
[6] Pauše Ž.: Uvod u matematičku statistiku, Školska knjiga Zagreb, 1993
[7] Fatkić E.: Modeliranje i optimizacija utjecajnih parametara na mehanička i fizikalna svojstva pletiva, Tekstilno-tehnološki fakultet Sveučilište u Zagrebu, Zagreb 2009.

DIFFERENCES OF BODY MEASUREMENTS FOR THE YOUTH POPULATION

Renata Hrženjak, Ksenija Doležal, Blaženka Brlobašić Šajatović
University of Zagreb Faculty of Textile Technology
renata.hrzenjak@ttf.unizg.hr

ABSTRACT:

The research was conducted on the population of young men aged 13 to 20 years in five Croatian regions, including the City of Zagreb. A sample of 4045 respondents was measured according to the rules of ISO and EN standards. Descriptive statistics were used to present differences of the main body measurements. The obtained results showed regional differences, mostly in body height, where it can be concluded that the growth by age is linear, and the tallest young men were measured in Dalmatia region. Differences in other body measurements show that the highest values of waist and hip girths have young men in Goransko-primorska region, and chest girth in Dalmatia region.

Keywords: body measurements, growth and development, young men, regional differences

1. INTRODUCTION

During child's growth characteristic changes happen, and the performance of anthropometric body measurements allows perceiving these changes which gradually occur in successive generations. From generation to generation children have become taller and earlier mature which is called secular trend. Over the last hundred years the average secular growth of body height in several West European countries and in USA has been about 1 cm per decade. As a period of a hundred years is too short for considerable genetic changes, the reasons for te secular trend mostly apply to the general improvement of food and health protection through control of infectious diseases by vaccination and better medical care and also improvement of housing conditions. Taking anthropometric measurements and their comparison with a specific period of time reveal changes in body dimensions, and their impact on health and life quality is investigated [1, 2].
A survey of the early 80s of the 20th century on a 10% sample of school children and youth aged 6 to 19 in Croatia showed that our schoolboys were on average higher than their peers in Belgium, Hungary, Greece and Italy. The average height of children and youth in Croatia in different geographic regions was different. Dalmatian children are somewhat above the means for the whole of Croatia, whereas the means of children in Zagorje are considerably lower. The average heights of schoolboys in other areas of Croatia is among the above mentioned extremes. In Lika, Gorski Kotar and Istria, they are around or slightly below average values for Dalmatia. In Slavonia, they are somewhat lower, but above the average for Zagorje. These differences could be attributed to certain ethnic characteristics. However, differences within the regions speak in favour of the stronger influence of environmental factors. General improvement of living conditions is also considered to be the main cause of positive secular changes in growth which means faster maturation of modern children and youth, and higher average body height in adulthood. These changes in developed countries are observed from the second half of

the 19th century [3, 4]. Also, the results of several repeated studies in the early 90s in some of our regions have shown positive secular changes. The middle height increased in Međimurje, Rijeka and Split. Moreover, Split schoolboys in 1992 have almost reached their Dutch peers, which today are considered to be the highest world population. Growth patterns of Zagreb schoolchildren seem to combine the characteristics of different European populations. According to their growth potential they are very similar to the tallest populations, i.e. Dutch, Norwegian and Swedish. At the same time they have characteristics of early maturation, this being typical for Mediterranean populations [4-6].
Guided by previous research this paper presents regional differences of young men aged 13 to 20 years within five Croatian regions (Goransko-primorska, Slavonia, Central Croatia, Dalmatia and City of Zagreb).

2. MATERIAL AND METHODS

The research sample includes 4045 young men aged 13 to 20 years. The sample was proportionally distributed into five Croatian regions as shown in Figure 1.

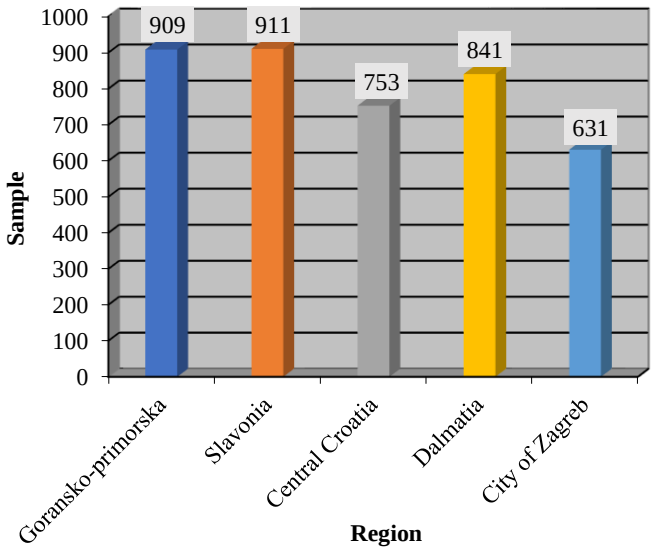


Figure 1: Number of measured young men within five Croatian regions

The figure shows that most children (909) were measured in the Goransko-primorska county, while the least number of children (631) was measured in the City of Zagreb. The research was organized and conducted by University of Zagreb Faculty of Textile Technology in collaboration with several institutions (Institute of Anthropology of Zagreb, School of National Health "Andrija Štampar" - Faculty of Medicine of the University of Zagreb, Faculty of Medicine of the University of Split, Faculty of Philosophy of the University of Osijek and Faculty of Economics & Business of the University of Zagreb) within the project Croatian Anthropometric System.
Anthropometric measurements (body height, chest girth, waist girth and hip girth) were measured with basic anthropometric instruments: measuring tape and one-arm and/or two-arm anthropometer [4, 7-12], Figure 2 and 3.

Figure 2: Plasticized measuring tape with tank [9]

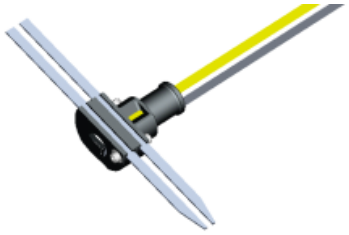


Figure 3: One-arm and/or two-arm anthropometer [13]

Descriptive statistics and analysis of data were performed using the statistical package SPSS. Differences between groups (primarily regional and age) were tested by t-test for independent samples, i.e. one-way analysis of variance. The correlation between body measurements was tested using Pearson correlation coefficients. All these methods are from the group of univariate data analysis methods.

3. RESULTS AND DISCUSSION

Changes of the main body measurements according to age and regions are presented in Figures 4, 5, 6 and 7.
Figure 4 presents the average values of body height for young men according to age and regions.

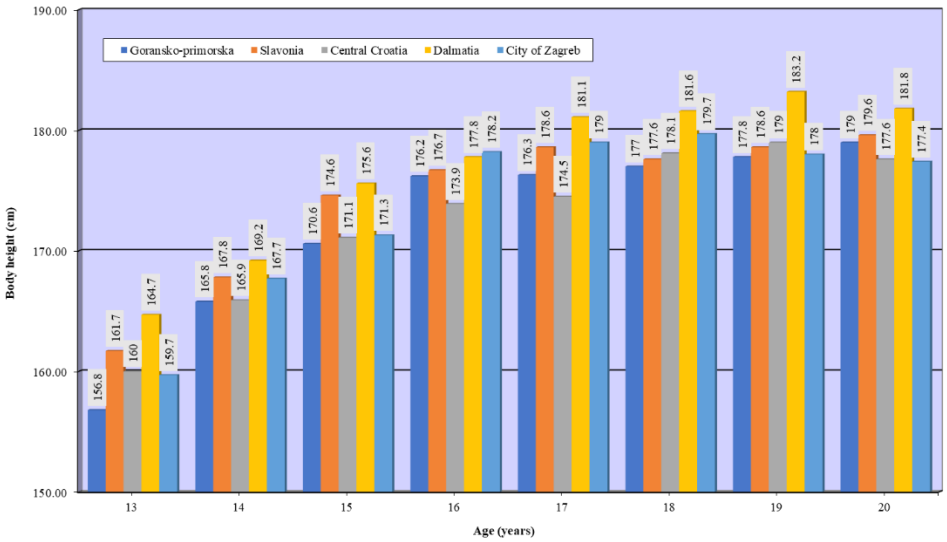


Figure 4: Average body height of young men according to age and regions

It can be concluded that the growth of young men is linear by the 17 years of age and then the trend of growth stagnates.

The difference in body height between regions is significant: especially in Dalmatia region. Young men from Dalmatia are higher than young men are from other regions (at 13 years of age 3 to 7.9 cm, at 14 years of age 1.4 to 3.4 cm, at 15 years of age 1 to 5 cm, at 17 years of age 2.1 to 6.6 cm, at 18 years of age 1.9 to 4.6 cm, at 19 years of age 4.2 to 5.4 cm and at 20 years of age 2.2 to 4.4 cm).

Histogram in Figure 5 shows young men's chest girth according to age and regions and Figure 6 shows histogram of young men's waist girth according to age and regions. It can also be noticed the pubertal momentum in development.

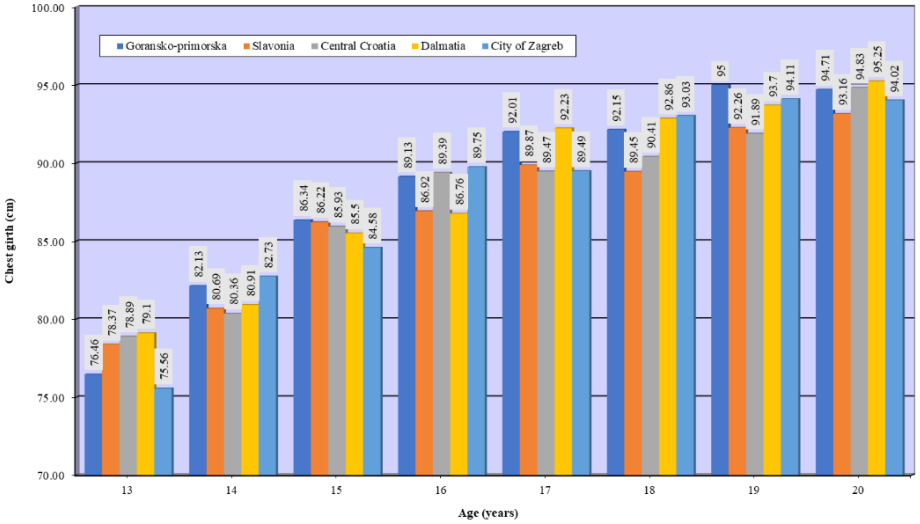


Figure 5: Average chest girth of young men according to age and regions

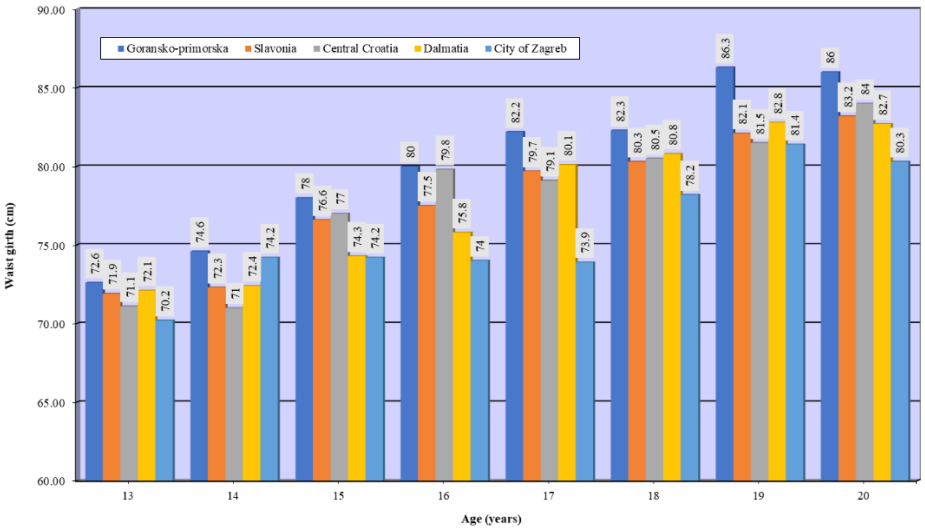


Figure 6: Average waist girth of young men according to age and regions

Chest girth size differences across regions are noticeable. But in this case Dalmatia region does not allone stand out regionally except at 13 (79.1 cm), 17 (92.23 cm) and 20 years of age (95.25 cm). Also young men in the City of Zagreb have the heighest values of chest girth at 14, 16 and 18 years of age (82.73 cm, 89.75 cm and 93.03 cm).
In the histogram showing the waist girth, large regional differences are visible, but here the Goransko-primorska region stands out (Figure 6). It can be concluded that young men in all age groups (except at 16 years of age) have a higher waist girth than other regions, according to age: at 13 years of age 0.5 to 2.4 cm, at 14 years of age 0.4 to 3.6 cm, at 15 years of age 1 to 3.8 cm, at 17 years of age 2.1 to 8.3 cm, at 18 years of age 1.5 to 4.1 cm, at 19 years of age 3.5 to 4.9 cm and at 20 years of age 2 to 5.7 cm.

Figure 7 shows the histogram of young men's hip girth according to age and regions.

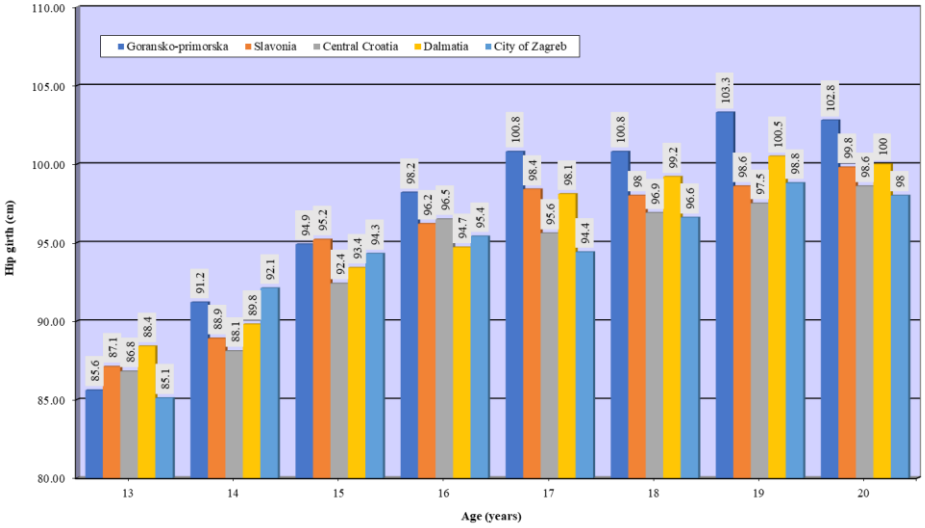


Figure 7: Average hip girth of young men according to age and regions

The differences between the regions are very similar as in the waist girth. Here also the Goransko-primorska region stands out. In five age groups it has the highest growth of the hip girth (at 16, 17, 18, 19 and 20 years of age), followed by Slavonia, City of Zagreb and Dalmatia region.

4. CONCLUSION

Previous studies on young population in Croatia has confirmed that modern children are on average more advanced and mature than their peers several generations ago [5].
Within this research it was confirmed that our children show positive secular changes, especially, in this case, young men from the region of Dalmatia and Goransko-primorska. At body height, the pubertal momentum of growth is visible. The trend of growth of young men is linear by the 17 years of age and then the trend of growth stagnates. Young men from Dalmatia region are higher than those are from other regions. Regional differences in chest, waist and hip girths also show biger values first in Goransko-primorska and then in Dalmatia region. This research also confirms that the growth potential and early maturation of young men in Croatia is being typical for Mediterranean populations.

5. REFERENCES

[1] Smolej-Narančić N. (2006). Antropometrija – od zamisli do primjene, – Podloga za nove hrvatske norme za veličinu odjeće i obuće, Tekstilno–tehnološki fakultet Sveučilišta u Zagrebu, Zagreb, 224-237, ISBN 953-7105-09-1

[2] Doležal, K. et al (2010). Anthropometric Evaluation, Standardization and Comparison of Garment Sizes, Book of Proceedings of the 5th International Textile, Clothing & Design Conference – Magic World of Textiles, Dubrovnik, Croatia, 03-06th October 2010, Dragčević, Z. (Ed.), Zagreb, University of Zagreb Faculty of Textile Technology, 441-446, ISSN 1847-7275

[3] Prebeg, Ž. (1988). Variations in Growth Patterns of School Children in Croatia, Collegium Antropologicum, 12 (1988) 2, 259-269, ISSN 0350-6134

[4] Hrženjak, R., Doležal, K., Brlobašić Šajatović, B. (2018). Regional Differences of Body Measurements for Croatian Girls, Book of Proceedings of the 9th International Textile, Clothing & Design Conference – Magic World of Textiles, Dubrovnik, Croatia, 7-10th October 2018, Dragčević, Z., Hursa Šajatović, A., Vujasinović, E. (Ed.), Zagreb, University of Zagreb, Faculty of Textile Technology, 191-196, ISSN 1847-7275

[5] Prebeg, Ž., Jureša, V., Kujundžić, M. (1995). Secular Growth Changes in Zagreb School Children over Four Decades, 1951-91, Annals of Human Biology, 22 (1995) 2, 99-110, ISSN 0301-4460

[6] Eveleth, P. B., Tanner, J. M. (1990). Worldwide Variation in Human Growth, Cambridge University Press, 2nd Edition, Cambridge, ISBN-13: 978-0521359160

[7] Ujević, D. et al (2006). Croatian Antropometric System Meeting the European Union, International Journal of Clothing Science and Technology, 18 (2006) 3, 200-218, ISSN 0955-6222

[8] Hrženjak, R. et al (2008). Anthropometric Investigations of Children in the Republic of Croatia, Book of Proceedings of the 4th International Textile, Clothing & Design Conference – Magic World of Textiles, Dragčević, Z. (Ed.), Dubrovnik, Croatia, 5-8th October 2008, University of Zagreb, Faculty of Textile Technology, Zagreb, 599-604, ISBN 978-953-7105-26-6

[9] Hrženjak, R. (2012). Influence of Body Proportions of Children and Youth as the Basis for Clothing Construction, PhD Thesis, University of Zagreb, Croatia

[10] Hrženjak, R., Doležal, K., Ujević, D. (2013). Development of Sizing System for Girls Aged 6 to 12 Years in Croatia, Collegium Antropologicum, 37 (2013) 4, 1095-1103, ISSN 0350-6134

[11] Hrženjak, R., Ujević, D. (2006). Hrvatski antropometrijski sustav - stanje, potrebe, perspektive, realizacija, Zbornik/Prvi kongres hrvatskih znanstvenika iz domovine i inozemstva, Barišić, P. (Ed.), 218-221, ISBN 953-6569-21-3, Zagreb-Vukovar, 15.-19. studenoga 2004., Ministarstvo znanosti obrazovanja i športa RH, Zagreb

[12] Buzina, R. et al (1984). Morfološka i funkcionalna antropometrija, Praktikum biološke antropometrije, Zagreb

[13] Hrženjak, R. et al (2008). Anthropometric Measurements and Analysis of Body Dimensions of Croatian Female Volleyball Players, Proceedings of the 8th AUTEX Conference, Working Towards Change: Academy and Industry together, Città Studi, Biella, Italy, 24-26th June 2008, Rovero, G. (Ed.), Torino, Politecnico di Torino, Poster session 1-Poster area 1 - (226), 1-6, ISBN 978-88-89280-49-2

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3D PRINTING OF BIODEGRADABLE POLYMERS IN THE TEXTILE INDUSTRY

Mislav Majdak[1], Iva Rezić[2]
[1]Faculty of Textile Technology, University of Zagreb, Prilaz baruna Filipovića 28a, 10000 Zagreb, mislav.majdak@ttf.hr
[2]Faculty of Textile Technology, University of Zagreb, Prilaz baruna Filipovića 28a, 10000 Zagreb, iva.rezic@ttf.hr

ABSTRACT:

In recent years, non-degradable plastics and polymers derived from fossil fuels are under high scrutiny by the global community. To overcome this problem, biodegradable polymers derived from natural sources are under the spotlight due to their ability to decompose into carbon dioxide and biomass in a much shorter time. Therefore, biodegradable polymers are replacing conventional polymers used in packing, bottling, etc., but the most interesting usage of biodegradable polymers is in the medical field. Biodegradable polymers such as polylactic acid (PLA), are reliable materials for surgical implants such as rods, scaffolds, surgical screws, and also sutures, and skin grafts. 3D printing (additive manufacturing) has helped in the increase of the usage of biodegradable polymers. 3D printing is a methodology by which the thermoplastic polymers can be modeled into a desirable structure. The main advantage of 3D printing is in its versatility, that is, the ability to print a CAD modeled object in a relatively short time. By 3D printing, biodegradable polymers can be modeled into materials with complex geometry and structure. The main goal of this paper is focused on 3D printing of PLA polymer foreseen as a carrier of antibacterial coating of metal and metal oxide nanoparticles. 3D printed materials are intended to be coated with antibacterial nanoparticles using the sol-gel method. By doing so, the coated polymer material becomes efficient against Staphylococcus aureus. The printed plate had a complex "sandwich" geometry and a net-like structure. Due to the low elasticity of PLA, the printed plate was brittle. Although the results were not acceptable for direct usage without previous testing "in vivo", this research has shed a light on the possibility of the usage of 3D printed materials in medical applications.

Keywords: Biodegradable polymers, PLA, 3D printing

1. INTRODUCTION

Nowadays, polymers are a staple of everyday life, and their negative impact on ecosystems around the globe is more evident than ever, with one of the major culprits being the textile industry [1]. Jönsson et. al. [2] have stated that the production of synthetic polymer fibers is on the rise, and that by the year 2030. their production per year will exceed the value of 100 Mt. With the growing concern of the impact

non-degradable polymers have on the ecosystem, many have proposed the use of biodegradable polymers [3].

According to the European norm EN 13432:2000 [3, 4] and the ASTM standard D-5488-94d, biodegradable polymers are materials that are capable to decompose into water, carbon dioxide, biomass without an adverse effect on the surrounding environment. Their use has shown an annual growth of 17 to 20%, with one of the most common polymers in use being polylactide (PLA) [5]. One of the most interesting applications of PLA is in the medical field. In recent years, PLA has been the focus of many investigations concerning the use of the said polymer for drug delivery, reconstructive surgery, orthopedic surgery and oncology [6,7]. As Tyler et. al. have mentioned [6], 3D printing will have a tremendous effect on the biomedical application of PLA.

3D printing, also known as additive manufacturing is a method by which, depending on the process, a 3D object is created. The most commonly used process is Fused Deposition Modeling. FDM is a process by which a layer of melted polymer is extruded through a nozzle, and cooled by a fan. The process continues with the stacking of a polymer melt on a previously extruded layer until the desired structure is obtained. The method itself is lauded for its accessibility, low cost and precision [8, 9], while the main drawbacks, as Wong and Hernandez [9] have stated are the low resolution, and the slowness of the process during the printing of large parts.

In this paper, a great deal of focus will be concentrated on the whole process needed to make a 3D object. That is, the process of computer-aided design (CAD), modeling and printing of a plate with a complex structure and geometry using a semi-professional 3D printer Ultimaker 2+, Ultimaker (Utrecht, Netherlands). The 3D printed object is intended for further treatment using the sol-gel method, to act as a carrier of metal and metal oxide nanoparticles. The proposed use of such material is to suppress the growth and spread of deadly microorganisms and fungi, such as *Staphylococcus aureus*, as an independent material or as a part of a textile material.

2. EXPERIMENTAL PART

2.1. Methodology

For the purpose of producing a 3D printed object, a PLA polymer filament was used. The polymer filament was obtained from *Ultimaker B. V.* (Geldermalsen, The Netherlands). 3D printer Ultimaker 2+ was purchased from *Ultimaker* (Utrechct, The Netherlands). For the purpose of Computer-aided design of the 3D object, *Blender*, a free to download software was used, as was *Ultimaker Cura*, a free to download CAD software intended to calibrate the 3D object for printing.

3D printing is a process that includes the following stages:

1. Computer-aided design of the 3D object,
2. Modeling of the 3D object,
3. 3D printing.

The first stage involved the modeling of the envisioned object. For this purpose *Blender* was used. During this process, a 3D model of a cube (Figure 1.), was modeled into a 3D model resembling a net (Figure 2.). Thus, the 3D modeled object was converted into a *.stl* file, a file suitable for *Ultimaker Cura*.

As it has been already stated, *Cura* software is used to calibrate the already designed model. The purpose of this step is to adapt the 3D model (Figure 3.) for printing. The specifications of the printer as shown in Table 1. don't allow the printing of the newly designed model, therefore a more suitable shape and geometry was designed as shown in Figure 4.

After the final modeling, 3D printing can comence. Before the start, an adhesive, in this case, glue was applied to the work surface of the printer. By doing so, the accidental displacement of layers during printing is minimized. Before the extrusion of the polymer melt through the nozzle, the said nozzle was heated to a temperature of about 185 ˚C. After the desired temperature has been achieved, a stream of

a polymer melt was extruded on the work surface, while at the same time a pair of fans cool the stream and the newly made layer. This process repeats itself until the desired object has been printed.

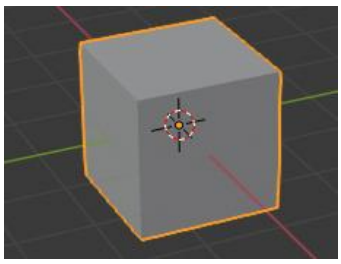

Figure 1: 3D model of a cube, which is a starting model of the Blender program.

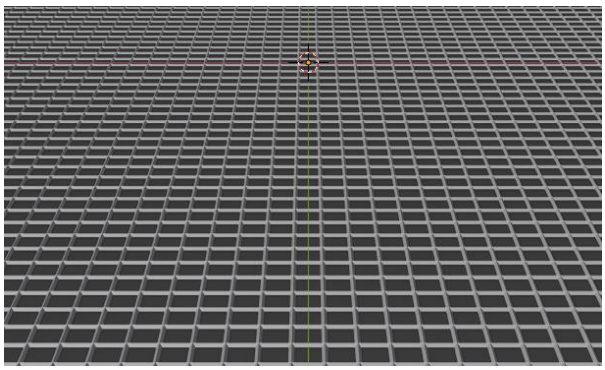

Figure 2: 3D model with a net-like structure in the Blender software.

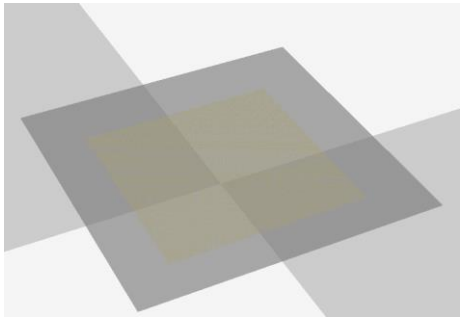

Figure 3: 3D model with a net-like structure in the Cura software.

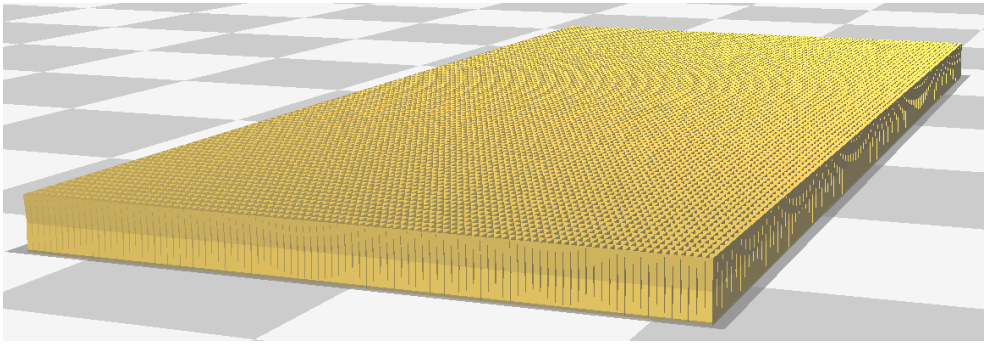

Figure 4: 3D model of an object intended for 3D printing.

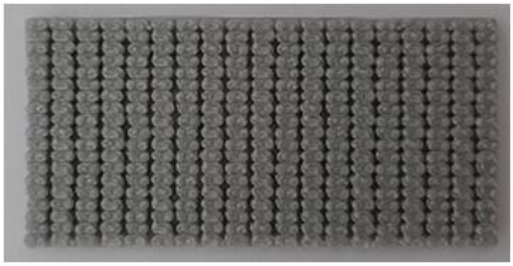

Figure 5: 3D printed object.

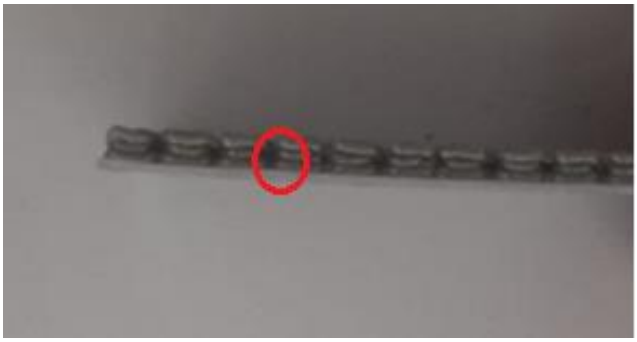

Figure 6: Cross-section of a 3D printed object.

Table 1: Properties of the 3D printer.

Polymer filament	Nozzle width	Dimensions of the object	Layer height	Speed	Temperature	Print time
PLA	0,4 mm	width: 24 mm lenght: 50 mm height: 2 mm	0,5 mm	40 mm/s	185 ˚C	21 min

2.1. Results and Discussion

The 3D printed object, as shown in Figures 5 and 6, was nothing like the model shown in Figure 4. Reasons for this discrepancy could be the low resolution of *Ultimaker 2+*, which is the most plausible cause, since the 3D printer is a semi-professional printer, and not reliable at printing of objects with complex geometry and structure. Another reason for the lackluster results could be in the dimensions of the object itself, which is also plausible given that the data shown in Table 1 indicates a small ratio of dimension (width: 24 mm; length: 50 nm; height: 2 mm) and nozzle width of 0,4 mm.
Another problem is the fragility of the object. The object tended to break apart at the "seams" of the, which are highlighted in Figure 6. Therefore, the cross binding between the individual "blocks" of polymer was not sufficiently strong to allow bending of the said object.
Although the results were not great, 3D printed object was printed in a short time (21 minutes), and even though the resolution of the printed object was quite low, the "sandwich" cross shape indicates that a somewhat complex shape can be achieved.
Although the results were not acceptable for direct usage without previous testing "in vivo". 3D printed objects could be used as carriers for antimicrobial coating of metal and metal oxide nanoparticles with the use of the sol-gel method, and with further modifications, 3D printed objects could be applied in the production of protective wear.

3. CONCLUSION

In conclusion, 3D printing is a versatile method of production, with its main advantage being the ability to quickly print parts or objects. With this in mind, we can say with great confidence that in the near future 3D printing will have a large influence on the textile industry, that is on the industry of medical textiles: That is to say, with the current events of the COVID-19 pandemic, and the apparent need to protect the first responders and the general populace. Although, many investigations have been made towards the use of biodegradable polymers for applications in different medical fields, such as orthopedic surgery, etc. it would be of great interest to investigate the use of biodegradable polymers for the use as antibacterial carriers. In this paper, we have presented the process of designing, modeling and printing of a 3D object. Although the 3D printed objects were not acceptable for further studies, such as the investigation of mechanical properties, or "in vivo" antibacterial testing, we have shown that the process can be done easily, by anyone for the purpose of investigation. As we have stated earlier, the plates were brittle, that is the bonds broke easily by bending. Therefore, more investigations have to be made towards the improvement of the mechanical properties of the printed object. One proposed idea is to print net-like objects of larger dimensions or to print objects with a completely different structure and geometry, ones that don't break while bending.

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4. REFERENCES

[1] Gautam, S., Sharma, B., Jain, P. (2021). Green Natural Protein Isolate based composites and nanocomposites: A review. Polymer Testing 99, 1-10.
[2] Jönsson, C., et. al., (2021). Biocatalysis in the Recycling Landscape for Synthetic Polymers and Plastics towards Circular Textiles. ChemSusChem 14, 1-14.

[3] Avérous, L., Pollet, E. (2012). Biodegradable polymers. In: Avérous, L., Pollet, E. (eds) Environmental Silicate Nano-Biocomposites. Green Energy and Technology. Springer, London. https://doi.org/10.1007/978-1-4471-4108-2_2
[4] Available at: https://ecozema.com/en/why/en13432/, Accessed: 20. 5. 2021.
[5] Platt, D., K. (2006). Biodegradable Polymers Market Report. Smithers Rapra Limited, Shawbury, Shrewsbury, Shropshire, SY4 4NR, UK. ISBN: 1-85957-519-6
[6] Tyler, B., et. al. (2016). Polylactic acid (PLA) contorilled delivery carriers for biomedical applications. Advanced Drug Delivery Reviews 107, 163-175.
[7]. Davachi, Mohammed, S., Kaffashi, B. (2015). Polylactic Acid in Medicine, Polymer-Plastics Technology and Engineering, 54:9, 944-967, DOI: 10.1080/03602559.2014.979507
[8]. Wong, V., K., Hernandez, A. (2012). A Review of Additive Manufacturing: Review Article ISRN Mechanical Engineering 208760, 1-10, doi:10.5402/2012/208760
[9] Gibson, I., Rosen, D., Stucker, B. (2015). Development od Additive Manufacturing Technology. Gibson, I., Rosen, D., Stucker, B. Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing ISBN 948- 1- 4939-2113-3, DOI 10.1007/978-1-4939-2113-3.

3D TECHNOLOGIES IN THE DEVELOPMENT OF INDIVIDUALIZED CLOTHING SEGMENTS

Slavica Bogović
University of Zagreb Faculty of Textile Technology, slavica.bogovic@ttf.hr

ABSTRACT:

The paper presents the use of 3D technologies in the development of individualized clothing segments. Segments of garments that are integrated into a garment are rigid elements that support or protect certain parts of the body from external mechanical influences. 3D technology includes 3D scanning, 3D modelling and 3D printing. For the development of individualized objects, digitalization of the human body was performed using the 3D body scanner Vitus Smart. The process of digitization of the human body resulted in a point cloud which was prepared for the modelling process by optimizing the number of points and closing the point clouds of the human body. The prepared point cloud serves as a standard for 3D object development. Using computer programs for 3D modelling, the desired object is formed respecting the shape of the body and the rules of 3D modelling of objects for the 3D printing process. Depending on the purpose of the garments or clothing segments, it is necessary to define the side thickness and the filling of the 3D printed model based on the selected polymer and the desired strength of the finished garment segment.

Keywords: 3D body scanning, 3D modelling, 3D printing

1. INTRODUCTION

3D technologies are increasingly used in everyday human activities, and especially in the production of individualized products or product prototypes. They are used in various fields such as medicine, architecture, mechanical engineering, etc. 3D technologies include the procedures of 3D scanning, 3D modeling and 3D printing of objects. Depending on the end use properties of the object, the types of materials for 3D printing are selected, as well as other printing parameters that are crucial for the properties of the object. In the field of textiles and clothing, the application of 3D printing is developing in several different directions. Possibilities of 3D printing of flexible structures [1], whole garments [2, 3], 3D printing on textile material [4], as well as 3D printing of elements that are incorporated into garments [5-9] are being investigated. Incorporated items of clothing are often made according to the shape of the body and serve as protection for a part of the body [5-8] or for corrective purposes such as orthoses [9]. In order to ensure the necessary properties of the elements of clothing made in this way, it is necessary to have a virtual cloud of points of the human body according to which the shape of the object to be made is modelled.

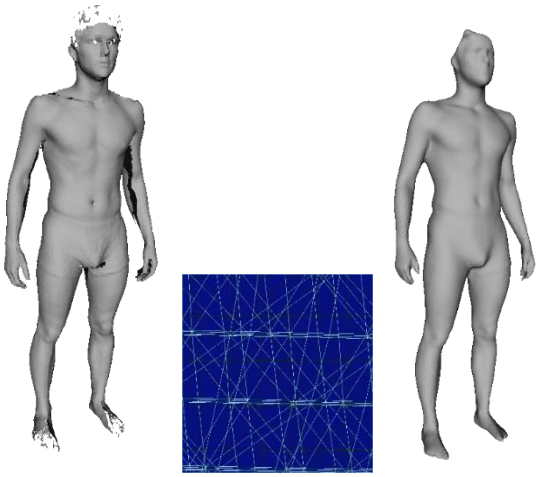
2. 3D TECHNOLOGIES

For the development of individualized objects, it is necessary to harmonize the possibility of data application with the use of adequate technical capabilities of 3D scanners, software packages for 3D

computer design and 3D printers. Since each of these technologies has the ability to process different types of data, it is necessary to reduce them to forms that can be used independently of the manufacturer of equipment intended for scanning, modelling and printing. The most suitable data format that is applicable in all computer programs of the listed input and output units are the obj (Wavefront OBJect) and stl (Standard Tessellation Language) data format.

2.1. 3D scanning

Digitization of the human body is carried out with the help of a 3D body scanner with appropriate computer support. The VitusSmart 3D laser body scanner, which captures the body with an 8-camera system, was used for the human body digitization process. The human body scan takes 12 seconds. The result of the scan is a cloud of dots of the human body that can contain about 500,000 points (Figure 1a). Since each point of the body is recorded with 4 cameras, a quadruple point cloud is obtained. Figure 1b shows a network segment obtained by scanning. Due to the technical design of the 3D scanner, segments appear on the point cloud where no points have been recorded. These are segments that are horizontal or are in the shadow of a body part when scanning. The point cloud in this case has openings that need to be closed in order for the resulting point cloud to serve as a standard for further data processing. To simplify the point cloud and close it, computer programs are used that can be an integral part of the computer program of the 3D scanning system or computer programs for 3D object modelling are used. Figure 1c shows a simplified point cloud that is closed using the Poisson algorithm. The point cloud thus prepared is exported in stl form and serves as a standard for 3D modelling of garment segments [5-9].



a. *b.* *c.*

Figure 1: 3D scanned human body
a. A point cloud after scanning
b. A grid obtained based on a 3D scanned point cloud
c. Closed point cloud

2.2. 3D modelling

Different software packages can be used for the 3D modelling process of individualized clothing segments. The most commonly used software packages are Maya, Rhino3D, Solidworks, MeshLab, Blender, etc. [5]. When 3D modelling, it is necessary to take into account the anthropometric characteristics of the human body, taking into account the ultimate function of the garment. In addition to static measures and body shape, it is often necessary to consider the dynamic anthropometry of the human body. The shape of the garment segment that is incorporated into the garment must be aligned

with the construction of the garment to ultimately satisfy the protection function. In addition to the above parameters, it is necessary to know 3D printing technology in order to make a garment segment of the required strength and shorten the production time. Figure 2 shows the rules for modelling an object that is 3D printed by the FDM / FFF method [10].

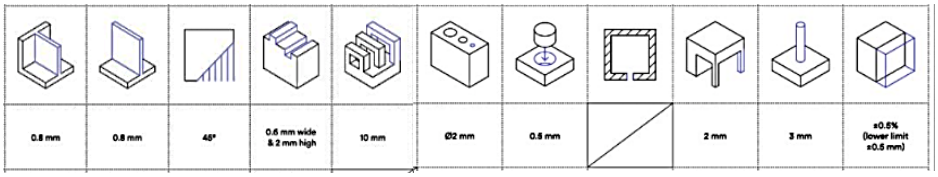


Figure 2: Design rules for 3D printing [10]

For the purpose of making a segment of a garment, the 3D cloud of body parts is extracted from the cloud of human body points using 3D printing. The 3D modelling shown in Figure 3 was performed in the Blender software package. A procedure for modelling a chest protector that serves as protection for field hockey players is presented. In this case, the dynamic anthropometry of the body was taken into account, which means that the person was scanned in the position he most often occupies when using the said protective equipment. The 3D modelling process itself was performed from the basic element of a cube that has a predetermined volume [6].

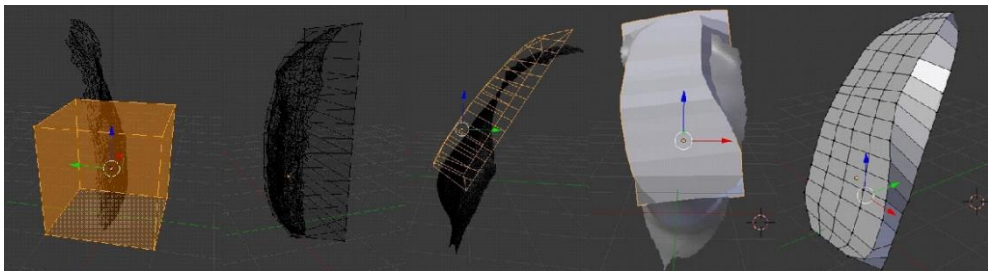


Figure 3: 3D modeling of the chest protector [6]

In modelling protection for the lower leg, the computer program Blender was also used, whereby the procedure itself began with defining a plane that is divided into several segments and adapted to the shape of the leg. Finally, after the mantle was defined, volume was added and a printable shin guard was obtained (Figure 4) [5].

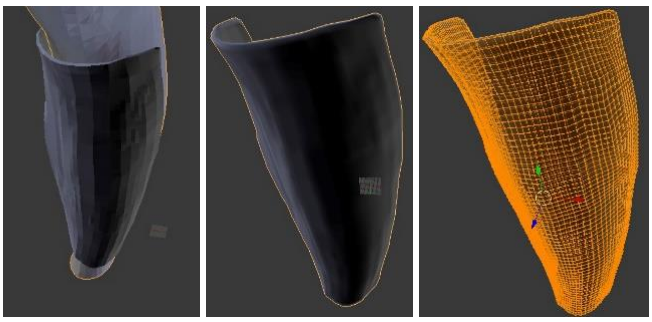


Figure 4: 3D modelling of lower leg protection [5]

In a similar way, 3D modelling of the torso guard for the female body was performed. The shield serves as protection in fencing and is made of several elements that are interconnected. Since fencing is a sport in which the position of the body is asymmetrical, the result is a modelled shield that monitors the dynamics of the body during the sport. Figure 5 shows the shape of the shield and its segments and the elements that are built in so that they can be joined into a complete protective garment. The shield is developed for the left-handed person, and can be incorporated into a garment made of textile. This shield can also be used as a separate garment [8].

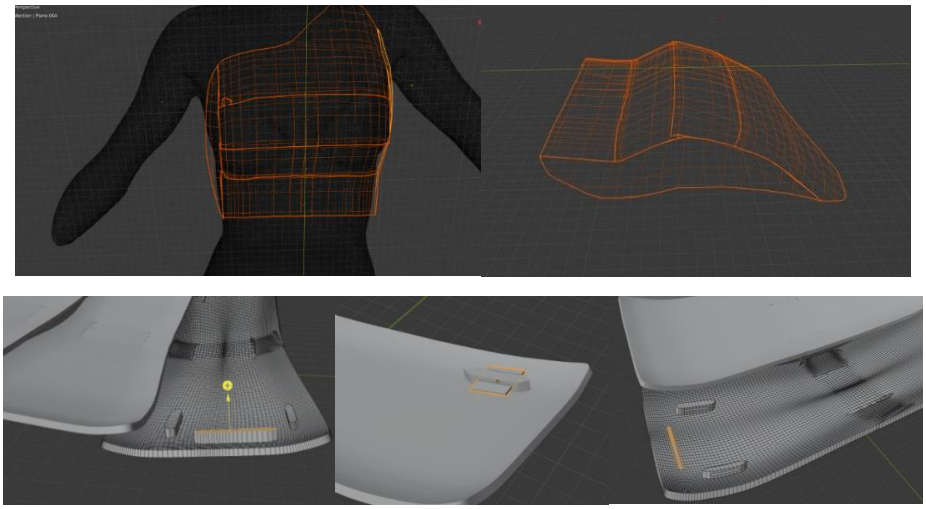


Figure 5: 3D modelling of the side of the body shield [8]

2.3. 3D printing

After the 3D modelling, it is necessary to prepare the 3D virtual object for the 3D printing process. In doing so, the parameters that provide adequate protection are defined. Using the FDM/FFF procedure, it is possible to define wall thicknesses as well as the type of filling when printing (Figure 6). Figure 6 shows some types of fillings. In addition to the type of filling, it is necessary to define the density of the filling, which together with the parameter of wall thickness and the type of polymer used affects the strength of the object.

The polymers most commonly used in the 3D printing FDM/FFF process are acrylonitrile/ butadiene/styrene (ABS), polycarbonate (PC), polyamide (PA), flexible elastoplastomeric polyurethane (TPU), polylactic acid (PLA), Polyethylene Terephthalate (PET) although other polymers are being developed that are used, such as: wood-polymer or metal-polymer composites [11].

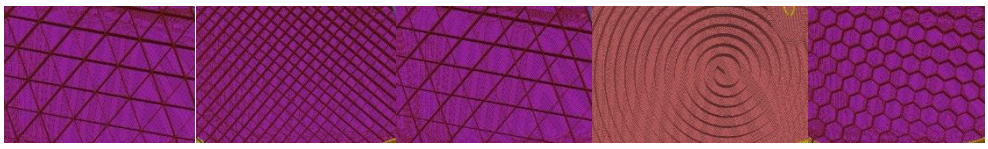


Figure 6: Fills in 3D printing

The preparation of a garment segment for 3D printing is carried out by generating layers of 3D shapes because the above 3D printing process takes place by layering a polymer. The elements that are individually adapted to the body are curved, and the process of 3D printing requires printing the support, which significantly extends the production time.

For 3D printing, a PLA polymer was used, which is printed at a temperature of 190-22000C with a substrate temperature of 6000C. Printing was performed using a Creality cr 10 max printer that has dimensions of 450 × 450 mm and can print up to 470 mm in height. It also has the ability to print different polymers as substrate and nozzle temperatures can be regulated.

Figure 7 shows the chest guard (left) and part of the torso guard (right). The hull guard is shown with a support located at the bottom. The support is printed in a thinner structure so that it can be removed relatively easily after production.

The shields shown have the required strength and are fully adapted to the body shape of the end user. They are characterized by low weight compared to similar examples made of other materials and in series production.

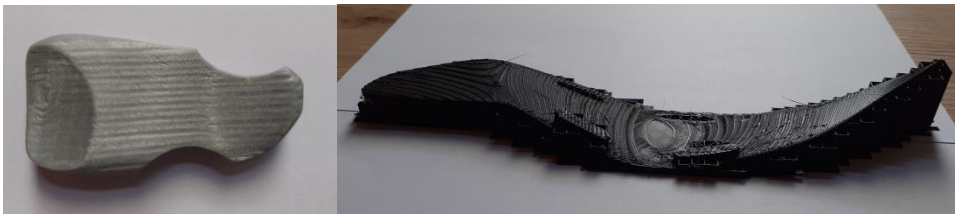


Figure 7: 3D printed chest and torso protectors

3. CONCLUSION

Based on the presented results of making individualized segments of garments that are incorporated into the garment, it can be concluded that a systematic approach is needed in their production. It is necessary to know the technique and technology of 3D scanning of the human body and to adapt the obtained data of digitized human bodies to further processing. It is also important to know the technique of 3D printing and the influence of printing parameters on the final quality of the manufactured segment of the garment. In order to obtain a well-made segment of a garment, it is important to know the static and dynamic anthropometry that have an impact on the construction of elements created by 3D printing as well as the impact on the functionality of the entire garment with incorporated elements. In order to reduce the consumption of polymer and shorten the printing time, it is important to apply the rules for 3D modelling of objects. Taking into account all the above, a quality functional individualized segment of the garment as well as the entire garment can be developed. In this way, adequate protection of body parts is ensured, which is not always the case when using protective accessories made in a standard way in several sizes. In case the protection elements are used in sports activities as shown in this paper, it can also be concluded that their use will certainly be able to contribute to better sports results because the equipment used for protection is extremely light compared to the one used so far.

4. REFERENCES

[1] Spahiu, T., Canaj, E., Shehi, E. (2020) 3D printing for clothing production, Journal of Engineered Fibers and Fabrics, https://doi.org/10.1177/1558925020948216

[2] https://www.materialise.com/en/cases/iris-van-herpen-debuts-wearable-3d-printed-pieces-at-paris-fashion-week

[3] Hrženjak, R.; Bogović, S.; Rogina-Car, B. (2020) 3D Printing Technologies for Clothing Industry: A Review. Book of Abstracts of the 8th International Ergonomics Conference - Ergonomics 2020

Sumpor, D. ; Čubrić, G. ; Jambrošić, K. ; Jurčević Lulić, T. ; Leder Horina, J. ; Milčić, D. ; Salopek Čubrić, I. ; Šabarić, I. (ed.).Zagreb: Hrvatsko ergonomijsko društvo, pp. 16-20

[4] Pei, E., Shen, J. and Watling, J. (2015) Direct 3D Printing of Polymers onto Textiles: Experimental Studies and Applications. Rapid Prototyping Journal 21(5)pp. 556 – 571.

[5] Bogović, S. (2018) Nove tehnologije pri oblikovanju zaštitne odjeće i opreme, Zbornik radova 7. Međunarodni stručno-znanstveni skup "ZAŠTITA NA RADU I ZAŠTITA ZDRAVLJA", Kirin S. (ed.), Karlovac, Veleučilište u Karlovcu, pp. 578-584, ISSN 2623-6435

[6] Milošević, P.; Bogović, S. (2018), 3D Technologies in Individualized Chest Protector Modelling, Textile & Leather Review, 1, 2, pp. 46-55, ISSN 2623-6281 (online)

[7] Čorak A. (2020) Primjena 3D tehnologija pri izradi muških hlača namijenjenih igračima ragbija u invalidskim kolicima, Sveučilište u Zagrebu Tekstilno-tehnološki fakultet, Zagreb, završni rad

[8] Pavličević, M. (2020) Izrada individualizirane zaštitne odjeće za mačevanje, Sveučilište u Zagrebu Tekstilno-tehnološki fakultet, Zagreb, završni rad

[9] Bogović, S.; Kabashaj, E. (2021) Individualizirano modeliranje ortoze primjenom 3D tehnologija. Zbornik radova 6. Znanstveno-stručno savjetovanje: Kulturno nasljeđe Ujević. Ujević, D. (ed.).Krivodol: Kulturno-umjetnička udruga Ujević, str. 174-177

[10] https://www.mcb.uu.se/u-print/services

[11] Godec, D. et. al (2018). Utjecaj parametara 3D tiskanja na savojna svojstva 3D tiskanog proizvoda, Zbornik radova 11. Znanstveno–stručnog savjetovanja Tekstilna znanost i gospodarstvo. In: Ercegović Ražić, S., Martinia Ira Glogar, M., Novak, I. (ed), pp. 74-79, Sveučilište u Zagrebu Tekstilno-tehnološki fakultet, Zagreb, Hrvatska

QUALITY OF PRAMENKA WOOL AS A TEXTILE RAW MATERIAL

Husein Vilić[1], Amir Hasic[2], Emir Mujić[1], Amir Zenunovic[2], Refik Sahinovic[1]
[1] Biotechnical Faculty, Luke Marjanovica bb, Bihac, e-mail: husein.btf@gmail.com,
[2] Faculty of Technology, Tuzla, e-mail:a.hasic@gmail.com,

ABSTRACT:

Wool is one of the key products of sheep, in addition to meat and milk. It represents a significant raw material for the textile industry, for the production of so-called coarse fabrics. In our country, unfortunately, wool is used less and less, and even represents a significant environmental problem. The paper analyzes physical - mechanical properties such as: length, elasticity, strength, extensibility, twisting ability, flexibility and color, and analysis of some chemical properties, such as: resistance to acids, bases and organic solvents, microchemical reactions and characteristic staining. The obtained results showed that the quality of domestic pramenka wool is not satisfactory, but that it can serve as a raw material for the production of coarse fabrics and sweaters, because wool is a good thermal insulator.

Keywords: wool, qality, sheep, fineness

1. INTRODUCTION

The story of sheep and wool begins in Asia 10,000 years ago during the Stone Age. The people of Mesopotamia at the time exploited sheep and their products to meet three basic needs: food, clothing, and shelter. From then until today, sheep are considered very efficient, the least demanding of all domestic animals. Due to the fact that sheep are fed various, indigestible nutrients, they convert food into proteins for human consumption (meat, wool, milk) [1]. In addition to providing numerous products, sheep can also reduce adverse effects on the environment, meet human needs and thus make life better. One of the most important products of sheep is wool, which is obtained from domestic breeds, and consists of wool fibers folded into strands. Wool in the narrow sense means sheep's hair, which does not separate after shearing and has the ability to spin and roll [2]. For many years, sheep's wool from the territory of Bosnia and Herzegovina has not been industrially processed and has no economic importance. Wool is sheared primarily for the welfare of the animal and not for obtaining useful textile raw material. The reason for this lies in the fact that the wool of indigenous breeds-Pramenka and its strains are considered coarse wool that are not suitable for making fine and prized clothing products, so wool becomes an undesirable by-product of sheep breeding and a significant environmental problem. In addition, wool is still an irreplaceable textile raw material in some countries due to its chemical and physical properties, although it is less and less used as a raw material, and therefore its production is in crisis due to low world market prices, which results in increasing the use of man-made fibers in industry. The world produces over 2.5 million tons of medium fine and fine wool. The wool of our sheep breeds belongs to the roughest assortment and is unsuitable for processing.

Wool has the natural property of regulating temperature, the inner hair of wool can absorb water vapor, while the outer surface gets steam [3]. Wool, as the noblest textile raw material, is mostly used for the production of men's suits and women's costumes and dresses. It is also often used, alone or in a mixture with other fibers, for the production of knitted clothes, carpets and rugs. Wool can be used in a mixture with almost all textile fibers [4].

2. MATERIAL AND METHOD OF WORK

The Pramenka sheep breed was used for these researches, on two farms, in the municipalities of Cazin and Bihać. The sheep were kept under appropriate conditions and fed classically, during the summer they stayed outdoors and fed on pasture, and in the winter they were kept in facilities and fed with quality shade and, if necessary, concentrated nutrients. All research was performed in the laboratories of the Biotechnical Faculty. The main goal of this work was to analyze the physical and mechanical properties of wool, such as: length, elasticity, strength, stretchability, twisting ability, flexibility and color, and analysis of chemical properties, such as resistance to acids, bases and organic solvents and microchemical reactions and characteristic staining. A total of 50 samples were analyzed.

Figure 1: Taking and preparing a wool sample for analysis

A

B

Figure 2: Used apparatus for determining the quality of wool A-lanomether B-Spectrophotometer

3. RESULTS OF WORK

Table 1: Strand length and wool fiber thickness

Farm	Broj uzoraka	Strand length (cm)	Fineness of wool fibers (μm)
Cazin	50	12,1	38,9
Bihac	50	12,4	38,7
Average	50	12,25	38,8

In the sheep from the farm from Bihac, the length of the strands was slightly longer (12.4 cm) compared to the sheep from the farm in Cazin (12.1 cm), and the fineness of the wool fibers was also slightly

better in the sheep from the farm in Bihac. (38.7 μm), in relation to sheep from the farm from Cazin (38.9 μm). However, the measured differences were not statistically significant.

Table 2: Values of 3 measured parameters (strength, extensibility, twisting ability) in sheep on two farms

Farm	Strength	Extensibility	Twiating ability
Cazin	Good	No	No
Bihac	Good	No	Weak
Average	Good	No	No/weak

From the results shown in Table 2, it can be seen that the strength is good in all samples, that there is no extensibility while the twisting ability was absent or was weak. These results are characteristic of wool fibers in Pramenko sheep and completely agree with the results of numerous authors [5, 6, 7, 8]

Table 3: Value of flexibility, color and burning test in tested sheep

Farm	Flexibility	Color	Burning test
Cazin	Flexible Finely flexible Well flexible	Beige Dark beige Light brown	Burning with a weak flame is extinguished It burns easily with a weak flame It burns with a black flame
Bihac	Flexible Well flexible -	Beige Dark Beige Light beige	Burning with a weak flame is extinguished It burns easily with a weak flame It burns with a black flame

As for the flexibility of wool fibers, it ranged from flexible to finely flexible, in sheep on both farms. After staining, it can be concluded that the tested samples had different colors, and as for the combustion test, it can be concluded that the samples burn in different shades. Similar results of the analysis of the mentioned properties of wool are reported by other authors [9, 10, 11, 12].

Table 4: Resistance values to bases, dyes and solvents

Farm	Bases	Dyes	Solvents
Cazin	Decomposes Nor do they break The wollbecomes soft	Gives the color natural woll Has consistency Color white fiber soft	Stability The fibers are torn
Bihac	Decomposes Nor do they break The wollbecomes soft	Gives the color natural woll Has consistency Color white fiber soft	Stability

After the test performed on the resistance to bases, it is seen that the wool fibers decompose finely after treatment, the decomposition of the thread occurs as well as the tearing of the thread. As for the resistance to bleaching agents, it can be seen that they give the color of natural wool and are soft, while the fibers are resistant to organic solvents. Very similar results regarding these properties of wool fibers are reported by other authors [9 i 10].

4. CONCLUSION

Examining some of the characteristics of wool fibers in Pramenka sheep, on two farms, the following conclusions can be drawn:

1. The average length of the strands was 12, 25 cm, and the average fineness of the wool fibers was 38.8 micrometers,
2. After the extensibility test, it was shown that there was no extensibility,
3. The twisting test showed that there is no or weak twisting ability,
4. Wool fiber Pramenka sheep has good to fine flexibility,
5. The color of the wool fibers ranged in shades from beige to light brown,
6. The burning test showed that the wool fiber burns with a weak flame and
7. Bleaching agents soften wool fibers, give it softness and white color.

In general, it can be concluded that the quality of Pramenka wool fibers is poor.

6. REFERENCES

[1] Šahinović, R., Krajinović, M., Vegara, M., Vilić, H.(2004). Basics of general animal husbandry. University textbook, Biotechnical Faculty, Bihać.
[2] Škundrić, P., Kostić Mirjana, Medović Adela, Mihailović Tatjana, Asanović Koviljka, Sretković Ljiljana (2008). Textile materials. Faculty of Technology and Metallurgy, Belgrade.
[3] Jovanović, M. (1983). Use value of domestic wool. Hussar Institute. Leskovac.
[4] Jovanović, M. (1988). Fundamentals of fiber science. Construction book, Belgrade.
[5] Markotić, B., Čaušević, Z. (1975). Beginning of work on the reclamation of Dup sheep through the sheep branch of ZZ "Mehurići" near Travnik. Agricultural Review, 1-2.
[6] Krajinović, M. (2006). Sheep and goat breeding. Textbook, Faculty of Agriculture, University of Novi Sad.
[7] Čaušević, Z., Tahirovic, N., Antunovic, I. (1988). Contribution to the knowledge of the creation of fine sheep in BiH. Sheep Days of Yugoslavia 88. XI Conference on the topic: The current state of wool production in Yugoslavia. Salaš-Zaječar, 1988
[8] Mioč, B, Pavić Vesna, Ivanković, A.(2000Types and breeds of sheep and goats in the Republic of Croatia, Stockbreeding, 54 (1): 51-56.
[9] Mioč, B., Pavić Vesna, Barać, Z., Sušić, V., Prpić, Z., Vnučec, I., Mulc, D.(2006). The exterior of the Rab sheep. Faculty of Agriculture, University of Zagreb.
[10] Mioč, B., Sušić, V., Pavić Vesna, Barać, Z., Prpić, Z. (2006). Preparation of sheep for shearing and procedures with wool until transport. Livestock, 60: 2006 (2): 129-141.
[11] Gutić, M. (2006). Sheep breeding, Production technology, Faculty of Agriculture, Čačak, University of Kragujevac.
[12] FAO (2005): Production Yearbook, Rome, Italy.

MODULAR CLOTHING AS ONE OF THE GUIDELINES FOR SUSTAINABILITY IN FASHION

Šabarić Irena, Karin Franka, Guša Ana-Marija
University of Zagreb Faculty of Textile Technology, irena.sabaric@ttf.unizg.hr
University of Zagreb Faculty of Textile Technology, franka.karin@ttf.unizg.hr
University of Zagreb Faculty of Textile Technology, anamarija.gusa@gmail.com

ABSTRACT:

The concept of modular clothing in the design process, although represented to a lesser extent than other approaches to sustainability in fashion, is in line with this trend. The aim of this paper is to show how one basic garment can be easily transformed in such a way that with each change we get a new or different one. Modular garments are thoughtful, well-conceived, individualized, multi-purpose, and functional. For such garments, it is necessary to use quality textile materials, because in this way the lifespan of the product is extended, and the design does not follow seasonal, fashion trends. With this type of clothing, it is important that the module base can be upgraded or transformed in at least one way. The collection of modular clothing presented in the paper has the possibility of upgrading by changing the segments on the garment. It consists of basic garments that can be transformed in different ways by adding or subtracting elements. In this way, depending on the elements offered and provided by the designer, several garments with only one base can be obtained from one garment. This is shown in the results of work on two models of the modular travel clothing collection, which are a good guideline for further research into the modular design that can be taken as one of the sustainable fashion methods.

Keywords: sustainable fashion, modular clothing, slow fashion, functionality

1. INTRODUCTION

We associate the term modular with products that are associated with terms from industrial design to fashion. Modular components include mechanisms of standard units that can be separated, added, subtracted, and recombined. The goal is the multipurpose use of one basic product. Diversity in use also prolongs the life of products, which has a positive impact on ecology and sustainable development [1]. The concept of modularity is applied in various branches of design. Its purpose is to reduce the complexity of a particular product, by dismantling the system to varying degrees of interdependence and independence, and by "hiding the complexity of each part behind the abstraction and interface" [2]. Modularity in clothing design is a new direction, which is accepted by a small number of designers because it requires careful thought and precision during the design process in order for the complexity of modular design to meet all the characteristics of modularity. Modular clothing consists of several, different clothing parts that can but do not have to be combined with each other and combined into one garment. It is the transformation that is the biggest advantage of modular clothing. Rapid transformation into different garments and for different occasions is a great advantage that raises the value of the garment. In addition to exceptional functionality, modular clothing nurtures sustainable development, is not subject to rapid change, and is a great example of slow fashion practice without the influence of rapidly changing fashion trends.

2. MODULAR CLOTHES

Clothes whose basic form can be upgraded with certain elements or additional modules are called modular clothes. Such clothing has the ability to adjust the outfit in any part of the day. Depending on the function of the garment, individual elements can be assembled or disassembled and transformed into a series of solutions and possibilities, depending on the occasion and the needs of the consumer. The results of modular design are garments composed of different units that are integrated [3]. The modular system consists of a lot of segments and accessories that are added to or removed from the main garment using a number of fasteners. Segments and add-ons are selected based on user preferences. Examples of modular clothing accessories that can be added and subtracted are sleeves, collars, various laces, decorative accessories such as lace, clothing accessories, various clothing fasteners, and the like [4].

2.1. Modular clothing and sustainable fashion

In 1930, Ukrainian designer Valentine Nicholaevne Sanine Schlee presented the first example of modular clothing. They were double pants, part of her high fashion collection. A similar example as part of sportswear was presented by designer Claire McCardell. A step forward in modular clothing was made by American designer Sandra Garratt. She began the transformation of garments, standing out with a dress that could be transformed into a skirt. She designed multifunctional clothing that was comfortable to wear, wearable for a variety of occasions and affordable in design for all users. Forms of clothing after cutting left a minimal amount of waste fabric and thus nurtured sustainable development [5]. The problem of the fashion industry is the availability of large quantities of clothing of low price and questionable quality, which leads to impulsive purchase and unsustainable consumption, which shortens the useful life of the product and leads to the disposal of unmarried clothing in landfills and increases the flow of textile waste. Due to rapid and mass production, fashion markets are oversaturated with clothing and clothing that has not been sold leading to an increase in textile waste that is not adequately disposed of. Garments that are not sold make up 5-10% of the total production [6]. Modular clothing is a good example of slow fashion due to the prolonged use of a garment. Due to its multifunctional application, modular clothing design prevents the need to demand new garments, thus slowing down production processes that negatively affect the environment, as well as the accumulation of textile waste.

2.2. Characteristics of modular design

There are three main features of modular design. These are diversity, flexibility, and continuity. Diversity in modular design is the ability to change an item of clothing according to the occasion through a variety of module assemblies. This satisfies the needs of the user who participates in the process of selecting and assembling the module, extends the life of the product, and reduces production costs. Flexibility allows for efficient resource allocation and lower energy consumption in the five phases that garments go through. These are design, production, sales, use and disposal after use. Continuity is the ability to apply modular standards to multiple long-term serial products. For example, a module purchased this season can be combined with a module next season, and even over several seasons [3]. Modular clothing could stop or at least slow down fast fashion in the future. Customizable modules could be upgraded seasonally, depending on trends and user needs. The aim is for modular garments to be made of quality textile materials, thus extending the life of the garment and fulfilling aspects of sustainable development.

2.3. Types of modular design

There are two types of modular design: single-function and multi-function. Both species build on the basic structure or take on a different form. A single-function module has one fixed function, which means that it has only one connection method. Decomposition of one module is the simplest and most widespread on the market. A multifunction module has two or more functions. Multifunctionality is achieved by disassembling or assembling the module, and the module itself can serve a function other than the original one. The more complicated the modules and their design, the more complex it is and the more free the user is. It is more functional, more detailed and has the possibility of transformation into something completely new in relation to the original function [3].

2. 4. Sustainable fashion through modular structures

The advantage of modular design is the adaptation and transformation of form without the garment losing its original value. By transforming a garment through an upgrade with modules, the existing garment is perfected without changing its characteristics while the usable properties increase. Modular clothing raises awareness of sustainability among consumers even though they do not show sufficient concern about unsustainable development by consuming fast fashion. The positive impact of modular design on sustainable development takes place precisely through consumers who have interaction in the modular design process. The modules are designed to be worn in different ways and thus conceptualize the life cycle of garments and customer satisfaction. When the satisfaction with the garment disappears, the consumer is offered the opportunity to send the product to the service provider. Then the manufacturer makes a new variant of the garment according to the customer's needs or just upgrades it with new modules. The user participates in the selection of designs, fabrics, colors and details according to personal needs and occasions in which they will wear the garment. Great emphasis is placed on the quality of the material so that the modules can be joined, disassembled, which is extremely important for the longest possible duration of the garment [6]. The longer the garment lasts, the less likely it is to end up as a textile waste.

3. EXPERIMENTAL PART

The idea to design a modular collection was born from an awareness of sustainable development with the aim that collection models can be transformed quickly and easily into garments for everyday occasions and as such reduce the need for new garments, and the main inspiration for designing the collection came during the trip which need to pack a large number of garments for different events. This is how the idea of developing a product that can be worn in different ways and for different needs came about. The collection consists of six basic garments. The modules are designed to be implemented on the basis of the original garment and on another garment base from the collection with the aim of obtaining as many different garments as possible by combining bases and modules. The six bases consist of a T-shirt, dress, pants, jacket, skirt, and top. The modules are collars, sleeves, an accessory for the length of a dress or skirt, and cuffs, designed so that the entire collection complements each other, and individual parts are multi-purpose [7].

3.1. Description of the modular clothing collection

The modular travel collection consists of pants, a skirt, a top, a T-shirt, and a dress. These garments have different functions and can be adapted to warmer and colder weather. Clothing can be in a shorter or longer version and can be combined in layers. The collection is intended for a businesswoman who attends business meetings, dinners, also for a walk in the park or when she needs more casual clothes.

The materials used in the experimental work are bengaline fabric and tulle in black to achieve an impression of elegance [7].

Figure 1: Collection of modular travel clothing

4. RESULTS

4.1. Dress

The dress consists of two bases, a T-shirt, a shorter skirt, a skirt length module, and a sleeve. The base of the dress can be used alone or in combination with two or more modules. That would mean we have a sleeveless blouse, a sleeveless blouse, a shorter dress with or without sleeves and a longer sleeveless and sleeveless dress, and a shorter or longer skirt. Bases and modules are connected by snap fasteners hidden inside the garment [7].

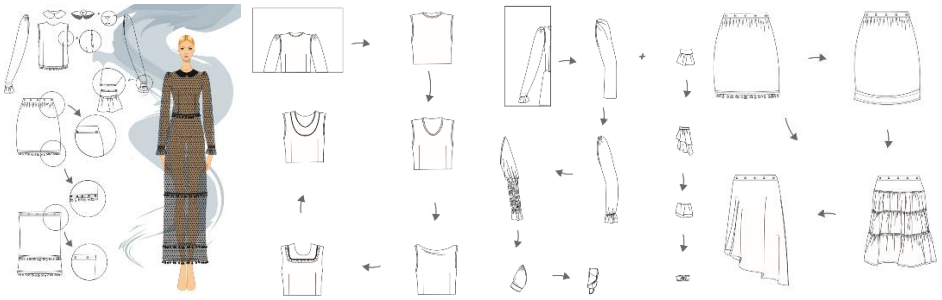


Figure 2: Modular dress

4.2. Pants and jacket

The suit consists of trousers and a matching jacket. The sleeves on the jacket are modules that when removed we get a vest. The length of the jacket is variable, it can be a shorter or longer variant depending on whether the module is attached to the length of the jacket. Pants are a base without modules, but a number of pants variants have been added to suit different body shapes and design solutions [7].

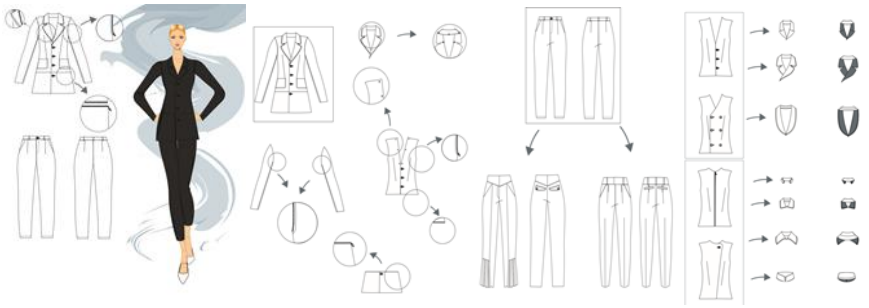


Figure 3: Modular suit

Figure 4: Skirt base and dress base (shirt and skirt) with a module for a longer version of the skirt

Figure 4: Detail of connecting the base of the dress and the sleeve module

5. CONCLUSION

A modular approach to clothing design requires a lot of thought and requires new solutions, but it opens up a number of possibilities for the production of clothing according to the principles of sustainable development. The main advantage of modular clothing is the transformation of garments by adding or subtracting individual modules. With such an approach, one garment can be used for different occasions with a variety of design solutions. The use-value of a garment is significantly extended and the need to follow the rapidly changing fashion trends that are the main problem of mass production is reduced. Modular design is one of the directions of slow fashion that could make big changes for fast fashion and its negative impacts on society and the environment. This paper presents one of the possibilities of making modular clothing and it is evident that this is another direction in which fashion could be developed with the aim of reducing waste and slowing down production. A modular approach in clothing design is one way to address the accumulation of waste that is a big problem of today's fashion industry when fashion trends change on a daily basis. In this way, the consumer's need for change is met, but also textile waste is reduced because the life of the garment is extended.

4. REFERENCES

[1] Webster, M. (last accessed 06.07.2021). Modular adjective, https://www.merriam-webster.com/dictionary/modularity

[2] Baldwin, C.Y., Clark, K.B. (2000). Design Rules: The power of modularity, Chapter 3: What Is Modularity?". Cambridge Mass: MIT Press, pp. 63–92., ISBN 9780262024662

[3] Meng, M.L., Ying, C.,Ye, W. (2018). Modular Design in Fashion Industry. Journal of Arts & Humanities, Vol. 07., Issue 03,2018,27-32. ISSN 2167-9053

[4] Modular apparel system and a system and method for customizing apparels. (last accessed 06.07.2021). URL: https://patents.google.com/patent/US20160021950A1/en

[5] Deihl, N. (2018). The Hidden History of American Fashion: Rediscovering 20th-century Women Designers. Bloomsbury Academic, ISBN-10 1350000469

[6] Niinimäki, K. (2013). Sustainable fashion: New approaches. Aalto ARTS Books: Helsinki, Finska, ISBN 978-952-60-5573-2

[7] Guša, A.M. (2020). Modularna odjeća za putovanja, Sveučilište u Zagrebu Tekstilno-tehnološki fakultet, Zagreb, diplomski rad

SECTION/SEKCIJA
F

DECISION-MAKING PROCESS AND CONSUMER PERCEPTION OF PRIVATE BRANDS

Irnesa Imširović, Arnela Nanić, Hana Žerić
Ekonomski fakultet Univerziteta u Bihaću, Pape Ivana Pavla II/2, 77000 Bihać, Bosna i Hercegovina
irnesa.imširović@efbi.unbi.ba
arnela.nanic@efbi.unbi.ba
hana.zeric@efbi.unbi.ba

ABSTRACT:

In today's market, there is a large number of companies that offer a different assortment of products, with a common goal – to satisfy the consumer needs. Therefore, due to a large number of influencing factors, consumers are often hesitant when making a final purchase decision. Price is a significant influencing factor, and can create a perception among consumers about a superior product of excellent quality. Nowadays, consumers have an increasing choice of products due to the emergence of private labels, which are high quality but their price is lower than manufacturer brands. This is where the struggle for consumers between private and manufacturer brands arises, because in every market there is a segment of price sensitive consumers and a segment that is willing to pay unreasonably high price just to own a certain brand. The research was carried out by using an online survey questionnaire on a sample of 112 respondents.

The aim of this paper, based on the collected data, is to gain an understanding of the consumer decision-making process when they are buying private brands, what is the most important for that decisions, and what are the habits of consumers. The main goals of this paper are: how they originated and what are the basic characteristics of private labels, what are the attitudes and perceptions of consumers about private labels, to determine what influences the decision-making process in category of private labels, what added value private brands provide to consumers, how they private brands are positioned in their mind, and what are main market trends of this brand category in Bosnia and Herzegovina and a chance to expand in the times to come.

Keywords: consumer perception, shopping habits, private brands

1. INTRODUCTION

Consumer behavior is a relatively young discipline with a special focus on consumer behavior during and after purchases process. The aim of this paper is to discuss exactly this form of behavior and the way of consumer making decisions about buying products of private labels. This special category of products has become popular and has caused many problems for owners of classic brands. Nowdays, consumers have an increasing choice of products due to the emergence of private labels, which are high quality but their price is still lower than manufacturer brands. This is where the struggle for consumers between private and manufacturer brands arises, because in every market there is a segment of consumers that is price sensitive and a segment that is willing to pay unreasonably high price just to own a certain brand. In accordance with the set goals and the subject of the paper, the main hypothesis

is defined, as well as several auxiliary hypotheses that will be proven or disproved after the analysis of the results of the empirical research. The basic hypothesis of this paper is: H1: Low price affects the perception of lower quality of products/services. Given the usually lower price of private brands compared to manufacturer brands, consumers perceive this category of products as products with a lower level of quality in case of shopping for some special occasions. H2: Buying private brands as gifts for consumers is a matter of low status and is not suitable. From the perspective of consumers, private brands do not have the meaning of a superior product such as Nivea. They generally believe when a private brands product is donated to create a bad image of themselves or even hurt the ego of another. H3: Consumers most often buy private brands in the category of ordinary/basic products. In the category of ordinary/basic products, consumers most often choose one of the private brands, because the degree of differentiation of this product category is quite low.

2. THEORETICAL FRAMEWORK

This part of the paper presents the theoretical framework of the private labels, from the history and development of private brands, conceptual definition and key characteristics, positioning, and price-quality ratio of this product category, to the changes and trends and future expansion of private brands.

2.1. History, concept and characteristics of private labels

The concept of private labels is based on generic products that could be purchased in individual retail chains; it was the retail chains that guaranteed the satisfactory quality of these products [1]. Over time, retail chains have labeled their generic products with labels highlighting their own name to guarantee quality. Private labels have developed through the stages. The first stage of development characterized private labels and their products as extremely low quality with low price. The brand name was the same as the name of the retail chain. The second stage for private labels meant a shift in the domain that they had some of the elements of identity, such as name, sign, slogan. They were still products of lower quality than classic brands because they had low production costs. The third stage marks, which is the current one, the gradual equalization of the quality of private and producer brands, but the prices are still lower. The last stage, which is predicted in the future, will be characterized by the leadership of private labels whose products will be of even superior quality and their prices will be the same as those of the brands.

Private labels are those brands that are owned by someone other than the manufacturer of the products that are owned by that brand [1]. A private label (a brand of an intermediary, distributor or store) is a brand created and owned by a reseller of a product or service [2]. Therefore, the key difference is between the brand of the manufacturer and the intermediary or seller who owns the brand and not who creates or produces it. According to Vranešević [1], private labels are brands owned by intermediaries who hire manufacturers to produce products that will be owned by those brands. These are brands managed by the owners, not the manufacturers. They are also called commercial, trade or own brands. Companies through a private brand create an image of their business and their products and thus will attract consumers who will be loyal to them. There are brands of wholesalers and retailers.

If the retailer is the owner of the brand, the brand can only be purchased in the stores of the retailer in question. On the other hand, if the brand owner is a wholesaler or distributor, the brand is available to all members of the distribution channel[3]. Private labels most often succeed in the category of food products, cosmetics and other products used in the household, because higher profit rates are achieved by launching consumer goods. What characterizes private labels are low prices, which are associated with low quality in the consumer's perception, and this is where the competitive board between private and manufacturing brands emerges.With the help of private labels, retail chains can [1]: Attract and retain clients by implementing various activities to build and reflect loyalty and achieve lasting closeness with their clients; Be free to set prices; It is easier to resist blackmail from strong manufacturer

brands; Make higher profits; Improve your own image. According to Alić, Peštek and Merdić [4], the relationship between product quality and monetary costs is the basis for consumers' perception of the value they receive for the money spent. Price is most often associated with quality perception, and consumers use price as a signal of product quality. As for private labels, it can be said that their success depends on the ability to offer an appropriate level of quality at an attractive price. According to Keller [5] as they were more competitive in today's market, private label manufacturers began to work on improving the quality of their products but also on expanding the range by offering a larger number of private label variants, including premium products.

2.2.Trends and the future of private labels

Private labels, due to the numerous advantages they bring to both companies and consumers themselves, have recently experienced great growth, which is especially noticeable in times of crisis, given the large price difference. According to Čirjak, Krajnović and Bosna [6] private labels of retail chains all over the world therefore experienced a boom during the global economic crisis. The crisis has caused most consumers to try to replace a branded product with a cheaper one under a brand name. The recession has motivated consumers to better and faster accept private labels as a replacement for well-known ones. Traditionally, private labels can become and survive strong in markets and in categories where [1]:

- ✓ there is a surplus of production capacity,
- ✓ products are experienced as everyday: low prices and low risk,
- ✓ products can be easily compared by the customer,
- ✓ producers invest little in development, and the technological conditionality itself is small,
- ✓ there is a large price gap, and intermediaries want and have sufficient funds to develop private labels with quality products,
- ✓ there are small deviations in quality and the distribution is well developed,
- ✓ brands lose their image due to frequent significant price reductions,
- ✓ brands do not have a large number of extensions, which provides the opportunity for private labels to become a more recognizable choice.

Demand for private label products shows a growth trend. The result is a situation, such as in the past during crises and recessions, when new paradigms and lifestyles come into force and when austerity is not unique to the "lower" classes [7]. In the process of buying products of private labels, the positioning of the point of sale and prices plays an increasing role. The concentration of sales in large chains is increasing the share of private labels, which in some countries is approaching half of the share in total sales. Much is being invested in improving the quality of private label products, thus increasing trust in them. There is no doubt that the quality of private labels will continue to improve [7]. The importance of private labels can no longer be ignored because in the most developed markets their market share exceeds 40% [8]. Therefore, a further trend of growth and expansion of private labels is to be expected, as well as an increase in the level of quality of private labels due to the increase of competitors in this category, but also changes that occur in the environment.

3. METHODOLOGY AND RESULTS OF EMPIRICAL RESEARCH

3.1. Research methodology

In order to collect data for the purposes of this paper, a survey questionnaire was conducted, which aimed to investigate the attitudes and perceptions of consumers about private labels and their propensity to buy them. The structured survey questionnaire was formed using the Google Forms. Respondents completed an online closed-ended questionnaire, which contained 13 questions. The first four questions

aimed to determine the structure of the sample, the next questions referred to the respondents' familiarity with the concept of private labels, whether and how often they buy them and what is their perception of them, as well as places of purchase and product categories, while the last part was formed by applying the Likert scale (1 I do not agree at all - 5 I completely agree). These claims, of which there are eleven in total, referred to product quality, price, design and packaging, which is crucial when buying, to which they pay special attention, whether a private label product is a matter of low status, etc. The research was conducted on a sample of 112 respondents (N = 112). The survey questionnaire was realized in a way that it was sent via e - mail addresses to potential respondents and distributed via social networks.

3.2. Results, analysis and discussion

The survey was completed by 112 respondents, of which 83.9% were female and 16.1% were male. According to the analysis, most respondents were aged 18 to 25 years, as many as 71.2% and 79 respondents, respectively, and the rest was divided as follows, 18.9% belong to the age group from 26 to 35 years, 8.1% belong to the age group from 36 to 45 years, and only 1.8% belong to the age group from 46 to 55 years.When asked about the status of respondents, out of the total number, 42.9% are students, 29.5% are employed and the rest 27.7% are in the unemployed category.When asked "How familiar are you with the term private label?" (Figure 1), it turned out that a relatively small number of respondents know exactly what the term means, as many as 13.4% of respondents are not familiar with the term, more than half of respondents.58.9% roughly know what that means, and the remaining 27.7% of respondents are fully familiar with the term.

The results of the answer to the question: “Do you buy products of private brands?“ showed that the majority of respondents buy products of private brands and perceive them as quality and affordable products 63.4%. Of the total, 12.5% of respondents buy private labels because they cannot afford the products of well-known brands. A relatively small number of respondents do not buy 7.1% and consider them to be of poor quality and poor products. 17% of respondents do not buy products of private labels, but are thinking of starting to buy them.

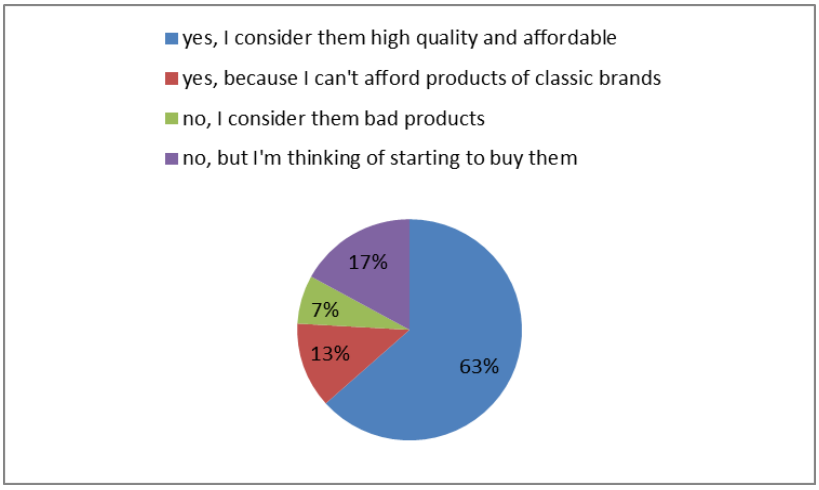


Figure 1: Purchase of private label products

To the following question: "What is your opinion on the quality of private label products?" More than half of the respondents, 59.8% of them answered that they consider private brands equal in quality with

the products of classic brands. Only 4.5% consider these to be low quality products; 9.8% of respondents say that these are high quality products, and the remaining 25.9% of respondents cannot assess. The next question aimed to investigate in which retail chains respondents buy private labels the most. Most respondents 67.9% buy the private brand in DM, followed by 60.7% in Bingo, Robot 20.5%, Belamionix 21.4% and Konzum 16.1%. In the next question, the respondents had to state which products are in the basket after the purchase. More than half of the respondents, 68.8% chose the option of "equally: private and classic brands", then 8.9% of respondents in the basket find mostly products of private brands, and 22.3% mostly products of classic brands. The next question referred to the type of products of private brands that they most often buy. " The results are shown in the figure below:

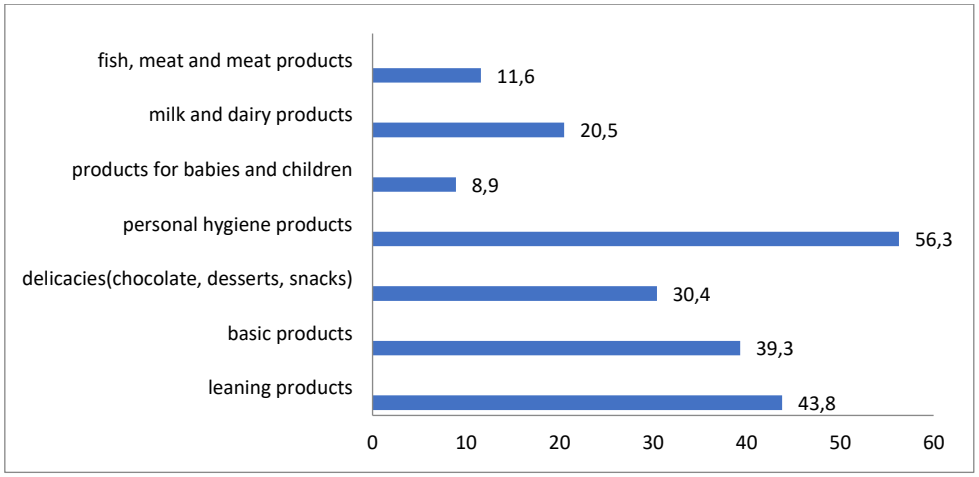


Figure 2: Types of private label products that respondents buy

The next part of the questionnaire included several statements for which respondents had to choose the appropriate degree of agreement (Likert scale). We will analyze only some of them. According to the results of the survey, the majority of respondents did not agree with the statement about the quality of packaging design of private labels 31.25%, 47.3% are neutral, while only 21.4% agreed with the statement. 37.5% of respondents agreed with the statement "I am ready to pay a higher price for a private label product compared to a classic brand if I consider it quality", 19.6% disagree, while 42.8% are neutral.

In the next question (Figure 3) results show that as many as 39% of respondents agreed with the statement "Private label products are getting better". Respondents expressed the lowest degree of agreement for the following two statements: "Low price is a signal of poor quality" did not agree with 61.6% of respondents, only 10.7% agreed with this statement while with the statement "Buying private labels as gifts is a matter of low status ”did not agree with 54.5% of respondents, and only 8.9 of them agreed with the statement.

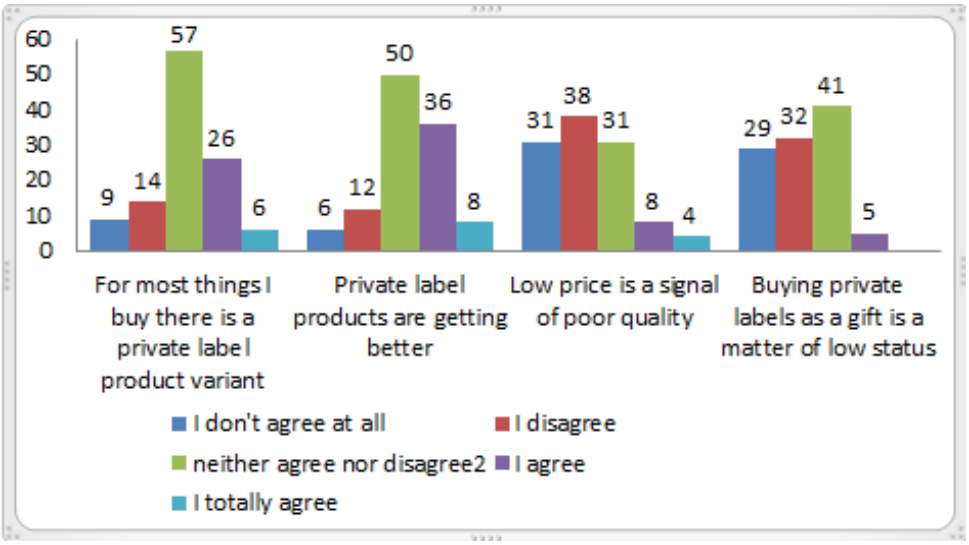


Figure 3: Likert scale response analysis

4. CONCLUSION

Private brands have led to changes in consumer buying behavior. Retail chains are introducing their private labels to the market to take advantage of the financial situation and thus differentiate their products from the competition. With the help of private labels, retail chains can attract customers, improve their own image, make higher profits and more easily resist competition. With low prices and solid quality, they position their own brands well, mostly in the category of consumer goods. In every market, there is a segment that is price sensitive and a segment that is willing to set aside more money for products of classic brands with which they can highlight their status. The results of the research showed the perception and buying habits of consumers of private labels. Consumers perceive this category as very high quality products with a lower price than classic products that anyone can buy. A larger segment of consumers puts the products of private and producer brands in the same rank. Low price is not a signal of poor quality, they attach more importance to quality rather than price. The research indicated poor promotion of private label products and thus consumers are insufficiently informed to buy such a product. Owners should work on the visual identity of the brand, on the design and appearance of the packaging in order to bring private brands closer to the classic ones. The research showed that the most purchased products are personal hygiene products, cleaning products and basic foodstuffs. Consumers are ready to buy a private label product as a gift, without fear of portraying themselves as a person of low purchasing power. It is obvious that private labels are becoming more and more popular on the market and that in the future they could appear in all product categories as products of superior quality.

5. LITERATURE

[1] Vranešević,T. (2007), Upravljanje markama, Accent, Zagreb
[2] Kotler, P., et.al. (2006), Osnove marketinga, Mate, Zagreb
[3] Renko,S.,Županić,I.,Petljak, K.:Trgovačke marke –imperativ svakog trgovca, research paper, Ekonomski fakultet Sveučilišta u Zagrebu, available at https://bib.irb.hr/datoteka/501255.ITR_Renko_Zupanic_Petljak.pdf
[4] Alić,A., Peštek,A., i Merdić,E. (2019), Determinants influencing consumers loyalty towards a

private brand, Poslovna izvrsnost, Vol 13, No2.
[5] Keller K.L.(2013), Staretegic Brand Management – Building, Measuring and Managing Brand Equity, Pearson
[6] Čirjak,M., Krajnović,A i Bosna, J., (2012), Privatne marke, Ekonomska misao i praksa, No2.
[7] Sopta, M.,(2007), Upravljanje trgovačkim lancima strategijom privatnih maraka, Market Tržište,Vol.19 No 1.
[8] Horvat, S., Istraživanje razvoja privatnih maraka u Republici Hrvatskoj, Market-Tržište, Vol 21, No1, 2009.

PROHIBITION OF DISCRIMINATION AS AN INDIRECTLY PROTECTED HUMAN RIGHT AND FREEDOM IN CONNECTION WITH THE EXERCISE OF ECONOMIC AND SOCIAL RIGHTS AND FREEDOMS

Jasmina Bešlagić
University of Bihac, Faculty of Law, Džanica mahala 68, 77 000 Bihać,
jasmina.beslagic@unbi.ba

ABSTRACT:

The principles of equality, parity and non-discrimination are the basic principles of modern international and domestic law. Considering the prohibition of discrimination as a human right and freedom, considering the criteria of the legal regime of protection in the classification of human rights and freedoms, the prohibition of discrimination can be considered as indirectly protected human right and freedom. These are such human rights that an individual can exercise only in connection with the exercise of another human right and freedom, so we say that this is a right that is protected by "ricochet". This paper mostly problematizes the issue of non-discrimination in the exercise of economic and social rights and freedoms, with special reference to the exercise of the right to work. The prohibition of discrimination in the exercise of the right to work implies equality of all in opportunities and treatment in the process of acquiring the status of a employee, equality in the exercise of rights arising from that status, as well as equality in the event of termination of status of a employee. Differentiation, exclusion or preference is allowed only on the basis of knowledge and ability criteria and not on the basis of any of the prohibited grounds of discrimination.

Keywords: Discrimination, prohibition, human rights and freedoms, economic and social rights and freedoms, the right to work

1. INTRODUCTION

„...Freedom from discrimination has a place before other human rights precisely because the consequences of its violations, ie. measures of discrimination against people, always have inhumane and far-reaching consequences. By its nature, discrimination always and inevitably produces mass and systematic human rights violations...“.[1]
The principles of equality, parity and non-discrimination are the basic principles of modern international law, as well as the basic principles of a democratic society or a society that aspires to become one. They represent the basis for the regulation of every legal system, and they are also built into the human rights system, and thus become the basis for the construction of the entire social system.

[1] Degan, V.Đ., cit. according to: Barić-Punda, V., (2005). *Načelo nediskriminacije – jedno od temeljnih načela zaštite ljudskih prava i sloboda*. Split: Zbornik radova Pravnog fakulteta u Splitu, no. 1, page 27.

Discrimination implies a relationship based on the abolition or restriction of the principles of equality and equality in the acquisition, use and enjoyment of human rights and freedoms, ie citizens.[2] Here we find a connection between the stated principles of non-discrimination, equality and parity, where these terms are not synonymous.[3]

Discrimination exists as much as the human race. Even at the time of slavery, there were two social classes among which there were great social differences - slaves and slaveholders. It was similar in the age of feudalism, so it was unthinkable to equate a serf and a feudal lord in any respect. Unlike the previous two periods in the development of human society, the period of capitalism is characterized by the beginning of the struggle for human rights, and thus the beginning of the struggle against discrimination, but without significant results. With the advent of socialism, the expected changes in the field of protection of human rights and prohibition of discrimination did not come, so the idea of creating a society of equals proved unrealistic.[4]

1. THE CONCEPT OF DISCRIMINATION

In the broadest sense of the word, discrimination is distinction or discernment. It means "classifying" individuals and/or groups into separate categories, but also treating individuals and/or groups differently based on the fact that makes them different.[5] Discrimination therefore constitutes a prohibited, unlawful or impermissible distinction between persons or groups of persons. Discrimination exists when equals are not treated equally or when unequals are treated equally.[6] In order for a certain conduct to be considered discrimination, it is necessary that it be based on one of the prohibited grounds of discrimination and that there is no justifiable justification for such conduct.

Numerous international human rights instruments prohibit but do not define discrimination.[7] However, there are also those international human rights instruments that contain a definition of discrimination.[8] Such documents, although they refer to specific forms of discrimination with regard to their basis, offer complete definitions of discrimination, applicable to other forms of discrimination, so they are of special importance in the legal-theoretical sense. From their definitions of discrimination, it is possible to set four criteria that answer the question of whether there is unequal treatment in a particular case: whether there is different treatment; whether it is done in equal cases (comparability test); whether there is an objective and reasonable justification for such conduct (justification test); and whether there is a proportionality between the goal and the means (proportionality test).[9]

[2] Šunderić, B., cit. according to: Brković, R., (2008). *Dostojanstvo na radu u legislativi Srbije i međunarodni radnopravni standardi*. Banja Luka: Pravna riječ, vol. V, no. 14, page 329.

[3] Equality is fairness in the treatment of members of different social groups, in accordance with their common and specific needs.(Živanović, A., (2010). *Rječnik različitosti*. Banja Luka: Helsinški parlament građana, page 13.) Equality is a concept according to which all human beings are free to develop their abilities and make free choices without restrictions established by social stereotypes, prejudices and expected social roles. (Živanović, A., (2010). *Rječnik različitosti*. Banja Luka: Helsinški parlament građana, page 7.)

[4] Brković, R., (2008). *Dostojanstvo na radu u legislativi Srbije i međunarodni radnopravni standardi*. Banja Luka: Pravna riječ, vol. V, no. 14, str. 329.

[5] Matulić, T., (2009). *Jednakost i nediskriminacija: vrijednosna polazišta u suzbijanju diskriminacije,* Zagreb: Zbornik Pravnog fakulteta Sveučilišta u Zagrebu, vol. 59, no.1, page 8.

[6] Aristotle's principle, see more: Fredman, S., (2011). New York: *Discrimination Law*. Oxford University Press, page 8-14.

[7] For example,International Covention on Civil and Political Rights, 1966 (Article 2, paragraph 1) and the European Convention for the Protection of Human Rights and Fundamental Freedoms, 1950 (Article 14) with Additional Protocol No. 12.

[8] For example, International Convention on the Elimination of All Forms of Racial Discrimination, 1965 (Article 1, paragraph 1) and Convention on the Elimination of All Forms of Discrimination against Women. 1979 (Article 1).

[9] Vandenhole, W., (2005). *Non-discrimination and Equality in View of The Un Humen Rights and Treaty bodies*. Antwerpen – Oxford: Intersentia, page 33-34.

When we talk about defining discrimination within domestic sources of law, the Law on Prohibition of Discrimination in Bosnia and Herzegovina,[10] considers discrimination to be: "any different treatment, including any exclusion, restriction or preference based on actual or presumed grounds towards any person or group of persons and those related to them on the basis of their race, color, language, religion, ethnicity, disability, age, national or social origin, affiliation with a national minority, political or other beliefs, financial status, membership in a trade union or other association, education, social status and gender, sexual orientation, gender identity, gender characteristics, as well as any other circumstance which has the purpose or consequence of preventing or endangering any person's recognition, enjoyment or realization on an equal basis, rights and freedoms in all areas of life."[11]

3. PROHIBITION OF DISCRIMINATION AS A RIGHT OR FREEDOM

In legal theory, there is a division of human rights according to several criteria. The most exploited classification of human rights is the one according to the time of its origin, so we know the human rights of the first, second and third generation. The first generation of human rights, which we also call classical or civil-political human rights, originated in Europe as a product of the French and other bourgeois revolutions, and found their political expression in the Declaration of the Rights of Man and Citizen of 1789. Their foundation was aimed at eliminating the arbitrariness of the state in relation to the individual and establishing a democratic social system by guaranteeing freedom, equality and security of man within that system.[12] This group of human rights includes, among others: the right to life, the right to liberty and security of person, the prohibition of torture and any cruel, inhuman or degrading treatment or punishment, human rights related to criminal proceedings, the right to privacy, freedom of thought, conscience, religion and beliefs, the right to express and inform, the right to participate in government and other rights and freedoms. Second generation human rights or economic-social human rights in particular began to develop in the middle of the last century. Their origin and development is closely connected with the need to provide basic existential conditions for the life of each individual, but also members of their family. However, even today, the guarantee of this group of human rights has remained at the level of proclamation, because it depends on the political, economic, social and other conditions that the state can offer to an individual.[13] This group of human rights includes: the right to work, the right to equal pay for equal work, trade union rights and freedoms, the right to social security, the right to protection of the family, employed mother and child, etc. The human rights of the third generation or the rights of the people arose at the latest. They are first mentioned within the 1981 African Charter on the Rights of Man and of the People, and their proclamation aimed to open up opportunities for the independence of those peoples who were under colonialism or some other kind of occupation.[14] The rights of the people include: the right to equality of the people, the right to self-determination, the right to manage national resources, the right to peace and other rights. Given the fact that the social system has a tendency of constant development, the rapid development of the fourth generation of human rights is to be expected.

The second criterion for classifying human rights is the criterion of justiciability, so we are talking about the classification of human rights according to the possibility of their realization through the competent courts. This is how we know the plaintiff's human rights, ie. those human rights whose realization is

[10] Law on Prohibition of Discrimination of Bosnia and Herzegovina, „Official paper of Bosnia and Herzegovina" no 59/09 and 66/16.

[11] Article 2, paragraph 1 of the Law on Prohibition of Discrimination of Bosnia and Herzegovina.

[12] Sadiković, Ć., (2001). *Evropsko pravo ljudskih prava.* Sarajevo: Fond otvoreno društvo BiH – Pravni centar FOD BiH Sarajevo i Magistrat, page 50-51.

[13] Sadiković, Ć., (2001). *Evropsko pravo ljudskih prava.* Sarajevo: Fond otvoreno društvo BiH – Pravni centar FOD BiH Sarajevo i Magistrat, page 51-52.

[14] This group of human rights is characterized by a legal-theoretical dilemma about the character of human rights, given that it is a matter of collective rights, while in theory the prevailing understanding is about the individualistic character of human rights.

possible through judicial protection, and these are primarily classical human rights and inalienable human rights, ie. those in which protection cannot be achieved through the courts. This division of human rights is of special importance because it indicates a large gap between proclaimed and realized human rights, so there is a whole corpus of human rights that are declaratively guaranteed, but cannot be achieved through the courts.[15] This primarily refers to economic and social human rights, which are mostly inalienable.

The last criterion for the classification of human rights is the criterion of the legal regime of protection, ie the criterion of the possibility of restricting a human right. In this context, we know absolutely, relatively and indirectly protected human rights. Absolutely or completely protected human rights are those that can not be limited under any circumstances, and relate to the physical and moral integrity of the individual. This group of human rights includes: the right to life, the right to liberty and security of person, the prohibition of torture and any cruel, inhuman or degrading treatment or punishment, human rights related to criminal proceedings and other rights.

Relatively or conditionally protected human rights are those that may be restricted under certain circumstances, but only when provided for by law and necessary in a democratic society to protect public order. For example, the right to privacy, freedom of movement, freedom of association and assembly, etc. which may be restricted when certain conditions are met and when it is necessary to protect the public interest. According to the criteria of the legal protection regime, there are also indirectly protected human rights. These are such human rights that an individual can use only in connection with the exercise of another human right. An example of an indirectly protected human right is the right to non-discrimination, because it always relies on the protection of another human right, so we say that it is a right that is protected by "ricochet".[16]

4. DISCRIMINATION AND ECONOMIC AND SOCIAL RIGHTS AND FREEDOMS

Some of the economic and social rights and freedoms have already been mentioned, but this group of human rights and freedoms also includes: the right to fair and favorable working conditions; the right to advancement in accordance with years of service and abilities; the right to limit the number of working hours; the right to rest and leave from work; trade union rights and freedoms; and other rights and freedoms.[17]

According to the criterion of time of origin, economic and social rights and freedoms belong to the second generation of human rights. They arise later in relation to civil-political human rights, which suggests the emergence of the need to protect some other values related to the existence of man as a segment of the social system, in addition to those related to his physical and moral integrity. It has been shown that a guarantee, say the right to life, makes no sense without a guarantee of rights and freedoms related to the quality of human life and the satisfaction of basic living needs. In the realization of economic and social rights and freedoms, the role of the state is irreplaceable, which is determined positively, because it is faced with the requirement to act, ie. creating all the necessary political, legal, economic, social and other preconditions for the realization of this group of human rights.[18]

According to the criterion of justiciability, economic and social rights and freedoms belong to the group of inalienable human rights. If we look at the right to work, as one of the basic rights in this category, the question of passive legitimacy is justifiably raised when initiating the procedure for exercising this right. In that case, is a specific employer or all employers passively legitimized, or is it the state? Namely, the

[15] Sadiković, Ć., (2001). *Evropsko pravo ljudskih prava.* Sarajevo: Fond otvoreno društvo BiH – Pravni centar FOD BiH Sarajevo i Magistrat, page 54-55.

[16] Sadiković, Ć., (2001). *Evropsko pravo ljudskih prava.* Sarajevo: Fond otvoreno društvo BiH – Pravni centar FOD BiH Sarajevo i Magistrat, page 55-56.

[17] This category of human rights includes other rights and freedoms, such as the right to education, cultural rights, rights arising from copyright and the like.

[18] Gradaščević-Sijerčić, J., (2000). *Evropska konvencija o ljudskim pravima i ljudska prava na rad i povodom rada*. Sarajevo: Ljudska prava vol. 3-4, no. 1, page 23-24.

exercise of the right to work is conditioned by the ability of the other party, especially the state, to satisfy a specific claim, ie to provide a job to the claimant. Satisfaction of such a requirement depends on a number of factors, starting from the development of the social system and the existence of basic preconditions for achieving full employment, as well as the situation on the labor market. Therefore, it would be inappropriate to initiate proceedings against any employer or the state itself due to the impossibility of exercising the right to work, so it seems impossible to demand in court the exercise of the right to work, but also other economic and social rights and freedoms. For these reasons, the right to work is considered a principle rather than a right in itself.

If we look at economic and social rights and freedoms through the prism of the legal regime of protection, they belong to the group of relatively protected human rights, because under certain conditions they can be limited. An example is the restriction of the exercise of trade union rights and freedoms, such as organizing and conducting a strike, because it is limited in certain specific activities due to the protection of public order, public health, protection of the rights and freedoms of others, etc. The right to work is also one of the rights that can be restricted under certain circumstances through classical ways of restricting human rights and freedoms.[19] However, even without the existence of conditions for this type of restriction, the right to work is subject to the impossibility of realization due to the lack of economic, social, political and other conditions that are the obligation of the state in order for this right to be realized.

4.1. Right to work and discrimination

The right to work is one of the basic principles and rights in the system of labor relations in modern social systems. It is one of the basic economic and social rights and a precondition for the realization of numerous other rights and freedoms. With freedom of work and the right to work[20], it is the basis of all labor legislation. The right to work was first mentioned in the attitudes of social utopians in the second half of the 19th century, when the need arose to protect workers from "risk" and "injustice" in the face of market freedoms, although the guarantee of the right to work dates back to the French bourgeoisie. revolution when this right was required to become part of the 1979 Declaration of the Rights of Man and of the Citizen, and was later introduced into the constitutions as a program provision.[21]

The right to work is defined as providing, on the principles of equality in opportunities and treatment, employment and work to every able-bodied individual, in accordance with knowledge and abilities and pre-determined conditions, with the aim of achieving material well-being and spiritual development of the individual and his family members. . It is closely related to the principle of equality and justice, but its actual realization depends largely on the economic and overall social development of a particular state. Creating conditions for the realization of the right to work is not only the responsibility of the state, but also of numerous other entities in the social system that manage the means of work, financial, but also other means that affect economic trends in the state. This especially refers to the representatives of the government, institutions, owners of capital, etc. However, the obligation to exercise the right to work is addressed to the state, not to any of its bodies. Therefore, as already mentioned, the right to work can be considered a program principle and an inalienable human right.

[19] Derogations, exceptions and restrictions, see more: Sadiković, Ć., (2001). *Evropsko pravo ljudskih prava.* Sarajevo: Fond otvoreno društvo BiH – Pravni centar FOD BiH Sarajevo i Magistrat, page 57-61.

[20] Freedom of work is observed both from the aspect of the worker when it represents the freedom in establishing and terminating the employment relationship, and from the aspect of the employer when it represents almost complete freedom in terms of establishing the employment relationship. The right to work in the narrow sense is the right to independently and freely perform certain jobs, occupations or professions. In a broader sense, this includes freedom of work, because it also implies the freedom of a person to work independently or to establish an employment relationship where he wants and with whom he wants. (Dedić, S., Gradaščević-Sijerčić, J., (2005). *Radno pravo*. Sarajevo: Pravni fakultet Univerziteta u Sarajevu, page 183-185.)

[21] Ravnić, A., (2004.) *Osnove radnog prava – domaćeg, uporednog i međunarodnog.* Zagreb: Pravni fakultet u Zagrebu, page 101-102.

If we view the right to work as an "order addressed to the legislator", we conclude that it is a much broader concept than the right to employment, and is a complex right that includes the following obligations of the state: to take measures and activities to achieve full employment; to provide effective protection of the right of the worker to realize his own existence, as well as of the members of his family, by pursuing an occupation of his choice; establish or maintain free employment services; and provide and promote appropriate vocational guidance, training and retraining.[22]

If, on the other hand, we view the right to work through the prism of the prohibition of discrimination as a human right or freedom, then it excludes any distinction, exclusion or preference of one individual over another on any of the prohibited grounds, without justified and lawful reasons. The right to work implies equality of all in the possibilities and treatment in the process of acquiring the status of worker and employer, equality in the realization of the rights arising from that status, as well as equality in case of termination of status. This means that the right to work includes the prohibition of discrimination, so differentiation, exclusion or giving priority is allowed only on the basis of knowledge and ability criteria, and not on any of the prohibited grounds of discrimination. In addition to the above, the right to work also contains the principle of equality of working conditions and equality of rights based on work, which means that for equal work and work under the same conditions, equal rights are exercised. The right to work observed in this way, as a right that includes the prohibition of discrimination as a constitutive element of that right, could also be viewed as a justiciable human right,[23] because discrimination itself is justiciable human right or freedom.

5. CONCLUSION

The prohibition of discrimination is one of the basic indirectly protected rights and freedoms, since it is always linked to the exercise of another right and freedom. Therefore, we can consider it a right that is protected by "ricochet". Discrimination in the exercise of economic and social rights and freedoms, and especially in the exercise of the right to work, is a mass social phenomenon. It exists not only during of the employment, but also when it comes to the conditions and manner of establishing the employment, as well as in terms of determining the grounds for termination of employment. On the other hand, the principles of equality, equality and non-discrimination are the basic principles of modern international and domestic law, so discrimination is prohibited by numerous international documents, as well as domestic legislation. Differentiation, exclusion or giving preference in the exercise of economic and social rights and freedoms, and thus in the exercise of the right to work is allowed only on the basis of criteria of knowledge and ability, and not on the basis of any of the prohibited grounds of discrimination.

6. LITERATURE:

[1] Barić-Punda, V., (2005). *Načelo nediskriminacije – jedno od temeljnih načela zaštite ljudskih prava i sloboda*. Split: Zbornik radova Pravnog fakulteta u Splitu, no. 1;
[2] Brković, R., (2008). *Dostojanstvo na radu u legislativi Srbije i međunarodni radnopravni standardi*. Banja Luka: Pravna riječ, vol. V, no. 14;
[3] Convention on the Elimination of All Forms of Discrimination against Women, 1979;
[4] Dedić, S., Gradaščević-Sijerčić, J., (2005). *Radno pravo*. Sarajevo: Pravni fakultet Univerziteta u Sarajevu;
[5] European Convention for the Protection of Human Rights and Fundamental Freedoms, 1950 (Article 14) with Additional Protocol no. 12;[5] European Social Charter, 1965;
[6] Fredman, S., (2011). New York: *Discrimination Law*. Oxford University Press;

[22] Article 1 (II), European Social Charter, 1965. (revised 1996).
[23] Dimitrijević, V., Paunović, M., Đerić, V., cit. according to: Lubarda, B., (2004). *Evropsko radno pravo*. Podgorica: CID, page 233.

[7] Gradaščević-Sijerčić, J., (2000). *Evropska konvencija o ljudskim pravima i ljudska prava na rad i povodom rada*. Sarajevo: Ljudska prava vol. 1, no. 3-4;
[8] International Convention on Civil and Political Rights, 1966;
[9] International Convention on the Elimination of All Forms of Racial Discrimination, 1965;
[10] Law on Prohibition of Discrimination of Bosnia and Herzegovina, „Official paper of Bosnia and Herzegovina" no. 59/09 and 66/16.
[11] Lubarda, B., (2004). *Evropsko radno pravo*. Podgorica: CID;
[12] Matulić, T., (2009). *Jednakost i nediskriminacija: vrijednosna polazišta u suzbijanju diskriminacije,* Zagreb: Zbornik Pravnog fakulteta Sveučilišta u Zagrebu, vol. 59, no.1;
[13] Ravnić, A., (2004.) *Osnove radnog prava – domaćeg, uporednog i međunarodnog.* Zagreb: Pravni fakultet u Zagrebu;
[14] Sadiković, Ć., (2001). *Evropsko pravo ljudskih prava.* Sarajevo: Fond otvoreno društvo BiH – Pravni centar FOD BiH Sarajevo i Magistrat;
[15] Vandenhole, W., (2005). *Non-discrimination and Equality in View of The Un Humen Rights and Treaty bodies*. Antwerpen – Oxford: Intersentia;
[16] Živanović, A., (2010). *Rječnik različitosti*. Banja Luka: Helsinški parlament građana.

SPECIALIZED SOFTWARE PLATFORMS AS A SUPPORT TO BUSINESS CONNECTING

Amel Džanić, Alma Džanić, Mirela Kljajić-Dervić, Muharem Kozić
Faculty of Technical Engineering University of Bihac, dr. Irfana Ljubijankica bb, 77000 Bihac, Faculty of Economics Univerzity of Bihac, Pape Ivana Pavla 2, 77000 Bihac, Faculty of Economics University of Dzemal Bijedic in Mostar, University Campus, 88104 Mostar, amel.dzanic@gmail.com, almatdzanic@gmail.com, mirelakd@yahoo.com, muharem.kozic@unmo.ba,

ABSTRACT:

The importance of software in today's world is great, whether it is about the business, medicine, connecting the society, solutions for governments, or access to information that was impossible in the past. Software has become an inseparable part of modern life. Customized software offers „Business-to-Business" and „Business-to-Customer" solutions in business world. As a need for business connecting, there are specialized software platforms that go beyond the solutions offered by the „Business-to-Business" and „Business-to-Customer" concepts. The synergy between the businesses, governments and software engineers has given rise to software platforms that help and support business connecting. This paper gives an overview of services offered by certain software platforms designed for business connection, as well as the achieved results of one of them.

Keywords: software, platform, business connecting

1. INTRODUCTION

The development of the World Wide Web in the mid 1990s opened up the commercial viability of the internet as, for the first time, ordinary citizens were able to access the resources that it held. Soon, the number of websites increased from tens of thousands to millions [1].

The internet and related technologies, such as intranets and extranets, also help organisations to increase efficiency in their internal processes. From a business perspective, the internet has had a profound effect on the way firms operate, how they communicate with others, what products they produce, how they deliver products and services, and how they seek competitive advantage. The internet has changed the 'rules' of trading by presenting new challenges and opportunities and altering the way firms engage and build relationships with customers [1].

Along with the development of information and communications technology, software platforms that offer services and connect businesses are created in projects supported by governments and with joint activities of software engineers and businesses.

2. SOFWARE ENGINEERING

The simplest way to describe software engineering is that it is an engineering discipline that deals with all aspects of software development. Engineers do things in a way to make them functioning, ie. appropriate theories, methods and tools are applied. The use is selective from problem to problem, but the efforts are always made in order to solve the problems even when there is no appropriate theory and method for doing so. However, it must be said that these solutions must be found within both financial and organizational limitations. All aspects of software development include, in addition to software development, also software project management activities, as well as the development of tools, methods and theories that support software development [2].

2.1. Definition and types of software

The importance of software in today's world is great. Grady Booch is in his article "Leaving Kansas" made definition of software as follows: „*Software is the fuel on which modern businesses are run, governments rule, and societies become better connected. Software has helped us create, access, and visualize information in previously inconceivable ways and forms. Globally, the breathtaking pace of progress in software has helped drive the growth of the world's economy. On a more human scale, software-intensive products have helped cure the sick and have given voice to the speechless, mobility to the impaired, and opportunity to the less able. From all these perspectives, software is an indispensable part of our modern world* [3].

Software could be classified into two categories [2] [4]:

- Generic software – represents individual software system that is produced by software companies and anyone who has interest can purchase it. Examples of such software are, for example, Microsoft Office, anti-virus software, database software, etc.
- Customized software – is software system that is ordered by a particular customer. A software company produces a particular software for the particular customer. Examples of such software are support for certain business processes, air traffic control systems, etc.

The most important different between these two categories of software is that in the case of generic software, the software company controls and manages the software specification, while in the case of customized software, it is most often in the domain of the organization for which the software is made. Software engineers in that case must work on the basis of that specification. Nowadays, the boundary between these two categories is getting thinner and almost disappearing as generic products appear that are then adapted to the requirements of the users. An example of such software is an integrated business resource planning software solution (Systems Applications and Products in Data Processing) [2].

3. SOFTWARE AND BUSINESS-TO-BUSINESS

The internet has become an integral part of many organisations' means of undertaking business. It can be used as an additional channel through which businesses communicate with and trade with customers (business-to-consumer, B2C) and suppliers and partners (business-to-business, B2B) [1].

Electronic business (e-business) can be defined as the use of the internet to network and empower business processes, electronic commerce, organizational communication and collaboration within a company and with its customers, suppliers, and other stakeholders [1].

"The internet economy", "the information economy" or "the digital economy" - these terms are used to define the distinct contributions to the economy through use of the internet, digital technology, or information and communications technology (ICT) [1].

Information technology has also enabled new forms of management and control, both within organisations and between organisations. Information technology makes it possible to simultaneously co-ordinate economic activity in many different locations and beyond traditional organisational boundaries. This has enabled organisations to create new structures, such as the network organisation or the virtual organisation, that are more flexible and efficient, harness the best skills and experience of workers and eliminate many of the costs associated with running traditional hierarchical and rigid organisations [1].

4. PLATFORMS AND BUSINESS CONNECTING

A platform is a set of software and a surrounding ecosystem of resources that helps you to grow your business. A Platform enables growth through connection: its value comes not only from its own features, but from its ability to connect external tools, teams, data, and processes [5].

A platform offers a different, more straightforward approach to managing your growing business. Instead of purchasing a box of tools, a platform is more like an electrical outlet with the potential to easily plug in as many tools as you need. Products require integrations (sometimes custom, complex ones) to connect different tools, but platforms are designed from the start to help different tools work together and share information more easily [5].

Lately, platforms intended for business connecting have become more common. These kinds of platforms go beyond the „Business-to-Business", „Business-to-Customer" and related concepts. Specialized software platforms for business connecting are created by joint action of the government, software engineers and businesses. In the continuation of this paper the overview of the two specialized software platforms as a support to business connecting with the services they provide is given.

4.1. Enterprise Europe Network

Enterprise Europe Network – EEN is the project of the European Union that helps businesses innovate and grow on an international scale. It is the world's largest business support platform. This business connecting platform is active in more than 60 countries worldwide. It brings together 3.000 experts from more than 600 member organisations – all renowned for their excellence in business support. Member organizations include: technology poles, innovation support organizations, universities and research institutes, regional development organizations and chambers of commerce and industry. Individual businesses cannot become "members", but they can enjoy the many services offered.

Teams of Network experts in each member organisation offer personalised services to businesses. They know the local business environment and have contacts for business opportunities worldwide. Enterprise Europe Network' expert groups cover all key economic sectors, from healthcare to agrofood, from intelligent energy to fashion and textile.

Businesses can be connected through services offered by Enterprise Europe Network platform:

1. International partnership
2. Advice for international growth
3. Support for business innovation

4. Research and development

Businesses can be connected through the Enterprise Europe Network platform finding the right international partners to grow and expand abroad. The Network has the reach and expertise to find the right partner(s) for the local business to: manufacture or distribute products; access new markets; find the technology needed to drive innovation in business; cooperate in research and development projects. The Network platform manages Europe's largest online database of business opportunities. It contains thousands of businesses, technology and research cooperation requests and offers from companies and research and development institutions. The database is accessible for free.

The Network organises different types of business-oriented events supported through platform: business matchmaking events, trade missions and conferences and workshops. Brokerage events also known as business "speed dating" bring together businesses and other organisations looking for partners to take their projects forward. They often take place alongside international trade fairs and conferences. Participants share their partnership offers or requests and schedule meetings in advance. Business matching software platforms also in organization of brokerage events have a primary role as a support for business connecting. Trade missions also known as company missions are international visits for small groups of businesses. These tailor-made missions lead to many successful partnerships thanks to thorough preparation and local knowledge. Local business can either travel abroad to meet potential business partners or receive delegations from other countries. Conferences, training sessions, seminars and workshops can help prepare local business for international expansion. These events focus on topics covered by the Network advisory and support services. Topics include innovation, access to international markets, funding opportunities, regulations and standards.

Enterprise Europe Network experts provide businesses with the advice they need to grow and expand into international markets. Network advisory services mainly focus on EU topics. Areas of expertise are: EU legislation and standards; access to international markets; international public contracts, finance and funding; EU funding and application support; intellectual property rights; energy and resource efficiency; management improvements.

If the businesses are looking for a partner for joint development of research projects, participation in a consortium or some other form of cooperation on international research and development projects, the Enterprise Europe Network can help to find targeted contacts and potential partners [6].

All the above presented services for business connection could be expressed by the indicators such as: participants in regional/local events; SMEs/clients receiving individual advisory support; SMEs/clients receiving individual partnering support; brokerage events/company missions organised; meetings at brokerage events/company missions; expression of interests received; expression of interests made; clients in feed-back related actions; achievements (advisory service outcomes and partnership agreements); SMEs/clients using digital services provided by the Network; partnership profile produced.

From the April 2017 till December 2019 Enterprise Europe Network Consortium for Federation of Bosnia and Herzegovina has reached: 2236 participants in regional/local events; 194 SMEs/clients receiving individual advisory support; 505 SMEs/clients receiving individual partnering support; 63 brokerage events/company missions organised; 2451 meetings at brokerage events/company missions; 267 expression of interests received; 364 expression of interests made; 99 achievements (55 advisory service outcomes and 44 partnership agreements); over 5500 SMEs/clients using digital services provided by the Network; over 70 partnership profile produced. **data on Key performance indicators taken with permission of Enterprise Europe Network Consortium for Federation of Bosnia and Herzegovina*

4.2. Bizbook

Bizbook is the first software platform for business connecting in Bosnia and Herzegovina. It started in 2018 and won the award for the best Bosnia and Herzegovina start up at the same year. Bizbook is supported by the Government of Switzerland (Swiss Agency for Development and Cooperation SDC) through the MarketMakers project.

Bizbook introduces itself as "all-in-one business platform". It is online place where the companies can present themselves, research and collaborate, exchange knowledge and experience with business partners for mutual growth.

By connecting companies, they are enabled to support each other and strengthen business ties. This is made possible through the content/services offered by the platform:

1. Creating a company profile
2. Using personalization options
3. Finding a partner
4. Facilitated communication

Company profile contains basic information about the company, as well as a personalized way of editing the profile and entering content according to the wishes and needs of the company, and a display of selected products and/or services. Each user of platform can simultaneously publish current offers of their products and/or services and demand for products and services from other users. Companies create their identity by using the accessible sections of the platform, and thus provide available information to potentially interested companies about their current and ongoing business needs. The platform content search option is available to all registered users of the platform. The search can be performed according to different criteria and thus filter the data by location, category, service/product, keyword and country. An overview of all users of the Bizbook platform consist of a list of all users, as well as information about the companies they choose to be available to other users. Each user has access to the messaging system on the Bizbook platform, which they use in communication with other users of this platform to send inquiries about offers, participate in discussions, as well as receive e-mails and notifications from the Bizbook team, which can be useful to improve business and connecting [7].

Till November 2020, the Bizbook platform has been featured 689 companies from all over the Bosnia and Herzegovina, 270 closed deals, 1833 offers, 215 requests, over 700 products, and organized six B2B events. They digitize three trade fairs at Bosnia and Herzegovina [8].

5. CONCLUSIONS

The internet has been a catalyst for change in the way people communicate and has drawn the attention of diverse bodies including government, police and security agencies, the legal profession, public sector organizations, educational establishments and many, many more. The business community has been fundamentally changed by the advent of the internet as a means of communication and trading [1].

Although the development of software engineering and the Internet itself have made possible better business connecting of all business concepts, specialized software platforms for business connecting are a modern, meaningful and purposeful tool that enables aimed business connecting. In favor to this is a fact that such business connecting tools are a synergy of software engineering, government support and the needs of the businesses themselves. That is exactly what the services for business connection of the presented software platforms show, and especially the presented results of business connections of the same.

That could be shown, for example, only through one service of specialized platforms as are international trade fairs. International trade fairs have always been a kind of concept for business connecting. However, with the development of specialized software platforms for business connecting, international trade fairs are gaining a new dimension, where a special place in primarily online form, but also in physical form are taken by pre-scheduled business meetings.

It could be stated that with the further development of software engineering and information technologies in general, business connectivity services, and thus specialized software platforms as a support to business connecting, will continue to develop in accordance with business needs, and if there is a government support, then such business connectivity concepts through software platforms certainly represent the future of the business.

6. REFERENCES

[1] Combe, C., (2006). Introduction to E-business Management and Strategy. Elsevier, 14-22.
[2] Džanić, A., (2018). Magistarski/Master rad „Web aplikacija za podršku procesa izgradnje informacionog sistema“. Univerzitet u Bihaću, Tehnički fakultet Bihać.
[3] Booch, G., (1998). Leaving Kansas, IEEE Computer 15 (1).
[4] Sommerville, I., (2015). Software Engineering, Ninth Edition. Pearson Education, Inc.
[5] https://blog.hubspot.com/marketing/software-platform accessed 04/23/2021
[6] https://een.ec.europa.eu/ accessed 06/03/2021
[7] https://bizbook.ba/ accessed 05/21/2021
[8] https://swissep.org/our-impact/success-stories/a-letter-from-erna-sosevic-bizbook-founder accessed 05/21/2021

BRAND STORYTELLING - POWERFUL TOOL FOR IMPROVING MARKETING ACTIVITIES OF COMPANY

Arnela Nanić, Ajla Felić
Ekonomski fakultet Univerziteta u Bihaću, Pape Ivana Pavla II/2, 77000 Bihać, Bosna i Hercegovina
JU Stanouprava Bihać, 502.viteške brigade bb, 77000 Bihać, Bosna i Hercegovina
arnela.nanic@efbi.unbi.ba
ajla.felic@efbi.unbi.ba

ABSTRACT:

Future od branding is all about the storytelling ability. Nowdays storytelling has a very important role when it comes to influencing consumer's emotions, and making the final decision to buy and create a certain opinion about the product, brand. Today, storytelling is a potentially powerful and compelling tool in marketing strategy, simply because people love stories that will spark some emotions in them and, on the other hand, make them act accordingly. This paper places special emphas is at storytelling and its significance for consumers and marketing strategy. The aim of this paper is to research and determine the impact of storytelling on consumer's behavior; determine whether ads that include a story are easier to process, accept, and evaluate than ads without a story. The research was conducted using an online questionnaire. A structured survey questionnaire was used on a convenient sample of respondents. A total of 210 respondents participated in the study (n = 210). The subject of the paper is consumer's behavior, as a discipline that connects consumer's psychology, including all influential factors in the purchasing decision process. The key point of this research is how companies can use storytelling to influence consumers, their thinking, and improve marketing activities and the overall business of the company.

Keywords: brand storytelling, marketing strategy, consumer

1. INTRODUCTION

We can assume that storytelling can be used when promoting and selling products, because consumers are prone to affective decision making, and storytelling has been shown to have very strong persuasiveness, especially given the evocation of the affect of the story itself. The objectives of this study are as follows: to get acquainted with the term “Storytelling” and to present its role in marketing; determine the importance of storytelling as an important factor in making decisions and creating perceptions about products or services. The main goal of this study is to find out whether consumers are more willing to invest in certain product and services, which use structured stories compared to those that do not use stories. Based on the subject and objectives of the study, the main hypothesis is set, which says: H0: Products and services whose campaigns tell a story are more likely to be purchased by consumers compared to the same campaigns without a story. Auxiliary hypotheses read:

H1: Consumers prefer advertisements in the form of stories; H2: Facts tell, story sells- it is a true phrase that it is the story that sells the product; H3: Storytelling is gaining importance in marketing. Storytelling contributes to greater memorability and effectiveness of overall promotional campaigns and budgets with consumers. The effect of storytelling in promotional campaigns has different effects on different types of personalities to which consumers belong, consumers with different personalities will be affected differently by different type of story.

2. THEORETICAL FRAMEWORK

Today, the concept of storytelling plays a very important role in promoting the brand and attracting consumers. Recent researches indicates the effectiveness of this way of advertising, and the future of marketing is closely related to storytelling. The future of successful branding is tied to the capabilities and abilities of brand managers to tell stories and create successful brand storytelling campaigns. The main goal of telling such stories is to arouse emotions in consumers, which should ultimately direct them to buy a certain brand. Stories have a unique power to move the human mind and heart in the direction set by narrator himself. Storytelling is actually a skill that originated in the 19th century and soon spread to the world of political and managerial communication. Many older stories are originally folk tales, and they represent a wealth of oral traditions that are the result of experience, innovation and creativity, as well as the ability to tell narrator stories. The term of storytelling in modern marketing implies a methodology for designing quality brand stories, their efficient distribution to potential clients/followers and listening to their reactions, in order to define the brand strategy even more precisely. Seth Godin, one of the most important contemporary business philosophers, says: “People don’t buy goods and services. They buy emotions, stories and magic.”

Society is surrounded on a daily basis, to such an extent, by various stories that they are not seen as stories. This is exactly the great advantage of storytelling, it imposes itself as a natural tool in many areas of communication because it is not offensive or foreign but comes as something natural. Therefore, there should be no doubt about its success when it comes to its marketing purpose. Storytelling is a powerful art form. Stories entertain, educate and enlighten. They have the ability to transport listeners to a completely unknown location. With stories, an individual goes to places and times that are physically impossible for him, and they provide him with invaluable experiences and emotions that remain for a long time as proof of how powerful stories really are [1]. Rob Biesenbach, an award-winning communication consultant and author of renowned storytelling, presentation and communication skills programs, points out that: “If you can be a good storyteller, there are no limits to what you can do. Stories tear down walls, build trust and influence people's actions" [2]. He identified the elements that give a certain power to stories, and these are:

1. Stories affect emotions – people, in general, do not react to facts or logic
2. Dealing with the problem - it is necessary to take care of people, not the process
3. Stories connect people
4. Stories humanize us - people crave the personal side
5. Stories raise roles - it is necessary to appeal to universal, common values
6. Stories are tied to deeds, not words - one of the most important items of any story is telling the story itself, not relying on claims.

"Facts tell, stories sell." - it is the story that sells, marketing experts are always happy to come back and use the most basic element - the story. A story is easier to remember than a dry fact, and here we can see how much power it actually has. Telling brand stories is about using an authentic, emotional story to drive growth and boost customer loyalty. It represents a new era of integrated marketing communication where brand-funded content is integrated through various media channels and market activities organized by the organization.

Storytelling is becoming an indispensable part of the marketing of all brands that want to keep up with the times. The world has never been so (over) saturated with information, products and offers. It is therefore difficult sometimes to distinguish who and on what basis to trust. While facts certainly play an undeniable role in building trust by the target audience, stories offer a unique opportunity to communicate those facts. They increase credibility, capture attention and occupy the mind. It's amazing how much we believe the stories. They allow the listener to interpret the message of the story according to his conditions [3]. Storytelling is a powerful art form. Stories entertain, educate, and enlighten. They have the ability to transport an audience to another location and teach them about issues and people they may know nothing about. The same is true of grantwriting [4]. Good storytelling displays the struggle between expectation and reality inall its nastiness [5]. Much information is stored, indexed, and retrieved in the form of stories. Although lectures tend to put people to sleep, stories move them to action. People relate to each other in terms of stories—and products and brands often play both central and peripheral roles in their stories [6].

Brand Story is the narrative that, in the telling, portrays the heart and soul of the brand and emotionally connects your brand with the consumer. The Brand Story needs to be infused into all organizational activities and assets (people, culture, product, packaging, facilities, marketing, customer experiences, etc.). It's the "big S" story. Your Brand Story expresses the heart and soul of your brand and emotionally connects you with your customers. Your Brand Story gives meaning to who you are and what you do. Your Brand Story unites your employees with a common purpose and connects them with the customers they serve. You use your Brand Story to communicate what you stand for, what you promise, and what your customers experience. Your Brand Story provides the foundation for your most fundamental business decisions and is the meaning at the heart of all your messages. Your Brand Story creates the powerful and virtually unbreakable emotional bond that turns customers and employees into avid brand advocates [7] .

According to Arch G. Woodside there are some principles of storytelling behavior:
- "Human memory is story-based" is the first principle of sto-rytelling behavior. Information is indexed, stored, and retrieved in the form ofstories. A story is useful because it comes with many indices (i.e., touch points to the lives of listeners/viewers or to others that cause implicit and/or explicit awareness and emotional connection/understanding in the minds of listeners/viewers). The following report illustrates indices in stories.
-Second, a substantial amount of information stored in and retrieved from memory is episodic-stories that include inciting incidents, experiences,outcomes/evaluations, and summaries/nuances of person-to-person and person-and-brand relationships within specific
-Third, retrieving, reliving, or repeat watching of stories results in "proper pleasure"—a catharsis
-Fourth, specific brands and products often play pivotal roles enabling consumers to achieve the proper pleasure that results in a consumer mentally and/or physically enacting a specific archetype-and reliving the experience byperiodically retelling a given story.
-Fifth, individuals seek clarity, to make sense of prior conversations, events,and outcomes from others and themselves by telling stories [8]

3. METHODOLOGY AND ANALYSIS OF RESEARCH RESULTS

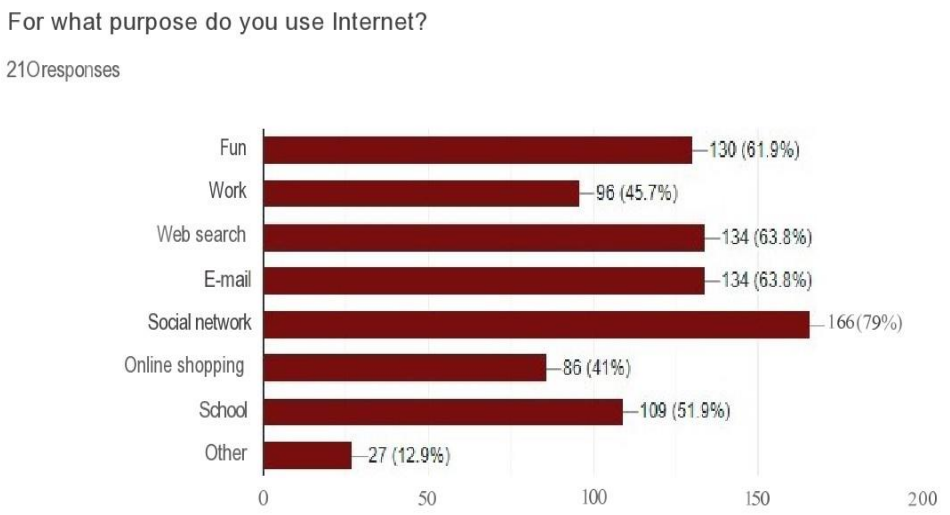
This study will use the scientific methodology of the survey, as well as independent research or giving concrete examples from practice, and giving personal suggestions for further improvement. The structured survey questionnaire was realized in electronic form. The survey consisted of 15 questions divided into 3 categories, ie sections. The first section contains basic demographic questions: gender, age, employment status and income. The second section covers general questions to determine whether the profile of the respondents meets the needs of the research. In the second section, respondents answered questions about the frequency of use of the Internet and social networks, as well as the

purpose for which they use it. The third section contains questions of great importance for research, which were later used to draw conclusions, and consist of questions about storytelling, its impact on consumers. The invitation to the survey was sent via social networks. The selection of respondents for this survey questionnaire was done by random selection, therefore, the appropriate sample method was used. The research itself was conducted on a total of 210 respondents (n = 210).

Sample structure: 70% of women and 30% of men participated in the research; the largest number of respondents, who participated in the survey, are between 20 and 24 years old (44.3%).Then, 26.2% of respondents aged over 34, 12.9% aged 25-29, and 8.6% aged 30-34 and only 8.1% of respondents aged between 15 and 19; the largest number of respondents have a college / university degree (56.2%), and 34.3% with a high school degree; 48.6% of them are employed, 14.9% are unemployed, and 29.8% are students and a very small percentage of respondents (6.7%) are primary and secondary school students;

The first question asked to the respondents referred to the use of the Internet in everyday life. Out of the total number of respondents, as many as 97.1% stated that they use the Internet every day. The next question was to obtain information on the purpose of using the Internet. The results showed that the Internet is mostly used for social networks (79%), for web search and email (63.8%), and for entertainment (61.9%). This is followed by learning (51.9%), work (45.7%), online shopping (41%), and for other purposes 12.9%.

Chart 1: Use of internet



The next question asked by the survey questionnaire was: are you familiar with the concept of "storytelling" in marketing? The results showed that a higher percentage of participants were not familiar with storytelling (56.7%), and 43.3% were familiar with the concept of the same, but given the structure of the age group of respondents, we can say that the answer is satisfactory. In order for the participants to better understand what storytelling is in marketing and to answer the questions that follow more easily, a short promotional campaign with a story was set up within the survey. With this question, the respondents had to watch a video - Gillette's promo video in which brandstorytelling is

applied, and determine whether it caused them certain emotions when watching. This question was answered by all 210 respondents, of which as many as 68.6% answered that Gillete's promotional campaign caused emotions in them, 21% answered that it was not, and 10.5% did not watch the video.

The next question was: A good story can create a connection between a brand and a consumer. As many as 18 respondents did not answer this question. Of the 192 respondents, 63% believe that a good story can make them connect with the brand in some way, and gain trust. 28.1% answered with “maybe” and only 8.9% believe that a good story cannot connect a consumer with a brand. (chart 2.).

The last question referred to the probability of buying a product whose advertising campaigns contain stories, and not just data or "facts" about the product itself. 62% of respondents gave an affirmative answer, that they are more likely to buy a product if there are stories in advertising campaigns, 29.3% answered with "Maybe" and only 8.7% answered with "No" (table 1.).

Table 1: Impact of brand storytelling to consumers

	Can a good story create a connection between a brand and a consumer?	Do you think that you are more likely to buy a product if there are stories in advertising campaigns?
YES	63%	62%
NO	8.9%	8.7%
MAYBE	28.1%	29.3%

The results of the research confirmed the hypotheses set out in the introductory part of the paper. The research showed that, despite the fact that a larger number of respondents were not familiar with the very concept of storytelling in marketing, they respond well to stories and provoke emotions in them. Which we can confirm with the mentioned questions from the survey questionnaire, in which the respondents confirmed it after watching the video. Also, based on the survey questionnaire, we come to the conclusion that respondents believe that good storytelling can gain the trust of certain brands, which is very important for their decision to buy products.

4. CONCLUSION

As many things have changed and progressed over time, we can conclude that consumer’s attitudes have also changed. Their way of thinking, their beliefs, motives for buying, and thus the time they devote to research before buying any product. The competition is growing day by day, every day there are more and more products on the shelves, there are more and more ways to buy, which is why consumers are overwhelmed with information. That is exactly why companies have to do something that will make them stand out and something that will make them different in the sea of the same. By telling a story this is achieved, once you create a strong connection with the consumer and when consumers gain trust, it is very difficult to lose it. Storytelling is of great importance today in every segment, but especially in marketing, and will be even more represented in the future. Storytelling as a marketing tool has become a part of everyday life as consumers have become more demanding compared to previous time periods and conditions. Humans are by nature emotional beings who like to listen to stories and convey them. As we could conclude, the stories remain in the memory and evoke emotions. The goal is to achieve good communication and connection with the same, through promotional campaigns, whether it is campaigns that will cause happiness or sadness, it is important to create a connection with consumers. Good stories build the trust of the audience from the very

beginning. The stories don't go anywhere and offer no value unless a connection is established with the audience. The basis for this relationship is trust. In order to earn trust, sellers must promise valuable information that will be the reason for the listener's time spent. They must commit to deepening relationships and understanding consumers around them and the world around them.

Promotional campaigns with storytelling certainly evoke emotions and create a connection between consumers and the brand. Each story must have a narrator who will bring the story in a special and interesting way. The narrator needs to be honest as it affects the emotional state of the listener or the viewer. One needs to know what connects him and the listener. Stories have heroes and characters with unfulfilled desires, and only the narrator can fulfill them in a way that makes each individual a hero.

A story is not good if it does not provoke the emotions of the listener or the viewer because indifference shows the failure of the story, but also of the narrator. If listeners connect with the story on an emotional level, they will want to become a part of that story. Marketing offers a number of solutions to attract users, but currently one of the best tools to attract them is certainly storytelling. By playing on the emotions of the users themselves, all the doors and possibilities of the company are opened for their attraction and only retention, which ultimately leads to loyalty. The research shows how the story itself affects consumer's perception of the price and quality of products, and that customers unknowingly perform activities encouraged by producers by watching, listening or reading the story itself.

REFERENCES:

[1] C. Ramsdell, (2010), Storytelling, str. 282
[2]ODELL,PATTY:http://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=123648001&login.asp&lang= hr&authtype=shib&custid=s4162699
[3] B. Chiat, (2009), Storytelling and Other Strategies in the Art of Persuasion, Sacramento, str. 3
[4]. https://idaho.pressbooks.pub/write/chapter/storytelling-narration-and-the-who-i-am-story/
[5]. McKee, R., (2003), Storytelling that moves people: A conversation with screenwritingcoach, Robert McKee. Harvard Business Review, 8, p. 53
[6] Arch G. Woodside , Kenneth E. Miller, (2008), When consumers and brands talk: Storytelling theory and research in psychology and marketing, February, Psychology and Marketing 25(2):97 – 145, p.97
[7]. Allen, D.; Campbell, M.; Johnson, S.; Wachtman, E. 360◦ Brand Story Building. 2013. Available online: http: //www.storytellings.com/images/StoryTellings_360_Brand_Story_Building.pdf (accessed on 20 may 2021)., p.5-6
[8]. Arch G. Woodside , (2010), Brand–Consumer Storytelling Theory and Research: Introduction to a Psychology &Marketing Special Issue, June 2010Psychology and Marketing 27(6):531 – 540., Available from: https://www.researchgate.net/publication/229552995_Brand-Consumer_Storytelling_Theory_and_Research_Introduction_to_a_Psychology_Marketing_Special_Issue [accessed May 20 2021]., p.532-533.

INDUSTRIAL DESIGN AS AN OPPORTUNITY FOR SMALL AND MEDIUM ENTERPRISES

[1]Belma Bajrić, [2]Hajro Kofrc, [3]Fadil Islamović, [4]Refik Šahinović
[1]Faculty of Law, University of Bihac, Džanića mahala 68, 77000 Bihać, belmabajric5@gmail.com
[2]Faculty of Law, University of Tuzli, Muhameda Hevaija-Uskufija 7, 75000 Tuzla, hajro.kofrc@untz.ba
[3]Technical Faculty, University of Bihac, Dr. Irfana Ljubijankića bb, 77000 Bihać, f.islam@bih.net.ba
[4]Biotechnical Faculty, University of Bihac, Luke Marjanovića bb, 77000 Bihać, sahinovic.r@gmail.com

ABSTRACT:

Industrial design in today's business and legal transactions is a key factor in the success of products in the market. The recognizable appearance of the product, the product according to the taste of the consumer and the visual appeal, represents an opportunity for small and medium enterprises. Small and medium-sized enterprises, by investing a significant amount of time and resources to improve the attractiveness of product appearance, can strengthen business competitiveness, business logic and generate additional revenue. The goal of small and medium enterprises is that by registering an industrial design, often combining creative design with a distinctive trademark, they become the owner of the exclusive right to prevent others from copying or imitating the design, gaining the possibility of its monetization, storage, transport, repair and sale. Using national, regional or international routes, small and medium enterprises determine the scope and duration of protection, all with the purpose of achieving lucrative goals.

Keywords: Industrial design, attractive appearance of products, advantages of industrial design protection, conditions and manner of industrial design protection

1. INTRODUCTION

Business entities in Bosnia and Herzegovina[1] are insufficiently educated about the numerous development opportunities and ways to invest in their own development, including the field of using the legal framework in order to strengthen the business position and competitiveness in the market. The field of industrial property in BiH is a poorly researched and used area by business entities, missing many opportunities to improve the performance of registered activities in the domestic and foreign markets. Precisely industrial design is an effective chance to achieve better product placement on the market, using the regulations prescribed by the legislation of Bosnia and Herzegovina. Industrial design, as one of the rights of industrial property, is a territorial and time-limited right, but it enables small and medium enterprises, which are the backbone of modern economic systems, and which should certainly strive for businesses in BiH to make themselves more recognizable in the market, and to prevent third parties from unauthorized use, production or copying of their identifiable

[1] Hereinafter: BiH.

products. Industrial design protects the external appearance of a product or part of a product, which represents the elaboration of its functional and aesthetic (decorative) elements, not focusing exclusively on aesthetic characteristics. If the focus were exclusively on aesthetic characteristics, then it would be a work of art, and then it would be subject to protection under the regulations applicable to copyright. By investing in the acquisition of industrial design, especially in the field of textile production, furniture production and similar activities, small and medium enterprises would ensure market recognition through the product to the taste of consumers due to its visual appeal, and ultimately increase their assets.

2. INDUSTRIAL DESIGN IN BIH

Industrial design in BiH is regulated by the Law on Industrial Design.[2] The Law on Industrial Design prescribes the conditions of design protection, method of acquisition, maintenance, content, traffic records, termination and protection of industrial design in BiH, but also the design that is internationally registered for BiH on the basis of the Hague Agreement on International Registration of Industrial Design. 1999), adopted in Geneva on 2 July 1999.[3], in all matters not expressly regulated by the Hague Agreement.

According to the provisions of this Law, a design is protected if it is new[4] and has an individual character[5]. And the product design applied in a complex product as its integral part, will be considered to be new and to have an individual character if:
a) the component incorporated in the complex product remains visible during regular use of the complex product and
b) the visible characteristics of the component meet the requirements of novelty and individual character.[6] Also, a very important issue is the making of the design available to the public. In the context of the above, the Law stipulates that the design has become available to the public, in the sense that it was published, exhibited, used in trade in goods and services, or otherwise disclosed before the day of filing the application for recognition of industrial design, or priority date, if requested, unless there was no reasonable possibility in standard business lines for business circles specializing in a given area to find out about the discovery of the design. And it won't be considered that the design has become available to the public, in the sense of the above, just for the reason that it was disclosed to a third party under the explicit or implicit conditions of keeping the design secret.

[2] Law on Industrial Design, Official Gazette of BiH, No. 53/2010. The set of laws in the field of industrial property, which were adopted in 2010 and entered into force in 2011, is one of the few legislative solutions on which a consensus was reached relatively quickly to regulate these issues at the state level.
[3] Hereinafter: The Hague Agreement.
[4] A design shall be deemed to be new if the identical design has not become available to the public anywhere in the world, before the date of filing the application for recognition of an industrial design for that design, or if there is no previously submitted application for recognition of identical industrial design (Art. 4 para. 1. Law on Industrial Design).
[5] A design shall be deemed to have an individual character if the overall visual impression it leaves on an informed user differs from the overall visual impression left on that user by any other design which became available to the public before the date of filing the industrial design recognition application, or days of recognized right of priority of opposing industrial design. When determining the individual character of a design, the degree of freedom and objective limitation of the author when creating the design of a specific product, caused by the technological and functional characteristics of that product, must be taken into account (Art. 5 of the Law on Industrial Design).
[6] Listed under the provisions of Art. 6. Law on Industrial Design. Regular use referred to in this Article means the use of the end user, excluding maintenance, servicing or repair of the product.

Thus, a design shall not be deemed to have become available to the public if the design was disclosed by the author, his legal successor or a third party who received the information from the author or his legal successor, or on the basis of action taken by the author or his legal successor, from the moment the disclosure of the design is made, less than 12 months have elapsed to the date of filing the application for recognition of the industrial design, or if the right of priority has been claimed, from the date of priority. An exception exists, also, if the design has become available to the public as a result of abuse in relation to the author or his legal successor.[7]

The right to an industrial design belongs to the author of the design or his legal successor. Foreign natural and legal persons with regard to the protection of industrial design in BiH enjoy the same rights as domestic natural and legal persons if it arises from international treaties or conventions to which BiH has acceded, ratified or from the principle of reciprocity, which is assumed until proven contrary.[8]

Industrial design which in its meaning implies a pleasing appearance of the product, creative design, different from all others for the informed user, and which includes three-dimensional or two-dimensional appearance of the whole product or part thereof, determined by its visual characteristics, especially lines, contours, colors , the shape, texture and / or materials of which the product is made, or of which it is decorated, as well as a combination thereof, must refer to an industrial or craft product.[9]

There are reasons to exclude industrial design protection. An industrial design cannot protect a design that is exclusively conditioned by the technical function of the product, and the absolute reasons for refusing an application for recognition of an industrial design are:
a) a design which is not a three-dimensional or two-dimensional external appearance of the whole product or part thereof, which is not determined by its visual characteristics, in particular lines, contours, colors, shape, texture and / or materials of which the product is made or decorated, as and their combination,
b) the publication or use of which is contrary to public policy or accepted moral principles,
c) which contains the national or other public coat of arms, flag or emblem, name or abbreviation of the name of a country or international organization, as well as their imitation, except with the approval of the competent authority of that country or organization,
d) which contains the name or abbreviation, coat of arms, emblem, flag or other official emblem of BiH or its entities, cantons, District or imitates them, except with the approval of the competent authority.
In addition to the absolute, there are relative reasons for rejecting an application for recognition of an industrial design on the basis of an objection, which are:
a) if the design is not new,
b) if it doesn't have an individual character,
c) if the design is exclusively conditioned by the technical function of the product,
d) if it infringes an older copyright or an industrial property right of another person,

[7] According to: Art. 7. Law on Industrial Design.
[8] According to: Art. 8. Law on Industrial Design.
[9] An industrial or handicraft product is an object that can be produced industrially or by hand in a large number of identical copies. The design is an intangible good, and therefore, the material from which an object is made (e.g. wood, plastic, stainless steel, etc.) is not covered by the object of protection. But exceptionally, if the choice of material is such that its quality affects the external shape of the product, then that visual effect (and not the material itself) is covered by the subject of protection. See more: Marković, Slobodan, Intellectual Property Law, Magistrate and Faculty of Law, University of Sarajevo, Sarajevo, 2007, p. 175.

e) if it represents or contains the image of a person, except with the express consent of that person[10] and
f) if it may hurt national or religious sentiments.

Industrial design is acquired by entering in the Register of Industrial Design and is valid for five years from the date of submission of the application, provided that it can be sold four more times enjoy for the same period.[11] The competent authority for the procedure of industrial design protection is the Institute for Intellectual Property of BiH.[12]

3. SMALL AND MEDIUM ENTERPRISES AND INDUSTRIAL DESIGN

In 2006, the World Intellectual Property Organization[13] published an Introduction to Industrial Design for Small and Medium-Sized Enterprises in the Edition "Application of Intellectual Property in Business"[14], in which it pointed out the most important segments in the business of small and medium enterprises related to the application of industrial design. This edition has contributed to the development of the awareness of business entities to expand their activities in the field of industrial design, with the aim of making greater profits. As examples of good practice through the brochure, many are listed, and among them stand out notorious:

Picture 1. Flashlight DURACELL

Picture 2. TOBLERONE

The aforementioned educational edition should point to the effects that business entities, and above all small and medium-sized enterprises, can achieve industrial design protection within their business. In addition to investing financial resources and significant time in creating original and more attractive looks of its products, it is possible to achieve multiple benefit: strengthening the inside, preventing competition to copy and mimic other design, achieving additional revenue, achieving fair return on product design, the ability to address the use of protected resources Designs to other business entities through a license agreement, encourages a fair market competition, the possibility of

[10] A design representing or containing the image of a deceased person may be protected only with the consent of the spouse and children of the deceased, and if there are none, with the consent of the parents, and if no parents, with the consent of other heirs unless otherwise provided by the will. For the protection of a design that represents, it contains the image of a historical or other deceased celebrity, the permission of the competent authority is also required (Art. 11, para 2 and 3 of the Law on Industrial Design).
[11] In the world, the period of protection varies from country to country, so in the United States, for example, for design patents, it is 14 years, while registered community design in the European Union lasts up to 25 years.
[12] www.ipr.gov.ba
[13] Hereinafter: WIPO. www.wipo.int
[14] WIPO publication number 498

compensation for damages converted for unauthorized copying of other design, inspection of counterfeit goods, etc.[15]

Another convenience that stands at the disposal of small and medium-sized enterprises is to select "route" is the way of protecting the industrial design in the insanity. In the context of protection mode, they can use:
a) the National route (business entities may choose a state where they want to protect their design and submit to the competent authority of that State, with this method of registration is quite impractical and set out for the purpose of translating text to the national language with the payment of administrative and other fees);
b) Regional route (business entities may refuse a group of states where they want to protect their design, which are members of regional agreements, which provide simultaneous design registration in more than one country by submitting an application to regional intellectual property institutions) [16]and
c) International route (Hague agreement allows business entities, who want to internationally protect their design, to submit an international report to WIPO which administered to this Agreement, and select the Member States of the said Agreements where protection is to be made using the procedures of the same. This way is quite simplified and cheaper.).[17]

4. CONCLUSION

Small and medium-sized enterprises in order to achieve more effective business and creation as a more successful business strategy should consider the potential to create original design of their products. This is an opportunity to strengthen their visibility and competitiveness on the market, and achieve greater placements of products and profits in traffic. The Bosnian-Herzegovinian legal framework, as well as all countries in the environment in the harmonized manner, with slight differences, treat this area and provide equal opportunities for businesses. The readiness of small and medium-sized enterprises to respond to today's challenge and to offer a product for consumer tastes and visual attraction can mean a milestone in each of them. Investing in designing a wonderful product look different from competing is a new form of investment in development, which ultimately should result in the strengthening of the position of the business entity in the market. The design has become a question of prestige of a business entity, competitive advantage, way of preventing unauthorized copying etc. Therefore, everything that is managed to train small and medium-sized

[15] It is indispensable to mention that some designs although their expiration time remains as a recognizable brand of a particular contractor. Such a case is the cult of the Yugoslavian Kiosk K67 of the famous Slovenian architect and designer of Saša Mächtiga, who, at the beginning of May this year "witted" at Times Square in New York within the "Times Square Transmissions 2021" project. The famous "red box" is one of the features of the Yugoslavian industrial design. The modular design and structure of steel, glass and fiberglass represented one of the few experimental projects of the 60s that have experienced mass production. A total of 7,500 copies were produced, although most was used in the Socialist Federal Republic of Yugoslavia, a large number of them were exported abroad (Poland, Iraq, Kenya, New Zealand, Japan, former Soviet Union and the United States). About the importance of product packaging product in the context of product design see more: Muhamedbegović, Benjamin - Juul, V. Nils - Jašić, Midhat, Packaging and Packaging of Food, Faculty of Technology of the University of Tuzla, Tuzla Trondheim, 2015.
[16] African Regional Institute for Industrial Property (Aripo), Benelux Design Institute (BDO), Institute for Harmonization of the Internal Market (OHIM) for Community Design in the European Union and African Intellectual Property Organization (OAPI) for protection in the French speaking countries.
[17] See more: : www.wipo.int/Hague/

enterprises to be more competitive should be encouraged and developed. Using an adequate methodological apparatus (normative, historical and comparative method) with research activities and market data collection, it was concluded that business entities are not sufficiently educated and that it is possible through the work of chambers of commerce, relevant ministries and other relevant agencies and offices to make progress in the development of small and medium-sized enterprises within this area.

5. REFERENCES

[1] Markovic, Slobodan, *Intellectual Property Right*, Magistrat and Faculty of Law of the University of Sarajevo, Sarajevo, 2007.
[2] Muhamedbegović, Benjamin - Juul, V. Nils - Jašić, Midhat, *Packaging and Packaging of Food*, Faculty of Technology of the University of Tuzla, Tuzla Trondheim, 2015.
[3] Introduction to Industrial Design for Small and Medium Enterprises, WIPO Publication No. 498
[4] Industrial Design Act, Official Gazette of BiH, No. 53/2010.
[5] www.ipr.gov.ba
[6] www.wipo.int
[7] www.wipo.int/hague/

ACTION OF THE WORLD HEALTH ORGANIZATION AND THE EUROPEAN COUNCIL IN ESTABLISHING AN INTERNATIONAL TREATY MECHANISM ON PANDEMIC PREVENTION AND PREPAREDNESS AS A CHALLENGE OF GLOBAL SCALE

Ajna Jodanović[1], Albin Muslić[2], Samir Jodanović[3], Biljana Petrović[4]
Pravni fakultet Univerziteta u Bihaću, Džanića mahala 68, 77 000 Bihać, ajna_x@hotmail.com[1]
Pravni fakultet Univerziteta u Bihaću, Džanića mahala 68, 77 000 Bihać, albin_muslic@hotmail.com[2]
JU Razvojna agencija Unsko-sanskog kantona, Miroslava Krleže 2, 77 000 Bihać,
samir.jodanovic@rausk.ba[3]
Pravni fakultet Univerziteta PIM u Banjoj Luci, Despota Stefana Lazarevića bb, 78 000 Banja Luka,
1806biljana@gmail.com[4]

ABSTRACT:

Experiences acquired during the COVID-19 pandemic as a challenge of global dimensions have shown, that no single government or institution can adequately address the threat of future pandemics. In order to improve the capacity of states to combat pandemics at the global level, efforts are being made to establish an adequate international pandemic treaty mechanism within the World Health Organization.The main goal of this paper is to point out the basic aspects of the World Health Organization and the European Council in terms of collective action in the fight against pandemics, as well as to ensure greater transparency, reliability and accountability in the international system precisely on the basis of the adoption an international treaty on pandemic prevention and preparedness as a universal instrument.

Keywords: international treaty, the World Health Organization, European Council, pandemics, security challenges, international order.

1. INTRODUCTION

The inability to establish effective instruments of action in the circumstances of the COVID-19 virus pandemic at the international level, resulted in a decision to seek to establish an adequate contractual arrangement as a basis for responding to future pandemics. Starting from the fact that this is not yet established contractual mechanism, which will apparently be formalized by the end of the year, we will try to present the results achieved so far and the agreements within the World Health Organization and the European Council, which are aimed at enacting an international agreement on improvement pandemic preparedness and response.

2. THE BASIC ROLE AND SIGNIFICANCE OF THE WORLD HEALTH ORGANIZATION

With its 194 member states, The World Health Organization (WHO) is the directing and coordinating authority for health within the UN system.[1] The Constitution of the World Health Organization was signed in New York on 22 July 1946. It entered into force on 7 April 1948, when the 26th of the 61 Member States deposited its ratification. World Health Day is celebrated each year on 7 April.[2]

The World Health Organization is responsible for providing leadership on global matters, shaping the health research agenda, setting norms and standards, articulating evidence-based policy options, providing countries with technical support, and monitoring and assessing health trends.[3]

The World Health Organization was established as a specialized health agency of the United Nations in accordance with Article 57 of the Charter of the United Nations.[4] The Constitution of the World Health Organization defines the objective of Organization in Article 1:''the objective of the World Health Organization shall be the attainment by all peoples of the highest possible level of health''.[5] Article 2 grants the World Health Organization extensive normative powers to carry out its mission, authorizing the World Health Assembly (WHA) to adopt ''conventions, agreements and regulations and make recommendations with respect to international helath matters''.[6]

The Constitution of the World Health Organization is specific in terms of the scope and breadth of the agenda it sets for the Organization itself, because it sets out 22 functions for Organization, which cover almost every conceivable activity linked to the promotion of health.[7]

The Constitution of the World Health Organization created a normative institution with extraordinary powers.[8]

The Organization contributes to international public health in areas including disease prevention and control, promotion of good health, addressing disease outbreaks, initiatives to eliminate diseases (e.g., vaccination programs), and development of treatment and prevention standards.[9]

3. ACTION BY THE EUROPEAN COUNCIL IN THE FRAMEWORK OF THE REPRESENTATION OF THE EUROPEAN UNION AT INTERNATIONAL LEVEL

[1] Zamfir, I., Fardel, T. (2020). European Union involvment in the United Nations system: Broad partnership based on shared commitment to multilateralism, European Parliamentary Research Service, Brussels, p. 25.
[2] Beigbeder, Y., Nashat, M., Orsini, M.A., Tiercy, J. F. (1998). The World Health Organization, International Organization and the Evolution of World Society, Volume 4, Martinus Nijhoff publishers, Dordrecht, p. 12.
[3] Zamfir, I., Fardel, T., *op.cit.*, p. 25.
[4] Article 57 of the Charter of the United Nations. Available on: https://www.un.org/en/about-us/un-charter/full-text
[5] Basic documents: forty-ninth edition (including amendments adopted up to 31 May 2019), ISBN: 978-92-4- 000052-0, World Health Organization, Geneva, 2020. Dostupno i u online verziji na: https://apps.who.int/gb/bd/
[6] Gostin, L.O., Sridhar, D., Hougendobler, D. (2015). The Normative Authority of the World Health Organization, Governance for Health Special Issue Paper, Georgetown University Law Center, Georgetown, p. 2.
[7] Clift, C. (2013). The Role of the World Health Organization in the International System, Working Group on Governance, Paper 1, The Royal Institute of International Affairs, London, p. 7.
[8] Gostin, L.O., Sridhar, D., Hougendobler, D. (2015). The Normative Authority of the World Health Organization, Governance for Health Special Issue Paper, Georgetown University Law Center, Georgetown, p. 2.
[9] Yadav, M.K. (2017). Structure and Functions of the World Health Organization, IOSR Journal Of Humanities And Social Science (IOSR-JHSS), Vol. 22, No. 9, pp. 15–41.

The European Council acts as an institutionalized practice of occasional gathering of heads of state and government of the member states of the European Union - *summit.* It is a practice whose origins are linked to the early 70s of the last century. The European Council enters the constitutional text on the basis of the Single European Act, while gaining the formal status of an institution through the Treaty of Lisbon.[10]

The monitoring of activities in the field of external action indicates a significant effort of the European Council to form a visible profile in the international system. His performance shows the high frequency and intensity of his activities.[11]

The function of President of the European Council is mentioned for the first time in the Treaty of Lisbon, and is reflected, inter alia, in the representation of the Union at the international level.[12] Heads of state or government have turned the European Council into "the constitutional architect of the Union and the ultimate decision-maker".[13] The President of the European Council speaks on behalf of the European Union in the United Nations General Assembly. A further way of representing the Union is at the G7, G8 and G20 summits, where, in addition to the leaders of the largest member states, the Union is again represented by two presidents.[14]

4. THE ROLE OF THE EUROPEAN UNION IN THE PROCESS OF STRENGTHENING THE WORLD HEALTH ORGANIZATION

Globalization offers various opportunities and challenges when it comes to global health and its distribution.[15] Improving health and addressing health inequalities and externalities requires effective international action on health that entails essential *global* health functions beyond what individual nation-states can accomplish, even with external assistance.[16]

When it comes to the status that the European Union has within the World Health Organization (WHO), it should be emphasized that the Union has the status of an *unofficial observer*. This status of the European Union was established by an exchange of letters, which was published on 4 January 2001 in the Official Journal. The exchange contained a "Memorandum concerning the framework and arrangements for cooperation between the World Health Organization and the Commission of the European Communities". All member states of the Union are also members of the World Health Organization.[17]

The European Union has observer status in the governing bodies of the World Health Organisation. European Union representatives can attend the World Health Assembly, the Executive Board, and the EURO regional committee meetings, but can only speak after all members have spoken. This collaboration was set up through an exchange of letters, the most recent dating from 2001. A formal

[10] Misita, N. (2014). Uvod u pravo Evropske unije, Pravni fakultet Univerziteta u Sarajevu, Sarajevo, p. 108.
[11] Wessels, W. (2016). The European Council, Palgrave Macmillan, London, p. 240.
[12] Misita, N. (2014). Uvod u pravo Evropske unije, Pravni fakultet Univerziteta u Sarajevu, Sarajevo, p. 110.
[13] Wessels, W. (2016). The European Council, Palgrave Macmillan, London, p. 240.
[14] *Ibid*., p. 223.
[15] See more in: Yach, D., Bettcher, D. (1998). The globalization of public health, I: Threats andopportunities, American Journal of Public Health 88, No. 5, pp. 735-744.
[16] Ruger, J.P., Yach, D. (2009). The Global Role of the World Health Organization, Global Health Governance, Volume II, No. 2, p. 2.
[17] EXCHANGE OF LETTERS between the World Health Organisation and the Commission of the European Communities concerning the consolidation and intensification of cooperation, Official Journal of the European Communities, C1, Volume 44, 4 January 2001 (2001/C 1/04).

programmatic partnership was established between the World Health Organisation Regional Office for Europe and the European Commission in 2010 and renewed in 2015.[18]

The European Union and Union Member States are the World Health Organisation's largest financial donor, accounting for one third of the organisation's income. The negotiation of the international health regulations in which the European Union participates have also strengthened relations between the Union and the World Health Organisation. The European Union supports the work of the World Health Organisation on strengthening health systems in developing countries, both politically and financially. The European Union is also actively engaged in the World Health Organisation emergency programmes and was among the driving forces behind the World Health Organisation reform launched in 2012 to increase coherence in global health by improving its programmes and its financial and governing structures.[19]

The Council and the representatives of the governments of the member states approved conclusions on the role of the EU in strengthening the World Health Organization on 6 November 2020.The conclusions acknowledge the central role of the World Health Organization as the leading and coordinating authority in addressing global health challenges. At the same time, they recall that during many pandemics expectations on World Health Organization have often outweighed its capacities and its ability to support its member states in developing strong and resilient health systems. The Council and the representatives of the governments of the member states expressed their commitment to take a coordinating, proactive and leading role in an inclusive process to strengthen global health security and the World Health Organization, in particular its capacity for preparedness and response in health emergencies.[20]

5. BASIC ASPECTS OF COOPERATION BETWEEN THE EUROPEAN COUNCIL AND THE WORLD HEALTH ORGANIZATION IN THE PLAN OF ADOPTING THE INTERNATIONAL TREATY ON IMPROVING PANDEMIC PREPAREDNESS AND RESPONSE

As the directing and co-ordinating authority on international health work, the World Health Organization (WHO) provides leadership on matters critical to health and engages in partnership where joint action between countries is needed, helps shape the research agenda, sets norms and standards, articulates evidence-based policy options, provides technical support to countries and monitors health situation throughout the world. The World Health Organization's work covers a wide range of areas, in particular health systems, noncommunicable and communicable diseases, preparedness, surveillance and response, and the promotion of health through the life course.[21]

The COVID-19 pandemic is a global challenge. No single government or institution can address the threat of future pandemics alone. A treaty is a legally binding instrument under international law. An international treaty on pandemics adopted under the World Health Organization would enable countries around the globe to strengthen national, regional and global capacities and resilience to future pandemics.[22]

[18] Zamfir, I., Fardel, T. (2020). European Union involvment in the United Nations system: Broad partnership based on shared commitment to multilateralism, European Parliamentary Research Service, Brussels, p. 25.
[19] *Ibid*.
[20] https://www.consilium.europa.eu/hr/press/press-releases/2020/11/06/strengthening-the-world-health-organization-the-eu-is-ready-to-take-the-leading-role/ (10.06.2021)
[21] OECD /WHO (2016). International Regulatory Co-operation and International Organisations: The Case of the World Health Organization (WHO), Organisation for Economic Co-operation and Development and World Health Organisation, pp. 13-14.
[22] https://www.consilium.europa.eu/hr/policies/coronavirus/pandemic-treaty/ (05.06.2021.)

The proposal for an international treaty on pandemics was first announced by the President of the European Council, Charles Michel, at the Paris Peace Forum in November 2020. At a virtual summit hosted by Saudi Arabia on 21-22 November 2020, the G20[23] leaders expressed their strong commitment to coordinated global action, solidarity, and multilateral cooperation. When it comes to representing the European Union, it is important to emphasize that *Charles Michel*, President of the European Council, and *Ursula von der Leyen*, President of the European Commission, represented the European union at the two-day event. The G20 leaders committed to sparing no effort to make sure that all people have affordable and equitable access to safe and effective COVID-19 diagnostics, therapeutics and vaccines. They also committed to advancing global pandemic preparedness, prevention, detection and response. In this context, President Michel proposed an initiative to ensure a better global response to future pandemics, and stressed: ‘’An international treaty on pandemics could help us respond more quickly and in a more coordinated manner when pandemics occur. It should be negotiated with all United Nations organisations and agencies, in particular the World Health Organisation. The the World Health Organisation must remain the cornerstone of global coordination against health emergencies’’.[24]

At the meeting held on 19 February 2021, the leaders of the G7[25] group emphasized: "COVID-19 shows that the world needs stronger defences against future risks to global health security. We will work with the World Health Organisation, G20 and others, especially through the Global Health Summit in Rome, to bolster global health and health security architecture for pandemic preparedness, including through health financing and rapid response mechanisms, by strengthening the “One Health” approach and Universal Health Coverage, and exploring the potential value of a global health treaty".[26]

At the European Council of 25 February 2021 EU leaders underlined the need for global multilateral cooperation to address current and future health threats and agreed to work on an international treaty on pandemics within the World Health Organisation framework and to advance global health security. On 30 March 2021, leaders from all around the world joined the President of the European Council and the Director-General of the World Health Organization, *Dr. Tedros Adhanom Ghebreyesus*, in an open call for an international treaty on pandemics.[27]

When it comes to the action of the European Council in the direction of adopting an international agreement on pandemics, it is important to emphasize that on 20 May 2021 the Council adopted today a decision to support the launch of negotiations for an international treaty on the fight against pandemics. The objective of the Council decision was to assure the participation of the European union in the negotiations addressing matters falling within Union competence, in view of the Union's possible accession to the treaty. The proposal to conclude a treaty on pandemics was discussed in the context of international efforts to reinforce global health security, in particular on preparedness and response to health emergencies, in light of lessons learnt from the pandemic.[28]

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[23] The G20 is an international forum that brings together the world's major economies. The members of the G20 are: Argentina, Australia, Brazil, Canada, China, France, Germany, Italy, India, Indonesia, Japan, Mexico, the Republic of Korea, Russia, Saudi Arabia, South Africa, Turkey, the United Kingdom, the United States and the European Union. union. Spain is a regular guest.

[24] https://www.consilium.europa.eu/hr/meetings/international-summit/2020/11/21-22/#

[25] The G7 is an informal grouping of seven of the world’s advanced economies: Canada, France, Germany, Italy, Japan, the United Kingdom, the United States and the European Union. See more at: https://www.international.gc.ca/world-monde/international_relations-relations_internationales/g7/index.aspx?lang=eng

[26] https://www.consilium.europa.eu/hr/press/press-releases/2021/02/19/g7-february-leaders-statement/ (04.06.2021.)

[27] https://www.consilium.europa.eu/hr/press/press-releases/2021/05/20/eu-supports-start-of-who-process-for-establishment-of-pandemic-treaty-council-decision/ (04.06.2021.)

[28] https://www.consilium.europa.eu/hr/press/press-releases/2021/05/20/eu-supports-start-of-who-process-for-establishment-of-pandemic-treaty-council-decision/ (05.06.2021.)

At the World Health Assembly (WHA), which was held on 31 May 2021, the 194 members of the World Health Organization have adopted the decision to discuss a new international treaty on pandemics at a special session to be held in November 2021.[29]

The European Council met on 24 and 25 June 2021 in Brussels and welcomed the decision adopted by the 74th World Health Assembly to set up a special session in November 2021 to discuss a Framework Convention on Pandemic Preparedness and Response**.** On that occasion, it was emphasized that European Union ‘’will continue working towards an international treaty on pandemics’’.[30]

When we talk about the basic importance of making such a contract, it should be emphasized that it would be a universal instrument which could take the form of a framework convention under the World Health Organisation constitution. A special provision of the WHO Constitution, under Article 19, empowers the World Health Assembly to negotiate and agree on "conventions and agreements with respect to matters within the competence of World Health Organisation". The treaty on pandemics would be adopted by the World Health Organisation member states gathered at the World Health Assembly. Once adopted at international level by the assembly, the treaty would have to be ratified by a requisite number of countries in order to come into force. It would only become legally binding for those countries that ratify it at national level. Existing global health instruments, especially the International Health Regulations, would underpin such a treaty, ensuring a firm and tested foundation to build upon. When it comes to the fundamental goals to be achieved by establishing such a contractual mechanism, it should be emphasized that the proposal for a treaty is guided by a spirit of collective solidarity, anchored in the principles of fairness, inclusiveness and transparency. Previous experiences clearly show us that neither individual governments nor the global community can entirely prevent pandemics, but the international community needs to be much better prepared and better aligned in responding to possible future pandemics across the entire cycle of detection, alarm and response. The treaty would set out the objectives and fundamental principles in order to structure the necessary collective action to fight pandemics.[31]

6. CONCLUSION

Assuming that previous experiences have clearly shown us that individual governments, as well as the international community, have failed to fully establish modalities for effective pandemic prevention, the need to take a range of actions to adopt an adequate contractual mechanism aimed at early detection, warning and response to pandemics, is quite justified. The basic goal of adopting an international agreement on the fight against pandemics is certainly reflected in the effort to ensure better preparedness and harmonization of countries at the international level, when it comes to responding to possible future pandemics.

This contractual mechanism would establish the basic ways of collective action needed in the fight against pandemics, all in the spirit of collective solidarity with a strong foothold in the principles of justice, inclusiveness and transparency. In this paper, we pointed out the strong efforts of the European Council as one of the main institutions at the European Union level, to reaffirm the Union's commitment to establishing global solidarity in response to a pandemic, primarily by supporting the activities of the World Health Organization. The activities carried out under the auspices of the European Council indicate the readiness of the European Union and the Member States to make significant efforts at the global level when it comes, not only to fight the pandemic, but also to combat its negative consequences.

The COVID-19 virus pandemic is a challenge of global proportions, which requires an adequate response at the global level, and which, among other things, is reflected in the adoption of an

[29] https://www.consilium.europa.eu/hr/policies/coronavirus/pandemic-treaty/ (05.06.2021.)
[30] https://www.consilium.europa.eu/hr/meetings/european-council/2021/06/24-25/ (05.06.2021.)
[31] https://www.consilium.europa.eu/hr/policies/coronavirus/pandemic-treaty/ (05.06.2021.)

international agreement on improving preparedness and response to pandemics. One such universal instrument could establish better international cooperation in the fight against pandemics, but also within all phases that are of priority importance, and are reflected in adequate monitoring, warning and response to pandemics. Ultimately, an international agreement to improve pandemic preparedness and response could restore confidence in the international health system.

7. REFERENCES

[1] Beigbeder, Y., Nashat, M., Orsini, M.A., Tiercy, J. F. (1998). The World Health Organization, International Organization and the Evolution of World Society, Volume 4, Martinus Nijhoff publishers, Dordrecht.
[2] Clift, C. (2013). The Role of the World Health Organization in the International System, Working Group on Governance, Paper 1, The Royal Institute of International Affairs, London.
[3] Gostin, L.O., Sridhar, D., Hougendobler, D. (2015). The Normative Authority of the World Health Organization, Governance for Health Special Issue Paper, Georgetown University Law Center, Georgetown.
[4]Misita, N. (2014). Uvod u pravo Evropske unije, Pravni fakultet Univerziteta u Sarajevu, Sarajevo.
[5] Ruger, J.P., Yach, D. (2009). The Global Role of the World Health Organization, Global Health Governance, Volume II, No. 2.
[6] Yach, D., Bettcher, D. (1998). The globalization of public health, I: Threats andopportunities, American Journal of Public Health 88, No. 5.
[7] Yadav, M.K. (2017). Structure and Functions of the World Health Organization, IOSR Journal Of Humanities And Social Science (IOSR-JHSS), Vol. 22, No. 9.
[8] Wessels, W. (2016). The European Council, Palgrave Macmillan, London.
[9] Zamfir, I., Fardel, T. (2020). European Union involvment in the United Nations system: Broad partnership based on shared commitment to multilateralism, European Parliamentary Research Service, Brussels.
[10] EXCHANGE OF LETTERS between the World Health Organisation and the Commission of the European Communities concerning the consolidation and intensification of cooperation, Official Journal of the European Communities, C1, Volume 44, 4 January 2001 (2001/C 1/04).
[11] OECD /WHO (2016). International Regulatory Co-operation and International Organisations: The Case of the World Health Organization (WHO), Organisation for Economic Co-operation and Development and World Health Organisation.
[12] https://www.un.org/en/about-us/un-charter/full-text
[13] https://apps.who.int/gb/bd/
[14] https://www.consilium.europa.eu/hr/meetings/international-summit/2020/11/21-22/#
[15]https://www.consilium.europa.eu/hr/press/press-releases/2021/02/19/g7-february-leaders-statement/
[16]https://www.consilium.europa.eu/hr/press/press-releases/2021/05/20/eu-supports-start-of-who-process-for-establishment-of-pandemic-treaty-council-decision/
[17] https://www.consilium.europa.eu/hr/policies/coronavirus/pandemic-treaty/
[18] https://www.consilium.europa.eu/hr/meetings/european-council/2021/06/24-25/
[19]https://www.international.gc.ca/world-monde/international_relations-relations_internationales/g7/index.aspx?lang=eng

NOVELTIES OF BANKRUPTCY LEGISLATION IN THE FEDERATION OF BOSNIA AND HERZEGOVINA

Albin Muslić, Ajna Jodanović
University of Bihac
School of Law
Dzanica mahala 66, 77 000 Bihac
albin_muslic@hotmail.com
ajna_x@hotmail.com

ABSTRACT:

The still valid legislative framework on bankruptcy dates back to 2003 with several subsequent amendments. However, in the past few years, legislative activities have been intensified in order to enact a completely new regulation, with the basic intention to improve the bankruptcy procedure.
In connection with the above, legislative innovations refer to the timely initiation of bankruptcy procedure, the introduction of pre-bankruptcy procedure, restrictions on the duration of bankruptcy procedure, specifying the legal position of bankruptcy trustees, improving the process of reorganisation of the bankruptcy debtor, etc. The meaning of these legal amendments was contained in the need to try to save businesses that already have or are likely to have financial difficulties, which may lead to their bankruptcy and have significant reflections on other entities that are in business-legal connection with a bankrupt company.
The subject of this paper was the analysis of the legal scope of the proposed legal solutions seen through the prism of the need to terminate the bankruptcy procedure in an adequate manner. The fulfilling of the full meaning in terms of two opposing positions, namely the need for bankruptcy creditors is to settle as soon as possible on the one hand, as well as the need for the bankruptcy debtor to be preserved despite the bankruptcy so that one could potentially continue to operate, on the other hand.

Keywords: bankruptcy, bankruptcy procedure, settlement of bankruptcy creditors, preservation of the bankruptcy debtor

1. INTRODUCTION

All business entities have a period of legal existence which begins with the establishment (registration) and ends with the termination of existence. In the following, the paper dealt with the cessation of the business entities' existence which by nature can be voluntary or coercive. In this regard, it can be seen as liquidation (voluntary or compulsory liquidation),[1]and the bankruptcy of the business entity. The main difference between bankruptcy and liquidation was contained in the fact that in case of fulfilment

[1] Art 4 of the Law on Liquidation Procedure, "Official Gazette of the FBiH", ser. 29/03. See more at, RIZVANOVIĆ, Edin – NANIĆ, Arif, Poslovno statusno pravo, JP NIO Službeni list BiH, Sarajevo, 2018, p. 352.

of legally prescribed conditions, liquidation is to be carried out on a solvent (solvent) business entity, while bankruptcy is on an insolvent (insolvent) business entity, i.e. on a subject exposed to threatening insolvency.

Therefore, if the business entity already has or it is realistic to expect that there will be difficulties in business that will have an impact on the settlement of the bankruptcy debtor's obligations to creditors, then the conditions for opening bankruptcy proceedings are met. Bankruptcy has its roots in the words "banca rotta", which in Italian means rotten, upside down, broken bench.[2]One of the main goals of the bankruptcy procedure is to settle the bankruptcy debtor's creditors by liquidating the bankruptcy debtor's property. However, although in everyday speech it is being considered that bankruptcy represents the end of the legal existence of a business entity, it should be borne in mind that this may not be the case at all. Namely, bankruptcy should reconcile two opposing positions, the first is that they are carried out for the purpose of settling bankruptcy creditors on the one hand, i.e. to preserve the bankruptcy debtor (if possible) on the other hand.

2. LEGAL FRAMEWORK ON BANKRUPTCY IN BOSNIA AND HERZEGOVINA

Bankruptcy legislation in Bosnia and Herzegovina is subject to entity-level regulation. The regulations governing the subject area are as follows:

- The Law on Bankruptcy Procedure (FBiH);[3]
- The Bankruptcy Law of Republic of Srpska (RS);[4]
- The Bankruptcy Law of Brcko District (BD BiH).[5]

Terminologically speaking, bankruptcy is a procedure regulated by law that is conducted over the property of a bankruptcy debtor in order to settle bankruptcy creditors due to the existence of bankruptcy reasons which are characterised as insolvency or threatening insolvency.[6]Moreover, an equally important issue relates to the need to achieve the effect of preserving the bankruptcy debtor during the bankruptcy procedure or after its completion. From the aspect of the initiator, the bankruptcy procedure can be initiated by the bankruptcy debtor, i.e. the bankruptcy creditors. The paper referred to the legal solution in the FBiH in the light of the amendments to the bankruptcy legislation.

The legal framework on bankruptcy in the FBiH has been based on the 2003 Bankruptcy Procedure Act, which was amended several times. Analysing the application in practice, it is evident that the current Law on Bankruptcy Procedure has not contributed to the efficiency and shortening of the duration of the bankruptcy procedure but on the contrary. This is significant due to the legal consequences that are produced for the bankruptcy debtor with the moment of opening the bankruptcy procedure. The fact is that with the opening of bankruptcy procedure, a whole series of legal consequences is produced, some of which are the result of an imperative legal determination, while some are in the domain of an optional determination. Significant legal consequences of opening bankruptcy procedure include: publishing the fact of opening bankruptcy procedure, closing the bankruptcy debtor's account and opening a new account, adding the name of the bankruptcy debtor's company as "in bankruptcy", transferring management to the bankruptcy trustee, termination of

[2] SAJTER, Domagoj, Ekonomski aspekti stečaja i restrukturiranja u stečaju, Sveučilište Josipa Jurja Strossmayera, Osijek, 2008., p. 15.

[3] The Law on Bankruptcy Procedure (FBiH), "Official Gazette of the FBiH", ser. 29/03, 32/04, 42/06, 4/17 and 52/18.

[4] The Bankruptcy Law of Republic of Srpska (RS), Official Gazette RS, ser: 16/16.

[5] The Bankruptcy Law of Brcko District (BD BiH), Official Gazette BD, ser: 16/19 and 29/20.

[6] See more at, ČOVIĆ, Šefkija, Poslovno pravo, Pravni fakultet Sarajevo, Sarajevo, 2003, p. 121. and 122.

employment contract, attraction jurisdiction over disputes, termination of enforcement proceedings, etc. The meaning of the mentioned legal consequences is that by opening the bankruptcy procedure the business operations of the bankruptcy debtor are disabled and that further generation of losses is stopped, and consequently the settlement of creditors is called into question. However, one must not lose sight of the fact that the bankruptcy of one business entity often leads to a chain reaction and the bankruptcy of a whole range of other entities that were in a business relationship with the bankruptcy debtor. For example, if the bankruptcy debtor had a business relationship with other business entities that sold most of the products to the bankruptcy debtor and for the production of the products in question they had to procure raw materials from their suppliers according to which they are in the role of debtor by opening bankruptcy proceedings, the business of the bankruptcy debtor's subcontractors will be called into question because due to the impossibility of collecting the receivables they have against the bankruptcy debtor. They will not be able to service their obligations to their creditors, which could potentially lead to bankruptcy. From the above example, we notice the importance of a high degree of prudence in opening bankruptcy proceedings as well as that the open bankruptcy proceedings be completed as soon as possible.

One of the problems in the existing legal solution is the fact that insufficiently precise standardization in practice happens to initiate bankruptcy procedure relatively late which produces multiple negative financial consequences not only for the bankruptcy debtor but also for other business entities located in the business in connection with the bankruptcy debtor. This has just been one of the main reasons that determined the legislator to approach the adoption of new bankruptcy legislation in the FBiH.

3. PROPOSAL OF THE LAW ON BANKRUPTCY PROCEDURE OF THE FEDERATION OF BOSNIA AND HERZEGOVINA

After several years of application of regulations, the proposal of the Law on Bankruptcy Procedure of the Federation of BiH was sent to the parliamentary procedure.[7]The basic intention of the regulations was to improve the business environment and to innovate the bankruptcy procedure in general. Structurally speaking, the novelties of the bankruptcy legislation can be observed through several main areas:

- reducing the duration of bankruptcy procedure;
- standardisation of pre-bankruptcy procedure and restructuring of the bankruptcy debtor;
- standardisation of the role of the Financial-Information Agency in the bankruptcy procedure;
- standardisation of sanctions for non-initiation of bankruptcy procedure;
- changes in the legal position of bankruptcy trustees;
- innovation of the legal framework regarding the protection of workers within the bankruptcy debtor;
- introduction of the institute of sale of the bankruptcy debtor.

Furthermore, the paper will deal at several segments of short novelties.

3.1. Duration of bankruptcy procedure

Although one of the basic principles of the current bankruptcy legislation was expressed in the efficiency of the bankruptcy procedure, in a way that the bankruptcy procedure was urgent,[8] practice shown that bankruptcy procedure took an extremely long time. One of the reasons was that the urgency in question was not concretised, on the one hand, but at the same time one should keep in mind the

[7] The paper analyses the Proposal of the Bankruptcy Procedure Act (date: decembar 2020.), furthermore: The Law on Bankruptcy Procedure (FBiH) –DRAFT.

[8] Art 9. Para 1. The Law on Bankruptcy Procedure (FBiH).

specificity of each bankruptcy procedure and the potential possibility of bankruptcy procedure for a number of objective reasons.

The Proposal of the Law on Bankruptcy Procedure of the FBiH seeks to improve the legal regulation in question through the introduction of a provision on limiting the duration of bankruptcy procedure. In particular, the Bankruptcy Procedure Law retains the principle of urgency,[9] with the remark that additional instruments on the duration of the procedure have been established. Thus, it was standardised that the bankruptcy procedure will be completed within a year and in complex cases two years from the day of the opening of the procedure.[10] In the event that it is not completed within one or two years, the bankruptcy procedure continues with the obligation of the bankruptcy trustee to inform the president of the court. Furthermore, the President of the Court will inform the Federal Ministry of Justice and the High Judicial and Prosecutorial Council of Bosnia and Herzegovina. Although the decision in question aims to speed up the bankruptcy procedure it can be opposed by at least two objections. Namely, which body has the authority and according to which criteria to define the concept of complexity of bankruptcy procedure and what positive benefits in practice will bring the provision of informing the president of the court, the Federal Ministry of Justice, or the High Judicial and Prosecutorial Council of Bosnia and Herzegovina when bankruptcy procedure is not completed on time?

In answering these dilemma, one should proceed from the assumption that the terms urgency and complexity of the procedure are factual issues that will be assessed in each specific case. For this reason, the provision in question, although in principle aimed at defining and regulating the shortening of the duration of bankruptcy proceedings, will not in itself contribute to that. On the contrary, bankruptcy proceedings will continue for a long time, whereby the bankruptcy estate will continue to be burdened. Thus bankruptcy creditors will potentially be unable to settle their claims against the bankruptcy debtor.

3.2. Preliminary procedure

The absolute novelty of the bankruptcy legislation is the pre-bankruptcy procedure which essentially represents a substitute for the existing pre-bankruptcy actions in the form of a preliminary procedure. It is a court procedure conducted by the court in the function of financial and operational restructuring of the debtor.[11] The aim of the pre-bankruptcy procedure is to regulate the legal position of the debtor in the function of releasing the existing financial obligations that the bankruptcy debtor has towards creditors, all for the purpose of continuing operations within the existing activity. Therefore, the pre-bankruptcy procedure seeks to preserve the bankruptcy debtor by remedying the financial anomalies. On the other hand, by opening the bankruptcy procedure, the basic goal is not to continue the business of the bankruptcy debtor but to settle the bankruptcy creditors, certainly with the possibility of preserving the bankruptcy debtor.

Bodies of pre-bankruptcy procedure are the court and trustee.[12]After the opening of the pre-bankruptcy proceeding the debtor may make the payments necessary for the regular operation of the business noting that he cannot alienate or encumber his property.[13] In order to open pre-bankruptcy proceedings, it is necessary for the court to determine the existence of threatening insolvency. It is expressed through the fact that the debtor is unable to settle the obligations upon maturity in the next 12 months and if the debtor is late for payment of 60 days.[14]

From the aspect of jurisdiction, the court in bankruptcy procedure:

- decides on the opening of pre-bankruptcy procedure;

[9] Art 15. Para 1. The Law on Bankruptcy Procedure (FBiH) – DRAFT.
[10] Art 18. Para 1. The Law on Bankruptcy Procedure (FBiH) – DRAFT.
[11] Art 2. Para 2. The Law on Bankruptcy Procedure (FBiH) – DRAFT.
[12] Art 27. The Law on Bankruptcy Procedure (FBiH) – DRAFT.
[13] Art 52. Para 2. The Law on Bankruptcy Procedure (FBiH) – DRAFT.
[14] Art 5. Para 2. The Law on Bankruptcy Procedure (FBiH) – DRAFT.

- appoints and dismisses the commissioner with the remark of supervising his work;
- monitors the fulfilment of obligations entrusted by this Law to the Financial Information Agency;
- decides on established and disputed receivables;
- decides on the suspension of the pre-bankruptcy procedure;
- decides on all other issues of pre-bankruptcy procedure, if they are not decided by another body of pre-bankruptcy one.[15]

On the other hand, the appointment of a trustee in bankruptcy procedure is identical to the appointment of a trustee in bankruptcy. Its activity is tied until the moment of confirmation of the pre-bankruptcy agreement, i.e. until the day of opening the bankruptcy procedure.

The law also regulates the duration of the pre-bankruptcy procedure up to 150 days from the day of its opening, noting that it can be extended to an additional 90 days for justified reasons. However, as with the conceptual determination of urgency and complexity of bankruptcy procedure, defining justifiable reasons as reasons for extending the duration of pre-bankruptcy procedure a factual issue, which is assessed in each case. Based on the determinant set in this way, it is to be expected that the justified reasons will be interpreted extensively and which will ultimately lead to an extension of the duration of the pre-bankruptcy procedure.

Pre-bankruptcy procedures are initiated at the proposal of the debtor or at the proposal of the creditor. In the case when the proposer of the pre-bankruptcy procedure is the creditor, in order for the procedure to be initiated, it is necessary for the debtor to agree with the proposal. Whether the pre-bankruptcy procedures will be opened or the motion rejected will be decided by the court. The decision to open pre-bankruptcy procedure is published on the court's notice board and on the court's website and in the Official Gazette of the FBiH. There is an obligation to submit it to the commercial bank where the debtor has an account and the Financial Information Agency that will publish it on its own website.

Considering that the goal of the pre-bankruptcy procedure was manifested in reaching an agreement and everything so that the debtor, relieved of current financial obligations, could continue to operate, the duration of the pre-bankruptcy procedure also depends on the above. Therefore, the pre-bankruptcy procedure lasts until the confirmation of the agreement, i.e. until the opening of the bankruptcy procedure, if the conditions for that have been met.

In order to initiate pre-bankruptcy procedure, the proposer must submit a plan for the restructuring of the bankruptcy debtor which must contain the following elements:

- the facts and circumstances from which the existence of imminent insolvency arises;
- the amount of lack of liquid assets on the day of the attached financial statements;
- financial restructuring measures and calculation of their effects on liquidity shortages;
- operational restructuring measures and calculation of their effects on operations;
- business plan for the period until the end of the current and for the next two calendar years with a detailed explanation of the reasons for determining each position of the plan;
- planned balance sheet on the last day of the period for which the business plan has been prepared;
- analysis of all receivables by amount and type (receivables of employees and former debtor's employees, exclusive rights, separation rights, receivables for which procedures have been conducted, unsecured receivables and other receivables);
- offer to creditors classified in groups by appropriate application of the rules on classification of participants in the bankruptcy plan on the manner, terms and conditions of the claims settlement.[16]

The restructuring plan is being voted on at the hearing. The court accepts the financial and operational restructuring plan and confirms the settlement in the pre-bankruptcy procedure if at least 25% of

[15] Art 28. The Law on Bankruptcy Procedure (FBiH) – DRAFT.

[16] Art 37. The Law on Bankruptcy Procedure (FBiH) – DRAFT.

creditors voted for the plan and if the sum of creditors'claims that voted for the plan has been greater than the sum of creditors' claims against financial and operational restructuring.[17]
If one of the creditors makes it probable that the financial and operational restructuring plan puts him in an unfavourable position in relation to the position he would have had if the plan did not exist, then if it is unlikely that the proposed plan will be able to service the obligations. Certain settlement of the amount that the creditors would have received if their claims had not been disputed, in the above cases the court will not accept the plan.

3.3. Legal position of the financial information agency

Given that one of the main intentions of the legal amendments in question has been contained in the more efficient conduct of bankruptcy procedure one of the instruments was contained in the standardisation of the role of the Financial Information Agency (hereinafter: FIA). The reason for this legal regulation was contained in the fact that the FIA has access to the business records of debtors and because business entities have been obliged to submit their reports to the FIA. The FIA is obliged to issue a misdemeanour order or to file a request for initiating misdemeanour procedure against the body authorised to represent the bankruptcy debtor if it does not submit a proposal for opening bankruptcy proceedings within the legally defined period (60 days from the date of insolvency). The provisions in question additionally discipline the bankruptcy debtor in terms of the obligation to initiate bankruptcy procedure in the event of insolvency. However, the mentioned authority of the FIA is directly related to the Law on the Financial-Information Agency which defined the scope of competence.[18] This implies *de lege ferenda*coordinated legislative activity against the Law on the Financial Information Agency in order to operationalise the jurisdiction and legal position of the FIA in bankruptcy procedure.

3.4. Legal position of the bankruptcy trustee

Significant changes also apply to bankruptcy trustees. Unlike the valid legal solution, the amendments to the bankruptcy legislation stipulate that one bankruptcy trustee may conduct a maximum of two procedures. In that way, a higher degree of professionalization of bankruptcy trustees was introduced. This principle has been relativized to some extent. The legislator made a difference in the number of bankruptcy procedures that can be conducted by bankruptcy trustees at the same time. Thus, a large-scale bankruptcy procedure and a small-value bankruptcy procedure have been defined. The difference between large and small value bankruptcy proceedings is related to the value of the bankruptcy estate. If the expected value of the bankruptcy estate exceeds 1,000,000.00 BAM, then it is a bankruptcy procedure of large value and then a limit is applied in the number of bankruptcy procedures (maximum two) that can be conducted by one bankruptcy trustee at the same time. On the other hand, if the expected value of the bankruptcy estate is up to 1,000,000.00 BAM, then it is a bankruptcy procedure of small value, and in that case there is no limit in terms of the number of bankruptcy procedures that can be conducted by one bankruptcy trustee at the same time.
Analysing the above, an objection can be made to the decision in question, due to the fact that bankruptcy procedures were separated according to the value of the bankruptcy estate, which must not be the case, because every bankruptcy procedure must have equal attention by the bankruptcy trustee, regardless of the bankruptcy estate. In other words, one bankruptcy trustee could not conduct more than two bankruptcy procedures where the expected value of the bankruptcy estate of each of the bankruptcy debtors is over 1,000,000.00 BAM. At the same time, hypothetically speaking, he could conduct several procedures where each bankruptcy debtor's expected value of the bankruptcy estate below 1,000,000.00

[17] Art 50. Para 7. The Law on Bankruptcy Procedure (FBiH) – DRAFT.
[18] Art 4 of the Law on Financial-informatics agency, "Official Gazette of the FBiH", ser. 80/11.

BAM. Finally, there is a special issue of defining the concept of the expected value of the bankruptcy estate, which in any case should be specified by objectified criteria.
Moreover, the continuous obligation of professional training,[19] as well as control and supervision of bankruptcy trustees[20] has been standardised.

3.5. Legal position of the bankrupted debtor's worker

The proposed legal solution was based on additional insurance of workers' rights, as well as the rights of previous workers in terms of claims against the bankruptcy debtor. The receivables of employees were classified in a higher payment order with the remark that members of the management board, members of the supervisory board and members of the audit committee were excluded from the said payment order. The reason for the exclusion of the persons in question was contained in the fact that they have been also most responsible for the financial condition of the bankruptcy debtor (as a result of which bankruptcy occurred) and whose claims against the bankruptcy debtor are usually extremely high. Workers have the right to collect all receivables arising from employment until the opening of bankruptcy procedure in the gross amount, then severance pay up to the amount prescribed by law or collective agreement. Moreover, the subject payment order also includes claims based on compensation for damage suffered due to an injury at work or occupational disease, as well as claims of family members of the deceased worker at work in full amount.[21]

3.6. Sale of bankrupted debtor

In terms of achieving the goals of the bankruptcy procedure, one of the novelties is the sale of the bankruptcy debtor as a legal entity. The basic meaning of the legal solution in question is that by selling the bankruptcy debtor his business was reduced to the usual level, relieved of obligations and all in the function of continuing the business of the bankruptcy debtor. The subject institute is not unknown in this area because it has been regulated by the Law on Bankruptcy Procedure of the Republic of Srpska since 2016.[22]
Essentially, the decision to sell the bankruptcy debtor as a legal entity is in the hands of the creditors' assembly. Procedurally, the bankruptcy trustee is obliged to inform the separate creditors about the sale of the bankruptcy debtor as a legal entity. If they express their opposition the court may decide that the cases on which there was a right of separation be previously separated and cashed according to the rules of enforcement. Furthermore, the bankruptcy trustee should make an executive assessment of the assets of the bankruptcy debtor before the sale as well as the value of the thing or part of the thing on which there has been a separate right.[23]
In the case of the sale of a bankruptcy debtor several legal consequences arise. The most important thing is that the bankruptcy procedures against the bankruptcy debtor have been suspended, and that all the money earned from the sale of the bankruptcy debtor enters the bankruptcy estate. Ultimately, if there is a sale of the bankruptcy debtor then the act of sale needs to be recorded in the registers.

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19 Art 75. The Law on Bankruptcy Procedure (FBiH) - DRAFT.
20 According to Article 80, para 3 of the Law on Bankruptcy Procedure (FBiH) - DRAFT bankruptcy judge may sanction a bankruptcy trustee in case he fails to fulfil his obligations, in the range of 1,700 - 5,000 BAM. It is about tightening the penal policy, because the bankruptcy court, if the bankruptcy trustee does not fulfill its obligations, could have fined him in the range of 500.00 - 1,700.00 BAM.
21 Art 92. The Law on Bankruptcy Procedure (FBiH) - DRAFT.
22 Art 158. The Law on Bankruptcy Procedure RS, Official Gazette RS, ser: 16/16.
23 Art 163. Para 3. and 4. The Law on Bankruptcy Procedure (FBiH) - DRAFT.

In order to eliminate frivolous buyers from the process of selling the bankruptcy debtor the deposit was standardised. The legislator has defined the deposit criteria. The deposit cannot be higher than 10% of the estimated value of the subject of sale with the remark that it cannot be higher than 50,000.00 BAM. Logically, in case the buyer does not pay the amount he accepted (auctioned) at the time of sale, the amount of the deposit in question is to be returned to the buyer.

4. CONCLUSION

After many years of application of the Law on Bankruptcy Procedure in the Federation of BiH and analysis of the observed practical shortcomings of bankruptcy procedures, in order to update the legislation, the existing legal solutions were amended and adjusted to the needs of business entities. The basic intention of the amendment to the bankruptcy legislation can be subsumed under a common denominator - the efficiency of the bankruptcy procedure.

It is in this paper that the most significant changes in legislation are analysed, which are still in the *de lege ferenda*prismwith a high degree of probability that they will soon become part of the *de lege lata* (positive legislation).

These novelties can be viewed in the function of shortening the duration of bankruptcy procedures, formalizing pre-bankruptcy procedure, standardising additional mechanisms regarding the legal position of bankruptcy trustees and regarding the sale of a bankruptcy debtor as a model of survival of a business entity over whose assets bankruptcy procedures were opened.

At the same time, since the novelties contain inaccuracies to a certain extent it would be useful to make additional corrections to them all in the function of achieving the goals of the bankruptcy procedure. Regardless of the dilemmas, it should be expected that the proposed changes in bankruptcy legislation will achieve the expected goals and that the practice of future pre-bankruptcy or bankruptcy procedures will confirm the legislator's expressed intention to change the approach to bankruptcy of the business entity in general. It will protect the interests of bankruptcy creditors on the one hand and the bankruptcy debtor and third parties on the other hand.

5. LITERATURE

a) Books:

1. ČOVIĆ, Šefkija, Poslovno pravo, Pravni fakultet Univerziteta u Sarajevu, Sarajevo, 2003;
2. RIZVANOVIĆ, Edin – NANIĆ, Arif, Poslovno statusno pravo, JP NIO Official GazetteBiH, Sarajevo, 2018;
3. SAJTER, Domagoj, Ekonomski aspekti stečaja i restrukturiranja u stečaju, Sveučilište Josipa Jurja Strossmayera, Osijek, 2008.

b) Laws:

1. The Law on Bankruptcy Procedure (FBiH) - DRAFT (date: decembar 2020.);
2. The Law on Bankruptcy Procedure (FBiH), "Official Gazette of the FBiH", ser. 29/03, 32/04, 42/06, 4/17 and 52/18;
3. The Law on Bankruptcy Law RS, Official Gazette RS, ser: 16/16;
4. The Law on Bankruptcy Law, Official Gazette BD, ser: 16/19 and 29/20;
5. The Lawe on Financial-informatics agency, Official Gazette FBiH, ser: 80/11;

PROBLEMS IN LEGISLATION AND NEEDS FOR IMPROVEMENTS IN THE WOOD PROCESSING INDUSTRY SECTOR

Ina Vejsiu[1], Erald Kola[2], Leonidha Peri[3], Julinda Kllapi[4]
1- Faculty of Forest Sciences, Agricultural University of Tirana, ALBANIA, inavejsiu@ubt.edu.al
2- Faculty of Forest Sciences, Agricultural University of Tirana, ALBANIA, Erald.kola@ubt.edu.al
3- Faculty of Forest Sciences, Agricultural University of Tirana, ALBANIA, leonidha.peri@ubt.edu.al
4- Wood Industry Cluster of Albania julindakllapi@yahoo.com

ABSTRACT:

Various wood processing and furniture task companies in cooperation with MIE, GIZ and the Faculty of Forest Sciences, are grouped in a non-profit organization called Cluster of the Albanian Wood Industry. One of the goals of this group is to enhance your competitiveness. The wood industry is an important branch in the industrial sector in Albania, and in this respect the cluster provides information on the development of its members.

Due to the latest situations created as a result of the Covid-19 pandemic, the industry is facing new challenges and demands. In order to identify the needs for intervention in the legal and economic aspect, to orient the necessary improvements to be undertaken in this sector, the cluster in cooperation with Faculty of Forest Science drafted a semi-structured question addressed to rights who have expressed their opinions on the topics of treatment.

The questionnaire was designed to touch on various areas such as fiscal and tax legislation, labor legislation, your policy and strategy, the needs for continuing qualification, etc.
According to the expectations, the companies and express themselves with clear opinions on the improvements and changes of customs practices for loans and first, for the recruitment of qualified staff, continuous training of staff to be up to date with technology

Keywords: wood industry, labor force, cluster, technology, legislation

List of abbreviations:

MIE	Ministry of Infrastructure and Energy
GIZ	Deutsche Gesellschaft fur Internationale Zusammenarbeit
SME	Small Medium Enterprise
VET	Vocational Education Training
CNC	Computer Numerical Control
HR	Human Resources
EU	European Union
USAID	United State Agency for International Development
WICA	Wood Industry Cluster Albania
FoFS	Faculty of Forest Science
IT	Information Technology

1. INTRODUCTION

The wood and furniture industry is one of the fastest growing industries in Albania. The sector has seen exports of furniture increase from $52 million in 2015 to $62 million in 2020, a 19% increase in the space of only five years (INSTAT, Trade Map). The development of the industry during these years can also be observed in other relevant metrics, such as the number of the companies operating in the sector, the number of employees, the GDP added value of the sector, the ratio between exports and imports, etc.

Official data from INSTAT, the Albanian Statistical Institute, show that the number of active, tax-paying furniture and wood processing companies in Albania has, for the first time in 2020, surpassed 1,000, and it employs more than 10,000 people. Due to the high levels of informality in the sector, the number of wood and furniture companies in the country can be up to three times as high as the official estimates suggest according to the stakeholders in the sector. Its GDP added value stood at 1% according to study of USAID in 2018, this in itself a remarkable achievement considering that a much larger and more important sector of the economy such as tourism reports a GDP added value of 2.4%. Imports of furniture, meanwhile, have dropped from $47 million in 2019 to $44.5 million in 2020, the Covid-19 situation certainly being one of the main culprits for this drop. Italy and China together account for roughly 60% of all imports (AIDA). The only relevant metric in which the sector is stagnating is FDI inflows which are negligible.

This history of success, however, disguises important challenges that the industry is currently facing and might prohibit its further growth. In order to map out these challenges we have conducted a questionnaire with 35 SMEs operating in the sector and a series of structured interviews with relevant stakeholders. The results of this questionnaire suggest that (a) shortage of labor force, (b) legislation gaps and government bureaucracy, (c) barriers to export d) limited access to professional trainings and e) low levels of digitalization are the most pressing challenges in the industry that need to addressed.

In the second section we will explain the methodology used in this study. We have conducted a survey with a sample of furniture production firms and two interviews with the head of wood processing department, Faculty of Forest Science, Agriculture University Tirana and head of sector for the industry development programs, Ministry of Infrastructure and Energy. Next Section 3 presents the reader with the main findings of the questionnaire and the interview. The findings from the interviews with the other main stakeholders provide another perspective regarding industry challenges. The fourth section, on the other hand, provides a series of customized recommendations for all the relevant stakeholders – (i) companies, (ii) Research and VET institutions, (iii) Government, and (iv) Wood Industry Cluster Albania – that might help mitigate these issues.

2. METHODOLOGY

In this chapter we are going to explain to methodology used in order to better explain industry needs and address their challenges.

Faculty of Forest Sciences, Agriculture University of Tirana in collaboration with the Wood Industry Cluster Albania have created a questionnaire and conducted several interviews with companies and other stakeholders. We have disseminated the questionnaire to 35 SMEs operating in the wood and furniture sector, mainly dealing with furniture production. In order to have a representative sample we have included in our survey both members and non-members of WICA. 62% of the companies that answered the questionnaire are WICA members. The questionnaire had open and multiple-choice questions, designed to retrieve as much information as possible in a short period of time.

To have a broader view on the topic we also conducted structured interviews with the Head of Wood Processing Department, Faculty of Forest Sciences, Agriculture University of Tirana and the Head of the Section of Industry Development Programs, Albanian Ministry of Infrastructure and Energy. The results of this qualitative research are interpreted and summarized in the third chapter.

3. FINDINGS

3.1. Questionnaire Findings

After analyzing the questionnaire results the main challenges that the wood sector is facing are:

a) *Shortage of labor force*
The sector is very dependent on the labor force availability. All the companies involved in this questionnaire report they have faced problems to find skilled workforce in the last two years.

In most cases, even when the companies are able to find workers they are not qualified and need a lot of in-house trainings. Another problem that the sector is facing is that most of the workers consider the job position as a short-term occupation and they leave after a few months. 90% of the companies declare that they faced this problem at least once in the last five years. 45% of the companies respond that they were able to find replacement within a short period of time. However, companies find this process time consuming and expensive as additional training is required for the new workers. For 22% of the companies finding replacement workers was very difficult and the rest could not replace them at all.

The situation looks better when it comes to skilled workers such as wood-processing engineers, architects and finance experts. The bigger companies' report that is easier to fill these roles in comparison to skilled workers involved in production processes.

45% of the companies need engineers that are specialized in wood processing, while the rest fulfill this need with architects. 80% of the firms do not follow a proper recruitment process when employing a new employee. 60% of the firms have continuous collaboration with the Faculty of Forest Sciences for graduate employees. The rest, about 40% of companies, prefer unofficial recommendations and do not follow any formal human resources procedure. 80% conclude that there is a mismatch between the knowledge they acquire at the University and the job market. In most cases graduates need to be trained in-house for an average of 3 to 4 months.

35% of the companies have responded that the market is also in need of architects specialized in furniture design. These companies are mainly bigger and are also engaged in exports. They need to improve and customize their furniture in order increase their competitiveness in the export markets. At the moment interior designers are dealing with furniture design as well. To address this problem the Faculty of Forest Sciences has opened a bachelor program in Furniture Design. The first cohort will graduate in 2021.

Moreover, there is also a lack of internal dedicated staff and an unwillingness to pay consultancy fees when it comes to applying for relevant national and international projects. All the companies answer that they are willing to participate in national and international projects dealing with technical assistance in the sector and access to capital. As for now the Wood Industry Cluster Albania is offering information and assistance to the members to apply in such projects. This in spite of the fact that the Cluster does not have the human resources to fully fulfill the needs of all of its members.

After carefully analyzing their answers we are summarizing below the reasons behind labor force shortage:

- Young generations do not find the sector attractive.
- High rate of emigration
- Lack of VET institutions offering wood processing programs
- Limited career perspectives and low wages

b) Legislation Gaps and Government Bureaucracy

Another important challenge that the companies are dealing with are the customs legislation bureaucracies. All the companies report that they have had at least 3 to 4 episodes of delay in obtaining their imports. According to them these delays are due to mistakes from the custom administration, lack of information and unnecessary bureaucracies.

As explained earlier in this chapters all the companies claim that they have had problems with the Labor Inspectorate regarding short-term workers. 50% of them have also incurred penalties for not paying employee taxes. Companies argue that the high turnover of the employees makes the whole process very time-consuming and frustrating for companies.

c) Barriers to Export

Only 35 % of the companies are exporting to non-EU and some EU countries. They have all claimed that they need to increase their productivity and improve technology to increase competitiveness in foreign markets. 25% report that they need further assistance to explore their export readiness.

Companies that have had exporting experience claim that getting safety certifications for the final products in compliance with the EU requirements is expensive and very time-consuming. All the exporting companies emphasize the need of a regional certification laboratory for the sector. This will decrease these companies' costs by a large margin and make their products more competitive as a result.

d) Limited Access to Trainings

All the companies agree that they need to train their employees on regular basis to be in line with new practices and new technologies. 65% of the companies' employees have participated in technical trainings for the use of CNC machineries. These trainings are offered as a bundle from the machineries' vendors.

80% of the companies have participated at least in one training organized by Tirana Chamber of Commerce, GIZ, USAID or other organizations. They have found these trainings useful in a moderate scale and argue that more specific trainings are needed for the industry.

e) Need for digitalization

Digital transformation is very important for the improving the production standards of the industry. Unfortunately, the degree of the digitalization is low in the wood and furniture sector. Only 30% of the sampled companies have started some digitalization process, mainly regarding the technology and online sales. Only 10% of them have a digitalization strategy but claim that they need external consultancy and financing to implement these processes. All the firms report that during the pandemic they considered engaging in digitalization transformation projects to increase production efficiency and sales. 70% find digital transformation complex and expensive.

Other challenges that the companies have mentioned during the survey are: worsened business climate as a result of the pandemic, difficulties in mitigating currency risk and waste management.

3.2. Interview findings

After analyzing the companies' questionnaire answers we have conducted structured interviews with the Head of the Wood Processing Department, FoFS and the Head of the Sector for Industry Development at MIE. The aim of these interviews is to have another point of view regarding industry challenges. Following the interview answers from these two important stakeholders we have reached into the conclusion that:

- They agree that the shortage of workforce is an important challenge that the industry is trying to overcome.
- They have different collaboration agreements with the university in order to engage students in internships programs and potentially employ them.
- The Head of the Wood Processing Department, FoFS emphasized that in the last 5 years they have noticed a decrease in the number of students applying for wood engineering degrees. As a consequence, the quality of the students that are entering the program recently is very low.
- Given that there is a substantial gap between the knowledge students acquire by the end of the degree and what is required from them in the workplace, the problem is further compounded by the fact that most students are either unable or unwilling to apply the knowledge in a real work environment. Young people do not find the industry attractive mainly due to the fact that the industry is not very well paid and there are no perceived career prospects.
- The government recognizes that there are some bureaucratic practices that need to be revised. They also claim that companies should address these issues officially to the government offices responsible.

4. RECOMMENDATIONS

The results of the companies' questionnaire and interviews with other stakeholders show that the industry is having difficulties because of the: shortage of labor force, legislation gaps and bureaucracies, barriers to export, limited access to trainings and lack for digitalization. The Covid-19 pandemic has also created a more problematic business environment. We have noticed that firms report similar issues and there are no substantial differences with regard to company size. The size of the company is an important factor when it comes to the recommendations provided and investment possibilities.

We are aware that most of the solutions to these challenges require long-term intervention from the government and research institutions. The willingness of the firms to collaborate with other stakeholders, co-finance investments and participate in national/international projects is crucial for the further development of the industry.

After carefully analyzing the outcome of this study we recommend the following areas for intervention for each of the stakeholders considered in this study: companies, research institutions, government and WICA.

(I) Companies

- Increase willingness to provide study visits at their factories and paid internship for university students
- Increase of the base salary at all levels
- Incorporate new compensation and incentive schemes
- Improve HR recruitment and other procedures
- Be willing to co-finance national/international projects in conjunction with the donors

- Increase collaboration with external consultants for better marketing, digitalization, new technologies, etc.
- Continuously invest in new technologies and staff trainings
- Become members in Wood Industry Cluster Albania to increase their lobbying power when dealing with government agencies and gain access to a plethora of other benefits

(II) Research and VET institutions

- Develop new curricula for wood processing for VET institutions
- Establish a training center for wood processing and furniture production
- Provide continuous education for the industry
- Include more IT-related subjects in order to make future industry employees more tech savvy

(III) Government

- Provide access to finance for firms that are willing to invest in digital transformation and innovation
- Fiscal facilitation for exporting firms
- Maintain open and regular communication channels with the companies in the sector
- Provide knowledge sharing and financial support for Wood Cluster Industry Albania
- Elaborate the possibility to finance the establishment of a laboratory for wood products certifications
- Facilitate the organization of B2B events with foreign companies

(IV) Wood Cluster Industry Albania

- Increase membership
- Share experience with wood and furniture clusters in the region
- Apply for international projects to get access to international funding for the industry with regards to trainings and co-financed investments
- Provide better coordination between stakeholders
- Develop an export readiness strategy for firms that are willing to go international

5. REFERENCES

[1] Çaushi, E., and Marku. P., (2013): Current situation of wood processing industry in Albania, Albanian Journal of Agricultural Sciences. 2013;12 (4), 747-750.

[2] Çaushi, E., Marku. P., and Lato, E., (2015): Overview of Albanian Wood Products and Furniture Manufacturing Industry and Issues Faced by SMEs Operating in it, Journal of International Academic Research for Multidisciplinary, Volume 3, Issue 5, 225-234.

[3] Grepcka, A., Peri, L., Kukali, E. (2010): Technology modernization and marketing positive correlation, a factor for development of primary wood processing industry in Albania (pages 1368-1374), Future with Forests, International Scientific Congress, Belgrade, Serbia, 11-13 November.

[4] Kropivšek, J., and Grošelj, P., (2020): Digital Development of Slovenian Wood IndustryDRVNA INDUSTRIJA 71 (2) 139-148.

[5] USAID (2021). Economics Development, Governance and Enterprise Growth Project: Improving the Competitiveness of the Wood and Furniture Industry through Digitalization.

[6] Albanian Statistical Institute,(2015): Furniture exports in 2015, [accessed 02.05.2021]

[7] Albanian Statistical Institute, (2020): Furniture exports in 2020, [accessed 02.05.2021]

[8] Albanian Statistical Institute, (2020): Number of wood and furniture companies 2020, [accessed 05.05.2021]

[9] Albanian Investment Development Agency (2020): Imports to Italy and China

TOURISM DESTINATION MANAGEMENT OF UNA-SANA CANTON

Mirela Kljajic-Dervic, Selma Sumar
Faculty of Economics Bihac, University of Bihac mirela.kljajic-dervic@efbi.unbi.ba
Faculty of Economics Bihac, University of Bihac selma.sumar@efbi.unbi.ba

ABSTRACT:

This paper will give theoretical overview of terms and concepts related to tourism, tourism destination and management due to the increase of importance of tourism sector in the world. The focus will be on Una-Sana Canton and especially city Bihac. Una-Sana Canton is an area that is characterized by tourism. Natural resources and rich cultural and historical heritage represent the basis for the development of tourism. Due to the process of globalization, tourism is becoming more and more important and therefore the concept of competitiveness of a tourism destination arises with it. The question is how to achieve the excellence and long-term competitiveness on the market when it comes to tourism.

Keywords: tourism, destination, destination management, tourism, Una-Sana Canton

1. INTRODUCTION

Tourism with its different complex components and elements is a worldwide used research topic. Very important role in tourism development has destination management with different stakeholders that are involved in the process.

Information is available at every corner and tourist are becoming more demanding due to the process of globalization, technology changes, pandemic crisis, etc. It is importan to track the chnages that are happening in order to recognize on time trends that appear on the market.

The competition in the sector of tourism is increasing so it is important for the destinations to achieve competitive advantage. Destination that wants to be competitive and modern need to find ways how to increase the number of tourists. Beside of attracting the tourist, destinations need to find ways to keep up the changes and to follow trends that are available in the market.

2. THE CONCEPT OF TOURISM DESTINATION

There is no universal worldwide accepted definition of a tourism destination, so for the purposes of this paper, several definitions will be presented in order to gain a better insight into the work itself.

The difference in interpretation of the concept comes depends from several factors such as the different aspect of observation. A tourism destination can be defined from different aspects. For example, tourism destinations can be defined within geographical boundaries or from the perspective of different stakeholders (sectors). (Gutlic, 2016: 20)

Destinations are natural or built (e.g., Dubai) physical geographical areas i.e., travel destination which, with its equipment, enables the acceptance and stay of tourists (Jovanovic, 2020: 200)

Tourists visit destinations. Destinations are places with some form of real or imagined border. It can be the physical border of the island, political borders or even borders created by the market, so, for example, a traveling wholesaler on a tour of the South Atlantic means only have in mind Australia and New Zealand. Central America comprises out of seven states, but there are few or almost no national tourism offices or tourism planners that perceive it as such. A typical Central American tour package includes only two or three countries, such as Costa Rica, Guatemala, and Panama."(Kotler et al., 2010: 726).

Also, when it comes to tourism destinations its contribution to the research of this concept and things related to this term, author Popesku has given a significant contribution. He beliefs that the destination is more than a geographic term or place. According to Pepesku the destination implies diversity of products, services, natural resources, created elements and information that can attract certain number of visitors in specific place (Popesku, 2011:41).

3. THE CONCEPT OF DESTINATION MANAGEMENT

Jurin (2008) as it is stated in the paper of Bartoluci, Cavlek et al. (2007) states that destination management implies the coordination of tourism products by one or more recognizable authorities through the systematic approach of all interested parties at the level of a tourism destination, in order to reach consensus among various options and on the choice of a partnership model to best suit the needs of a tourism destination

The task of destination management is to figure out the appropraitte balance between competitive external environment, social and economic goals, conserving natural resources, maintaining the attractiveness of the destination and building its reputation on the one hand and the economic contribution of tourism to the destination and the well-being of the local community (Golja&Lekic, 2020:112)

4. DESTINATION MANAGEMENT OF UNA-SANA CANTON

Having Una-Sana Canton as a research point of this paper the purpose is to understand the overall context and strategic framework for its development. The details and attractions of this Canton will not be presented.

The tourist-resource basis of Una-Sana Canton is well elaborated and presented in the documents:

- Strategy for development 2014-2020,
- Strategy for the development of communal activities 2014-2020,
- Master plan for tourism development for the protected area National Park "Una",
- Management plan for National Park "Una"

Based on the development vision that is stated in the Integrated development strategy that was developed by Cantonal Committee for Development of Una-Sana Canton in 2014, Una-Sana Canton is a euro-region - the emerald of Bosnia and Herzegovina, an area of comfortable life based on balanced sustainable development it is defined that six key development goals Una-Sana Canton will develop through:

- Developing of a competitive economy and by reaching the level of the average economic development of the Federation of Bosnia and Herzegovina,
- Building infrastructure in order to improve the quality of life of residents,
- Improving environmental protection and nature conservation,
- Developing human resources and improving the labor market,
- Ensuring a high level of social security and protection,
- Improving management development

Having this vision in mind, the vision will be achieved throughout specific strategic goals which include that legislation needs to be harmonized with EU legislation for sustainable use of resources, efficient instruments for the implementation of environmental protection measures need to be ensured and human resources for environmental protection and nature conservation through public involvement in environmental issue need to be developed.

Potentials for tourism development in the Una-Sana Canton area are based on preserved natural resources and rich cultural and historical heritage. The properties of natural resources for tourism development are poorly researched, and intangible and tangible cultural heritage is insufficiently represented in the overall tourist offer.

Certainly, the most recognizable tourist destination is the National Park "Una", which offers development of various selective forms of tourism (excursions, sports, fishing). What is beneficiary for an opportunity to increase tourist traffic in this Canton is the proximity of the Plitvice Lakes, located in Croatia, which are only 30 minutes away. The share of tourism in the total budget revenues of the Una-Sana Canton is low. Existing accommodation facilities are characterized by insufficient quality. The quality of the tourist offer is undermined by the lack of systematic inspection supervision and overlap in the performance of the activities of the cantonal and municipal tourist boards. There is also a need to improve the tourist infrastructure (for example bicycle paths or tourist signalization).

Since the Tourist Board of Una-Sana Canton has been re-launched and started operating, the recommendation for further steps would be to create strategy of Una-Sana Canton development which would use for a further action development strategy. This could be the starting point of destination management.

Una-Sana Canton, and for the most part the city of Bihac recorded an increase in tourist arrivals, but also a change in the number of overnight stays in recent years, which is shown in the table 1. There is an obvious increase in the number of foreign tourists, who on average spend more time at the destination. The data also shows the stagnation in the arrival of domestic tourists. The average retention time is extremely short, which does not provide a good basis for the full valorization of tourist potential. The turning point was the year 2020, when the coronavirus COVID-19 expended all over the world, including Bosnia and Herzegovina and the measures to suppress the spread included isolation of people, bans and restrictions on movement, and the closure of the borders. Strong consequences were felt in the sector of tourism which is visible in the overview number of tourist arrivals and overnight stays, where a decrease in the number of tourists by about 60% compared to the previous 2019 was recorded.

Table 1: Arrivals and overnight stays

YEAR	TOURIST ARRIVAL			OVERNIGHT STAYS			AVERAGE TIME		
	Domestic	Foreign	TOTAL	Domestic	Foreign	TOTAL	Domestic	Foreign	TOTAL
2012	19.173	8.720	27.893	42.178	13.999	56.177	2,2	1,6	2,0
2013	18.977	11.616	30.593	27.929	18.322	46.251	1,5	1,6	1,5
2014	17.957	12.183	30.140	25.468	19.446	44.914	1,4	1,6	1,5
2015	18.670	14.838	33.508	26.264	23.615	49.879	1,4	1,6	1,5
2016	21.548	19.702	41.250	30.328	32.208	62.536	1,4	1,6	1,5
2017	23.578	26.719	50.297	34.405	41.571	75.976	1,5	1,5	1,5
2018	18.682	29.942	48.624	27.312	47.057	74.369	1,5	1,6	1,5
2019	19.240	36.912	56.152	29.911	58.555	88.466	1,6	1,6	1,6
2020	17.743	4.867	22.610	29.569	8.825	38.394	1,6	1,8	1,7

Source: Monthly statistical review by cantons, Federal Bureau for Statistics

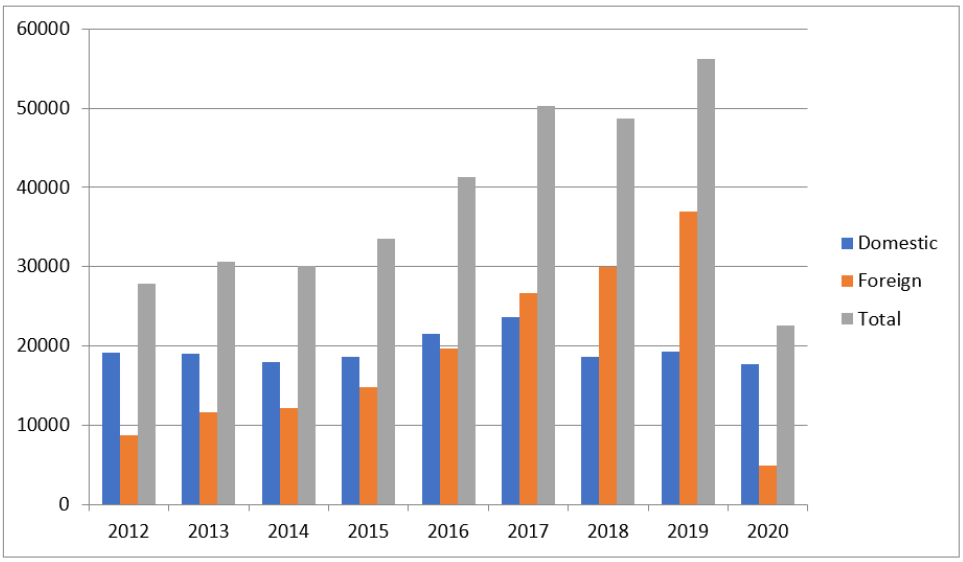

Figure 1: Structure of tourist arrival in Una-Sana Canton

Source: Monthly statistical review by cantons, Federal Bureau for Statistics

These data should be taken with reserve due to the presence of the gray economy in tourism and the non-registration of tourists due to the avoidance of paying the residence tax, but also due to the delay in the work of the tourist board of the Una-Sana Canton.

According to the Krizman-Pavlovic and Zivolic [1] tourist destinations are consisted out of six components that are commonly known as „six A“ and include aatractions, amenities, accessibility, available packages, activities and ancillary services.

If we apply these six components on the example of city Bihac as a tourist destination we can define for example: atractions (Strbacki buk waterfalls, amenities (restaurant „Obala“); accessibility (public bus transportation); available packages (offer of hotels or rafting services); activities (different activities during the visits such as lunch on the ship and ride along river Una) and ancillary services (hospitals or banks)

5. CONCLUSION

Thanks to the natural resources that Una-Sana Canton has in combination with the rich cultural and historical heritage, good foundations have been laid for creating successful, quality and recognizable brand. A destination such as Una-Sana Canton with tourist offer certainly represents one of the key booesters of economy and overall quality of life.

It needs to be emphasized the fact that the destination management has a fucntion of boosting the economy because, among many benefits, it generates new sources of income and also it generates new employment opportunities.

In order to develop certain tourist destination and to manage it successfully it is important to involve private and public sector that will carry out all the activities and duties. Cooperation between these two sectors is crucial for managing tourist destinations. Different stakeholders should be involved in every segment of creating and managing tourist destinations.

This paper represents only theoretical overview for this topic. Further recommendations would be to make research on this topic and to include for example questionnaire how tourists perceive Una-Sana Canton as a destination. The research could be made with foreign tourists as well as domestic and comparisons of their opinions and perceptions can be made. Also, the research does not have to include entire Una-Sana Canton. It can involve particular place in Una-Sana Canton.

6. REFERENCES

[1] Pavlović, D., Živolić, S., (2008). Upravljanje marketingom turističke destinacije: Stanje i perspektive u Republici Hrvatskoj. Ekonomska istraživanja, Vol. 21, No. 2, 99-113
[2] Jurin, E. (2008). "Pametne" turističke destinacije - okviri za razradu modela implementacije. Acta turistica nova, 2 (1), 123-143. Available at https://hrcak.srce.hr/37752
[3] Golja, T. i Lekić, R. (2020). DESTINACIJSKI MENADŽMENT U FUNKCIJI RAZVOJA KULTURNOG TURIZMA KONTINENTALNE HRVATSKE - PRIMJER DESTINACIJE KRIŽEVCI. Studia Polensia, 9 (1), 103-141. Available at https://doi.org/10.32728/studpol/2020.09.01.06
[4] Gutlic, S. (2016).City branding- Analysis of awareness of Bihac as a tourist destination. Zagrebacka skola ekonomije i menadzmenta
[5] Jovanović, V., (2020) Turizam i prostor, Univerzitet Singidunum, Beograd
[6] Kotler i suradnici, (2010). Marketing u ugostiteljstvu, hotelijerstvu i turizmu. Mate, Zagreb
[7] Popesku, J., (2011). Menadžment turističke destinacije. Available at http://www.singipedia.singidunum.ac.rs/content/663-Menad%C5%BEment-turisticke-destinacije?s=41113df3e50f6d98b38814e3dc143b38
[8] Integrirana strategija razvoja Unsko-sanskog kantona za period 2014-2020. (2014). Available at https://www.fzzpr.gov.ba/files/Unsko-sanski%20kanton/Strategija%20razvoja%20USK.pdf
[9] Federal Bureau for Statistics. Available at http://fzs.ba/index.php/publikacije/mjesecni-bilteni/

CHEMICAL MIGRATION FROM FOOD CONTACT MATERIALS INTO FOOD
- GAPS IN EU LEGISLATION AND SAFETY ASSESSMENT -

Benjamin Muhamedbegović[1], Nihada Ahmetović[2], Jasmin Suljagić[1], Belma Bajrić[3]
[1]University of Tuzla, Faculty of Technology, Univerzitetska 8, Tuzla,
[2]University of Tuzla, Faculty of Medicine, Univerzitetska 1, Tuzla
[3]University of Bihać, Faculty of Law, Džanića mahala 66, Bihać
benjamin.muhamedbegovic@untz.ba

ABSTRACT:

Food contact materials (FCM) must be produced according to highist hygiene standards and requirements prescribed by adequate legislation, and in that sense it must not release chemicals into the food, or react with food or affect its sensory properties. According to Castle, there is no ideally inert packaging material and everyone can release certain chemicals into food under certain conditions. The control of these processes is regulated in European Union by certain legislation, but not to a sufficient extent. 17 FCMs is recognized by European Framework Regulation (EC) 1935/2004 ,but smaller part of it is covered by specific regulations. Almost 30% of the 12,285 chemicals recorded in the FCM Database of food contact chemicals used in the production of food contact materials all over the world (established on the end of last year) is without informations on safety assesment. This points to a worrying gap in FCM legislation and safety data. In order to better protect consumers, there is an urgent need to revise and improve this legislation and to assess safety.

Keywords: food contact materials, packaging, chemical migration, legislation

1. INTRODUCTION

During production, processing, packaging, transport, storage, preparation and serving, food comes into contact with food contact articles (FCA) such as packaging, cutlery, dishes, desks, faucets, etc. Food contact articles are made of food contact material (FCM), which includes for example food packaging materials (FPM) [1].
Regulation (EC) No 1935/2004 on materials and articles intended to come into contact with food recognizes next food contact materials: active and intelligent materials, adhesives, ceramics, cork, rubber, glass, ion exchange resins, metals and alloys, papers and cardboards, plastics (and recycled plastics), printing inks, regenerated cellulose, silicones, textiles, varnishes and coatings, waxes and wood [2].
Plastic, paper and cardboard, glass and metals are also the most common food packaging materials (FPMs), while wood, ceramics and textiles are far less used for this purpose [3]. Plastic and

paper/cardboard are at the forefront of market share [4]. These two materials show the highest migration potential, especially if they are recycled, because recycled materials contain more potentially migrating substances compared to the original materials [5,6].

Food contact materials have been identified as a major source of chronic consumer exposure to chemicals that have the potential to migrate, contaminate food, and consequently endanger consumer health [7,8].

These chemicals are recognized in EU legislation as Food Contact Chemicals (FCCs) (Figure 1)[9].

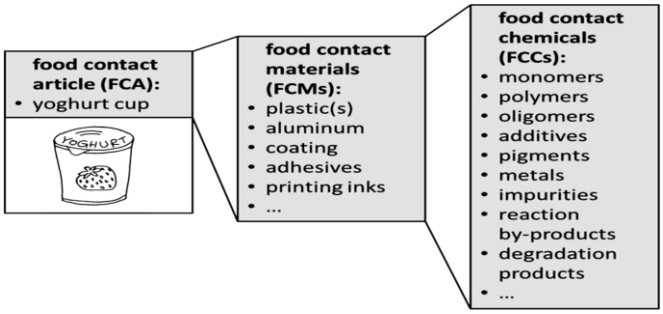

Figure 1: Articles, materials and chemicals in contact with food [9]

2. MIGRATION OF CHEMICALS FROM FCM TO FOOD

Migration is the transfer of chemicals from packaging to food and vice versa. Although migration is a two-way transfer of chemicals between packaging and food, in the EU legislation and food packaging terminology the term migration refers to the transfer of substances from packaging to food [10]. This transfer can occur by various mechanisms, such as: diffusion, gas phase migration, set-off migration, and for metal packaging by electrochemical corrosion [11].

The intensity of migration depends on:

- properties of food, packaging material and migrants,
- contact characteristics (type and scope of contact, time and temperature of contact).

Migrations are far more pronounced in fatty, liquid and semi-liquid foods. Higher concentrations of migrants in the material lead to higher levels of migration. Migration is greater if the packaging is thinner. Direct contact and a larger contact area between food and packaging, as well as time and higher contact temperature increase the migration potential. High-molecular-weight migrants, as well as migrants with complex molecular configurations, show a lower level of migration [12,13,14].

Migrants can originate from the basic packaging material and other components used for the final creation of packaging (adhesives, printing inks, coatings and varnishes). When assessing health risk, all possible migrants from the formed packaging form must be taken into account. Table 1 shows typical migrants from food packaging materials [15].

Table 1: Typical migrants from packaging materials [16].

Material		Typical contaminant
Plastics	Polyethylene terephthalate, PET	Formaldehyde, acetaldehyde, antimony, UV stabilizers
	Polyethylene, PE	Polyolefin oligomeric saturated hydrocarbons (POSH), nonylphenol
	Poly (vinyl chloride), PVC	Vinyl chloride, phthalates, epoxidized soybean oil (ESBO), organic tin
	Polystyrene, PS	Styrene, styrene trimmer
	Polypropylene, PP	POSH, erucamide, oleamide, butylhydroxytoluene (BHT)
	Polycarbonate, PC	Bisphenol A
Metal	Tin (Sn), steel (Fe) or aluminum (Al) with coating	Bisphenol A, bisphenol A diglycidyl ether (BADGE), ortho-phenylphenol, Sn, Al
Paper	Paper (coated)	Perfluorinated compounds
Cardboard (for liquid food)	Paper, aluminum, PE (combined material)	POSH, Isopropyl thioxantone (ITX), Benzophenones
Cardboard (for dry food)		Mineral oils, benzophenones, phthalates
Cardboard secondary packaging	Cardboard	Mineral oils
Glass	Bottle / jar cap with seal	Phthalates, ESBO, lead
Glass	Bottle / jar with plastic cap	UV stabilizer
Ceramics	Glazed ceramics	Heavy metals

EU FCM legislation recognizes two types of migration:

- total (global) and
- specific migrations.

Total migration is the migration of all migrating substances from packaging material into food. Specific migration is the migration of each migrant separately[2]. The Overall migration limit (OML) is the maximum total amount of non-volatile substances that can migrate from packaging material into food. It is expressed in mg per food contact area (mg/dm^2), and for FCMs for infants and young children in mg per kg of food (mg/kg). The total migration limit measures the inertness of FPMs / FCMs.
In Regulation (EU) 10/2011 on plastic materials and articles intended to come into contact with food OML is 10 mg/dm^2 and for FCMs for infants and young children it is 60 mg/kg of food [16].
In the EU, the maximum total migration is set at 60 mg/kg of food, and in Japan at 30 mg/kg. There is no legally binding value in the United States [17].
The Specific Migration Limit (SML) is the maximum amount of a specific substance that can migrate from packaging material to food. It is usually expressed in mg per kg of food. This is a safety limit derived from toxicological studies. Beside SML, there is a limit on the amount of material (Maximum Quantity Allowed QM), which is the maximum amount of substance in the finished material or article. QM can be expressed in mg/dm^2 of surface in contact with food or in mg/kg of substance in the material [18]. If SML for individual substances is not set, a default limit of 60 mg/kg of food can be used [17].
In the Annex of Regulation (EC) 10/2011, the SML is established for chemicals on the Union list which includes: a) monomers or other starting substances, b) additives other than dyes, c) improving substances in the production of polymers other than solvents, d) macromolecules obtained

microbiological fermentation. Only substances included in the Union list of approved substances can be intentionaly used for the production of plastic FCM and FCA [19]. Chemicals, before reaching the Union list of substances that can be used in the production of FCA and FCM, must undergo toxicological evaluations by the EU Scientific Committee [20]. To date, special regulations have been established in EU FCM legislation, in addition to plastics, for recycled plastics, ceramics, regenerated cellulose, as well as active and intelligent materials.

Substances from pisitive Union list used in the manufacture of FCMs/FPMs and FCAs are Intentionally Added Substances (IAS). Beside IAS in the final product can be identified also Non Intentionally Added Substances (NIAS). Article 3 of Regulation (EC) 10/2011, defines NIAS as impurities in used substances or reaction intermediates formed during the production process or decomposition or reaction products [2]. NIAS are a special challenge for plastics. In plastics, NIAS are oligomers, short-chain polymers with 2-10 units of monomers, that can migrate. During the polymerization process, free radicals are formed that react with any compound present in the reaction mixture, which implies that the by-products of the reaction are formed randomly. Identification of randomly formed compounds in plastics is not always possible, which makes chemical risk assessment a challenge, because only known substances can be toxicologically evaluated [21,22, 29]. NIAS is also characteristic of nonplastic FCM (Table 2).

Table 2: Examples of NIAS in non-plastic FCM (adapted from [21])

Non-plastic FCM / FPM	Examples of NIAS
Paper and cardboard	Sizing agent transformation products
Metals	Metal residues from alloys originating from arsenic (As) and antimony (Sb) impurities
Printing inks	Photoinitiator decay products
Adhesives	Solvent residues, residues of natural compounds, prepolymers / oligomers
Coatings	Epoxy oligomers, cyclo di BADGE (CdB), polyester resin oligomers
Pigments and colorants	Polychlorinated biphenyl residue, dioxin residue, polycyclic aromatic hydrocarbons in carbon black

3. AN OVERVIEW OF CURRENT EU FCM LEGISLATION

An overview of current EU FCM legislation is given in Figure 2. Regulation (EC) No 1935/2004, commonly called as the Framework Regulation is applicable to all FCMs [2]. All FCMs are also covered by Regulation (EC) No 2023/2006 which refers to the rules of good manufacturing practice (GMP) for FCMs and FCAs and which defines the elements of quality control to ensure that materials and products are produced in a standardized manner according to legal regulations and quality standards.

Regulation (EC) No 1935/2004 defines a list of FCMs for which specific directives should exist. Specific directives currently exist for plastics, recycled plastics, ceramics, regenerated cellulose, as well as active and intelligent materials [2]. There are also specific directives for some specific substances that are known to have the potential to migrate from coatings of metal cans to food, such as:

- Regulation (EC) No 1895/2005. BADGE and its hydrolysates BADGE · H_2O and BADGE · $2H_2O$ must not exceed SML of 9 mg/kg of food. SML is based on a TDI of 0.15 mg/kg. The second group of SML of 1 mg/kg of food refers to the three chlorohydrins BADGE (BADGE

· HCl, BADGE · 2HCl, BADGE · H_2O · HCl). The use of bisphenol F diglycidyl ether (BFDGE) and novolac glycidyl ether (NOGE) in FCM has not been approved due to a lack of toxicological data. However, BFDGE and NOGE are allowed in the coating of large transport containers. No migration limits have been set for such applications [11].

- Regulation (EC) No 2018/213 on the use of BPA in varnishes and coatings intended to come into contact with food and amending Regulation (EC) No 10/2011 regarding the use of this substance in plastic FCM defines a sharper SML of 0.05 mg / kg of food compared to the previous 0.6 mg/kg [42].
- Regulation EC 466/2001 setting maximum levels for certain contaminants in food has been supplemented by Commission Regulation EC 242/2004 on inorganic tin (Sn) in food, where Sn concentrations of 200, 100 and 50 mg / kg must not be exceeded in preserved food. and beverages and products for infants and young children [41, 11].

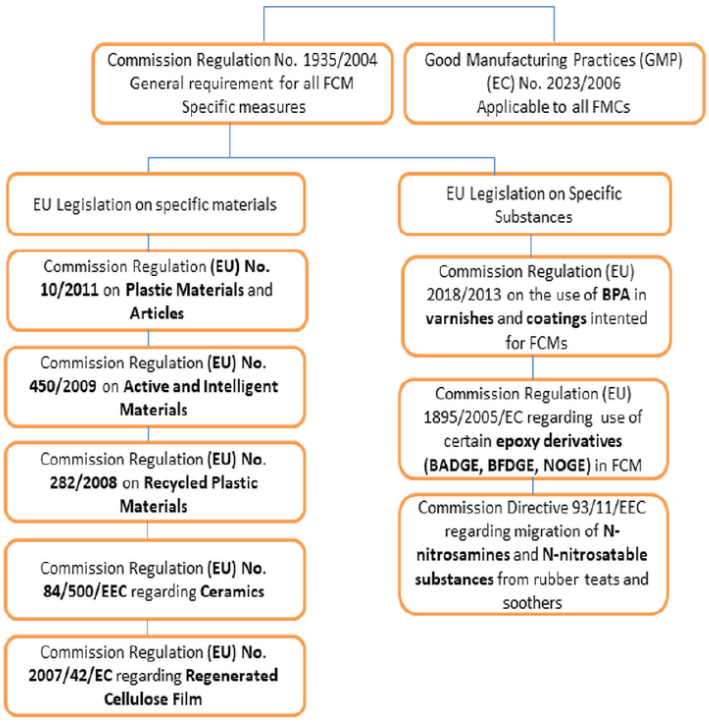

Figure 2: Overview of current EU legislation on FCM and some specific substances [35]

4. GAPS IN EU LEGISLATION AND SAFETY ASSESSMENT

Currently, there are no harmonized regulations at the EU level for 12 FCM, among which are packaging materials such as: paper, glass and metal, as well as materials for spatial and graphic design of packaging: printing inks, varnishes and adhesives and coatings.

The lack of harmonized European legislation for the so-called non-harmonized FCMs is a challenge to safety and compliance assessments as required by Article 3 of Regulation 1935/2004 which defines that FCMs are produced without transferring their ingredients to food in quantities that may endanger human health or lead to unacceptable changes in food composition or deterioration in organoleptic characteristics [19].

In order to better protect consumers due to the shortcomings of the existing EU FCM legislation, improvements in the legislative framework should be directed towards the requirements of relevant studies, projects and analyzes conducted in recent years by relevant authorities such as The European Consumer Organisation (BEUC- fr. Bureau Européen des Unions de Consommateurs), Chem Trust, Danish Consumer Counsil, Food Packaging Forum and JRC, EC expert team and others [39, 45, 46, 49]. Requirements, arising from the detected limitations and gaps of the legislative could be sublimated as follows:

1. Harmonization of all FCMs at EU level

Some EU Member States have adopted their own regulations for non-harmonized FCMs defining health safety conditions, lists of potential contaminants and their migration limits. In addition, industry sectors issue specific sectoral guidelines for non-harmonized FCMs. Eg. The Guidelines for Printing Inks of the European Printing Association (EuPIA) offer recommendations on how to formulate inks that will comply with Regulation 1935/2004. It is estimated that more than 5,000 chemicals are used in dyes [19, 24, 39].

The European Commission study on non-harmonized FCMs in the EU analyzed existing regulations at national or sectoral level and showed that the FCMs sector faces barriers to product movement due to current legislation at EU level and needs to be harmonized urgently. Inconsistent national regulations cause difficulties for producers and buyers of non-harmonized FCMs in the EU when importing or exporting. Study also states patchwork 16 different national schemes for risk assessment, chemical safety, compliance documentation and regulatory approaches. The study identified around 8,000 substances regulated at national level, of which some Member States regulate many, while others only a few. These differences therefore imply that European consumers are not guaranteed the same level of protection from chemicals depending on where they live [45,38, 39,49].

On 7 October 2020, the Council of Europe published Resolution CM/Res (2020) 9 on the safety and quality of food contact materials and articles, which calls for the harmonization of quality requirements and testing procedures for chemicals in the FCMs on the basis of technical guidelines. The resolution recommends that the governments of the Member States adopt appropriate laws and other measures to reduce the health risks due to human exposure to chemicals released from FCMs or FCAs [46]. An earlier resolution CM/Res (2013) 9, adopted with a similar intention, refers to measures to reduce the health risks of consumer exposure to metal ions from metals and alloys of metal cans into food during food production, storage and distribution. This Resolution is a reference for the application of Article 3 of Regulation 1935/2004. The resolution proposes Specific Release Limit (SRL mg/kg food) for metals and alloys, for 15 metals. The following values are proposed for the most widely used packaging metals: Al 5 mg/kg, Fe 40 mg/kg, Cr 0.250 mg/kg, Sn 100 mg/kg, Pb 0.010 mg/kg. To facilitate the implementation of the Resolution, the Council of Europe has also issued a Technical Guide on Metals and Alloys for Materials and Articles in Contact with Food, intended to assist the creators of national regulations [41,43, 44].

2. Regulate NIAS substances

It has been estimated that 30,000 to 100,000 NIAS substances potentially migrate into food from different FCAs. Some NIASs are often predictable, expected, and well researched, while others are not, and that increasing risk [29]. NIAS can occur in the reactions of packaging materials ingredients with food components. In the reaction of benzoic acid from PET bottles with ascorbic acid from beverages

benzene can be formed [23, 30]. NIAS recycled packaging materials can reach higher levels in food, compared to the original material, due to the fact that:

- materials intended for recycling may contain internal contaminants such as paints, additives and their decomposition products;
- the material may decompose during use and/or recycling,
- chemicals can accumulate when materials are recycled several times,
- previous use and/or misuse of packaging may contribute to the presence of unwanted and/or unexpected contaminants and
- non-food materials can enter the recycling process [24,25,26,27,28].

In this regard, EFSA (European Food Safety Authority) requires that the focus of risk assessment be shifted from starting materials used in the manufacture of packaging to the regulation of migrants from final materials and products [32].

3. Regulate the cocktail effect of a mixture of chemicals

Consumers are exposed to chemicals from FCMs /FPMs and chemicals from other sources (medicines, residues in food, environmental chemicals, etc.). Risk assessment is currently based on the assessment of individual substances, chemicals by chemicals, rather than cumulatively. This approach has implications for exposure assessment. Exposure can be underestimated and safe exposure levels exceeded in practice. One migrating chemical from the packaging alone does not have to show a significant toxicological effect on health. However, in the synergistic action in the cocktail, the chemicals significantly enhance the effect with each other. In this case, the toxicity of the cocktail is greater than the mere sum of the toxic values of the individual components of the cocktail [33, 34].

4. Installation of the precautionary principle

Incorporating the precautionary principle into FCM risk management legislation, modeled on the General Food Law. Substances of very high concern (SVHC), such as endocrine disruptors (ED) or chemicals that can cause cancer, alter DNA, or harm reproductive health, should be automatically banned in all FCMs [49].

Many of the chemicals used to produce FCMs are identified in Regulation (EC) No 1907/2006. 1907/2006 on the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH), as SVHC that interfere with the endocrine system are endocrine disruptors (ED) such as phthalate (e.g. Di-2-ethylhexyl phthalate, dibutyl phthalate, diisobutyl phthalate) and bisphenol (BPA and BPS).

Recycled paper and cardboard and linings of metal cans are sources of ED substances. Per and polyfluorinated compounds (PFAS) in paper and board coatings are considered bioaccumulative, persistent and reprotoxic based on in vitro and in vivo studies. BADGE and BFDGE from food and beverage can coatings are mutagenic and teratogenic. There is a lack of an efficient relationship between REACH and FCM. Although the chemical can be identified as SVHC under REACH, it does not generate automatic action and its substitution under FCM legislation [35, 47, 48].

5. Transfer the burden of proving compliance to manufacturers.

The burden of proving compliance should be shifted to manufacturers to implement them and keep them informed of the safety assessments of their FCMs. Article 16 of Regulation 1935/2004 requires the supplier to provide the customer with a Declaration of Compliance (DoC) confirming the product's compliance with this Regulation and any specific regulation (eg the Plastics Regulation). DoC allows the customer to then determine or verify the conformity of their own product. The DoC must be submitted to the competent authorities upon request. The authorities of the Member States must rigorously monitor the accuracy and reliability of safety assessments. DoC is also the traceability support provided for in Article 17 of the Regulation. Traceability of materials and objects must be

ensured at all stages in order to facilitate control, withdrawal of defective products, inform consumers and establish responsibility [2, 36].

6. Greater transparency in consumer information.
Clear and easily accessible information on chemicals present in migrating FCMs is essential for easier identification, traceability, and handling of chemical sources. Greater transparency in consumer information would allow for a “healthier choice” of FCMs / FCAs. Consumers are hindered in choosing "safe packaging" by the lack of data and transparency in the control of chemicals in contact with food. A team of researchers leadered by Food Packaging Forum established on November 30, 2020, the first database of 12,285 chemicals that could potentially be used worldwide to make FCAs and FCMs based on the analysis of 67 relevant and publicly available lists. They also coccluded that for more than a quarter of the substances (29%) identified in the database, no avaible information on toxicity [49, 37].

7. Introduce the concept of labeling "intended use".
Introduce the concept of “intended use” labeling which implies that products are safe only if used according to the manufacturer's intentions. Even if consumers are familiar with the food symbol in contact with food (glass and fork), consumers may be misled into believing that the safety of the labeled FCM has been adequately assessed and does not contaminate food. For example, a consumer may store hot or fatty foods in ice cream packaging after use [49].

8. Guarantee the same, high level of protection for FCMs made from raw and recycled materials.
A successful circular economy can only be achieved if consumers are convinced that secondary raw materials are safe. Challenges in safety assessments of chemical and consumer protection, in addition, should now be viewed through the circular economy. One contradictory aspect of the current legislative situation is that the EU encourages the recycling of packaging, but does not adequately control the chemicals used in the production of original packaging, which is a condition for safe recycling of that packaging [39]. There are currently regulations for recycled plastics, but not for recycled paper and cardboard, metal and glass [24]. In Europe, in 2017, more than 71% of paper and cardboard was recycled. This material is used in many European countries for direct contact with food in the so-called. fast food, dry food (flour, cereals, sugar, salt, rice and pasta) and food that must be peeled and/or washed before consumption (eggs, fruits and vegetables). In recycled papers NIAS are: phthalates, dye ingredients, photoinitiators and mineral oils [6, 25,26, 27, 31].
NIAS substances in printing ink may be the result of previous production steps of raw materials for ink, the reaction of ink ingredients during drying, crosslinking or curing of ink or the product of reactions with other packaging components or the result of cross-contamination during ink production or application [31].

9. Avoid replacing the chemical with related substances with similar hazardous properties.
Some regulated and approved chemicals require re-evaluation when new scientific insights into toxicity and exposure become available. BPA is an obvious example of a regulated compound whose use in FCM has been questioned in recent years, as numerous toxicological studies have published many detrimental effects of BPA on consumer health. Increasing evidence suggests that bisphenol F and S, which were initially evaluated as safe alternatives to bisphenol A, are also harmful [7, 39, 49].

10. Ensure effective implementation of FCM policy.
Member States must allocate sufficient resources for official FCM control, while the European Commission should promote a systemic implementation strategy to ensure that EU FCM policy is translated into real consumer protection [49].

5. CONCLUSION

In order to better protect consumers, revision is needed, improvement of the current EU legislation on FCM, where it is necessary for policy makers and strategies to urgently take into account the requirements and conclusions of studies on this topic by competent scientific and professional institutions and non-governmental organizations. to incorporate precautionary principles, greater transparency and improved consumer information. The competent services must step up the work of inspections. Consumers need to be educated about the risks to their health due to food and packaging interactions, because they are FCM is estimated to be the main source of chronic exposure of consumers to chemicals, and migratory substances are estimated to be the least controlled source of contamination of food consumers.

6. REFERENCES

[1] Groh, K., Muncke, J. (2017). In Vitro Toxicity Testing of Food Contact Materials: State - of - the - Art and Future Challenges. Compr Rev Food Sci Food Saf. 16 (5): 1123–1150 https://onlinelibrary.wiley.com/doi/full/10.1111/1541-4337.12280.
[2] Regulation (EC) No 1935/2004 on materials and articles intended to come into direct contact with food.
[3] Muhamedbegović, B., Juul, N.V., Jašić, M. (2015). Food packaging, Faculty of Technology Tuzla.
[4] ALL4PACK (2016). Packaging: Market And Challenges In 2016, https://www.all4pack.com/ accessed: 15.06.2020.
[5] Binderup, M.L., et al. (2002). Toxicity testing and chemical analyzes of recycled fiber-based paper for food contact, Food Addit and Contam, Vol 19, 13–28.
[6] Barthélémy, E., Spyropoulos, D., Milana, MR, Pfaff, K., Gontard, N., Lampi, E., Castle, L. (2014). Safety evaluation of mechanical recycling processes used to produce polyethylene terephthalate (PET) intended for food contact applications. Food Addit. Contam. Part A 31, 490–497.
[7] Geueke, B., Wagner, C.C., Muncke, J. (2014). Food contact substances and chemicals of concern: a comparison of inventories. Food Addit Contam A. 31 (8): 1438–50.
[8] Grob, K., Biedermann, M., Scherbaum, E., Roth, M., Rieger, K. (2006). Food Contamination with Organic Materials in Perspective: Packaging Materials as the Largest and Least Controlled Source? A View Focusing on the European Situation, Critical Reviews in Food Science and Nutrition, 46: 529–535.
[9] Muncke, J., Backhaus, T., Geueke, B., Maffini, MV, Martin, OV, Myers, JP, Soto, AM, Trasande, L., Trier, X., Scheringer, M. (2017). Scientific Challenges in the Risk Assessment of Food Contact Materials. Environ. Health Perspect. v.125 (9).
[10] Robertson, G.L. (2013). Food Packaging: Principles and Practice, Third Edition. CRC Press, Taylor & Francis Group, USA.
[11] Muhamedbegović, B., Jašić M., Šubarić D., Iličković Z., Uzunović F., Ćehajić A. (2018). Interactions food metal packaging, Proceedings International Scientific Conference 17. Ružička Days Vukovar, Croatia.
[12] Nerin, C., Contin, E., Asensio, E. (2007). Kinetic migration studies using Poropak as a solid-food stimulant to assess the safety of paper and board as food packaging materials. Analytical and Bioanalytical Chemistry, 387, 2283–2288.
[13] Poças, M.F., Oliveira J.C., Pereira J.R., Brandsch, R., Hogg T. (2011). Modeling migration from paper into a food simulant. Food Control, 22, pp. 303–312.

[14] Arvanitoyannis, I.S., Kotsanopoulos, K.V. (2014). Migration Phenomenon in Food Packaging. Food – Package Interactions, Mechanisms, Types of Migrants, Testing and Relative Legislation Food Bioprocess Technol 7: 21–36.
[15] BRC/FDF and Campden BRI, Guidance on migration from packaging materials into food, Consultation draft, August 2015.
[16] Muncke, J. (2016). Chemical Migration from Food Packaging to Food, Reference Module in Food Sciences http://dx.doi.org/10.1016/B978-0-08-100596-5.03311-4 accessed:06.04.2019.
[17] www.chemsafetypro.com/ Topics / Food_Contact / Food_Contact_Science_and_Testing_OML_SML_and_QM_Difference.html), accessed: 12.05.2021.
[18] Jamnicki, S. (2011). Evaluation of the suitability of different classes of recycled papers for the production of healthy food packaging, Doctoral thesis, Faculty of Graphic Arts, Zagreb.
[19] Schmid, P., Welle. F. (2020). Chemical migration from beverage packaging materials - A review. Beverages DOI: 10.3390 / beverages6020037.
[20] Sharkanj, B., Kipcic, D., Vasić – Rački, Đ., Delaš, F., Galić, K., Katalenić, M., Dimitrov, N., Klapec, T. (2010). Chemical and physical hazards in food ", Croatian Food Agency.
[21] ILSI Europe (2015). Guidance on best practices on the risk assessment of non intentionally added substances (NIAS) in food contact materials and articles, ILSI Europe aisbl Belgium.
[22] Bradley, E., Coulier, L. (2007). An Investigation into the Reaction and Breakdown Products from Starting Substances Used to Produce Food Contact Plastics. Central Science Laboratory UK, London. Available: https://www.foodpackagingforum.org/fpf-2016/wp-content/uploads/2014/06/Bradley-and-Coulier-2007.pdf.
[23] Muncke, J. et all (2020). Impact of food contact chemicals on human health a consensus Environmental Health 19 (1): 25 DOI: 10.1186 / s12940-020-0572-5.
[24] Geueke, B., Groh, K., Muncke, J. (2018). Food packaging in the circular economy: Overview of chemical safety aspects for commonly used materials Journal of Cleaner Production 193, 491-505.
[25] Pivnenko, K., Eriksson, E., Astrup, TF (2015). Waste paper for recycling: Overview and identification of potentially critical substances. Waste Management, 45, 2015.
[26] Abdullahi, N. (2014). Hazard chemicals in some food packaging materials Annals. Food Science and Technology, Vol. 15, Issue 1.
[27] Biedermann, M., Grob, K. (2013). Assurance of safety of recycled paperboard for food packaging through comprehensive analysis of potential migrants is unrealistic. Journal of chromatography, A, 1293, pp.107–19.
[28] Bengtström, L. (2014). Chemical identification of contaminants in paper and board food contact materials, PhD Thesis, Technical University of Denmark, 2014.
[29] Pieke, E.N. (2016). Identification and risk assessment of unknown contaminants migrating from Food Contact Materials. Kgs. Lyngby, Denmark: Technical University of Denmark.
[30] Van Poucke, C., Detavernier, C., Van Bocxlaer, JF, Vermeylen, R., Van Peteghem, C. (2008). Monitoring the benzene contents in soft drinks using headspace gas chromatographymass spectrometry: a survey of the situation on the belgian market. J. Agric. Food Chem. 56, 4504–4510.
[31] Jamnički - Hanzer, S. (2015). Deinking possibilities in the reduction of mineral oil hydrocarbons from recovered paper grades Cellulose Chemistry and Technology 49 (7-8): 677-684.
[32] EFSA, (2016). Recent developments in the risk assessment of chemicals in food and their potential impact on the safety assessment of substances used in food contact materials.https://efsa.onlinelibrary.wiley.com/doi/pdf/10.2903/j.efsa.2016.4357, accessed: 16.04.2018.

[33] Evans, R.M., Martin, O.V., Faust, M., Kortenkamp, A. (2016). Should the scope of human mixture risk assessment span legislative / regulatory silos for chemicals? Sci. Total Environ. 543, 757–764.
[34] Swingen, T., Winggaard, A.M. (2016). The risk of chemical cocktail effects and how to deal with the issue. J. Epidemiol. Community Health. 70: 322–323. doi: 10.1136 / jech-2015-206268.
[35] Toma, D., Socaciu, C. (2019). Chemicals Migrating from Food Contact Materials: European Regulations, Characterization and Human Exposure (An Overview) Bulletin UASVM Food Science and Technology 76 (2).
[36] Dainelli, D. (2007). Traceability and FCM in Chemical migration and food contact materials. Chemical Migration and Food Contact Materials: Barnes KA, Sinclair, CR, Watson, DH Ed: Woodhead Publishing Limited, Cambridge, England.
[37] Groh, K., Geueke, B., Martin, O., Maffini, M., Muncke J. (2020). Overview of intentionally used food contact chemicals and their hazards https://doi.org/10.1016/j.envint.2020.106225 November 2020 Environment International 150 (9): 106225.
[38] Vápenka, L., Vavrouš, A., Votavová, L., Kejlová, K., Dobiáš, J., Sosnovcová, J. (2016). Contaminants in the paper-based food packaging materials used in the Czech Republic, Journal of Food and Nutrition Research Vol. 55, no. 4, pp. 361–373,
[39] Warhurst, M. (2016). Chemicals in food contact materials: A gap in the internal market, a failure in public protection https://www.chemtrust.org/wp-content/uploads/chemtrust-foodcontactchemicals.pdf, accessed: 23.11.2018.
[40] Vujković, I., Galić, K., Vereš, M. (2007). Food packaging, Tektus, Zagreb.
[41] Geueke, B. (2016). Can coatings.https://www.foodpackagingforum.org/foodpackaging- health / can-coatings, accessed: 05.2. 2018.
[42] Commission Regulation EC 2018/213 on the use of BPA in varnishes and coatings intended to come into contact with food.
[43] Council of Europe Resolution CM/Res (2013) 9.
[44] Bolle, F. (2014). Innovative approach to product testing: Metals and alloys in contact with food - How to establish compliance with European regulations and recommendations, https://www.edqm.eu/medias/fichiers/abstracts .pdf (05/01/2018)
[45] Simoneau, C., Raffae, B., Garbin, S., Hoekstra, E., Mieth, A., Lopes, JA and Reina, V. (2016). Non-harmonized food contact materials in the EU: Regulatory and market situation, European Commission. https://publications.jrc.ec.europa.eu/repository/handle/JRC104198 .
[46] Resolution CM/Res (2020) 9 on the safety and quality of food contact materials and articles.
[47] Regulation (EC) No 1907/2006 of the European Parliament and of the Council on the Registration, Evaluation, Authorization and Restriction of Chemicals
[48] Vavrous, A., Sevcik, V., Dvorakova, M., Cabala, R., Moulisova, A., Vrbik, K., (2019). Easy and inexpensive method for multiclass analysis of 41 food contact-related contaminants in fatty food by liquid chromatography-tandem mass spectrometry. Journal of Agricultural and Food Chemistry. doi: 10.1021 / acs.jafc.9b02544.
[49] BEUC (2019) BEUC position on the regulation of Food Contact Materials, https://www.beuc.eu/publications/beuc-x-2019-096_time_is_ripe_to_repackage_food_safely.pdf, accessed: 02.03.2020.

INTERNET AS A SALE CHANNEL

Hana Žerić, Irnesa Imširović
Ekonomski fakultet Univerziteta u Bihaću, Pape Ivana Pavla II/2, 77000 Bihać, Bosna i Hercegovina
hana.zeric@efbi.unbi.ba
irnesa.imširović@efbi.unbi.ba

ABSTRACT:

With the advent of the Internet, which is the most efficient way of communication, online shopping has emerged. The number of Internet users is growing day by day, and there is an increase in sales through online stores. This is a very popular topic, especially after the appearance of the corona virus, which led to a sharp increase in online shopping. Customer expectations are high, so when buying online, they pay attention to prices, delivery time, payment methods, read reviews. An analysis of online commerce and social networks in the decision-making and purchasing process was performed. Through the online store is possible to order almost all products from clothing, footwear to technology, medicines, food. The paper investigates the impact of online reviews on the purchase decision, as well as the key disadvantages of this method of shopping. The empirical part of the paper investigates the attitudes of consumers towards online shopping in BiH. For the purposes of the research, an analysis of 30 web shops in BiH was performed, and a structured survey questionnaire was used to determine consumer attitudes about this method of shopping. In order to collect as relevant data as possible, secondary sources will be used in this paper. The aim of this paper is to present basic information about the Internet, e-commerce and to investigate consumer attitudes towards online commerce in BiH.
To research consumer attitudes towards online shopping, the Google Forms tool was used to create a survey questionnaire. The survey was attended by 77 respondents. Some questions was limited with one answer and some of it respondents could write by themselves. Online store in BiH are rated very good, and all information about them respondents found trough social networks.

Keywords: distribution, Internet, online store

1. INTRODUCTION

With the advent of the Internet, which is the most efficient way of communication, online shopping has emerged. In statistic we can see that the number of Internet users is growing day by day, as well an increase in sales through online stores. This is a very interesting topic, especially after the appearance of the corona virus, which led to a sharp increase in online shopping. Customer expectations are high, so when shopping online they pay attention to prices, delivery time, payment methods and read reviews. Through the online store is possible to order almost all products from clothing, footwear to technology, medicines, food. The objectives of the paper are: to present basic information about the Internet and digital marketing, to explain e-business and e-commerce, to investigate the use of online commerce in the world and BiH, to investigate consumer attitudes towards online commerce in BiH. The purpose of the research is to bring the concepts of online commerce, the Internet, e-commerce and e-commerce as

close as possible. The basic research hypotheses are: H1 - Consumers in BiH understand the importance of online shopping, H2 - Reviews have a great impact on consumers when shopping online, H3 - The biggest disadvantage of online shopping is the inability to try the product. Secondary data sources are used in this paper. To research consumer attitudes towards online shopping, the Google Forms tool was used to create a survey questionnaire. The survey was attended by 77 respondents. Only some graphs from the survey will be presented in this paper. The first part of the paper contains information on digital marketing and the Internet. Second part of the paper contains information on empirical research of consumer attitudes in Bosnia and Herzegovina.

2. INTERNET, DIGITAL MARKETING AND E-COMMERCE

This chapter will briefly explain how the development of the Internet, digital marketing and e-business has come about. Many people equate the term e-business with online sales, and in fact its most important role is the role of a means of communication. It is a global phenomenon and affects the way of life.

2.1. Internet

The Internet is a global computer network that offers information and communication services. The first computer network called APRANET (Advanced Research Project Agency) was created in 1969. The word Internet was first used in 1982. In the face of the Internet revolution, marketing communications are increasingly appearing today in the form of interactive dialogue between a company and its customers [1]. As the world number of Internet users began to grow in 1999, a new concept of e-commerce appeared, so Internet commerce began to expand. The Internet provides access to many information as well as the exchange of this information regardless of geographical area and time. We access the Internet using a modem that connects to a computer/laptop. It is a virtual world that has no boundaries. The Internet is a sales channel. It is considered to be the most efficient means of communication today, and the fastest growing marketing channel in the world.
In economics, the buyer is king. By browsing the websites, products and services offered on the Internet, the customer makes purchasing decisions. The Internet is a global network of interconnected computer networks that provides an immediate and decentralized opportunity for global communication [2].

2.2 The Internet as a sales channel

The population of Bosnia and Herzegovina is inclined to the traditional way of shopping because when you hear a word like buying or selling, you first think of shopping malls. This is a nation that likes to go to stores, look at products live, touch them, smell them, and there is a different attitude towards Internet sales. This way of communication is relatively cheap and accessible to everyone, it can be said this is the information age. The Internet is a convenient and cheap channel for buying books, music, applications. With the help of the Internet, customers get a lot of information easier and faster than when they visit stores. An example is the comparison of prices of certain products in different stores by browsing their web shops, reviewing reviews, informing about products. Over time, there is an increasing understanding of Internet values, making everyday life easier.
The Internet is not only a channel through which tangible goods can be sold, but also services such as booking accommodation in a hotel, scheduling appointments in salons or at the doctor/dentist. The customer does not have to spend time and money on a trip to the store, finding a parking space, finding a product, waiting in line, etc. Through the business catalog or on the website, the customer can browse and buy easily and in complete privacy [3]. In Bosnia and Herzegovina, mobile banking is developing more and more, so products and services can be paid for with one click. In the virtual world one can lease domains and hosting, create websites, online sales, marketing campaigns for products and so reach customers. By creating online shops, sellers, suppliers and buyers were connected. Today, you can buy almost everything from the Internet, from food, cars, clothes, shoes to technology and certain services.

It is very important that all information is available to customers in the palm of your hand. We went through a period of online teaching and realized that it is possible to acquire new knowledge and skills from the comfort of your home thanks to the Internet. All this is very important for the development of technology in a small country, and it is classified as an advantage of the Internet as a sales channel.

2.3 Digital marketing

Digital marketing is the fastest growing marketing channel, and its other name is online marketing. Digital marketing provides several significant benefits to potential customers:

- Comfort and practicality - customers can order products 24 hours a day wherever they are.
- Reduced inconvenience - online shopping is easy and is done in privacy. With online services, customers do not have to deal with sellers or be exposed to persuasion and various emotional pressures.
- Information - customers can find a number of comparative information about companies, products and prices without leaving their office or home. They can focus on objective criteria such as prices and method of payment, quality, performance and availability, speed of delivery and the like.
- Interactivity and immediacy - customers can "talk" to the seller's website to find the exact information, product or service they want, and then directly order or download it to the screen or computer disk. Receiving and sending information is fast compared to "express" mail or fax [2].

There are also some disadvantages associated with Internet marketing:

- Problems with measuring efficiency - given the novelty of this medium, more sophisticated and universally acceptable ways of testing audiences and measuring efficiency have not yet been identified. Different research firms use different methodologies for researching the Internet, which is why there are often significant discrepancies in the results of measuring the same phenomena, e.g., the number of Internet users.
- Audience characteristics - The web is not a good marketing channel for everyone. Many Internet users are interested in computer products and technology products, so almost half of all Web advertising is related to "computer-oriented" products. Also, the World Wide Web is not necessarily "worldwide" - there are reasons why the Internet is slower to adapt to foreign markets - language, cost, infrastructure, for example.
- Web time - the main objection to the Web is the time it takes to access information. As more and more people access the Web, this problem will get worse. Indicators of a significant "cancellation" rate caused by slowness on the Web are just emerging.
- Congestion - As the number of ads multiplies, the likelihood of a company ad being spotted decreases accordingly. One study found that only 7.2% of Internet users frequently or very often “click” on an advertising banner for more information, while half said they never do so.
- Costs and limited production quality - many advertisers believe that the Internet/Web is an efficient medium for more expensive things, but low efficiency for cheap consumer products such as soups or sweets. The relatively high costs of advertising and delivery limit the use of the Web. In addition, while this is an important point, Internet/Web advertising cannot offer the capabilities of many competing media from a production standpoint. The website does not have high quality TV or printed reproduction, ie TV and printed graphics [2].

2.4 E-business

E-business is more comprehensively defined than e-commerce, because it includes the sale and purchase of products and services, as well as the provision of customer service, cooperation with business partners, the application of e-learning and transactions within the organization. The components of an e-business system are: ERP, CRM, e-commerce, supply chain management, business intelligence. The electronic market has fewer barriers to entry than the traditional market and a neutral intermediary role. Customers in e-business have many advantages, and some of them are: global selection, lower prices, discounts, new products and services, improved quality, response to customer

requirements. The advantages of e-business providers are: business in the global market, customization and response to customer requirements, lower costs, easier and faster order processing. We can view e-commerce or online shopping as a process in which the customer buys goods and services from the merchant via the Internet in real time. Key information to check when ordering online: protection of personal data, delivery time, delivery costs, reviews. The emergence of e-commerce represents a real revolution in business, not only on a hitherto unseen superior technological basis based on modern telecommunications, computing, information technology and cryptology [4]. The first event related to the start of e-commerce occurred in 1970 when Baxter Healthcare began using telephone modems so that hospitals could order their goods. Later, they expanded that system to the PC ordering system. The field of e-commerce includes revenues from advertising, exchanges involving money, goods or services, e-mails, customer support.

There are many models of e-commerce. Those are [5]:

- storefront model,
- auction model,
- portal model,
- dynamic pricing model
- online trading and lending model

3. EMPIRICAL RESEARCH OF ONLINE SALES IN BiH

3.1 Analysis of web shops in BiH

In this part is presented analysis of 30 web shops from Bosnia and Herzegovina. The websites of these companies contain basic information such as address, telephone number and e-mail. The analysis covered clothing, footwear, equipment, medicines, hairdressing equipment, and a platform for publishing purchase announcements. Their characteristics are shown below.

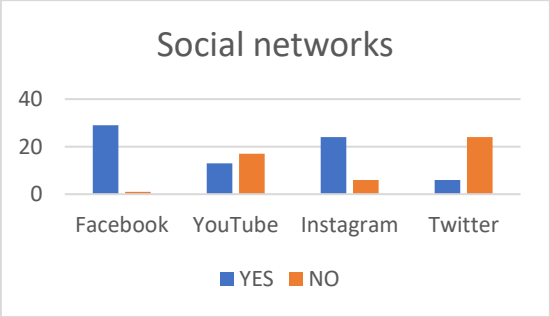

Figure 1: Presence on social networks

Only one page (3.33%) does not have access to the Facebook profile, while other stores have successfully linked their website to a Facebook account. According to the chart, 80% of pages are not present on Twitter, so this information leads to the conclusion that this network is not very popular in BiH. The YouTube channel owns 43.33% of the sites.

Lately, people trust influencers a lot and buy the products they promote, so Instagram has been a huge success. 80% of the analyzed sites has account on this social network.

There are various divisions of social networks, and the basic one is general (Facebook, Twitter,…) and specialized (business network LinkedIn, etc.). With the rapid development of technology and the Internet, many perspectives are opening up and different standards are being set. Today, social networks are available to average users and serve to meet basic human needs, and when it comes to young people they are even a matter of prestige, and often a simulation of virtual reality [6]. A video with a lot of views, more likes than dislikes and a favorable comment proves the quality of the content to new

viewers. Good quality leads to more likes and shares. In the description and in the video itself, viewers must be told to like, comment, share and view more videos. YouTube videos need to be optimized for keywords. Keywords should be included in the video title, description, tags, name of the video file being uploaded. This practice helps users find the video and improves the scale and relevance on the YouTube platform [7].

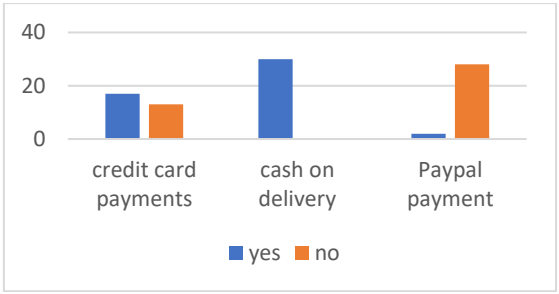

Figure 2: Payment methods

3.2 Researching consumer attitudes towards online shopping

To research consumer attitudes towards online shopping, the Google Forms tool was used to create a survey questionnaire. The survey was attended by 77 respondents and it had 23 questions. Some questions was limited with one answer and some of it respondents could write by themselves. The last part included demographic data. The aim was to find out whether respondents shop online, through which stores and to assess satisfaction with online shopping in Bosnia and Herzegovina.

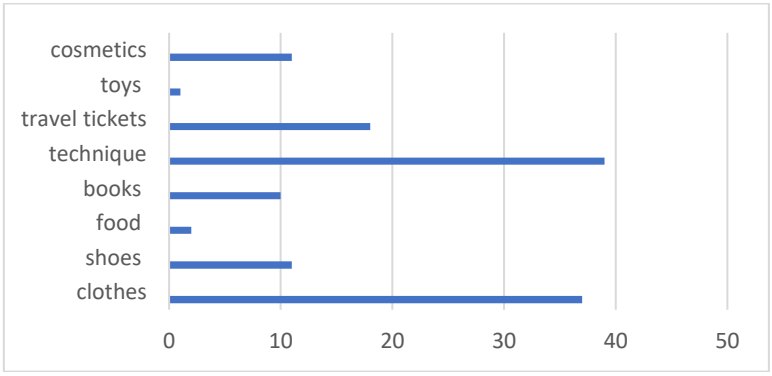

Figure 3: Products you buy through an online store

The most common answer to this question was technique 54.2%, followed by clothing 51.4%, followed by fashion accessories and cosmetics.

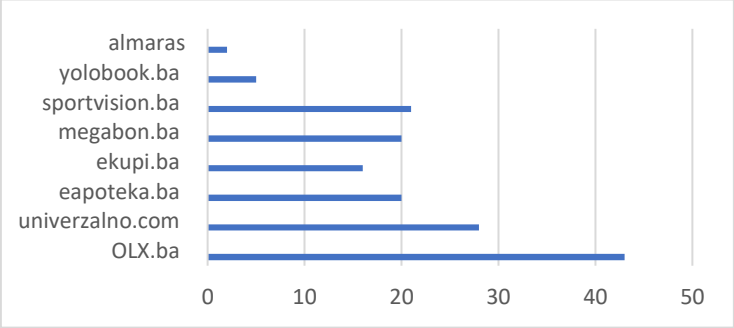

Figure 4: BiH online stores

The figure 4. shows the attendance of BiH online stores. According to 61.4% of respondents, it is Olx.ba that belongs to the category of advertisements and auction sites. This is followed by Univerzalno.ba store of mobile phones and equipment with 40% of votes and Sport Vision store of sportswear and footwear with 30% of votes.

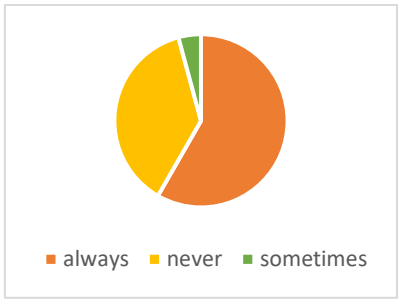

Figure 5: Do you read product reviews before buying?

The aim of this question was to find out whether respondents buy impulsively or plan their purchase. The graph shows that 58.3% of people read reviews, so it is concluded that their purchase is planned and confirms the hypothesis set at the beginning, which is that reviews have a great impact on consumers when shopping online.

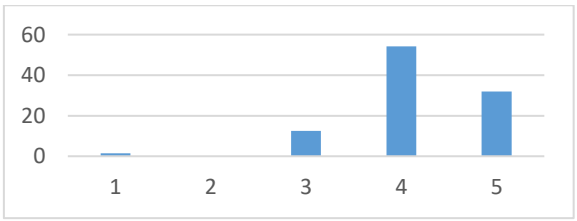

Figure 6: Evaluation of online trade in Bosnia and Herzegovina

When asked about satisfaction with online stores in Bosnia and Herzegovina, respondents with 54.2% gave this method of shopping four, and 31.9% gave a grade of five. According to this, it can be concluded that online commerce in Bosnia and Herzegovina is developing and has a growing curve. The hypothesis of understanding the importance of online shopping in BiH can be confirmed.

4. CONCLUSION

In the end, we come to the conclusion that online shopping in Bosnia and Herzegovina has a growing curve. It is becoming part of everyday life and it can be said that the products are available with one click. By using this method of shopping, the disadvantages of the classic way (going to shopping malls) are avoided and consumers buy from the comfort of their home 24 hours a day. The aim of this paper was to explain the origin of the Internet, digital marketing, the differences between the concept of e-business and e-commerce, to present online commerce in the world, and to analyze consumer attitudes. The online store has many advantages such as: home delivery, the ability to compare prices, discounts, but also disadvantages such as the inability to try the product and thus proved the third hypothesis. The most visited Bosnian-Herzegovinian page is the Olx.ba. Respondents most often order equipment and clothing, and some of interesting products they wrote about are: children's toys, home decorations, raw materials and utensils. The research confirmed the hypothesis about the importance of reviews. Sales through e-commerce are increasing from year to year. Future research should show how many billions e-commerce will reach. The corona virus pandemic has increased the use of online shopping in BiH, so retail chains have enabled their customers to shop online. There has been a greater role for delivery and business improvement. In the end, the online store in Bosnia and Herzegovina was rated very good. There is great hope that in the future this way of shopping will rule the whole world, especially the presence of many restrictions due to the corona virus.

5. REFERENCES

[1] Kotler P., Keller K., Martinović M., Upravljanje marketingom, 14. izdanje, MATE d.o.o, Neum, 2014.
[2] Tihi B., Marketing, Ekonomski fakultet u Sarajevu, Sarajevo, 2006
[3] Čekić Š., Bošnjak I., Tehnologijski marketing u transport i komunikacijama, Univerzitet u Sarajevu, Sarajevo, 2011.
[4] Milosavljević M., Mišković V., Elektronska trgovina, Univerzitet Singidunum, Beograd, 2011.
[5] Simović V., Elektronsko poslovanje, Visoka škola strukovnih studija za informacione tehnologije, Beograd, 2013.
[6] http://skr.rs/5Zk [accessed 22.07.2021]; page 96
[7] Deiss R., Henneberry R., Digital marketing for dummies, John Wiley & Sons, Inc., Hoboken, New Jersey, 2017.; str. 160-161

SECTION/SEKCIJA
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OCCURRENCE OF APPLE POWDERY MILDEW (*Podosphaera leucotricha* (Ellis.&Everh.) E.S.Salmon AN INCREASING PROBLEM IN ORCHARDS ON THE TERRITORY OF UNA-SANA CANTON (BOSNIA AND HERZEGOVINA)

Zemira Delalić

University of Bihac, Biotechnical faculty, Bosnia and Herzegovina
E-mail: zemirabtf@gmail.com

ABSTRACT:

Apple powdery mildew (Podosphaera leucotricha (Ellis.&Everh.) E.S.Salmon was monitored during 2019 and 2020 in north-western area of Bosnia and Herzegovina at 13 orchards of the following varieties:Senabija,Sarenika,Topaz,Cripps Pink,Idared, Braeburn, Gala, Elstar, Granny Smith,Jonagold, Fuji, Golden Delicious and Bukovija.A scale from 0-5 was used for determination of infection intensity on leaves of the examined varieties. The intensity of infection (Index of illness %) of the pathogen was analyzed using Townsend Heuberger method. High index of illness were determined for Elstar, Idared, Jonagold and Granny Smith (62-83%) in 2019 and 2020, which were therefore categorized as varieties highly sensitive to P.leucotricha.Moderate resistance was registered for varieties: Fuji, Golden Delicious, Topaz and Cripps Pink.The lowest infection indexes were present at Sarenika, Bukovija and Gala varieties (3-8%), while the Senabija and Braeburn variety did not indicate any infection symptoms.The causes of more intensive occurrence of pathogen infection are:sensitivity of cultivars, optimal temperature and humidity during apple vegetation, mild winters, dry and warm weather during spring, intensive fertilization, sensitive varieties and modern production technology. Farmers use sensitive varieties such as Idared, Elstar, Jonagold and Granny Smith, while quality agrotechnical and chemical measures are not applied in apple growing. Protection measures apple include the removal of white infected branches and their destruction. For new orchards, farmers should use resistant varieties. The basic measure of protection of P. leucotricha is the use of fungicides (erisificides): preventive, curative which can prevent secondary infection of fruits, leaves, flowers and of apples. Of the fungicides used are preparations: triazoles, pyrimidines, anilinopyridines, dinocap, triforine etc.

Keywords: *Podosphaera leucotricha*, apple varieties, infection

1. INTRODUCTION

The sector of fruit production is a very important element of EU agriculture and constitutes 6.7% of total agricultural production. The most important producers with regard to the economic value of produced fruit are: Spain (33.4%), Italy (18.7%) and France (11.4%), whose combined production amounted to over 60% of fruit production in the EU in 2015.The largest apple producers in the EU are:Poland 25%, Italy 19.2% France 15.5%[1]. The fruit sector offers a large variety of products. However, apples (12.7 million tons), oranges (6 m tons) and peaches (2.5 m tons) are the most important fruit regarding size of harvest in the European Union. Apple trees are the most common fruit tree in the European, and their cultivation covers 450,000 ha. The largest apple producer in the European Union is Poland. The area of apple growing in Poland covers 1/3 (32%) of the total area of apple cultivation in the European Union, and apple orchards there cover more than half (53%) of all fruit-growing

areas[2]. Apple is the second most widespread fruit culture in its presence, immediately behind the plum and it has an important role in the overall fruit production in Bosnia and Herzegovina. In 2015, there were 6 704 447 apple trees capable of yielding; the total yield was 91 471 t, with an average of 13.6 kg per tree [3]. The total number of fruit apple trees in the Una-Sana Canton (North-Western part of B&H) was 155 231, the total yield was 2 015 tons, an average of 13.0 kg per tree (Federation Institute of Statistics Una-Sana Canton in Figures, 2016). Total yield and yield per tree is still low compared to large European apple and pear producers (Italy, Austria, Poland, Spain, etc.). Apple is the most important continental type of fruit trees in the world in terms of production. In recent years, world production has been growing slightly [4]. However, one of the limiting factors in the production of this fruiting species in almost all breeding areas is the appearance of apple powdery mildew (*P. leucotricha*), which, along with the spotted leaves and the scabs on the fruit (*Venturia inaequalis*) is the economically most significant apple disease in our country [5]. Powdery mildew, caused by the obligate biotrophic fungus *Podosphaera leucotricha*, is a major disease of *Malus domestica* present in all major apple-growing areas of the world [6].

Biology of the pathogen is widely investigated all over the world in the past 100 years. Thousands of publications were aimed to investigate the pathogen features and to understand biology of this disease in order to improve powdery mildew forecasting and disease management [7]. Powdery mildew occurs wherever apples are grown. It can be both major and minor importance of the disease in commercial orchards but it is an important disease in apple nurseries worldwide. Economic loss dependent upon climatic conditions, cultivar susceptibility and orchard or nursery management practices. The management of powdery mildew in commercial orchards needs to be integrated with other apple diseases such as apple scab [8].Varieties resistant to powdery mildew caused by *Podosphaera leucotricha* are a major component of sustainable apple production [9]. Patogen *P. leucotricha* is native to North America, where it was first observed in 1871. In Europe, it was first registered in Tirol in 1873. Since then, it has been occurring regularly every year at a stronger or lower intensity [10]. The more massive appearance of apple powdery mildew in the northwestern part Bosnia and Herzegovina was registered in 2009 [11]. Intense occurrence of P. *leucotrich* was observed in 2019 in Una-Sana Canton (northwestern part of Bosnia and Herzegovina)[5]. Mortality of young fruits were determined from 29.33% to 58.0%, and on fruits from 22.0% to 42.0%. In the event of a strong attack, leaves and flowers are drying, decreasing the increase in fruit trees, fruit yields and the market price of fruits [12]. Until the discovery and use of systemic fungicides, disease was a limiting factor for the production of apples [13]. If protection from this pathogen is omitted, the genus can be completely absent.

The aim of this paper is to determine the pathogenic fungus, *P. leucotricha*, and monitor the intensity of infection during 2019 and 2020 in the northwestern part of Bosnia and Herzegovina for 13 orchards of the following varieties: Senabija,Sarenika,Topaz,Cripps Pink,Idared, Braeburn, Gala, Elstar, Granny Smith, Jonagold, Fuji, Golden Delicious and Bukovija. On the basis of the intensity of infection, one of the goals is to determine the resistance, the sensitivity of the varieties, and recommend quality protective measures.

2. MATERIAL AND METHODS OF WORK

In the two-year period (2019-2020), in June and July in the North-Western part of B&H (Una-Sana Canton), the appearance of fungus was reguraly monitored, the causative agent of apple powdery mildew in 13 orchards with varieties: Senabija,Sarenika,Topaz,Cripps Pink,Idared, Braeburn, Gala, Elstar, Granny Smith, Jonagold, Fuji, Golden Delicious and Bukovija. Diagnosing the cause of the disease was determined based on typical symptoms on plants. Then samples of diseased leaves and apples of apple plants were taken and in the microbiological laboratory the fungus was determined by microscopic method. The semi-permanent microscopic preparations of fungus were made [14], and microscopic observations and painted conidia and conidiofora were observed. The assessment of the

infection was carried out of the scale 0-5. Intensity of infection is calculated according to Townsend-Heuberger. For each variety, 200 sheets were selected by random selection. The infected leaves are ranked according to the scale: 0 = no symptoms; 1 = 1-10%; 2 = 10-25%; 3 = 25-50%; 4 = 50-75%; and 5 = 75-100% of infected leaves. The index of the disease was calculated according to the Townsend Heuberger formula:

$$I\% = \sum(n \times v) / NV \times 100$$

Where is I% = index of the disease; n = degree of infection by scale; v = number of sheets per category; N = highest degree of infection; V = total number of sheets examined. Based on the disease index, the resistance of the varieties was determined in the following way: 0-very resistant variety (all plants are completely healthy, index of disease 0); I-resistant (index of disease 10); II = medium-resistant (disease index 11-25); III = medium sensitive (index of disease 26-50) and IV = very sensitive (index of disease above 50).

3. RESULTS AND DISCUSSION

3.1. Symptoms and fungus properties

During the year 2019 *P. leucotricha* The fungus was detected on 50% of the examined plants and in 2020 on 65% of the examined plants. Fungus attack was registered on flower buds, leaves and shoots. (Figure 1,2,3). Infected twigs often are stunted and may die. When young leaves are infected, they tend to increase in length but not in width, and to become folded longitudinally [15]. Infections on leaves appear fi rst on the lower surface. These lesions may spread to the upper surface and cover the entire leaf with a white spores and mycelium. Infections along the leaf margin often result in leaf curling or crinkling.Severely infected leaves sometimes abscise by midseason. In nureseries, the fungus can spread to all developing leaves and cause severe stunting of vegetative terminal shoot [8]. Early fruit infection originated from diseased blossoms. Apple blossoms emerging from infected buds may give rise to small, russeted fruit. Infected fruits is covered with a network pattern of cork cells. Infected terminal buds are completely infected with spores. Partially affected buds give “white shoots“, which rise for several weeks, then discards leaves [16].

Fig. 1. White shoots(Photo by: Delalić Z.)

Fig. 2. Necrosis and leaves twisting (Photo by: Delalić Z.)

Fig.3. Symptoms on fruit(Photo by: Delalić Z.)

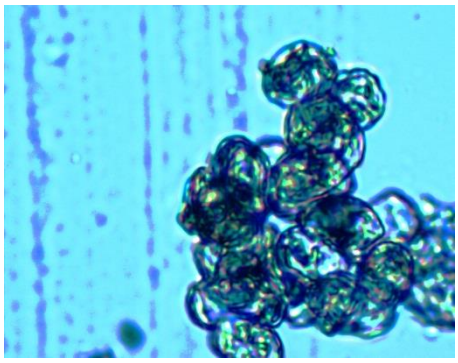


Fig.4. Conidia of fungus P. leucotricha (Photo by:Delalić Z.)

The fungus develops epiphyseal mycelium on leaves, shoots, flowers, and young fruits, so they look like they were covered with powdery mildew, which is why the disease is called "powdery mildew". Because of the development of the coating, the fungus cover the green parts of the plant that are less assimilated [17]. Individually infected leaves occurring during vegetation were secondary infected. On the reverse side of these leaves spruce with a whitish shroud were developed, chlorosis, and later necrosis and insertion of the leaf [18]. Disease cycle *P. leucotricha* is an obligate parasite that overwinters as mycelium in dormant buds infected during the previous growing season.Over wintering of the fungus is limited primarily by temperature. Infected buds are often failed to burst after a severe winters, The survival rate of these buds below –20 °C is less than 5%, while healthy buds can survive the temperatures of –30 °C. Temperatures below –12 °C can kill the mycelium int he infected buds and allow the buds to produce healthy leaves. [7]

It was found that *P. leucotricha* was developed as an epiphytic. On the surface of the plant organs it forms a mycelium with conidiophores and conidia, as confirmed by microscopy in the laboratory (Figure 4).

The mycelium is attached by the appressorium for plant tissue, and it is fed by haustoria. The conidias are in series (6-9), single-celled, elliptical size 12-20x23-30 μm. Cleistothecium may occur in groups of luteur or leaf handles, diameter 75-96 μm, round or pear-shaped.Two types of appendices are formed on them, the ones that are dichotomous at the top, upright, while others are basically rudimentary light-headed, simple and rarely split. In cleistothecium there is an elliptical askus (45-55x50-70 μm) with eight ascospores. Ascospores are single-celled, colorless, ellipsoidal (size 12-14x22-36 μm) [13]. Pathogen development in the north-western part of Bosnia and Herzegovina was favorably influenced by mild and wet winters [5].

3.1.Indexes of illness and resistance varieties

The indexes of illness ranged from 0-83%. In 2019 and 2020, as the most sensitive was tvariety Elstar(62-83%), Idared (64-78%) then the varieties Jonagold and Granny Smith.In the group of medium resistant varieties are Golden Delicious, Topaz, Fuji and Cripps Pink with a disease index of 11-23% was classified. Bukovija and Braeburn varieties were resistant to low intensity disease, and there was no infection with *P. leucotricha*. Research apple powdery mildew in 2016 and 2017 in North-Western Region of Bosnia and Herzegovina show that the variety Braeburn was resistant[5]. Due to the appearance of this pathogen and damage to apples, protection measures must be implemented each

year. Apple cultivars considered moderately to highly susceptible include Jonathan, Baldwin, Cortland, Idared, Rome Beauty, Monroe, Gravenstein, Stayman Winesap, Cox's Orange Pippin, Granny Smith, and Prima. Less susceptible cultivars include Delicious, Golden Delicious, Winesap, York Imperial, Nittany and Lord Lambourbe [8]. InCentral Transylvania, Romania, the most susceptible to powdery mildew attack were varieties of the Jonathan group (e.g.Jonathan, Jonne Spur, Jonathan Smith, Black John, Jonathan Watson, Nüred Jonathan, Delia, Aromat de vară, Roşu de Cluj) [19].

Table 1: Index of illness and resistance varieties in 2019. and 2020.

Sorta	Index of illness (%)		Resistance /sensitivity of varieties
	2019	2020	
Gala	3	5	resistant
Bukovija	3	3	resistant
Senabija	0	0	very resistant
Sarenika	4	8	resistant
Elstar	83	62	very sensitive
Golden Delicious	11	23	medium resistant
Topaz	13	12	medium resistant
Fuji	11	17	medium resistant
Idared	78	64	very sensitive
Braeburn	0	0	very resistant
Jonagold	61	60	very sensitive
Cripps Pink	15	12	medium resistant
Granny Smith	62	62	very sensitive

4. CONCLUSION

The pathogenic fungus P. leucotricha regularly occurs on fruit apple plants in the North-Western part of Bosnia and Herzegovina and causes significant damage to leaves, young shoots, flowers and fruits. The fungus was detected in 2019. on 50% of the examined plants and in 2020 on 65% of the examined plants.Disease indexes ranged from 0-83%. In 2019 and 2020, the most sensitive variety was Elstar (62-83%), Idared (64-78%), followed by Jonagold and Granny Smith. In the group of medium-resistant varieties are Golden Delicious, Topaz, Fuji and Cripps Pink are classified with a disease index of 11-23%. The varieties Bukovija and Braeburn were resistant to low-intensity disease, and there was no *P. leucotricha* infection. In the group of resistant varieties were Sarenika, Gala and Bukovija with a disease index of 3-8% was classified.

According to the farmers' statements, in practice, the quality of agro-chemical and chemical protective measures are not implemented, which indicates their lack of information on modern apple cultivation. Of the protection measures, it is important to remove "white shhots" during cutting, both during the winter and spring (green cuttings) and their destruction (burning or burial), so they won't spread spores. It is mandatory to disinfect pruning shears and destroy infected parts of plants so that the disease does not spread. It is important to avoid excessive use of fertilizers, especially in late summer. This will prevent the growth of juicy new tissue that the fungus easily infects. Excessive shade of plants, high humidity and poor circulation increase the chances of infection.Infections occur at temperatures of 65 to 80°F when relative humidity is high, such as at night. No moisture is required for spore germination

to occur. Consequently powdery mildew is often called the "dry weather disease."The rows of the cultivations should be placed in the direction of blowing the dominant winds, in order to ensure good air circulation and low relative humidity. When raising new plantations, producers need to choose resistant varieties, since later protection is difficult and expensive. The basic measure of protection against *P. leucotricha* is the use of fungicide. Fungicides are most commonly applied at intervals of 7 to 10 days, starting from the phenophase when the flower buds are visible, and until the phenophase when the shoots reach their full upgrowth.Because this is so difficult to curb the disease and it is crucial to eliminate spores that will constantly infect your tree, it is important to choose and properly apply fungicides. Classic fungicides that are used against apple scab, such as sterol inhibitors, are highly effective at controlling powdery mildew. These include myclobutanil and fenbuconazole.Since the fungus overwinters inside buds, you should start treating your tree early in the season before the blossoms start to show a pinkish color. Classic fungicides that are used against apple scab, such as sterol inhibitors, are highly effective at controlling powdery mildew. These include myclobutanil and fenbuconazole.Since the fungus overwinters inside buds, you should start treating your tree early in the season before the blossoms start to show a pinkish color.Sulfur fungicides can be used for treatment before symptoms appear. It is important to be careful with sulfur, because it can be harmful to apple plants. This class of fungicide includes the classic Bordeaux mixture of copper sulfate and lime. This combination is very effective in preventing powdery mildew and is certified as organic.

4. REFERENCES

[1] Data from the period of July/August (2016). http://ec.europa.eu/eurostat/statistics-explained/index.php/The_fruit_and_vegetable_sector_in_the_EU_a_statistical_overview.
[2] http://applesfromeurope.eu/for-professionals/apple-production-in-europe
[3] Statistical Agency of B&H, (2016).
[4] Nikolić, D., Keserović, Z. , N. Magazin, N., Paunović, S., Miletić, R., Nikolić, M., Milivojević, J. (2012).Stanje i perspektive razvoja voćarstva u Srbiji. IV Kongres voćara i vinogradara sa međunarodnim učešćem, Zbornik radova i apstrakata, 3-22, Vrnjačka Banja.
[5] Delalić, Z.(2019). Occurrence of Apple Powdery Mildew, Podosphaera Leucotricha (Ellis. & Everh.) E. S. Salmon in North-Western Region of Bosnia and Herzegovina. New Technologies, Development and Application. NT 2018. Lecture Notes in Networks and Systems, vol 42. Springer, Cham. Chapter, January 2019 with 59 Reads DOI: 10.1007/978-3-319-90893-9_57, In book: New Technologies, Development and Application, pp.491-497.
[6] Turechek, W.W. , Carroll, J.E., Rosenberger, D.A. (2004). Powdery mildew of apple. NY State Integrated Pest Management
.(www.nysipm.cornell.edu/factsheets/treefruit/diseases/pm/apple_pm.pdf).
[7] Holb, I.J. (2013). Apple powdery mildew caused by *Podosphaera leucotricha*: some aspects of biology, International Journal of Horticultural Science 2013, 19 (3-4): 19-23.Agroinform Publishing House, Budapest, Printed in Hungary.
[8] Hickey, K.D. and K.S. Yoder. (1990). Apple powdery mildew. Pages 9-10 in A.L. Jones and H.S. Aldwinckle, ed. Compendium of Apple and Pear Diseases. Am. Phytopathol. Soc., St. Paul, MN. 100 pp.
[9] Pessina,S., Angeli, D., Martens,S., Visser, R.G.F., Bai,Y., Salamini,F., Velasco,R., Schouten, H.J., anMalnoy, M.(2016). Plant Biotechnol J., 14(10): 2033-2044.Published online 2016 May 11. doi: 10.1111/pbi.12562.
[10] Miletić, N.(2000). *Podosphaera leucotricha* (Ell. i Ev.) Salm. - prouzrokovač pepelnice jabuke, Biljni lekar, 6, 450-456.
[11] Dervišević, S., Delalić, Z., Jogić, V.(2009). Analiza zdravstvenog zasada jabučastog voća na području općine Sanski Most, Zbornik radova, Smotra naučnih radova studenata agronomije sa međunarodnim učešćem, 41-48, Čačak.

[12] Stojanović, S.(2004). Poljoprivredna fitopatologija, Srpsko biološko društvo "Stevan Jakovljević", Kragujevac.
[13] Delalić, Z. (2007). Fitopatologija-specijalni dio. Grafičar, Bihać.
[14] Milošević, D. (2008). Fitopatologija-praktikum, Agronomski fakultet, Čačak.
[15]Ellis, M.A., Ferree, D.C. and Spring, D. E. (1981). Photosynthesis, transpiration, and carbohydrate content of apple leaves infected by Podosphaera leucotricha. Phytopathology 71: 392–395.
[16] Ivanović, M., Ivanović, D. (2001). Mikoze i pseudomikoze biljaka, Poljoprivredni fakultet, Beograd.
[17] Ciglar, I. (1998). Integrirana zaštita voćnjaka i vinograda, Zrinski d.d. Čakovec.
[18] Miletić, N.,Tamaš, N. (2009). Integralna zaštita jabuke, Zbornik radova II Savetovanja "Inovacije u voćarstvu", 95-106, Beograd.
[19] Sestraş, R. (2003). Response of several apple varieties to powdery mildew (*Podosphaera leucotricha*) attack in central Transylvania Conditions, Journal of Central European Agriculture (online), Volume 4.

ASBESTOSIS AS A PROFESSIONAL LUNG ILLNESS OF WORKERS

Anes Budimlić[1], Enver Budimlić[2], Dalila Midžić[3]
[1]Islamski pedagoški fakultet Bihać, Univerzitet u Bihaću, 77 000 Bihać
[2]Pedagoški fakultet Bihać, Univerzitet u Bihaću, 77 000 Bihać,
budimlicanes6@gmail.com, enver.budimlic@gmail.com, dalilabudimlic1@gmail.com

ABSTRACT:

Asbestosis is a progressive lung disease that occurs in workers who are exposed to inhalation of asbestos dust and fibers for a long time, which causes a chemical action of needle-shaped silicates by penetrating the membranes of lung tissue with a chronic inflammatory reaction, resulting in chronic fibrosis and permanent lung parenchymal damage. Asbestos is a chemical silicate that has outstanding technological properties. However, it has been shown to be dangerous to human health, due to its needle-shaped structure that easily penetrates the lung membranes and causes a chronic inflammatory reaction and a foreign body reaction there. This results in an inflammatory process in the lungs with all mediators of inflammation or may result in an inflammatory reaction in the pleura (lungs), especially in people with a weakened immune system and in people who suffer from asbestosis from some other systemic diseases. Eventually, pleural thickening develops in the pleura, in the form of granulations, and interstitial fibrosis develops in the lungs with a decrease in the ventilatory function of the lung parenchyma, which affects the working ability of workers, who are often absent from work due to severe health problems. But how fibrosis will develop, at what rate and with what prognosis depends exclusively on the patient's immune status, and the length of exposure to asbestos itself as a harmful chemical noxa. Asbestosis is a relatively benign, non-malignant disease. One hundred years ago, it was also deadly, due to the poor use of protective measures in the workplace, personal preventive measures and poor working conditions in terms of microclimate. However, as knowledge about the chemical harmfulness of asbestos to the health of workers has developed, and as work has begun in parallel with the introduction of special preventive measures to protect workers at work, mortality from asbestosis has been reduced to almost zero, even in our country.

Keywords: asbestosis lungs, pathological changes, diagnosis, prevention, treatment.

1. INTRODUCTION

Asbestosis is a breathing disorder caused by inhaling asbestos fibers. Prolonged exposure to these fibers in the lungs can cause scarring and shortness of breath. Symptoms can range from mild to severe, and usually appear after many years of exposure [1,2].
Asbestos is a heat-resistant natural mineral. In the past, it has been used in products such as insulation boards, cement or tiles.

1.1. Symptoms

The first symptom that appears in workers is dyspnea (shortness of breath) is the main sign that greatly affects the working ability of workers, although it should be emphasized that the first signs of the disease often remain unrecognized [3].

About 80% of patients develop hypertension, and as such have dyspnea, which masks the true cause of shortness of breath. However, the public today is better informed about this disease and if someone has been in contact with asbestos, then that person reports himself to the doctor [4].

The first is dyspnea in exertion, the second is dyspnea at rest. The third symptom is a cough that is dry and long-lasting with scanty secretions. The fourth symptom is frequent bronchitis. This is an objective sign, not a symptom, because obstruction at the level of the small airways can be measured and objectified. However, such damages are not specific, they can be caused by many other diseases. Most people with asbestosis became ill at work before the use of asbestos and asbestos products began to be regulated in the mid-1970s. Treatment is based on relieving symptoms. The effects of long-term exposure to asbestos usually show up 20 to 30 years after initial exposure. Wet asbestos irritates and damages lung tissue, and interferes with the delivery of oxygen to the blood causing inflammation of the membranes of the alveoli-alveolitis, and irreversible changes in terms of pulmonary parenchymal fibrosis [5,6,7]. Cigarette smoking increases the retention of asbestos fibers in the lungs, and often leads to faster disease progression.

Symptoms may include:

- Shortness of breath - the main symptom of asbestosis is shortness of breath. Initially, shortness of breath only happens with exertion, but eventually it will happen even while you are resting.

- Cough and chest pain - as the disease progresses, persistent dry cough and chest pain may occur.

- Deformity - advanced cases of asbestosis sometimes lead to deformity of the fingers.

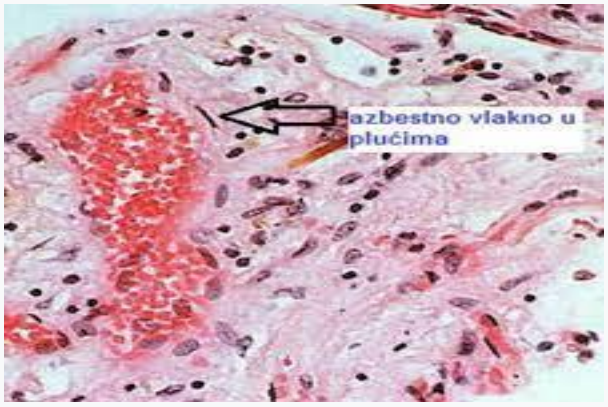


Figure 1: Asbestos fiber in the lungs

1.2. Causes of asbestosis

If you have been exposed to high levels of asbestos dust over a long period of time at your workplace, the inhaled fibers can get stuck inside the alveoli, tiny bubbles inside the lungs where oxygen and carbon dioxide are exchanged. As asbestosis progresses, more and more lung tissue is affected. Eventually, the lung tissue becomes so rigid that it cannot expand normally, that is, due to asbestosis and pathological changes in terms of fibrosis, atelectasis areas appear at the level of the lung alveoli [8,9].

1.3.Testing and diagnosis of asbestosis

Asbestosis can be difficult to diagnose because the symptoms are similar to other respiratory illnesses, especially if it is some other type of pneumoconiosis [10].

In order to determine the diagnosis, it is necessary to do a series of diagnostic tests:

- X-ray of the lungs - if asbestosis has progressed, the entire lungs may be affected and then look like honeycombs.
- Computed tomography (CT) - generally provides more detail and can help detect asbestosis at an earlier stage.
- Pulmonary function test - these tests determine how well the lungs are functioning. Pulmonary function tests measure how much air they can hold and the flow of air in and out of the lungs. Some lung function tests can measure the amount of oxygen carried into the bloodstream.

1.4.Treatment of asbestosis

Treatment is based on preventing disease progression and alleviating symptoms.

Treatment for asbestosis may include:

- Medications - The use of an inhaler sometimes helps with breathing problems.
- Therapy - To relieve breathing difficulties, your doctor may prescribe extra oxygen.
- Surgery - if the symptoms are severe, you may be a candidate for a lung transplant.

1.5. Prevention

Reducing asbestos exposure is the best prevention.

Many homes built before the 1970s contain asbestos in things like:

- Building insulation
- Insulation for hot water and steam pipes

- Sound insulation
- Roofs and shingles
- Vinyl floor coverings

In general, there is no cause for concern as long as these materials are in good condition.
Only when they are damaged is there a danger of asbestos fibers. Asbestosis occurs only after repeated exposure to large amounts of fiber for many years [10].
The term asbestos disease implies the existence of a scarring and carcinogenic effect of asbestos in tissues. The disease is characterized by pulmonary fibrosis and pleural scarring. Exposed to asbestos very often suffer from lung cancer, mesothelioma, laryngeal cancer and gastrointestinal tract cancer [11].

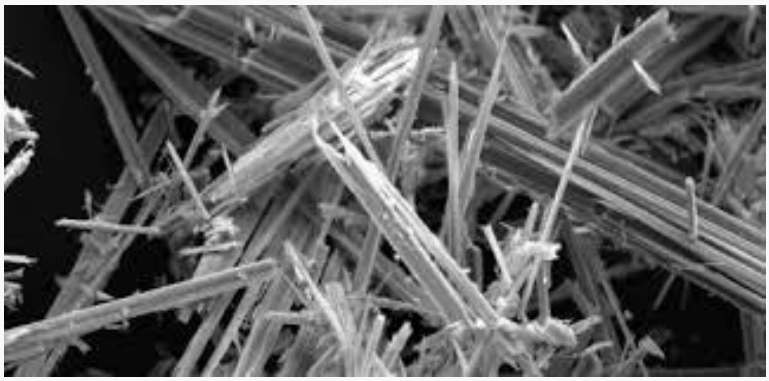


Figure 2: Asbestos fibers

2. ETHIOPATHOGENESIS

Asbestos is the common name for the fibrous types of silicate minerals that were used for fire protection. Asbestosis usually develops after exposure of the lungs to asbestos. The most important role in the development of asbestos disease is played by alveolar macrophages, which phagocytose asbestos fibers and surround them with an acidic mucopolysaccharide coating in which hemosiderin is incorporated. In this way, asbestos bodies are formed.The coating of asbestos fibers is the body's defense mechanism, which should prevent the negative effects of fibers in the tissue. But the process of forming asbestos bodies is completed only in 1% of retained fibers. The latent period before clinical detection of fibrosis usually lasts longer than 20 years. Because the process of eliminating and melting asbestos is slow, asbestosis progresses even after removing the patient from the harmful work environment [10,11].Asbestos diseases are most common among workers in asbestos production, among workers who use asbestos products (construction, insulation, shipbuilding). They can also be sick family members of these workers, as they bring asbestos fibers in clothing or hair into their homes. Asbestos fibers penetrate the lung parenchyma to the visceral and parietal pleura. They occur especially often in the area of the diaphragmatic and costal pleura [11]. Diffuse pleural thickenings mainly occur in the lower parts of the lungs surrounding the diaphragm. The synergistic effect of smoking should be taken

into account in the development of lung cancer. An association between asbestos exposure and mesothelioma has been demonstrated. Short-term exposure to asbestos several years ago is also important. The link between asbestos exposure and tumors of other organs is weaker than in lung cancer and mesothelioma.

3. CLINICAL SYMPTOMS

The clinical picture of asbestos disease depends on the form and progression of the disease.
Other diseases associated with asbestos exposure are pericarditis, pericardial mesothelioma, peritoneal mesothelioma, head and neck cancer, gastrointestinal cancer. Focal scarring changes in the pleura are found in almost half of workers occupationally exposed to asbestos. They do not impair lung function and are not potentially malignant. They are asymptomatic.
With significant scarring and extensive adhesive pleural changes in patients, dyspnea is observed during physical exertion, which gradually worsens over the years. In addition, there is a dry, irritating cough, chest pain and weight loss. Thickening of the visceral pleura can cause changes in the lung parenchyma, resulting in asymptomatic oval thickenings, which are seen on the X-ray as round lesions. The diagnosis is made using a CT that shows a characteristic "comet's tail" image.
Asbestosis is a chronic interstitial fibrosis, caused by inhalation of asbestos. Slow progressive dyspnea and dry cough occur. Basal inspiratory cracks are heard above the lungs on both sides. Stem fingers may form. The disease progresses to respiratory failure. The symptomatology of malignant diseases caused by asbestos does not differ from the symptomatology of malignant diseases that are not related to asbestos exposure.

4. DIAGNOSIS

Having reliable data on exposure to asbestos dust, for the diagnosis of asbestosis, it is sufficient to notice characteristic X-ray changes in the lungs and on the pleura and lung function tests. X-ray asbestosis is characterized by bilateral thickening of the interstitium in the lower lung lobes. The changes are best shown by computed tomography.The changes are initially focal in the form of small, irregularly shaped thickenings that grow more and more as the disease progresses. Pleural focal lesions in the form of pleural plaques are usually present. Occasionally we see exudative pleurisy and diffuse pleural thickening [11,12]. Cytological and histological examinations are only required if there is no data on asbestos exposure or radiological changes and functional tests are not specific for asbestosis. The pathohistological picture of asbestosis of the lungs is characterized by focal interstitial fibrosis and the finding of asbestos bodies. For asbestosis, a significant change in lung function is a restrictive ventilation disorder and reduced diffusion capacity. Impairment of pulmonary function is relatively small even in advanced asbestosis.Malignant diseases due to asbestos exposure are diagnosed according to the procedures described in the chapters on lung cancer and mesothelioma.

5. TREATMENT

There is no specific treatment. There are only protective measures in the workplace. Patients should be removed from further exposure - so as not to increase the load on the respiratory system with asbestos. Malignant disease due to asbestos exposure is treated as a non-asbestos-related malignancy [12].

6. CONCLUSION

Asbestos disease is always progressive in nature. Asbestos, which penetrates the lungs, stands there. Additional progression of asbestos scarring changes in the lungs and parietal pleura poses a potential risk of developing malignancy due to asbestos exposure. Damage Of ventilation function of the lungs is greater in patients with pleural and mixed asbestosis than in patients with pulmonary asbestosis. In patients with asbestosis with changes in the pleura of thelungs, lung function decreases with increasing age and length of exposure.

7. REFERENCES

[1] Omland Ø., Meyer HW., Lauridsen HL., Bønløkke JH., Sherson DL. [Work-up of asbestosis and estimation of **asbestos** exposure in an occupational context].Ugeskr Laeger. 2018 May 28;180(22):V10170739.PMID: 29808815

[2] Ross RM. Software for Apportionment of **Asbestos**-Related Mesotheliomas.Can Respir J. - 2016;2016:5340676. doi: 10.1155/2016/5340676. Epub 2016 May 18.PMID: 27445546

[3] Gualtieri AF., Lusvardi G., Pedone A., Di Giuseppe D., Zoboli A., Mucci A., Zambon A., Filaferro M., Vitale G., Benassi M., Avallone R., Pasquali L., Lassinantti Gualtieri M. Structure Model and Toxicity of the Product of Biodissolution of Chrysotile **Asbestos** in the **Lungs**.Chem Res Toxicol. 2019 Oct 21;32(10):2063-2077. doi: 10.1021/acs.chemrestox.9b00220. Epub 2019 Sep 10.PMID: 31464428

[4] Barlow CA., Grespin M., Best EA. **Asbestos** fiber length and its relation to disease risk.Inhal Toxicol. 2017 Oct-Dec;29(12-14):541-554. doi: 10.1080/08958378.2018.1435756.PMID: 29458304

[5] Ingravalle F., Ceballos LA., D'Errico V., Mirabelli D., Capella S., Belluso E., Pezzolato M., Bozzetta E., Dondo A., Di Blasio A., Meistro S., Vizio C., Fraccaro E., Ardizzone M., Seghesio A., Ru G. Wild rats as urban detectives for latent sources of **asbestos** contamination.Sci Total Environ. 2020 Aug 10;729:138925. doi: 10.1016/j.scitotenv.2020.138925. Epub 2020 Apr 25.PMID: 32371204

[6] Campopiano A., Cannizzaro A., Olori A., Angelosanto F., Bruno MR., Sinopoli F., Bruni BM., Casalinuovo F., Iavicoli S. Environmental contamination by naturally occurring **asbestos** (NOA): Analysis of sentinel animal **lung** tissue.Sci Total Environ. 2020 Nov 25;745:140990. doi: 10.1016/j.scitotenv.2020.140990. Epub 2020 Jul 18.PMID: 32717604

[7] Kettunen E., Hernandez-Vargas H., Cros MP., Durand G., Le Calvez-Kelm F., Stuopelyte K., Jarmalaite S., Salmenkivi K., Anttila S., Wolff H., Herceg .Z, Husgafvel-Pursiainen K. **Asbestos**-associated genome-wide DNA methylation **changes** in lung cancer.Int J Cancer. 2017 Nov 15;141(10):2014-2029. doi: 10.1002/ijc.30897. Epub 2017 Aug 2.PMID: 28722770

[8] van Zandwijk N., Reid G., Frank AL. **Asbestos**-related cancers: the 'Hidden Killer' remains a global threat.Expert Rev Anticancer Ther. 2020 Apr;20(4):271-278. doi: 10.1080/14737140.2020.1745067. Epub 2020 Mar 29.PMID: 32223452

[9] Kumagai-Takei N., Lee S., Srinivas B., Shimizu Y., Sada N., Yoshitome K., Ito T., Nishimura Y., Otsuki T. The Effects of **Asbestos** Fibers on Human T Cells.Int J Mol Sci. 2020 Sep 23;21(19):6987. doi: 10.3390/ijms21196987.PMID: 32977478

[10] Broeckx G., Pauwels P. Malignant peritoneal mesothelioma: a review.Transl Lung Cancer Res. 2018 Oct;7(5):537-542. doi: 10.21037/tlcr.2018.10.04.PMID: 30450291

[11] Beers MH., Porter RS., Jones TV., Kaplan JL., Berkwits M. The Merck Manuel of Diagnosis and Therapy, USA, Merck Research Laboratories, 2006

[12] Jerše M. Pneumokonioze, Med razgl 2012; 51: 329–57

THE IMPORTANCE OF PROPER DISPOSAL OF MEDICAL WASTE ON THE ENVIRONMENT AND HUMAN HEALTH

Anes Budimlić[1], Enver Budimlić[2], Dalila Midžić[3]
[1]Islamski pedagoški fakultet Bihać, Univerzitet u Bihaću, 77 000 Bihać
[2]Pedagoški fakultet Bihać, Univerzitet u Bihaću, 77 000 Bihać,
budimlicanes6@gmail.com, enver.budimlic@gmail.com, dalilabudimlic1@gmail.com

ABSTRACT:

Economic growth and growing material consumption result in a constant increase in the amount of waste. Almost every thing, material, device becomes waste after a while. Accumulation of waste disturbs the balance in nature and becomes an economic, environmental and health problem of today, which poses a task of special care for waste to society. The amount of waste generated is related to the technological development and economic level of a country. Economically more developed countries generate more waste and face serious problems with waste disposal and management. Large quantities of this waste are transported to economically less developed countries, which become large landfills for developed countries. Medical waste carries a higher potential risk to human health than other types of waste due to the hazardous and infectious materials it may contain. Most of the waste (85%) generated in health care facilities is actually risk-free, but the remaining 15% is pathological, infectious, pharmaceutical and chemical waste that requires special attention and appropriate disposal. Disposal of medical waste in an adequate manner is especially important in the event of infectious diseases, epidemic and pandemic, exclusively by incineration, as is the case in the COVID - 19 pandemic.

Keywords: medical waste, medical facilities, medical waste disposal, environmental impact

1. INTRODUCTION

Medical waste is a higher potential risk to human health and the environment than other types of waste, as it may contain hazardous and infectious materials. Most of the waste, more precisely about 85% generated in health facilities is risk-free, but the remaining 15% are pathological,infectious, pharmaceutical and chemical waste that requires special attention and appropriate disposal. By composition we divide medical waste into hazardous and non-hazardous. Medical waste treatment includes its sorting at the place of origin, collection, record keeping, reporting, storage, pre-treatment, treatment, transport and disposal. Waste collection and transport routes must be foreseen and clearly indicated in the Plan, they should be separated from the routes by which normal health activities take place (patients, clean laundry, sterile material, etc.) if not spatially, at least temporally [1,2].

2. WASTE SEPARATION

2.1. Inert waste

Inert waste is non-hazardous waste that is not subject to significant physical, chemical or biological changes and is not flammable, nor is it biodegradable. It does not work with substances in contact with it in a way that would affect human, animal and plant health, nor increase it permitted emissions into the environment. The content of contaminants in the aqueous extract and the ecotoxicity of the aqueous extract (eluate) of inert waste must be negligible and must not not endanger the quality of surface or groundwater in any prescribed parameter [3].

2.2. Non-hazardous waste

Non-hazardous waste is any waste that does not have any of the properties of hazardous waste [4].

2.3. Hazardous waste

Types of waste that are considered hazardous are marked with an asterisk(*). This waste contains substances or properties or must contain one or more of the properties, identified by the list of hazardous waste. For easier control and cross-border traffic of hazardous waste is marked as green (pharmaceutical), yellow (chemical), red (infectious) and waste with A or B lists. A special category of hazardous waste represents waste coming from health and similar institutions [5].

3. MEDICAL WASTE

Medical waste is waste generated during the protection of human and animal health from related research activities. The largest producers of medical waste are health care institutions, clinics, health centers, hospitals, diagnostic and research laboratories, morgues, autopsy centers, dental practices and community care services. For the category of medical waste in addition to separate collection, treatment, storage, transportation which includes equipping and marking vehicles for transportation with accompanying guidance documentation. Waste generated in health and similar facilities can be categorized by properties (non-hazardous and hazardous medical waste) and by physical state (solid, liquid and gaseous waste) [6]. 2

3.1. Non dangerous medical waste

Of the total amount of waste from the health care industry, about 75-90% is inert waste which is similar to a utility, includes standard waste, paper, cardboard packaging, and glass leftover food.

3.2. Hazardous medical waste

Hazardous medical waste poses a health hazard, requires special treatment and makes 15- 30% of the total amount of waste. This type of medical waste is dangerous to health humans, flora and fauna because it contains pathogenic microorganisms that can vary in length to survive.

Figure 1: disinfection, storage and disposal of waste

Figure 2: Acute and infectious waste disposal procedure

3.3. Pathological waste

Pathological waste contains parts of the human body and / or amputates, tissues and organs removed during surgical procedures, tissues taken for diagnostic purposes, placentas and fetuses, experimental animals and their parts. This category also includes anatomical waste defined by a professional health personnel who, for ethical reasons, require special care conditions [6].

3.4. Infectious waste

Infectious waste contains pathogenic biological agents (bacteria, viruses, fungi, parasites) that due to its type, virulence, under certain conditions, can cause disease in people who are exposed to them. It originates from laboratories, microbiological laboratories, dispensaries and hospital wards. This includes accessories, equipment and cultures that have been in contact with the infected the patient or his secretions. This type of waste is generated in larger quantities on surgical wards (gauze, equipment that has been in contact with blood or body fluids), in isolation units (clothing that has been in contact

with an infected patient or his fluids, sanitary material). Infectious waste in large quantities comes from the dialysis department (systems, gloves, pipes, filters).

3.5. Sharp objects

This category includes all medical waste with sharp or pointed ends that can cause stab wounds and cuts. In addition to stab wounds, it can also cause infection and infection microorganisms. Includes needles, scalpels, lancets, blades, glass, nails, saws.

3.6. Pharmaceutical waste

Pharmaceutical waste includes pharmaceutical products, drugs and chemicals that are returned with compartments where they were spilled, squandered, prepared and unused. The drugs it is expired or should be discarded for any reason. In addition to the above in this group include vials containing medicines and vaccines, serums that are unused and need take care as well as bottles, boxes and packaging.

3.7. Chemical waste

Chemical waste consists of discarded solid, liquid or gaseous chemicals used in medical, diagnostic or experimental procedures, cleaning and disinfection. Dangerous chemical waste contains toxic or hazardous chemicals, including cytostatics and cytotoxic agents. In addition to corrosivity, its properties are also highly flammable and genotoxic. Laboratory also fall into this category reagents, X-ray film and solvent developers.

3.8. Cytotoxic waste

Cytotoxic waste is hazardous medical waste generated during production, preparation and administration of pharmaceutical substances with cytotoxic activity, and includes packaging and accessories used in preparation and application. Cytotoxic waste consists of materials, needles and the vials in which it is packaged and to which it is administered, and the expired medicines.

3.9. Radioactive waste

We define radioactive waste as solid and liquid waste contaminated with radionuclides that are used in laboratory diagnostics and diagnostics and therapy in nuclear medicine departments.All material that has come in contact with is considered contaminated radionuclide, whether it is body fluids, secretions or secretions of patients to whom. Radioactive waste is classified according to the level of radioactivity and over time his half-life. In hospitals, most of the radionuclides are used half-life of 6-60 days and the waste category itself is subject to special regulations [6].

4. MEDICAL WASTE AS A RISK TO HEALTH AND THE ENVIRONMENT

Hazardous medical waste accounts for only 20% of the heterogeneous waste mix, but poses a major risk to human health and the environment. Medical waste carries a higher potential risk to human health than other types of hazardous waste due to the causative agents of infectious diseases and the toxic

substances it may contain. In that way, patients in hospitals, health workers, as well as the population that comes into contact with this waste can be infected.

The importance of proper treatment of hazardous medical waste has grown rapidly in recent years due to the emergence and spread of infectious diseases, especially due to the spread of resistant (drug-resistant) microorganisms from health facilities to the environment.

Rodents and insects are especially dangerous if they have free access to places with a high concentration of infectious disease agents. Medical waste (discarded materials and used products) can also cause poisoning and lead to a number of injuries (eg burns, cuts). The environment is also polluted by wastewater from health care institutions, as well as discarded drugs (antibiotics, cytostatics) and toxic elements and compounds (mercury, dioxin) if disposed of together with municipal waste. In addition, medical waste from hospitals may contain waste of a certain level of radioactivity.

All persons who may come into contact with hazardous medical waste are exposed
potential health risk, namely:

- medical staff: doctors, nurses, other medical and non-medical workers in health care institutions;
- patients inside and outside health care facilities and their visitors;
- employees in public utility companies that handle and transport waste;
- landfill employees, including those searching for waste;
- the entire population, and especially children if they play with objects that arecan be found in waste outside of health facilities.

The population can be exposed to the risk of medical waste in a direct and indirect way, through various routes of contamination:

- Inhalation,
- By penetrating the skin,
- Through contaminated water and food.

Untreated hazardous medical waste must not be disposed of with municipal waste. If untreated hazardous medical waste is collected and disposed of together with municipal waste, especially in places that are not intended for disposal, the danger to the health of the population increases many times over.

5. MEDICAL WASTE MANAGEMENT AND DISPOSAL

Medical waste management includes collection and transport activities and medical waste treatment procedures, including supervision of these activities and procedures and supervision and measures carried out at sites after medical waste treatment as well as actions taken by the waste trader or intermediary.Management of radioactive medical waste and other types of waste generated in the health care sector are regulated by special regulations.The regular work activity includes procedures for sterilization of cultivated microorganisms and tissues and equipment, and microbiological and similar laboratories, as we have surgical or similar departments and surgeries that are not considered waste management activities and are performed in accordance with the rules of the medical profession [5,6].

6. CONCLUSION

Waste disposal,medical waste in particular should be a priority. Well organized care, and plans that include strategies and implementations provide a better approach to solving this problem. Education

of staff on ways of handling medical waste, as well as education on work in a safe way will definitely expand the knowledge and understanding of the disposal of this type of waste, and at the same time expand the awareness of medical workers who are always exposed to the danger of stings, infections, poisoning by chemical and cytotoxic substances. The person conducting the education is hospital infection control nurse or head nurse of the institution.

7. REFERENCES

[1] Borowy I. Medical waste: the dark side of healthcare.Hist Cienc Saude Manguinhos. 2020 Sep;27(suppl 1):231-251. doi: 10.1590/S0104-59702020000300012.PMID: 32997065

[2] Kalogiannidou K., Nikolakopoulou E., Komilis D. Generation and composition of waste from medical histopathology laboratories.Waste Manag. 2018 Sep;79:435-442. doi: 10.1016/j.wasman.2018.08.012. Epub 2018 Aug 11.PMID: 30343773

[3] Capoor MR., Bhowmik KT. Current perspectives on biomedical waste management: Rules, conventions and treatment technologies.Indian J Med Microbiol. 2017 Apr-Jun;35(2):157-164. doi: 10.4103/ijmm.IJMM_17_138.PMID: 28681801

[4] Mousel D., Bastian D., Firk J, Palmowski L., Pinnekamp J. Removal of pharmaceuticals from wastewater of health care facilities.Sci Total Environ. 2021 Jan 10;751:141310. doi: 10.1016/j.scitotenv.2020.141310. Epub 2020 Aug 3.PMID: 32861185

[6] Akkajit P., Romin H., Assawadithalerd M. Assessment of Knowledge, Attitude, and Practice in respect of Medical Waste Management among Healthcare Workers in Clinics.J Environ Public Health. 2020 Sep 28;2020:8745472. doi: 10.1155/2020/8745472. eCollection 2020.PMID: 33061997

MEASURING OF OPERATIONAL EXCELLENCE IN WORKING CONDITIONS OF COMPANIES FROM TEŠANJ SUB-REGION DURING COVID-19 PANDEMIC PERIOD

Ismar Alagić
TRA Tešanj Development Agency / University of Zenica, Faculty of Mehanical of Engineering
Trg Alije Izetbegovića 11, BA-74260 Tešanj/ Fakultetska 3, BA-72000 Zenica
ismar.alagic@gmail.com ; alagicismar@yahoo.com

ABSTRACT:

The objective of this article is to present extensive report and analysis of companies in metal working sector in Tešanj sub-region. Author used financial analysis to select about 50 with highest potential based on revenue, profitability, number of employees etc. It is important to emphasize that selected companies play different roles in the entire eco-system of the metal processing sector in this geographic area. For this analysis Author used following five complementary methodologies: Financial analysis from available data at FIA (Financial–intelligence Agency of Bosnia and Herzegovina); Operational Excellence Survey; Commercial Excellence Survey; Face to Face interview with executives; and Site visit.
The financial analysis shows that there is a slight revenue reduction in the period 2017-2019 which has been further reduced due to COVID-19 pandemic in 2020. Financial data for 2020 are not available yet, but from the conducted interviews we can expect an average of 10% demand reduction which is quite alarming. The Commercial Survey revealed that the average buyer has a significant bargaining power. It is not much different with supplier bargaining power which makes production position difficult. The Operational Survey revealed that there is no significant risk management in place. Also Technical equipment sophistication is not satisfactory and level of automation is low. IT systems are not implemented to the latest standards and digital transformation is taking place too slow compared to the developed world. There is hardly any investment in research and development of the own products and often companies just produce parts for the final product of a customer. It was very interesting to see that companies which rated them self as higher performers in the Excellence Survey actually have lower EBITA, Lower Monthly Salary, Lower Liquidity and Lower percentage of external sources of finance. This means that there is a significant misunderstanding what is Operational/Commercial Excellence and how "excellent looks like". Companies which are more ambitious and have better understanding of the industry rated themselves with lower rate and interestingly their EBITA is higher in average. This means that management need more education and benchmark studies to get a better understating of industry and competition.
This article will point out to systemic competitiveness and well-known world-renowned models for measuring operational excellence with a focus on companies from Tešanj sub-region during COVID-19 pandemic period.

Keywords: Operational Excellence, measuring methodology, metalworking industry, COVID-19, Tešanj.

1. INTRODUCTION

The final goal of this article is to select up to 10 companies with a good growth potential and propose an Action Plan for these companies. The purpose of the Action Plan is to contribute to increasing competitiveness, innovation, digitalization, exports and employment of these companies. In the period of from January to February 2021 we managed to visit 35 companies in Tešanj sub-region. In parallel we were collecting, analyzing and compiling these data according to the pre-defined methodologies [1]. These methodologies are presented in the sequel.

2. APPROACH TO RESEARCH AND METHODOLOGY

The defined project scope is:
- Develop a situational analysis of the metal processing sector in the region of Tešanj, Usora and surroundings 100 km from Tešanj;
- Prepare a database with basic information; contact details, number of employees and others economic business indicators) for at least 100 SMEs from the metal processing sector in the area of Tešanj, Usora, and the surrounding area of 120 km from Tešanj, with good improvement potential of standard business indicators;
- Develop and document an analysis of the business for 30 SMEs from the specified database on the project area with detailed information and recommendations, and then select up to 10 SMEs from the project area of the FAB-LAB project (Tešanj, Usora, Doboj-south) to develop action plans using the Porter tool diamond and five forces;
- Create a unique sales offer - USP for already selected 30 SMEs from the project area.

The objective of this project is to deliver an extensive report and analysis of 30 companies in metal processing sector in Tešanj region. Based on that research and analysis the action plan was developed for selected 10 companies which have highest potential and have demonstrated the highest level of cooperation. Initially we have made a data base of 100 companies in the Tešanj sub-region which have different role in the eco-system of metal processing. Vast majority are production companies and some are suppliers to the production. We used financial analysis to select about 50 with highest potential based on revenue, profitability, number of employees etc. Then we started contacting them all with request for cooperation and participation. Finally, we got 35 companies who accepted to cooperate.

It is important to emphasize that selected 35 companies play different roles in the entire eco-system of the metal processing sector in this geographic area. Vast majority are manufacturing companies however some of them are typical suppliers of raw materials (e.g. Saracevic, Euro-Metali), waste processing company (Eko-Servise), metal processing machine development (Procassa Fisher), metal construction engineering (EN Project), measuring instruments (Amt-Metriks), metal construction (Inžinjering 1) etc. In this way we managed to get a better overview of the eco-system and individual roles of these companies. The details of all these companies are provided later in this article. For our analysis we used five complementary methodologies:

- Financial analysis from available data at FIA (Financial–intelligence Agency of Bosnia and Herzegovina)
- Operational Excellence Survey (see details below)
- Commercial Excellence Survey (see details below)
- Face to Face interview with executives
- Site visit

The financial analysis shows that there is a slight revenue reduction in the period 2017-2019 which has been further reduced due to COVID-19 pandemic in 2020. Financial data for 2020 are not available yet, but from the conducted interviews we can expect an average of 10% demand reduction which is quite alarming.

The Commercial Survey revealed that the average buyer has a significant bargaining power. It is not much different with supplier bargaining power which makes production position difficult. The Operational Survey revealed that there is no significant risk management in place. Also Technical equipment sophistication is not satisfactory and level of automation is low. IT systems are not implemented to the latest standards and digital transformation is taking place too slow compared to the developed world. There is hardly any investment in research and development of the own products and often companies just produce parts for the final product of a customer.

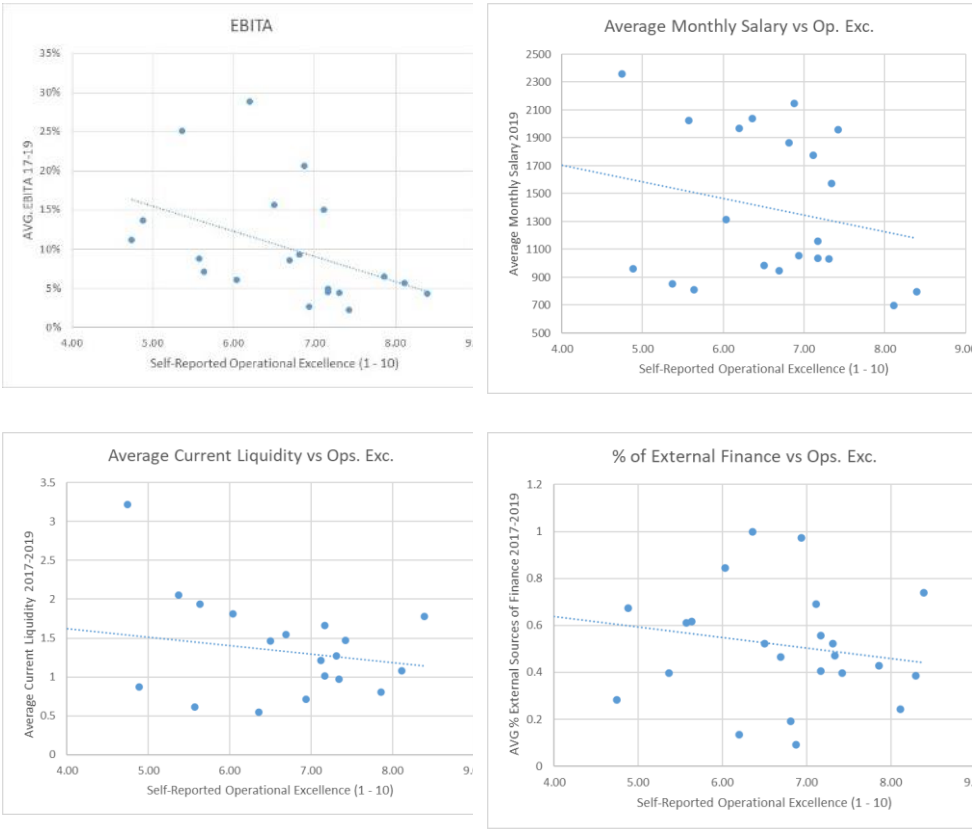


Figure 1: Results of Commercial Survey.

It was very interesting to see that companies which rated them self as higher performers in the Excellence Survey actually have lower EBITA, Lower Monthly Salary, Lower Liquidity and Lower

percentage of external sources of finance. This means that there is a significant misunderstanding what is Operational/Commercial Excellence and how "excellent looks like". Companies which are more ambitious and have better understanding of the industry rated themselves with lower rate and interestingly their EBITA is higher in average. This means that management need more education and benchmark studies to get a better understating of industry and competition.

After compiling and analyzing collected data and discussions with companies we have developed the Action plan for 10 selected companies. Actions are proposed based on available resources and expertise with objective to gain the highest impact in shortest time (Quick and Small Wins). After considering various options with companies a decision was made to create a strategy by formation of "Development and Cooperation Cluster" which will be working on a structured PROGRAM. Up to 10 selected SME's will form a cluster and in a period of two months will work on Common Product Development and Specific Projects which will create "Small Wins" (Quick Interventions) in about 5 companies with a measurable impact. We strongly believe that this approach will create the highest impact and value. About 10 to 15 leaders from about 10 companies will be working in a close cooperation in the period od May and June 2021. The details of the Action Plan (the PROGRAM) related to the formation of the "Development and Cooperation Cluster" are provided in the Action Plan section below. We combined few methodologies in order to cover most of value supply chain of selected companies. We used following methodologies:

- Financial analysis and assessment from the Financial Information Agency (FIA) for the period of 2017-2019 as the fiscal 2020 has not been reported yet Porter's five forces analysis though conducting a Commercial Excellence Survey
- Methodology of Operational Excellence Survey in order to asses internal weaknesses
- Methodology of Structured Interview in order to have direct face to face contact with company leadership
- Methodology of Site Visit to get an impression of production maturity, machinery age and technology.

Using financial analysis we have made a fast company performance assessment. This was the bases for the selection of about 40 most potential companies out of 100 that we contacted for site visit and surveys. After visiting 35 companies and conducting surveys with 30 companies we have made a selection of 10 companies for the Action Plan. We presented the Action Plan Proposal to these 10 companies, which was additional 10 face to face meetings with the company executives.

3. ANALYSIS OF SURVEY DATA FROM COMPANIES

We developed a tool to summarize a company financial performance in the period 2017 till 2019. The data available in the FIA (Financial–intelligence Agency of Bosnia and Herzegovina) are given in a relatively raw forma. An example of a balance sheet is given in figure 2.

BILANS STANJA	2017	2018	2019
AKTIVA			
UKUPNO TEKUĆA SREDSTVA	166,903	345,334	552,175
UKUPNO STALNA SREDSTVA	81,694	154,765	214,466
Ostala aktiva	0	0	0
UKUPNO AKTIVA	248,597	500,099	766,641
PASIVA			
UKUPNO TEKUĆE OBAVEZE	99,282	226,293	388,278
Obaveze prema dobavljačima	37,961	53,065	276,247
Obaveze za kratkoročne kredite	30,898	127,630	51,298
UKUPNO DUGOROČNE OBAVEZE	10,615	0	0
Dugoročni krediti	10,615	0	0
UKUPNO OBAVEZE	109,897	226,293	388,278
UKUPNO KAPITAL	138,700	273,806	378,363
UKUPNO PASIVA	248,597	500,099	766,641

Figure 2: An example of a balance sheet.

In order to make a simple overview we made the waterfall diagrams for Balance Sheet, Income Statement and Cash Flow for 2019 as well as bar diagrams for revenue, Number of Employees, EBITA and Net Profit in the period 2017 -2019. This is illustrated in figure 3. We also made and an assessment of other financial performance KPI's as they are available and we made a visual comparison with the industry average in order to get an overall impression of the Financial Excellence as such. In figure 4 is an example of the KPI table and industry comparison.

Figure 3: Waterfall diagrams for Balance Sheet, Income Statement and Cash Flow for 2019.

If a KPI is 20% or more better than Industry Average we mark it with GREEN color. If a KPI is 20% or more worse than Industry Average then we mark it RED color. This provides a good impression of the company overall financial performance in a glance.

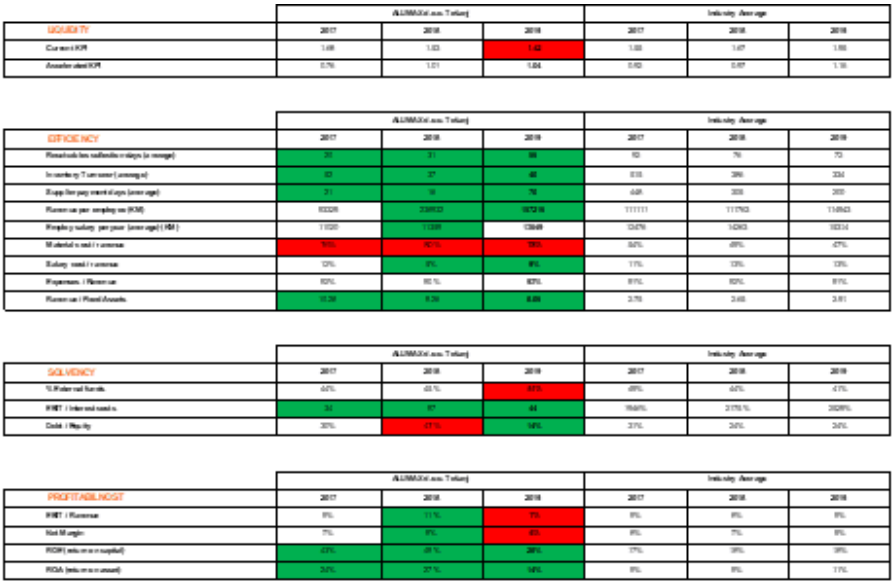


Figure 4: An example of the KPI table and industry comparison.

We assume that the FIA database is big enough as based on country level (Bosnia and Herzegovina) so the comparison makes sense under assumption that company primary activity is correctly assigned.

Figure 5: Methodology of Competitive Advantage Analysis according to Porter's.

4. RESULTS APPLICATION

We have organized visit of 35 companies in order to have face to face interview and a short site visit with an objective to have a "touch and feel" experience of all companies which are part of the study. An important part of the interview was an informal getting to know owners and directors of the company and build a quality relationship with them. However the interview was a structured questionary with focus on following area: COVID – 19 Impact; Business Model & Supply Value Chain; Marketing & Sales; Operation & Technology; Standards & Legal Requirements; Improvement and Growth Opportunities, and: Current Challenges.

1. COMPETITION
1.1 We do not have many competitors, and the intensity of competition is low
1.2 Demand for our products is constantly growing
1.3 Our products are much better than the products of our competitors
1.4 The geographical concentration of industry is high
1.5 We are very close to our customers and the market
1.6 Our customers are very loyal and devoted to us
2. BUYER BARGANING POWER
2.1 We have a large number of customers
2.2 We have large and identical orders
2.3 We are different from the competition
2.3 Buyer is not price sensitive
2.4 Customers do not have an easy replacement option for our products
2.5 Customers cannot easily find competition information
2.6 Switching to other competitors would cost customers a lot
3. SUPPLIER BARGANING POWER
3.1 We have a large selection of alternative suppliers that can meet our needs
3.2 We can easily change suppliers
3.3 We have excellent management of our suppliers
3.4 We can easily replace the products of our suppliers
3.5 We can easily negotiate the price with our suppliers
4. THREAT OF NEW ENTRANTS
4.1 Entering our market is expensive and demanding (for new competitors)
4.2 We belong to the large quantity industry
4.3 Large capital investments are needed for new players / competitors
4.4 It takes long cumulative experience for someone to be competitive in our market
4.5 Access to sales channels in our market is demanding and difficult
4.6 Switching from other products to our products is expensive
5. THREAT OF SUBSTITUTION
5.1 The number of replacement products for our products is small and limited
5.2 The customer does not have an easy option or need to replace our products with a substitution
5.3 Our products are different from the products of our competition
5.4 Switching from ours to replacement products would be expensive for customers

Figure 6: The questionary.

Depending on their availability we have usually spent about one hour interview and about half an hour till one hour site visit. The result of all interview are presented in the company list at the end of this report. A general conclusion from the interview is that many companies are facing family generation ownership transition. This is an important challenge to be taken care of. The change management is one way how to help them to make these transitions smoother. The other important observation is the diversity in respect of machinery. Some companies have quite new and modern machines but some are using very old ones. In some cases there is a combination of both. Some companies are based on lot's of welding activities in order to make and assemble a more complex product (a truck trail, transformer housing, supporting construction etc.). In others again we have many CNC machines making different parts for different end users. There is quite a number companies producing ALU and/or PLC joinery [3].

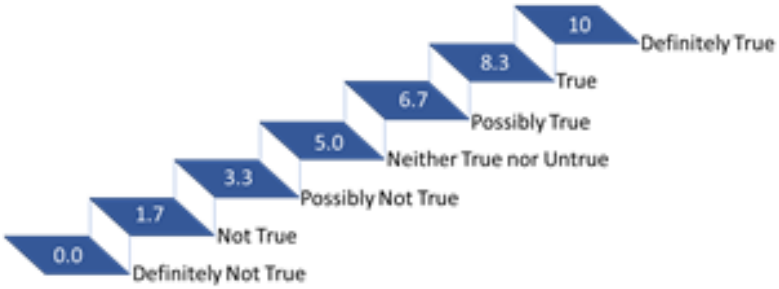


Figure 7: The Survey Questionnaire True scale.

As the above Survey study has shown not many examples of Research and Development activities. It presents the results of research conducted by Author in the recent period by applying the tools "diamond of competitiveness" and developed by the theorist Michael Porter [3,6]. The research was conducted on the value chain of companies from the metal processing sector in the municipality of Tešanj. This research has been presented in the author's book "Value Change Management" [2]. In the sequel we will present the research results which are relevant for our study. We used the Porter's Five forces analysis as a tool to identify where is the greatest potential for improvement [4,6,7,8,9]. This is illustrated with the figure 5.

We developed a Survey and send to selected 30 companies to fill it in and provide a self-estimation where is their company position in the market that they are competing. The main objective of this Survey was to try to get each company to report the weak and strong points related to the commercial and operational performance, with a final goal to offer them an action plan and proposal how to address and improve the weak parts of their business. In that respect we relay on their honest and professional estimate of the questions we have asked in the survey. The questionary is provided in figure 6. On each statement a company participant could made a selection between seven possible answers, seven possible levels of trueness. In figure 7 is the illustration of this trueness scale: So, the participants was asked to provide an answer on all questions from the above Commercial Excellence Questionnaire by choosing one of seven possible answers: Definitely True; True; Possibly True; Neither True or Untrue; Possibly Not True; Not True, and; Definitely Not True.

Similarly to the Commercial Excellence we have conducted an Operational Excellence Survey with same principle. The questionary per category is provided on figure 8.

1. Labor force, expertise and opportunities for development
1.1 On average, the expertise of employees in their workplace is high
1.2 On average, there is the possibility of further employee development and growth in the hierarchy
1.3 The speed of finding quality employees in the local labor market is satisfactory
1.4 Retaining employees in the company is not a problem
2. Technical equipment, machines and automation
2.1 The adequacy of the machines and equipment is excellent
2.2 The degree of automation is high
2.3 The degree of robotization is high
2.4 The degree of integration of equipment / machines into the ERP system is high
3. IT and Digital Transformation
3.1 The adequacy of the IT system is excellent
3.2 The degree of Digitization is high
3.3 The degree of integration of work processes into the IT / ERP system is high
4. Space, infrastructure, energy
4.1 The adequacy of existing buildings and spatial planning is excellent
4.2 Adequacy and the possibility of capacity expansion is excellent
4.3 Adequacy and the possibility of increasing the consumption of energy, water, gas, drainage, etc. is excellent
4.4 There are quality initiatives and projects focused on energy efficiency
5. Organization and Work Processes
5.1 There are clearly defined work processes, owners, metrics and process management
5.2 There are clearly defined and systematized jobs
5.3 There is a clearly defined and functional management and reporting system
5.4 There is a clearly defined system of remuneration and promotion in the workplace
5.5 There is a clearly defined system of projects and initiatives for business improvement (Long-term Business Plan, etc.)
6.Management & Leadership
6.1 We have a culture of open doors policy and close cooperation between workers and managers
6.2 Directors and managers regularly visit production, storage, distribution, etc. facilities in order to improve them
6.3 Everyone in the company is motivated and trained to improve the process (completed LSS Yellow belt, Problem Solving,
6.4 A system of team / multidisciplinary problem solving (LSS) has been established
6.5 There are quality initiatives and social responsibility projects
6.6 There are quality initiatives and projects aimed at sustainability and environmental protection
7. Finance
7.1 We have a clearly defined financial process of control and management (controlling)
7.2 We have a clearly defined financial reporting system and use it on a daily basis to improve it
7.3 We use financial statements on a daily basis to improve workflows and Supply Chain Management
8. Product Design & Innovation & Branding
8.1 There is a dedicated department that focuses on product development and research
8.2 There are quality initiatives and projects aimed at the product innovation
8.3 There is a clear branding and marketing strategy for our products and the company as such
8.4 We continuously monitor customer satisfaction, complaints, and perform market analysis
8.5 Customer complaints and ideas are taken as essential information in the design of new products
9. Risk Management
9.1 There is a quality risk register with identified technical and commercial risks
9.2 There is a quality mitigation / risk mitigation plan with clearly defined responsibilities and responsible persons
9.3 The risk mitigation plan is implemented, reported and discussed together with other key activities of the firm
9.4 All objectives defined in the Risk Mitigation Plan are achieved on time and within the projected budget

Figure 8: The questionary for Operational Excellence Survey.

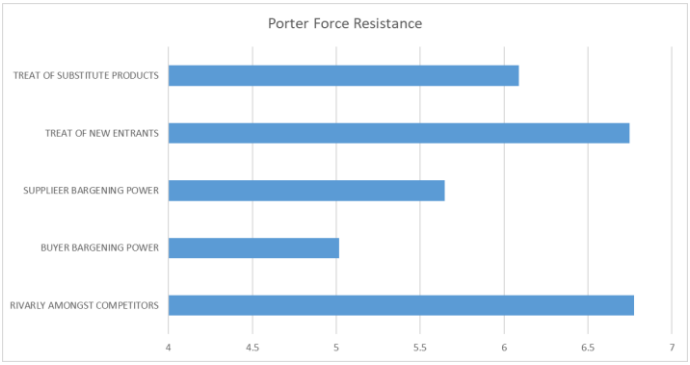


Figure 9: Average results of Commercial Excellence based on Porter five forces.

Each answer will then generate a Excellence score from 0 to 10. For example if answer is Definitely Not True, the score will be 0. If answer is Definitely True the score will be 10. The answers will be then complied per questionary category in order to get a final overview for each company and also combined for all 31 company that has participated in the Survey. Unfortunately due to secrecy agreement we will not provide the answers for each specific company but a an average for all 31 companies. The final result is shown in the figure 9. The average result of the self-reported Commercial Excellence based on Porter five forces. It seems that customer loyalty and level of competition is not the major challenge for these companies. It is still a challenge as the score for "Rivalry Amongst Competitors" and "Treat of New Entrants" is about 6,7 which is an average answer "Possibly True".

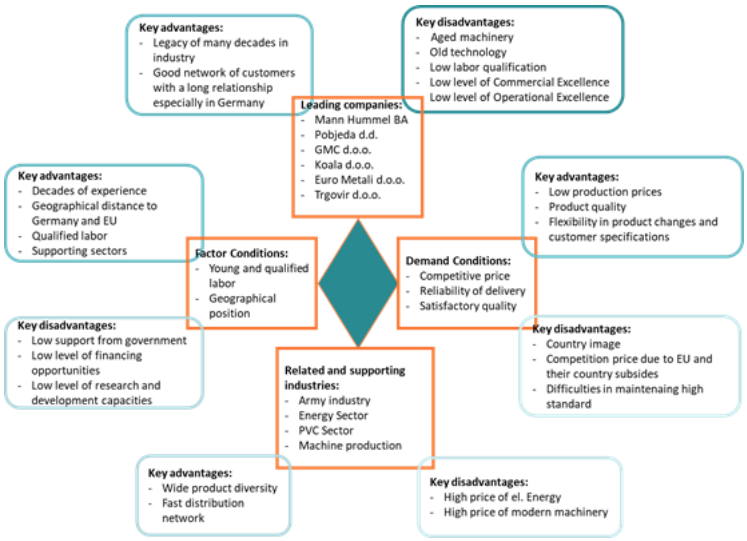


Figure 10: Application of Porter's diamond.

The major challenge are: Buyer bargaining power (score about 5); Suppler bargaining power (score about 5,6), and;Treat of substitute products (6,1). It would be important to have a deeper Root Cause Analysis why these companies are in a such low bargaining power towards both customers and suppliers too. We can elaborate on based on our experience and interviews we have made. In many cases the European customer are Sales Agents or Big Corporations which have professional (often native English and German speaking) negotiators who negotiate terms, conditions and prices. On side of companies often are less professional sales representatives. There is often no plan B, on the side of Bosnian companies, to push the limit of price and be ready to drop the deal, as there is another customer that will accept terms and price.There is no marketing plan for a continuous and active acquisition of new customers which will make the bargaining power easer as a Plan B, would exist in case of dropping some deals. There is no cooperation in sense of forming a Sales Cluster and negotiate price, terms and conditions from the Cluster. This may be especially interesting for negotiation prices with Suppliers as the lager amounts will be purchased. The treat of substitutes is probably due to global shift towards lighter and cheaper materials, for example from Steel towards Aluminum, or from Aluminum towards plastics). These companies are mainly focused on Steal and some on Aluminum, and it is good that they are aware of the shift and hopefully they will do something about this risk and start mitigation or transition action plans on time [5]. The above analysis is just a high level one.

In this article we did not focus on the macro but rather micro and company level in order to deliver best Action plan for companies. There are many open question at the macro level such as direction of the car industry. Many of companies which were part of this survey are very much integrated in the car industry eco system. In that respect the impact of electrical car on their business should be done separately and a mitigation plan for each company should be done.

Code	Naziv kompanije	Broj zaposlenih (zadnja godina) 2019	Godišnji prirast uposlenih 17 - 19	Prosječna Mjesečna Plata 2019	Prirast aktive 2017-2019	Prihodi od prodaje 2019	Prirast prihoda 17-19	Prirast EBITA 17-19	Dobit 2019	Prirast Dobiti 17-19	Average EBITA 17-19	Average Likvidnost Tekuća	% ljudi iz ...	Bodovanje van EBITA
F28	METAL SKOP d.o.o. Tešanj	10	0%	1949	10%	680,487	-34%	-149%	114,214	-171%	35%	10.97	7%	4
F13	KATIĆ d.o.o. USORA	51	4%	1926	-6%	2,921,845	-12%	-71%	430,636	-75%	29%	7.42	13%	4
F22	HidroRing d.o.o. Tešanj	9	0%	852	6%	795,459	8%	14%	166,154	6%	25%	2.05	40%	2
F20	EN PROJEKT d.o.o. Tešanj	4	0%	2447	6%	111,563	-11%	-370%	2,478	-650%	21%	8.80	9%	3
F33	TRI-M Hrvić d.o.o. Tešanj	8	13%	2027	16%	303,734	-9%	123%	-58,478	112%	19%	1.73	38%	5
F11	JUNIOR-EKO-TERMIK d.o.o. Tešanj	17	9%	982	16%	680,491	-27%	-389%	71,955	-51%	16%	1.47	52%	1
F30	KPM-BH d.o.o. Tešanj	24	12%	1011	-13%	1,091,862	1%	15%	9,366	36%	15%	7.38	32%	4
F9	Global metal construction d.o.o. Usora	180	12%	1775	14%	17,573,122	3%	-1%	1,897,753	-5%	15%	1.33	69%	5
F3	COSIC PROMEX d.o.o. Usora	142	7%	982	-7%	7,900,966	8%	31%	1,009,620	32%	14%	0.87	67%	4
F32	Kosić Paintings d.o.o. Tešanj	479	6%	900	3%	38,297,816	16%	11%	3,148,981	20%	13%	1.17	65%	5
F31	MANN+HUMMEL BA d.d. Tešanj	620	3%	2095	-18%	71,260,512	-2%	-22%	6,175,154	-24%	13%	2.24	21%	5
F19	Sarp Food Technologies d.o.o. Tešanj	4	0%	2300	4%	531,313	12%	-70%	36,989	-71%	11%	3.22	28%	4
F4	AMT-METRIKS D.O.O. TEŠANJ	3	17%	1863	17%	634,774	7%	11%	41,076	10%	9%	15.36	19%	6
F14	MEDENA COMMERCE d.o.o. TEŠANJ	66	7%	2025	10%	4,577,427	4%	-51%	126,006	-100%	9%	0.01	61%	3
F1	ALUMAX d.o.o. Tešanj	11	9%	945	34%	1,729,379	26%	19%	104,557	22%	9%	1.51	47%	5
F23	Feneinox d.o.o. Gračanica	17	0%	811	-15%	663,653	12%	58%	59,718	29%	7%	1.92	63%	4
F17	EKO-SERVIS d.o.o. TEŠANJ Društvo za otkup,proizvodnju i preradu sekundarnih sirovina	32	22%	3289	12%	7,646,379	28%	16%	441,962	22%	6%	0.80	42%	8
F21	EURO-METALI d.o.o. Doboj Jug	70	16%	1313	4%	40,134,611	11%	-1%	2,284,662	-6%	6%	1.81	84%	4
F7	FESTA d.o.o. Tešanj	24	8%	700	21%	3,985,848	11%	34%	237,548	48%	6%	1.03	24%	6
F6	SARAČEVIĆ d.o.o. Tešanj	49	8%	1158	10%	19,972,235	1%	-27%	779,911	-30%	5%	1.67	50%	4
F10	INŽINJERING 1 d.o.o. Tešanj	84	11%	1036	3%	10,249,516	-2%	346%	1,012,997	-58%	4%	1.01	41%	3
F16	TRGOVIR d.o.o. za trgovinu na veliko i malo Gračanica	92	1%	1033	4%	42,873,266	3%	-48%	1,814,395	-38%	4%	1.27	52%	2
F5	EURO ONIKS d.o.o. Tešanj	97	13%	795	-5%	7,597,184	8%	22%	321,521	26%	4%	1.78	74%	6
F25	MBA com d.o.o. Doboj	1	-750%	17727	-815%	55,071	-875%	-30%	-16,538	59%	3%	6.43	32%	4
F29	OPTIMAX BH d.o.o. Tešanj	7	-7%	4168	-11%	793,312	-34%	158%	-226,478	131%	3%	0.51	90%	2
F12	NALIMPROFIL d.o.o. Tešanj	51	-2%	1057	2%	4,195,951	-9%	11%	36,366	23%	3%	0.71	97%	3
F15	POBJEDA d.d. TEŠANJ FABRIKA PUMPI I PREČISTAČA	321	-7%	1956	4%	19,823,576	-10%	-102%	50,616	-127%	2%	1.47	40%	2
F34	Tvornica transportnih uređaja energetik d.o.o. Tuzla	169	22%	1442	14%	10,390,707	21%	47%	53,551	32%	1%	1.38	34%	5
F24	PREIS USORA d.o.o. Usora	180	13%	2039	10%	12,632,723	15%	-50%	-620,515	-26%	-3%	0.55	100%	
F18	PROCASSA-FISCHER d.o.o. Tešanj	12	46%	1017	48%	535,695	44%	55%	75,022	38%	-6%	0.90	84%	
F26	BME d.o.o. Tešanj	136	-3%	3276	-64%	16,572,463	3%	30%	81,451	-112%	-6%	1.00	89%	
F8	PREVENT FAD d.d. Jelah - Tešanj	135	41%	0	-14%	6,511,719	-190%	57%	-4,924,880	59%	-38%	4.41	38%	
F27	HEMTECH d.o.o. Tešanj	3	5%	780	49%	135,671	30%	5%	-32,625	7%	-60%	0.77	97%	
F35	LB Profile BH d.o.o. Tešanj	27	31%	630	38%	3,268,165	47%	24%	-419,255	27%	-58%	0.59	100%	
F6	FERRETTO GROUP CENTRAL EUROPE d.o.o. Usora	87	43%	1574	38%	10,936,327	50%	46%	-3,479,250	45%	-102%	0.97	47%	

Figure 11: The financial performance of analyzed companies in the period of 2017 till 2019.

The figure 12 presents the Action plan distributed in 10 days. Each company will assign 1 to 2 high potential leaders to participate.

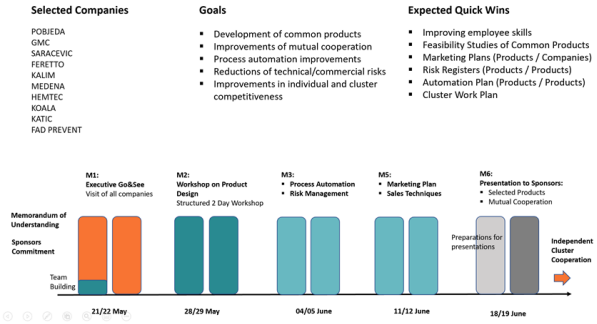


Figure 12: The Action plan of intervention.

5. CONCLUSION

Based on many business parameters (revenue, EBITA, number of employees, net profit etc.) we have made a preliminary list of 50 companies to contact regarding this study. We focused on highest potential companies with highest revenue, profit and number of employees and have contact them first by email and later by mobile phone in order to encourage them to participate on this study. Unfortunately some of these companies have refused to participate, some have initially agreed but later on they never had time to make an appointment or fill in our surveys. Naturally we continued with those companies which were more cooperative and interested and we made an analysis and interviews with more than 30 companies. Another important criterion for selection was geographical distance to Tesanj metal cluster as we intend to facilitate their mutual cooperation and partnership. This physical distance should make an unique opportunity in that respect. In the sequel we present all companies that we made an face to face interview. For each of these companies we will make a short business model description and financial performance in the period of 2017 till 2019.

6. REFERENCES

[1] Alagić I., Priručnik: Projekti i upravljanje proizvodnjom, ISBN 978-9958-31-473-5, COBISS.BH-ID 43378694, Off-set, Tuzla, 2021.
[2] Alagić Ismar, Upravljanje lancem vrijednosti – snabdijevanje i logistika, ISBN 978-9958-31-441-4, COBISS.BH-ID 29091590,Off-set, Tuzla, 2020.
[3] Alagić I. Industrial Engineering & Maintenance: Lean Production - Six Sigma with application of tools and methods in specific working conditions, ISBN 978-9958-074-09-7, COBISS.BH-ID 24232454, Štamparija-S, Tešanj, 2017.
[4] Alagić I., KAIZEN IN PRACTICE-CASE STUDY OF APPLICATION OF LEAN SIX SIGMA METHOD IN WORKING CONDITION OF WOOD-PROCESSING FIRM, New Technologies, Development and Application, ISSN 2367-3370, ISSN 2367-3389 (electronic) Springer International Publishing AG, part of Springer Nature 2019.
[5] Alagić I., THE APPLICATION OF DMAIC LEAN SIX SIGMA METHODS IN ASSEMBLY TECHNOLOGY DESIGN OF FILTER W 1022 /LE 19172, 7th International Conference "NEW TECHNOLOGIES, DEVELOPMENT AND APPLICATION", NT-2021, Academy of Sciences and Arts of Bosnia and Herzegovina, Sarajevo , Bosnia and Herzegovina, June 24th-26th. 2021.
[6] Porter, M.E.: The Five Competitive Forces That Shape Strategy, Harvard Business Review, January 2008.

[7] Christian Staudter, Renata Meran, „Design for Six Sigma and Lean Toolset: Implementing innovations successfully“, Springer, USA, 2009.
[8] Basem El-Haik, Davim M. Roy, „Service design for Six Sigma: a roadmap for excellence“, John Wiley & Sons, USA, 2005.
[9] Urs Buehlmann: Value Stream Mapping, Leadership and Skills Development Training, Bern University of Applied Sciences, Biel, Switzerland, 2016.

AGRO-ECOLOGICAL SOIL ZONES IN THE AREA OF THE MUNICIPALITY OF BUŽIM

Mirsad Ičanović[1], Edis Softić[2]
[1]Biotechnical faculty Bihać, Luke Marjanovića bb. 77 000 Bihać, BiH
[2]Technical faculty Bihać
e-mail: icanovicmirsad@yahoo.com

ABSTRACT:

Limited areas of arable agricultural land impose the obligation of proper and rational use of space for both agricultural and non-agricultural purposes. Using a modern FAO methodology of agro-ecological zoning, thereby including all the necessary parameters, we made a map of agro-ecological zones in the municipality of Bužim, for the purpose of this paper. After a detailed research and determination of the factual situation, and typical identification and physical and chemical properties of the land, and accepting the division of agricultural land in the municipality of Bužim, we zoned out three agro-ecological areas, urban areas and forest areas. Based on that, a projection of production development was made, which assumes types and ways of use with regard to the intensity of agricultural production, such as: I Agro-ecological area - land reserved exclusively for intensive agricultural production, II Agro-ecological area - land intended for semi-intensive agricultural production, III Agro-ecological area - lands reserved for extensive agricultural production, IV Zone - zone of urban spaces and areas excluded from the sphere of plant production and V Zone - forest zone.

Keywords: agro-ecological area, land, agricultural production, Bužim municipality

1. INTRODUCTION

Bužim Municipality is located in the southern part of the northern temperate climate zone and is influenced by continental air currents. Administratively and geographically is a part of Una-Sana Canton, i.e. Federation of Bosnia and Herzegovina, it covers the total area of 13.026,27 ha, which makes it the smallest municipality of the Una-Sana Canton. According to 2013 Census the population of the municipality was 20.298.

In this municipality there are two repartition of soils/land with associated classes and types, namely automorphic/terrestrial and hydromorphic soils. The total of eight types of land has been identified: regosol, calcomelanosol, calcocambisol, Terra rossa, eutric cambisol, distric cambisol, luvisol and fluvisol, and six land capability classes including two related land capability subclasses. Currently the relationship between high-quality land and lower quality categories moved towards less quality categories. The purpose of this paper is to generally protect agricultural land from use in a variety of non-agricultural purposes and to facilitate the work of spatial planners in order to make quality spatial planning decisions.

2. MATERIALS AND METHODS

For the purpose of mapping agro-ecological zoning, a land capability classification was conducted based on data from the Basic Soil Map of Bosnia and Herzegovina on the scale of 1:50.000, with accompanying interpretations, using satellite and aerial images of the sample area. Afterwards a study of the land potential within the Una-Sana Canton [8] was made, and data gathered, obtained through the additional study of the soil at selected sites of Bužim Municipality, for comparison and correlation with the old soil data. The total of eight profiles was analyzed for the morphological, physical and chemical parameters [1], [5], [2], [6].

Soil map of Bužim Municipality was prepared in accordance with the results obtained in the scale of 1: 25.000, and the entire mapping and processing of the obtained data was performed using GIS technology. Using a modern FAO methodology of agro-ecological zoning, a map of agro-ecological zones of the municipality of Bužim was made.

3. RESULTS AND DISCUSSION

There are two soil orders in the Municipality of Bužim: automorphic/terrestrial and hydromorphic soils. Situated out of reach of the flooding or underground waters and characterized by water percolation through solum, automorphic soils are the dominant ones [7]. Due to denser net, the quality of data presented and the comprehensiveness of the research probes and profiles, eight soil types were observed in the research area and the soil map was developed at the scale of 1:25 000.

Table 1: Soil types in the Municipality of Bužim

Soil Type	Area (ha)	Percentage (%)
Regosol	128.01	0.99
Kalkomelanosol	331.60	2.54
Calcocambisol	2,272.20	17.45
Eutric cambisol	1,867.45	14.33
Distric cambisol	5,266.51	40.42
Rossa	709.16	5.44
Luvisol	1,550.98	11.91
Fluvisol	900.31	6.92
Total	**13,026.27**	**100.00**

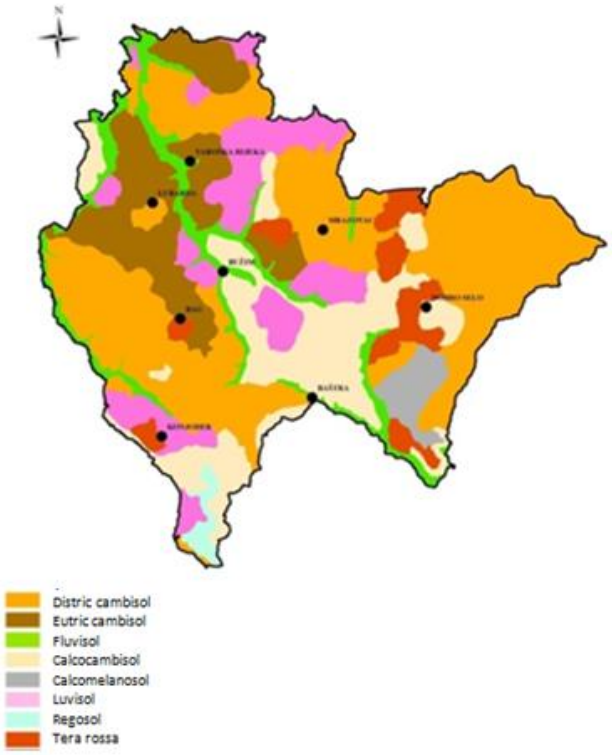


Figure 1: Soil Map of Bužim Municipality [4]

The projection of production development assumes different types and ways of land use with regard to the intensity of agricultural production in the municipality of Bužim. A total of five agroecological zones were singled out:

I Agro-ecological zone consiting of lands exclusively for intensive agricultural production,
II Agro-ecological zone consiting of lands intended for semi-intensive agricultural production,
III Agro-ecological zone lands for extensive agricultural production,
IV Zone - urban spaces and areas excluded from the sphere of plant production
V Zone – otherwise known as the forestry zone.

3.1. I Agro-ecological zone

As far as the potential of the land goes, this zone iz considered to be the valuable in the municipality, and covers 1,409.73 ha. The zone is an intensive production facility based on a lowland area, located by the watercourse, with the possibiliy of complete arrangement of agricultural land, and the possibility of irrigating a large part of the plots and the application of modern agricultural machinery.

The dominant type of soil in the valley part of the municipality is alluvial soil (fluvisol). Administratively speaking, the zone covers areas around towns Čaglica, Varoška Rijeka, Zaradostovo, Čava, a smaller part of Konjodor and Jusufović.

3.2. II Agro-ecological zone

This zone presents a zone of semi-intensive production and covers an area of 4,208.12 ha, and is thus the largest area of the municipality. In this zone limited lands of medium potential (generally less suitable for cultivation) are grouped, so that they can only exceptionally be used as arable land, and are mostly used as meadows and orchards. The lands are represented by slopes on which arable land, orchards and grasslands are interchangable in the production system. The soils are characterized by a small depth of the solum, with a slope of the terrain greater than 10^{o}. Agricultural lands are generally affected by erosion processes.

The main limiting factors of their more intensive use in field production are: small depth of the solum, strong slope of the terrain and difficult use of machinery. It is characterized by heterogeneity of land cover. The following soil types are present within this zone: calcomelanosol, district cambisol, eutric cambisol and calcocambisol.

3.3. III Agro-ecological zone

As far as the land potential goes, this zone represents the weakest lands in the area of the municipality, whose total area is 1,272.43 ha. This agro-ecological zone is dominated by areas under meadows and pastures. Part of the area within this zone, which is characterized by soils of deeper solum, favorable topography and mild terrain inclinations, can be used for growing cereals (rye, barley, oats) and tubers (potatoes), as well as medicinal and aromatic plants. From the areas of quality category VIII in the mountainous part, which are located on strongly inclined and rocky terrains, their change and improvement cannot be expected. According to the way they are used, they are mostly located under meadows and pastures.

3.4. IV Zone - urban spaces and areas excluded from the sphere of plant production

Zone IV includes urban areas and areas located within industrial zones, roads, surface mines, gravel pits and all unproductive land areas which are permanently excluded from agricultural and forestry production. In the area of the municipality of Bužim, these areas cover 87.09 ha. Soil loss, due to the construction of various facilities, is an inevitable process, but most often the most fertile deep soils are destroyed, instead of using less fertile, shallow, gravelly and stony soils less suitable for agricultural production.

3.5. V Zone – forestry zone

Of all five zones, the forestry zone is the most represented, occupying a total 6,749.79 ha. This area is characterized by heterogenity of land cover, with the present consequences of erosion processes. Zone V includes all land areas that are under forest vegetation. It is in the mountainous part of the area of the municipality of Bužim, mountain Radoč, with a very developed orography, where the erosion processes are most intense. The most common limiting factor of soil production capacity on silicate substrates is the slope of the terrain, and on sail limestones the depth of the solum, stonyness and rockiness of the surfaces.

Map 2: Agro-ecological zone of soil of the municipality of Bužim

4. CONCLUSION

With regard to altitude, the area of the municipality from the ecological-production aspect and the use of land for other purposes, as well as its sensitivity to negative impacts, can be divided into three designated zones: zones with altitudes up to 300 m. n. v., a zone with altitudes from 300 to 450 m and a zone of altitude areas with altitudes over 450 m.

This research has indicated the presence of areas that are permanently or temporarily unsuitable (N class of suitability) for the cultivation of the most important agricultural crops. In order to improve the agricultural-production space, it is necessary to arrange it with a systematic and planned approach, respecting all professional and environmental standards in agricultural production. Due to the increase

of agricultural areas, these areas should certainly be taken into account, because by removing their significant limitations, if investments in soil / land repair are economically viable, it is possible to raise the degree of suitability and increase the land fund of suitable soils / lands in USC.

The Geographic Information System has proven to be an excellent system that enables the interaction of climate, terrain and soil resources and other data, their presentation through thematic bases, as well as easier access to this data for the needs of the AEZ. The obtained research results are a good basis for making decisions regarding the use of the land within the Canton, but also in the pilot area of the research of the municipality of Bužim.

5. REFERENCES

[1] Bogunović, M., Ćorić, R. (2014) Višenamjensko vrednovanje zemljišta i racionalno korištenje prostora. Mostar 2014.

[2] Čustović, H. and Tvica, M. (2005). Praktikum za pedološka istraživanja. Sarajevo:Poljoprivredno-prehrambeni fakultet.

[3] Ćorić, R., Bogunović, M., Husnjak, S., Vego, D., Lasić, V., Šaravanja, P., Sefo, E., Kajić, N., Ivanković, S. (2013) Višenamjensko vrednovanje zemljišta u Federaciji Bosne i Hercegovine, Federalno ministarstvo poljoprivrede, vodoprivrede i šumarstva. Sarajevo 2013.

[4] Federalni zavod za agropedologiju (2015) Pedološka karta područja Unsko-sanskog kantona M 1:50.000.

[5] Hadžić, V., Belić, M. and Nesić, Lj. (2004).*Praktikum iz pedologije*. Poljoprivredni fakultet, Novi Sad 2004. Retreived from: http://www.kartografija.hr/daljinska.pdf (accessed on July,19 2011).

[6] Husnjak, S., Bogunović, M., Jurišić, M., Hengl, T. (2003) Izrada tematskih karata u GIS okruženju.

[7] Ičanović, M. (2016): Istraživanje stepena pogodnosti zemljišta Unsko-sanskog kantona za uzgoj najznačajnijih poljoprivrednih kultura. Doktorska disrtacija. Biotehnički fakultet Bihać.

[8] Resulović, H., Bukalo, E., Žurovec, J., Imamović, Š. and Muić-Šarac, T. (1998). *Zemljišni potencijali na području Unsko-sanskog kantona*.Sarajevo: Zavod za agropedologiju.

[9] Resulović, H., Čustović, H. and Čengić, I. (2008). *Sistematika tla/zemljišta*. Poljoprivredno-prehrambeni fakultet Univerziteta u Sarajevu.

ANALYSIS OF ERYTHROCYTIC PARAMETERS OF BROWN TROUT (*Salmo trutta* L.) FROM THE RIVER UNA AND KRUSNICA

Subha Avdić[1]*, Azra Bakrač[1], Radoslav Dekić[2], Irma Šarić
[1] University of Bihac Faculty of Biotechnology, Luke Marijanovica bb, 77 000 Bihac, BiH
[2]University of Banja Luka, Faculty of Science, Bulevar vojvode Petra Bojevića 1A, 78000, Banja Luka, BiH
.*Corresponding author, e-mail subha.avdic@unbi.ba

ABSTRACT:

For full biological monitoring and insight into the general state of the environment, it is extremely important to monitor the organisms physiological processes. The erythrocyte parameters of fish are indicators of the general biological state of organisms, by means of wich the state of the environment can be assessed. The waters of the canton Una-Sana are less explored ecosystems in terms of ichthyofauna and especially the hematology of fish species. The aim of this study was to determine the erythrocyte parameters of indigenous brown trout from the Una and Krusnica rivers. In this study, carried out in September 2013, a total of 19 individuals from both localities were analyzed. Higher values for HB, HCT, MCV, MCH, MCHC were recorded in birds of the Una river trout, while individuals from the Krusnica river had a higher number of erythrocytes. Comparing the results from both localities obtained by this study, significant differences were noted for the values of HB, MCV and MCHC.

Keywords: Erythrocytic parameters, *Salmo trutta*, Una, Krušnica

1. INTRODUCTION

Blood analysis parameters from the aspect of understanding the functioning and adaptation of organisms to the physico-chemical environmental factors can serve as a reliable indicator of the environmental state of various water bodies [1]. Blood parameters are an important tool for determining the physiological state of fish, and are usually used as a physiological index according to their internal and external changes [2, 3]. Fish erythrocytes are a very reliable indicator of various sources of stress, even over an extended period of time, and an useful tool in providing information on the current state of the erythropoiesis process [4]. The number of erythrocytes and leukocytes, hemoglobin concentration and hematocrit value are used as indicators of good health in fish populations [5]. The fastest way to detect the effects of stressors can be done by analysis of hematological parameters, making these tests greatly important, especially for aquaculture [6]. To ensure that physiological parameters can be used for the purposes of biomonitoring aquatic ecosystems, it is necessary to obtain reference values of hematological parameters and compare different analysis [7]. The aim of this study was to assess the quality of habitats based on the obtained results of erythrocyte parameters of brown trout blood from the rivers Una and Krušnica.

2. MATERIAL AND METHODS

2.1. LOCALITY

Una River springs in the village of Donja Suvaja below the mountain Čemernica and the hill Lisina in the Republic of Croatia. The total length of the stream is 210 km [8], while the average flow drop is 1.67% [9]. This river possesses characteristics of mountain, hilly and plain rivers. Plandište,the site where the sampling in Una River was performed has the following coordinates N 44 ° 49′06.2″ E 15 ° 52′15.7″ (Fig. 1).
The Krušnica River springs near the village of Gudavac in the municipality of Bosanska Krupa, at an altitude of 200 m, and flows into Una River at an altitude of 140 m [10]. Thus, the total fall of this right tributary of the mainsten Una is 60 m,whilst the Krušnica River is only 6.5 m long. The sampling of brown trout was done at the spring of Krušnica River with the coordinates N 44 ° 51'29.95″ E 16 ° 10'11.40″.

Figure 1: Research site

2.2. ELECTROFISHING

Fish sampling was performed with an IG 200-1 Aqua Tech direct current generator, with the current strength of 5 kW, after which the individual trouts were transferred to net keepers at the sites for resuscitation and adaptation after stress.

2.3. HEMATOLOGICAL PARAMETERS

Blood from brown trout individuals at both sites was taken by puncturing the heart with a sharp and wide sterile needle (1.0-1.2 mm). From hematological parameters, erythrocyte count (RBC), hematocrit

value (HCT), hemoglobin concentration (HB) and hematological index, which includes average erythrocyte volume (MCV), average hemoglobin concentration in erythrocytes (MCH), average hemoglobin value per liter of erythrocytes (MCHC), were analyzed. The number of erythrocytes was determined by the standard method in a hemocytometer, the value of hematocrit was determined by microhematocrit centrifugation, and Drabkin's hemoglobin cyanide method was used to determine hemoglobin concentrations [11]. The hematological index was calculated from RBC, HCT and HB values..

2.4. STATISTICAL ANALYSIS

Statistical data processing was done in Microsoft Office Excell 2007 - Statistical Analysis Tools. A t-test (two samples) was used to compare the data and determine statistically significant differences between the data.

3. RESULTS AND DISCUSSION

In this study, 9 brown trout individuals from the Una River and 10 individuals from the Krušnica River were analyzed (Table 1). A higher mean value of hemoglobin was recorded in individuals from the Una River (74.49 ± 15.43 g / l) compared to individuals from the Krušnica River (48.52 ± 4.43 g / l). The mean value of hematocrit in fish from the Una River was 0.45 ± 0.17 l / l, and is higher than in individuals from the Krušnica River 0.38- ± 0.08 l / l. Individuals from the Krušnica River had a higher average erythrocyte count (0.74 ± 0.16 x 1012 / l), in contrast to fish from the Una River (0.60 ± 0.27 x 1012 / l). Extremely high MCV values were recorded in individuals from both localities, with individuals from the Una River having a higher value of this parameter compared to individuals from the Krušnica River. Hematological indices MCH and MCHC were higher in fish from the Una River compared to fish from Krušnica. Statistically significant differences were observed for HB, MCV and MCHC values.

Table 1: Values of erythrocyte parameters of brown trout from the Una and Krušnica rivers

	Una River (n=9)		**Krušnica River (n=10)**		Sig.
	Mean ± stdv	**Range**	**Mean ±stdv**	**Range**	
HB (g/l)	74,49±15,43	44,44-92,59	48,52±4,43	40,74-55,55	**0,001***
HCT (l/l)	0,45±0,17	0,29-0,86	0,38-±0,08	0,25-0,50	0,054
RBC (10^{12}/l)	0,60±0,27	0,27-0,90	0,74±0,16	0,59-0,98	0,164
MCV (fl)	888,89±431,22	418,16-1629,63	526,01±123,89	395,83-754,10	**0,002***
MCH (pg)	150,56±81,21	78,19-280,58	68,81±16,62	47,78-92,58	**0,000***
MCHC (g/l)	177,26±49,49	81,83-228,76	136,56±38,92	88,88-207,40	0,511

* statistically significant difference p <0.05

Hematological parameters are used as markers for the general health of organisms [12]. The total number of erythrocytes in less active species ranges from 0.5 to 1.5 x10^{12} / l, and in more active from 3 to 4.2 x10^{12} / l [13]. The recorded mean values of the number of erythrocytes in our studies at both sites are lower than the mean values reported by [14], which amounted to 1,289 x10^{12} / l, 1,167 x10^{12} / l, 1,070 x10^{12} / l. The mean value of erythrocyte counts in fish at both localities was quite similar to the mean erythrocyte count of brown trout from Central Europe in spring (0.7 ± 0.17 x10^{12} / l), and slightly lower compared to brown trout units at the same locality in autumn , where the mean value recorded was 1.04 ± 0.15 x 10^{12} / l [15]. The mean value of erythrocyte counts in brown trout from the spring of

Bosna River in all four seasons was about 1.00 $x10^{12}$ / l, which is higher than the values recorded in this study [16]. Since the values of erythrocytes, hemoglobin and hematocrit increase as an adaptation to the reduced amount of dissolved oxygen [17], it can be concluded that the amount of oxygen in the Krušnica River is lower than in the Una River.

The mean values of hematocrit in autochthonous fish species from Republika Srpska from three localities were 0.378 l / l, 0.399 l / l and 0.418 l / l ,and were similar to the values of hematocrit in fish from both localities in our research [18]. According to [19], the hematocrit value of brown trout from the Svratka River was 0.350 l / l, with this value being slightly lower compared to the hematocrit value of fish from the Krušnica and Una rivers. The mean value of hematocrit for farmed trout was 0.400 l / l, and values were recorded in a slight deviation from the results of our study [20]. The mean hematocrit value in brown trout individuals from the Ponor River was 0.394 l / l and was higher in relation to the brown trout hematocrit values from the Krušnica River and lower in relation to fish from the Una River [21].

The mean value of hemoglobin in fish from the Una River (74.49 g / l) is higher than the recorded values of brown trout by seasons from the Bosna River (winter 67.0 g / l, spring 71.7 g / l, summer 64.0 g / l and 69.4 g / l in autumn), while brown trout from the Krušnica River had much lower hemoglobin values (48.52 g / l) compared to fish from the Bosna River [16]. In experimental studies of the influence of cobalt chloride on the hematological parameters of brown trout in one control group, a higher mean value of hemoglobin (8.73 g / dL^{-3}) was recorded compared to our studies [22]. [18] states the lower limit of the amount of hemoglobin of 65.28 g / l and the upper limit of 99.24 g / l, where it can be stated that the obtained results of this study are closer to the lower limit values of this literature data and even below the lower limit. The values of hemoglobin in farmed brown trout were 64 g / l, therefore lower in relation to the hemoglobin values of fish from the Una River, but also higher in relation to fish from the Krušnica River [20].

Reference values of mean erythrocyte volume (MCV) range from 200-600 fl [23], where it can be concluded that MCV in fish from the Una River is much higher than the stated reference values, while MCV fish from the Krušnica River is closer the upper limit of the stated values. The recorded values of the mean value of hemoglobin in erythrocytes (MCH) in brown trout from the Una River are much higher than the reference values for this hematological parameter (20-110 pg), while in individuals from the Krušnica River they are within the reference values [23] . However, the stated reference values for hematological indices should be taken with caution, since recent literature data indicates that there are no reference values for brown trout blood parameters, especially at the time of spawning [24]. High values of MCV and MCH in brown trout from the Una River are associated with a low mean value of the total number of erythrocytes. In a recent study of hematological parameters of brown trout blood from the Somesul Cald River before and after spawning, much lower MCV values (before spawning 168.6 fl and after spawning 134.7 fl) were recorded as well as MCH (before spawning 39.28 pg and after spawning 35.59 pg) in relation to our research [25]. The recorded mean values of hemoglobin per liter of erythorcytes (MCHC) in fish at both sites in our study are slightly lower compared to the values recorded [18] at three sites 200.23 g / l, 209.22 g / l and 216, 46 g / l.

4. CONCLUSION

The values of erythrocyte parameters of the autochthonous species of brown trout (*Salmo trutta* L.) from the Una and Krušnica rivers are quite similar to the literature data of the same species. Quite high values of MCV individuals from the Una River are the result of a low mean value of erythrocyte count. Based on the results of this study, it can be concluded that the brown trouts from both localities are in good general health, which is an indicator that the water quality is good, since hematocrit values and hemoglobin concentration indicate the presence of infection and anemia in fish caused by various pollutants.

5. LITERATURE

[1] Dekić, R., Ivanc, A., Bakrač-Bećiraj, A., Bošković, J. (2009b). Normalne hematološke vrijednosti gajenog lipljena. IV međunarodna konferencija "Ribarstvo", 358-364.
[2] Xiaoyun, Z., Mingyun, L., Khalid, A. and Weinmin, W. (2009). Comparative of haematology and serum biochemistry of cultured and wild Dojoloach Misgurnus anguillicadatus. Fish Physiology and Biochemistry, 33, 435-441.
[3] Satheeshkumar, P., Ananthan, G., Senthil Kumar, D. and Jagadeesan, L. (2011). Haematology and biochemical parameters of different feeding behavior of teleost fishes from Vellar estuary, India. Comparative Clinical Pathology, 21(6), 1187-1191.
[4] Řehulka, J., Adamec, V. (2004). Red Blood Cell Indices for Rainbow Trout (*Oncorynchus mykis* Wlabaum) Reared in Cage and Raceway Culture. Acta Vet. Brno, 73, 105-114.
[5] Omoregie, E. & Oyebanji S.M. (2002). Oxytetracycline-induced blood disorder in juvenile nile tilapia oreoshromis ničoticus (Trewavas). *J. World Aquac. Soc*., 33, 337-382.
[6] Radu, D., Oprea, L., Bucur, C., Costache, M., Oprea, D. (2009). Characteristics of Haematological Parameters for Carp Culture and Koi (*Cyprinus carpio* Linneaus, 1758) Reared in an Intensive System. Bulletin UASVM, Animal Science and Biotechnologies, 66,(1-2), 336-342.
[7] Hlavova, V. (1993c). Reference values of the haematological indices in grayling (*Thymallus thymallus*). Comparative Biochemistry and Physiology Part A: Physiology, 105(3), 525-532.
[8] IBG; Programski ured Bihać (2003). Program razvoja riječnog sliva Une, Swiss Agency for Development and Cooperation, Bihać.
[9] Spahić, M. (1991). Rijeka Una – potamološka razmatranja. Zborniku radova: Valorizacija prirodnih i društvenih vrijednosti sliva rijeke Une, 6, 161 - 167.
[10] Defense Mapping Agency - DMA (1996): Map of Bosanska Krupa. Bosnia and Herzegovina 2384 I M709 Edition 6-DMA (Scale 1:50 000), The United States Goverment, Washington D.C., USA.
[11] Blaxhall, P. C. & Daisly, K. W. (1973): Routine hematological methods for use with fish blood. J. Fish. biol., 5, 771-781.
[12] Chowdhury, G., Hossain M. S., Dey, T., Akhtar, S., Jinia M. A., Das, B., Islam, M. J., Iqbal, M. M. (2020). Effects of dietary probiotics on the growth, blood chemistry and stress response of Pabda catfish (Ompok pabda) juveniles. AACL Bioflux, 13(3):1595- 1605.
[13] Witeska, M. (2013): Erythrocytes in teleost fishes: a review. Zoology and Ecology, 23, 275-281.
[14] Dekić, R., Ivanc, A., Lukač, M., Krnić, J. (2012): Morfometrijske karakteristike eritrocita *Telestes metohiensis* (Steindachner, 1901). Veterinaria 61 (3-4), 115-127.
[15] Maciak, S., Kostelecka-Myrcha, A. (2011). Regularites of variation of the red blood indices characterizing the respiratory function of blood in selected fish. Zoologica Ploniae. 56(1-4), 35-48.
[16] Pavlović, V., Mlađenović, O., Kekić, H., Vuković, T. (1962). Sedimentacija eritrocita, broj eritrocita i koncentracija hemoglobin potočne pastrmke (*Salmo trutta m. fario* L.) i lipljena (*Thymallus thymallus*) iz izvorišnog toka reke Bosne u sezonskim i ekološkim uslovima. Godišnjak Biološkog institute Univerziteta u Sarajevu. 15(1-2), 55-76.
[17] Tavares-Dias, M., Moraes, F. R., Imoto, M. E. (2008). Hematological parameters in two neotropical freshwater teleost, *Leporinus macrocephalus* and *Prochilodus lineatus*. Bioscience Journal, 3, 96-101.
[18] Ivanc, A., Dekić, R. (2012): Ekofiziološka istraživanja autohtonih vrsta riba Republike Srpske, Prirodno-matematički fakultet Banja Luka, Skup 4 (1), 26-35.
[19] Hlavova, V. (1988). The red blood picture of brown trout (*Salmo trutta*) and grayling (*Thymallus thymallus*) during the spring season. Zivocisna Vyroba. 33, (10), 949-960.
[20] Romestand, B., Halsband, E., Bragoni, G., Knežević, B., Marić, D., Prochnow F. (1983). Etude hematologique comparé des constantes erythrocytaires de quelques poissons marins et d'eaux douces. Rev. Trav. Inst. Pech. marit. 46, 147-156.

[21] Dekić, R., Manojlović M., Friščić J., Lolić S., Golub D. (2016). Morphometric and Physiological Characteristics of Brown Trout (*Salmo trutta*) from the Ponor River. Agro-knowledge Journal. 17 (3), 233-242.
[22] Atamanalp, M., Kocaman, E.M., Uçar, A., Alak, G. (2010). The Alterations in the Hematological Parameters of Brown Trout Salmo trutta fario, Exposed to Cobalt Chloride. Journal of Animal and Veterinary Advances. 9(16), 2167-2170.
[23] Hlavova, V. (1993b): Refernce values of the haematological indices in brown trout, *Salmo trutta m. fario*. Folia Zoologica. 42 (1), 47-62.
[24] Campbell, T. (2012). Hematology of fish. In: Veterinary hematology and clinical chemistry, 2 nd Edition. Thrall M., Weiser G., Allison R. W., Campbell T., Wiley-Blackwell, Ames, USA, 607-614.
[25] Alexandru, S. N., Mireșan, V. (2020). Prespawning and postspawning hematological parameters and oxidative stress biomarkers of brown trout (*Salmo trutta*) (Pisces: Salmonidae) from Someșul Cald River. AALC Bioflux, 13 (5), 2993-3003.

PRINCIPLES AND MICROBIOLOGICAL CRITERIA IN FOOD CONTROL

Huska Jukić [1], Mersiha Jusić [1], Sandra Tutić [1], Samira Dedić [2], Aida Džaferović [2]
[1]University of Bihac, Faculty of Health Studies, Nositelja hrvatskog trolista 4, 77000 Bihać, BiH, huskaj037@gmail.com
[2]University of Bihac, Faculty of Biotechnology, Kulina Bana 2, 77000 Bihać, BiH, samira.dedic@yahoo.com

ABSTRACT:

Food safety is essential for human consumption and health. In order for food to be healthy, it must be free of harmful substances in quantities that could, acutely or chronically, endanger human health. A potentially dangerous food is one in which microorganisms (usually bacteria) have favorable conditions for growth and reproduction. In order to avoid contamination of food, good hygiene practices should be implemented, which are a series of recommendations because they are desirable in the production, processing, storage and supply of food in order to prevent its microbiological, chemical or physical contamination. In order to be sure of the health safety of food, Institute of Public Health ZU USK conducts continuous monitoring of food health throughout its laboratory throughout the year.

Keywords: food, safety, health safety

1. INTRODUCTION

The term "food safety" is increasingly common in everyday life, and implies the healthiness and suitability of food for human consumption in accordance with its purpose. To produce health-correct food is possible while ensuring adequate hygienic measures in the production facility, and the overall supervision of the production process for a timely reaction in the possible occurrence of difficulties. In disease foodborne diseases include all diseases whose causative agents can be transmitted: microbiologically, chemically and physically harmful factors. Microbiological harmful food-borne factors are the most common causes of foodborne diseases, although the population has a widespread opinion that chemicals such as pesticides, additives and environmental contaminants are primarily responsible for health damage. Foodborne diseases, although preventable, are a public health problem in all countries of the world [1].

2. ROLE OF HYGIENIC - HEALTH SUPERVISION IN PROTECTING HEALTH HUMAN

Food-induced diseases mean those diseases that arise after consuming food or water contaminated with pathogenic microorganisms, microbiological toxins, chemical substances or, in turn, contaminated with plant or animal toxin. The healthiness of foodstuffs, therefore, primarily involves the finding of harmful substances that can threaten human health. Foods are an ideal environment for the growth and

reproduction of microorganisms and can be a carrier of various infectious diseases, primarily those common to humans and animals (zoonoses), but also those that are only transmitted by food. They can also contain specific causes of bacterial poisoning of humans as well as microorganisms that, with their biochemical activity, can lead to the formation of various toxic substances. From this it is a result that hygienic quality is the basis of the overall valorization of foodstuffs [2].

2.1. Microorganisms – foodborne pathogens

According to recent data, it is estimated that in the US, which is considered to have the safest trade and food production in the world, there are 25 to 250 million cases of human disease annually after consuming different types of food. According to the same estimate, between 6 and 10,000 people die each year from these consequences. Regarding reports and logins, their number is less than 5% in total, and in the occurrence of bacterial poisoning only 41% of the causative agents are determined [3].
Foodborne diseases, although preventable, are a public health problem in all countries of the world. In developing countries, microbiological contamination of food is a consequence of poor sanitation and insufficient education of food handlers. Data from developed countries show that the level of economic development, in itself, and good sanitary infrastructure are not sufficient preconditions for effective prevention of foodborne diseases. It has been established that the long journey of food from primary production to the end user and preparation of ready meals for a large number of users, favor the emergence of microbiological contamination of food, growth and reproduction of microorganisms [4].
According to WHO estimates, nearly two million people worldwide die each year from diarrheal syndrome, the most common clinical manifestation of microbiological contamination of food consumption. In developed countries, about 30% of the adult population suffers from food-borne diseases each year. It is estimated that the incidence of foodborne diseases in developing countries is higher than the incidence in developed countries.
The WHO has decided that, in order to determine the burden of community (countries, regions) on communicable food diseases, the number of lost years of life (DALYs) lost due to premature death and disability is used as a metric (measurable) indicator.
Most countries do not have data on the number of years of life lost due to foodborne diseases, and data on the number of reported cases of foodborne diseases, which is only the tip of the iceberg, are most often used [4, 5].

2.2. HACCP and GPH: Standards in Food Industry

Healthy food is necessary for the proper growth and development of every person and has a leading role in the quality of life of people. In Europe, food businesses are legally responsible for the safety of the food they produce, transport, store or sell. They are required to adopt a preventative approach by identifying and controlling hazards before they compromise the safety of food. To comply with these requirements, many food businesses follow relevant industry standards. Consumers rightfully expect that food is safe to eat. Unsafe food can lead to foodborne illness which is at best unpleasant and at worst fatal. Food safety is intrinsically linked to physical, chemical and/or microbiological hazards which can occur at any point in the food chain from farm to consumption. Food businesses have an important role to play in the control of these hazards. Food industry standards are typically produced by national or international organisations such as the International Standards Organisation (ISO), with designated responsibility for standards and/or food safety, or by the food industry itself, through a representative body such as the British Retail Consortium (BRC). Food industry standards play an important role in helping food businesses consistently produce safe food products that are compliant with legislation. Nowadays many standards are auditable and certifiable by independent third parties, such as Société Générale de Surveillance (SGS) [6, 7].
However, certification does not prove that a food is safe, only that it was produced under a properly implemented management system.The European Union actively encourages the development of national guides to good practice for hygiene and for the application of HACCP principles. Many of

these integrate business operations such as good manufacturing practices (GMP), GHP and HACCP; thereby, providing food businesses with a means to develop an integrated food safety management system. This is a cost-effective system for controlling product safety and quality. It also allows a food business to demonstrate its commitment to food safety, and outwardly conveys the degree of confidence required by consumers and regulators alike [8, 9].

Microbiological criteria provide the food industry and regulatory agencies with guidelines for control of food processing systems and are an underlying component of any critical control point that addresses a microbiological hazard in Hazard Analysis and Critical Control Points (HACCP) systems [10].

Before implementing HACCP, good hygiene practices (GHP) must be in place. These are known as prerequisite programmes and are mostly specified in corresponding legislation. Examples include personnel hygiene and training; cleaning and sanitation; maintenance and services; pest control; plant and equipment; premises and structure; storage,

HACCP forms the foundation of European and international legislation for the food industry and is a key component of international trade in food products. Today food industry standards play a major role in assisting food businesses to achieve compliance with legislation and in many cases exceed legislative requirements. Furthermore, they enable food businesses to ensure consistency in terms of product safety and quality [1, 11,12].

Poultry production has undergone great progress over the past 20 years, and hence increased consumption of chicken meat. Poultry meat takes a special place in food consumption. Several factors have a significant influence on the quality of chicken meat: the way of breeding, the type of food, the temperature of the environment, the transport of animals, the ways of stunning before slaughter, the process with the carcases during and after slaughter, storage conditions. Several authors reported on the technological quality of chicken meat [13, 14, 15, 16].

In the results of the research Jukić et al. chemical and microbiological properties of chicken meat from the intensive and existent state for samples of intensive bulk purchased in retail, one sample was positive for Salmonella spp. In the samples of chicken meat of intense fattening value of Enterobacteriaceae and the collection of aerobic colonies were larger than extensive fattening, which is to be expected because the samples were purchased in retail and the manner of storage and transportation could have been affected by the presence of these bacteria [13].

The hygienic condition of the animals before, during and after slaughter can be crucial for the quality of the finished product.Also microbes are ubiquitous in distribution, so contamination can occur at any stage of the food chain from farm to fork.That is why it is very important to monitor the microbiological quality of meat and meat products to create better quality and safety [17].

3. THE EXPERIMENTAL PART

3.1. Materials

Laboratory tests shall be performed according to the methods listed in Annex 1. Regulations. Laboratories within food business operators, ie within the facility where the samples are taken, must act in accordance with good laboratory practice and use the methods from Annex l. Regulations.

Laboratories authorized for official control must be accredited according to the standard BAS EN ISO / IEC I7025 - general requirements for the competence of testing and measuring (calibration) laboratories and conduct tests according to the accredited standards listed in Annex l. Regulations.

If a food business operator uses sampling or testing procedures that do not comply with Annex 1, Chapter l. Of the Ordinance, and the test results for a certain microorganism for which the criterion is determined by the Ordinance are unsatisfactory, the food business operator must consider the batch subjected to such sampling and testing unhealthy, in accordance with Articles 13 and 14 of the Food Act, and take appropriate corrective measures. (http://www.fsa.gov.ba).

3.2. Methods

Microbiological analysis in the analyzed samples was carried out in the laboratory of Public Institution „Veterinary Institute" Bihac. Aerobic mesophilic bacteria were determined by the method from Annex 1 of the Ordinance and according to the standard BAS EN ISO / IEC17025. According to microbiological criteria, there are two ways of interpreting the results conducted microbiological testing of samples:

Table 1: Regulations on microbiological criteria for food, Annex 1.

Food category	**Microorganisms, their toxins, metabolites**	**Sampling plan**		**Limitations**		**Analytical reference method**	**The stage at which the criterion is applied**
		n	**c**	**m**	**M**		
Meat products	*Salmonella*	5	0	absence in 25g		BAS EN ISO/ IEC17025	Products placed on the market during the shelf life

In this case, the results of the performed microbiological tests are interpreted as follows:
Satisfactory: if all 5 (n) samples show the absence of Salmonella in 25 g.
Unsatisfactory: if Salmonella in 25 g is found in any elementary unit of the sample [18].

The second way is three classifications, when two limit values (lower "m" and upper "M") are given in the microbiological criterion and the obtained test results can be interpreted as "satisfactory, acceptable or unsatisfactory". Two limit values and three possible interpretations of the results are common for the production process hygiene criteria.

Table 2: Example of interpretation of the results of the three classifications

Food category	**Micro-orga-nisms**	**Sampling plan**		**Limitations**		**Analytical reference method**	**The stage at which the criterion is applied**	**Procedures in case of unsatisfactory results**
		n	**c**	**m**	**M**			
Semi-finished of meat	*E. coli*	5	2	500 cfu/g ili u cm^2	5 000 cfu/g ili u cm^2	BAS ISO/ 16649.1 or 2	Completion of the production process	Improving production hygiene and improving the selection and / or origin of raw materials

In this case, the results of the performed microbiological tests are interpreted as follows:
Satisfactory: If all established values are less than the lower limit value, 500 cfu/g or cm^2 (<m);
Acceptable: If a maximum of 2 elementary units of sample (c) of the 5 (n) values obtained are between the lower and upper limit values („m" i „M"), 500 and 5000 cfu/g or cm^2, and other obtained values less than or equal to the lower limit value, 500 cfu/g (≤m);
Unsatisfactory: If one or more values are greater than the upper limit, 5000 cfu/g or cm^2 (>M), or if more than 2 elementary units of the sample (c) of the tested 5 (n) values are between the lower and upper limit values („m" and „M"), 500 or 5000 cfu/g or cm^2 [18].

4. RESULTS AND DISCUSSION

The quality of food that is good in bacteriological, chemical and physical terms must always be maintained to avoid disease or health problems. Cross-contamination of food by touch is one of the main causes of food poisoning. Meat that has not been cooked is often contaminated with bacteria and causes food poisoning. This is most common in poultry (*Salmonella* and *Campylobacter* spp.). These bacteria naturally live inside the intestines of poultry, or all the animals we use for food, and can be transmitted during dissection and preparation. It is not possible to have an insight into the contamination of meat with bacteria that cause food poisoning. It is therefore advisable to treat all meat as potentially contaminated.

Table 3: Number of samples of meat and meat products made ('" VETERINARY INSTITUTE Bihac")

Meat and meat products		
Number of total analyzes performed	**Number of samples processed**	**Number of unsatisfactory analyzes**
7410	1891	97

Table 4: Number and type of bacteria in unsatisfactory analyzes

A type of bacteria	**Number of unsatisfactory analyzes**
Aerobic mesophilic bacteria	57
Sulfite-reducing clostridia	2
Salmonella spp.	16
Campylobacter spp.	12
Enterobacter	4
Escherichia coli	6

Data we received from the Bihac Veterinary Institute, show that 5.13% of samples were not of satisfactory quality, of which *Salmonella* 0.85%, Aerobic mesophilic bacteria 3.01%, *Escherichia coli* 0.32%, *Campylobacter* spp. 0.63%, *Enterobacter* 0.21% and Sulfate-reducing clostria 0.1%.Our collected data should be interpreted with caution due to a small number of samples. Poultry meat is considered to be at higher risk of *Salmonella* contamination than other meat [19]. Numerous studies around the world have reported different levels of *Salmonella* pollution when it comes to poultry meat: 9.9% in Italy [20], 19.4-36.7% in Belgium [21], 60% in Portugal [22], and in Algeria 17.97% [23]. Heredia et.al. (2001.) they did research on minced meat undoubtedly collected from retail facilities in the city area of Monterrey, Mexico and analysed for microbiological contamination. The results of the microbiological analysis of the samples were not of satisfactory quality over 75% of the samples contained a total of 105 mesophilic microorganisms per g, and over 40% had 106 total coliforms per g. In most samples, fecal coliforms are present. *Staphylococcus aureus* was detected in 2.3% of samples, *Salmonella* spp. at 11.4%, *Listerio* spp. in 62%, and *L. monocytogenes* in 16%. *Escherichia coli* was detected in 76% of samples [24]. In their research Kibra et.al, (2019.) they examined minced meat and meat contact surfaces in selected butcher shops of Addis Ababa, Ethiopia. In total, they had 40 test samples, of which 16 minced beef, and the remaining 24 samples of surface swab collected from 8 butcher shops Prevalence *E. coli*, *Salmonella* and *S. aureus* in minced meat and contact surface samples were 43.75 and 29.17%, 6.25 and 4.17% and 37.50% in that order [25]. Taremi Mahnaz et.al., (2006.) they examined 241 samples of chicken and beef from retail facilities in Tehran (Iran) to the presence of Campylobacter. In total, 88 (36.5%) were isolated *campylobacter*. *Campylobacter* is isolated from a significantly higher number of chicken meat (63%) of beef (10%) [26], and according to research by Korsak et al., (1998.) and Osano and Arimi, (1999.) this pathogen is isolated with only 2% to 10% beef

samples [27, 28]. Poultry raw meat is usually contaminated with *Campylobacter*, especially chicken products from retail chicken has previously been reported in industrially developed countries: 46% in Japan [29], 50% in Spain [30], and 73% to 100% in the United States [31,32, 33]. In their research, Ayesha Zafar et.al, (2016.) examined 30 meat samples purchased at different local meat stores in Karachi. They found that almost all samples were inappropriate for human nutrition due to the presence of a high aerobic number, coliform, fecal coliform and *Salmonella* spp. The average aerobic number of log10cfu/g samples of chicken, mutton and beef was 6.67, 6.38 and 7.05 respectively. Of the 30 samples, 29 were highly contaminated with coliforms, and among them 26 were positive for fecal coliforms. The results also showed that 13 of the 30 meat samples tested positive for *Salmonella* [34]. According to the aforementioned authors, they showed a higher number of unsatisfactory samples according to the microbiological quality criterion compared to our results that showed fewer samples with unsatisfactory microbiological quality. The quality of food that is good in bacteriological, chemical and physical must always be maintained in order to avoid diseases or health problems. Healthy and safe food is an important factor to improve the standard of public health [35]. Each year in Europe, meat is associated with 2.3 million foodborne illnesses, with a high contribution from beef meat. Many of these illnesses are attributed to pathogenic bacterial contamination and inadequate operations leading to growth and/or insufficient inactivation occurring along the whole farm-to-fork chain [36].

The effects that microbial contaminants cause on meat include spoilage of the meat, food poisoning and condemnation of carcasses, which results into reduction of income to farmers as well as meat sellers. The consumers and meat handlers may acquire infectious diseases such as brucellosis, Staphylococcus food poisoning, leptospirosis, anthrax, clostridiosis, erysipelas, glanders, listeriosis Q-fever, salmonellosis, streptococcosis, tetanus, tuberculosis and yersiniosis due to poor handling of food animals and meat [17, 37].

The EU has one of the highest food safety standards in the world, thanks in large part to current food safety legislation. A key tool to ensure the flow of information to enable a rapid response when public health risks are detected in the food chain is the RASFF (Rapid Alert System for Food and Feed). The RASFF system is the basic tool for exchanging information on potentially dangerous products in all Member States, in cases where there is a risk to human health, which has led to certain measures such as withdrawal, seizure or ban on the sale of certain products [37].

The Central European Institution for Risk Assessment and Food and Food Safety is the European Food Safety Authority (EFSA). Rapid flow of information is enabled through the Rapid Alert System for Food and Food (RASF. The success of these institutions and the successful assurance and quality control of food and feed are impossible without networks of accredited laboratories.

The report provides an accurate overview of the micro-organisms that cause food-borne diseases in Europe and explains which are the most common sources of these infections. The report is important in the monitoring, control and prevention of zoonoses in the European Union. The latest report from the European Food Safety Authority (EFSA) and the European Center for Disease Prevention and Control (ECDC) advises that the conclusion of the reported results may be greatly influenced by insufficient identification and insufficient reporting of outbreaks. In 2018, out of a total of 359,692 cases of food and waterborne diseases in the European Union (EU), 41,203 people were hospitalized and 572 died [38].

The 2019 report compiled by EFSA-ECDC confirms that *Listeria monocytogenes* is the only foodborne pathogen with a significantly higher number of confirmed cases in the last 6 years, representing the highest number of deaths in the EU in 2018, with a mortality rate of up to 15, 6% [38].

The management and control of foodborne pathogens are mainly based on conventional detection methodologies, which not only take a lot of time and labor, but also involve high costs of consumables. The food industry is currently under great pressure due to various food crises that have occurred over the years, so it is very important that pathogen detection methods be as fast, efficient, sensitive and specific as possible. Recent research aims to develop detection methodologies based on advanced technology, such as sensors, that integrate a variety of concepts ranging from molecular and immunological techniques to the use of nanotechnology [39].

In studies by Agüeria et al., (2020.) they examine the methodologies used (audits and analytical methods), sampling sites, eligibility criteria, and main findings. They emphasize that the results of the analyzed studies represent a scientific basis for the design or improvement of sanitary procedures and their verification in food companies, and also provide relevant information for the authorities dealing with food safety [40]. They focused on the procedures carried out for the verification of cleaning and disinfection programs in food establishments and emphasized that the verification activities are useful because they represent a tool for continuous improvement of implemented safety and hygiene management systems [40].

In order to ensure that food handlers comply with food safety requirements and undergo correct attitudes and behavior, appropriate education and training, observation and evaluation of food handling, regular communication on food safety risks and responsibilities are required [41, 42, 43].

Yammine i Karam (2020.) in their research they also emphasize the need for routine monitoring and verification to assess the effectiveness of control measures and food safety systems over time. This encourages the need for continuous joint efforts between governments, the food industry, researchers and consumers to limit the microbiology of contamination and ensure safe food [41].

5. CONCLUSION

By healthy food or food suitable for consumption we mean those food that meets the quality, storage conditions, preparation and distribution. A potentially dangerous food is one in which microorganisms (most often bacteria) have favorable conditions for growth and reproduction. In order to ensure the health of food, it is necessary to implement measures of good hygiene practice (DPH). When it comes to meat and meat products, the emphasis would be on proper storage and rapid cooling of meat products as they can help prevent foodborne infections. It is extremely important that the managers and employees of food establishments understand what good hygiene practice is and that they follow and apply it in their daily work. In order to be sure of the health safety of food, the "ZU Institute of Public Health of the USK" conducts continuous monitoring of the health safety of food in its laboratories throughout the year. Microbiological examinations of food determine the presence of pathogenic or potentially pathogenic microorganisms and / or their toxins that have a negative impact on human and animal health. Food safety is also ensured by the HACCP system in the way of proper food business.

6. REFERENCES

[1] Codex Alimentarius (2003). Hazard Analysis and Critical Control Point (HACCP) system and guidelines for its application. CAC/RCP 1–1969: Rev 4.

[2] Kralik, G., Petričević, A. (1993.a). The Influence of Initial pH Value in Broiler Breast on Other Meat Characteristics. 11t^{h} European Symposium on the Quality on Poultry Meat 04-08.09.1993, Tours, France, I. Quality of Poultry Meat: 262-266.

[3] Kralik, G., Senčić, Đ., Maltar, Z., Mandić, B. (1993.b). Utjecaj u smjese dodanih PolyzimR preparata na performancu brojlera. Krmiva 35(2): 45-57.

[4] Bažok, R., Đugum, J., Grbeša, Darko., Hadžiosmanović, M., Havranek, J., Ivanković, A., Jakopović, I., Orešković, S., Rupić, V., Samaržija, D., Tudor K.M. (2004). Sigurnost hrane/Od polja do stola. M.E.P. d.o.o., Zagreb.

[5] Novaković, B., Jusupović, F. (2014). Ishrana i zdravlje. Medicinski fakultet, Novi Sad.

[3] Deaton BJ. (2004): A theoretical framework for examining the role of third-party certifiers. Food Control 15:615-619.

[6] Zdolec, N. (2007). European Union regulations on food hygiene (I). Meat, IX (I), 6-8.

[7] European Food Information Council (2011). Food safety controls in the European Union. Food Today.

[8] European Food Safety Autority (2013): Anual Report 2012, Corporate Publication.

[9] European Commission. (2004): Regulation (EC) No 852/2004 of the European Parliament and of the Council of 29 April 2004 on the hygiene of foodstuffs.
[10] Pierson, M., Zink, D., Smoot, L**. (**2007). Indicator Microorganisms and Microbiological Criteria, p 69-85. *In* Doyle M, Beuchat L (ed), *Food Microbiology: Fundamentals and Frontiers, Third Edition*. ASM Press, Washington, DC. doi: 10.1128/9781555815912.ch4
[11] European Commission (2002). Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the european food safety authority and laying down procedures in matters of food safety.
[12] Food and Agricultural Organization (1998. Food quality and safety systems – A training manual on food hygiene and the Hazard Analysis and Critical Control Point (HACCP) system.
[13] Jukić. H., Dedić, S., Rodić, M. (2019). CHEMICAL AND MICROBIOLOGICAL PROPERTIES OF CHICKEN MEAT FROM THE INTENSIVE AND EXISTENT, 12th International Scientific Conference on Production Engineering. Sarajevo - Bosnia and Herzegovina, 18th-20th, September 2019.
[14] Čorbo, S., Dedić S., Makić H., Omanović, H. (2015). Kvalitet lipida masti brojlera u zavisnosti od primjenjenog sojinog ulja i goveđeg loja u ishrani brojlera. Godina XVII (2015) siječanj-veljača, broj 1, časopis MESO. 91 ISSN 1332-0025, str. 130-137.
[15] Dedić, S., Čorbo, S., Makić H., Jukić, H. (2016). Sadržaj toksičnih metala makro i mikroelemenata u mesu brojlera ovisno od izvora masti obroka. Originalni znanstveni rad. godina XVIII (2016.) siječanj – veljača, broj 1: MESO str. 449-457.
[16] Dedić, S**.,** Čorbo S., Omanović H., Operta, S. (2016.). Effects ofusing soybean oil and beef tallow in diet on the proximate composition and content of cholesterol in fat tissue and broiler meat. 26th INTERNATIONAL SCIENTIFIC-EXPERT CONFERENCE OF AGRICULTURE AND FOOD INDUSTRY Sarajevo, September 27 – 30, 2015: Radovi Poljoprivredno-prehrambenog fakulteta Univerziteta u Sarajevu str. 113-117, UDK 63/66 (058)0808.1/2 BH ISSN 0033-858.
[17] Pal M, Dulo F, Patel A, Ayele Y. (2018). Microbiological and hygienic quality of Meat and Meat Products. Beverage and Food World, 2018; 45(22):21-7.
[18] Odluku o smjernicama/vodičima o mikrobiološkim kriterijima za hranu, Agencija za sigurnost hrane Bosne i Hercegovine. https://fsa.gov.ba/wp-content/uploads/2021/01/bs-Smjernice-vodic-za-mikrobioloske-kriterije-za-hranu.pdf.
[19] Jordan E, Egan J, Dullea C, Ward J, McGillicuddy K, Murray G, Murphy A, Bradshaw B, Leonard N, Rafter P, McDowell S. Salmonella surveillance in raw and cooked meat and meat products in the republic of Ireland from 2002 to 2004. Int J Food Microbiol 2006; 112:66–70.
[20] Busani L, Cigliano A, Taioli E, Caligiuri V, Chiavacci L, Di Bella C, Battisti A, Duranti A, Gianfranceschi M, Nardella MC, Ricci A, Rolesu S, Tamba M, Marabelli R, Caprioli A; Italian Group of Veterinary Epidemiology. Prevalence of Salmonella enterica and Listeria monocytogenes contamination in foods of animal origin in Italy. J Food Prot 2005; 68:1729–1733.
[21] Uyttendaele MR, Debevere JM, Lips RM, Neyts KD. Prevalence of Salmonella in poultry carcasses and their products in Belgium. Int J Food Microbiol 1998; 40:1–8
[22] Antunes P, Re´u C, Sousa JC, Peixe L, Pestana N. Incidence of Salmonella from poultry products and their susceptibility to antimicrobial agent. Int J Food Microbiol 2003; 2:97–103.
[23] Mezali L., Mossadak H.T., (2012). Prevalence and Antimicrobial Resistance of Salmonella Isolated from Meat and Meat Products in Algiers (Algeria) Foodborne Pathogens And Disease Volume 9, Number 6, 2012 ª Mary Ann Liebert, Inc. DOI: 10.1089/fpd.2011.1032
[24] Heredia N., García S., Rojas G., Salazar L., (2001). Microbiological Condition of Ground Meat Retailed in Monterrey, Mexico *J Food Prot* (2001) 64 (8): 1249–1251.https://doi.org/10.4315/0362-028X-64.8.1249
[25] Kibrom Zerabruk, Negussie Retta, Diriba Muleta, Anteneh T. Tefera, (2019). Assessment of Microbiological Safety and Quality of Minced Meat and Meat Contact Surfaces in Selected Butcher Shops of Addis Ababa, Ethiopia, *Journal of Food Quality*, vol. 2019, Article ID 3902690, 9 pages, 2019. https://doi.org/10.1155/2019/3902690.

[26]Taremi Mahnaz, Mohammad Mehdi, Soltan Dallal, Latif Gachkar, Sanaz MoezArdalan, Koorosh Zolfagharian, Mohammad Reza, Zali (2006). Prevalence and antimicrobial resistance of *Campylobacter* isolated from retail raw chicken and beef meat, Tehran, Iran. International Journal of Food Microbiology Volume 108, Issue 3, 1 May 2006, Pages 401-403.
[27] Korsak, N., Daube, G., Ghafir, Y., Chahed, A., Jolly, S., Vindevogel, H., (1998). An efficient sampling technique used to detect four foodborne pathogens on pork and beef carcasses in nine Belgian abattoirs. J. Food Prot. 61, 535–541.
[28] Osano, O., Arimi, S.M., (1999). Retail poultry and beef as sources of Campylobacter jejuni. East. Afr. Med. J. 76, 141–143.
[29] Ono, K., Yamamoto, K., (1999). Contamination of meat with Campylobacter jejuni in Saitama, Japan. Int. J. Food Microbiol. 47, 211–219.
[30] Dominguez, C., Go´mez, I., Zumalaca´rregui, J., (2002). Prevalence of Salmonella and Campylobacter in retail chicken meat in Spain. Int. J. Food Microbiol. 72, 165–168.
[31] Baker, R.C., Paredes, M.D., Qureshi, R.A., (1987). Prevalence of Campylobacter jejuni in eggs and poultry meat in New York State. Poult. Sci. 66, 1766–1770.
[32] Willis, W.L., Murray, C., (1997). Campylobacter jejuni seasonal recovery observations of retail market broilers. Poult. Sci. 76, 314–317.
[33] Smith, K.E., Besser, J.M., Hedberg, C.W., Leano, F.T., Bender, J.B., Wicklund, J.H., Johnson, B.P., Moore, K.A., Osterholm, M.T., (1999). Quinoloneresistant Campylobacter jejuni infections in Minnesota, 1992–1998. Investigation Team. N. Engl. J. Med. 340, 1525–1532.
[34] Ayesha Zafar, Erum Ahmed, Hafiza Wajiha, Abdul Basit Khan (2016). Microbiological Evaluation of Raw Meat Products Available in Local Markets of Karachi, Pakistan. Proceedings of the Pakistan Academy of Sciences. Vol. 53 No. 2 (2016)
[35] Cahyani, R., Waluyo, J., & Iqbal, M. (2020). Identification of Bacteria on Seblak Food around University of Jember Based on Microbiological Criteria of Processed Food. BIOEDUKASI: Jurnal Biologi Dan Pembelajarannya, 34-40. doi:10.19184/bioedu.v18i1.14835
[36] Vincent Tesson Mfecjdomsggb. A (2020). Systematic Review of Beef Meat Quantitative Microbial Risk Assessment Models. Int. J. Environ. Res. Public Health. 2020; 17(688).
[37] Pal, M., Tesfaye, S. and Dave, P. (2013). Zoonoses occupationally acquired by abattoir workers. Journal of Environmental and Occupational Science 2: 155-162.
[38] EFSA-ECDC. (2019). The European Union one health 2018 zoonoses report. EFSA Journal, 17(12), 1– 276. https://doi.org/10.2903/j.efsa.2019.5926.
[39] Carolina Ripolles-Avila, Maria Martínez-Garcia, Marta Capellas, Josep Yuste, Daniel Y. C. Fung, José-Juan Rodríguez-Jerez (2020). From hazard analysis to risk control using rapid methods in microbiology: A practical approach for the food industry https://doi.org/10.1111/1541-4337.12592.
[40] Agüeria D.A., C. Libonatti, D. Civit (2020). Cleaning and disinfection programmes in food establishments: a literature review on verification procedures. Journal Applied Microbiology ISSN 1364-5072 https://doi.org/10.1111/jam.14962
[41] Yammine J., L. Karam, (2020). Microbiological Quality and Safety of Retail Chicken and Beef Products in Lebanon. Journal of Food Quality and Hazards Control 7 (2020) 60-66
[42] Nyarugwe S.P., Linnemann A.R., Luning P.A. (2020). Prevailing food safety culture in companies operating in a transition economy-Does product riskiness matter? Food Control. 107: 106803. [DOI: 10.1016/j.foodcont.2019.106803]
[43] Powell D.A., Jacob C.J., Chapman B.J. (2011). Enhancing food safety culture to reduce rates of foodborne illness. Food Control. 22: 817-822. [DOI: 10.1016/j.foodcont.2010.12.009]

ANALYSIS OF PERCEPTIONS AND ATTITUDES ABOUT WATER ISSUES IN CROATIA

Lidija Jakšić, Marinela Vulić, Snježana Kirin
Karlovac University od Applied Sciences, Trg J.J. Strossmayera 9, 47 000 Karlovac, Croatia,
lidija.brckovic@vuka.hr

ABSTRACT:

Water is one of the most important natural resources and due to the growing needs for water, which occur as a result of urbanization, as well as various industries, there is an increase in consumption which leads to increased water pollution. The quality of water in Croatia is different at different areas, and it mostly depends on the level of area development and industry structure. This study aims to assess the perceptions of the general public and to analyze the information and awereness of citizens about the quality of drinking water in Croatia, as well as their responsible behavior towards available resources. It is important to make citizens aware of the importance of conserving water resources. The survey was conducted with a questionnaire and it was found that most responders are satisfied with the quality of water they use.

Keywords: water, water quality, pollution, public perceptions, questionnaire survey

1. INTRODUCTION

Water is one of the most important natural resources of the ecosystem and has an important role for both drinking as well for various industries. [1] The availability and quality of surface or ground waters has been changing, mainly due to urbanization and industrialization. [2] Water is used in all sectors of the economy, in different ways and in varying amounts. Access to sufficient quantities of fresh water is crucial for many economic sectors and communities that depend on these activities. [3] Therefore, it is important to make citizens aware of the responsible behavior towards that resource. Although the quality of drinking water in Croatia is relatively good, it depends on the area in which we are located, as well as the availability of resources. Human activities significantly affect the elements of water quality, and can also cause a permanent negative impact on water. [4] Although among the EU countries, Croatia recorded the highest freshwater resources, it is important to make citizens aware of the importance of conserving water resources because water use is a part of the daily routine. For this reason it was conducted this survey with a quesstionaire to gain insight into perceptions of citizens about this issue, but also to raise awareness of the importance of acting responsibly towards this source. Several studies have been conducted in other countries, especially the United States (Mahler 2010., Adams 2013., Borisova 2013., Evans 2015., Gholson 2018.) [5 - 9] which deal with similar topics. The aim was to gather information in different groups of citizens through surveys. One of them is study which aims to assess and compare the perceptions of different groups such as the general public, post-secondary students, and also water professionals in Oklahoma on water issues in the state. [10] There is also study conducted among university students in Malaysia, where it was found that students in this

group are quite aware of the water problem. [11] Studies have shown that several factors affect water conservation behavior [12, 13], including a range of demographic variables, such as gender, age [14], education, and information transparency of water consumption, which is the strongest factor. [15] Some of the previous studies have found that clean drinking water has been identified as a key factor related to water perceptions. [16] There are also several surveys of water consumption behaviour and perceptions of residents with private water supplies [17], but in Croatia more than 90% of the population uses water from public water supply [18] so because of that the aim was to discuss the perceptions of the general public. Also the goal was to achieve a diverse sample, so there were no restrictions or requirements on the characteristics of responders. Several studies also reported an 18% decrease in water consumption in Zaragoza, Spain because of improved water conservation awereness [19] and also the 20% reduction in the water consumption of California residents is also attributed to water conservation awareness programs [20].

2. MATERIALS AND METHODS

The survey was conducted in the period from June 4, 2021 to June 18, 2021. The aim of this study is to assess and discuss the perceptions of the general public about water issues in Croatia. The survey included 15 questions which can be classified into several categories. First category of questions (1 to 3) included general information about responders (gender, age, county where they live). Second category (4 to 10) were questions about satisfaction with the water they use for drinking and also which is main resourse of drinking water in their household. Third category (11 to 12) tested responders' knowledge about household wastewater. At the end there were questions (13 to 14) related with information about surface water quality in their area and question (15) about awareness of responsible behavior towards available water resources.

3. RESULTS AND DISCUSSION

In the survey participated 267 citizens, of which 190 were females (71,16%) and 77 were males (28,84%) (Figure 1). According to Figure 2, the respondents are mostly citizens up to 35 years, while two responders (1%) are older than 66 years and they live in Zagreb County and also they mostly use bottled water, and the water they use goes into the septic tank system (Figure 11). Most responders are mostly from The City of Zagreb (19,10%) and Split-Dalmatia County (17,60%). (Figure 3)

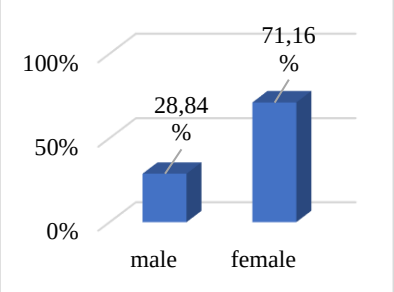


Figure 1: Gender of responders

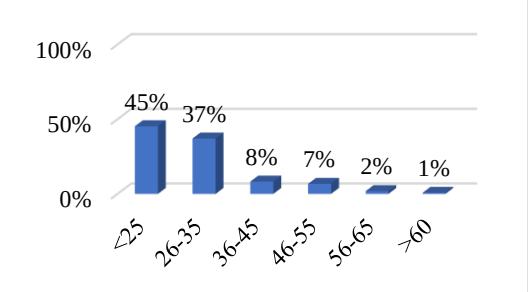


Figure 2: Age of responders

There are few responders (4%) who are not satisfied with quality of water they use for drinking (Figure 4), and these are citizens mostly from Brod-Posavina County and Primorje-Gorski Kotar County and also these responders consume tap water.

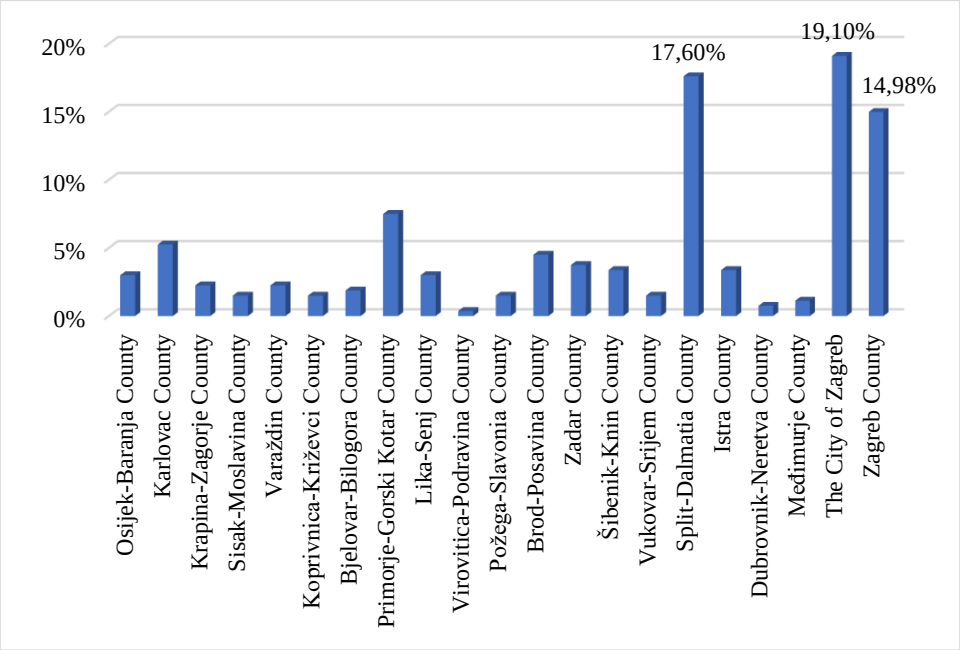


Figure 3: County in which the responders live

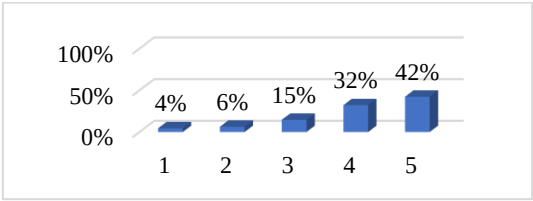


Figure 4: Satisfaction of responders with drinking water (from 1 to 5)

A small number of responders use bottled (6%) and spring water (3%), while 10% of respondents use water from wells and some of them (8%) add additives to improve quality of water. (Figure 6). The largest number of responders use tap water and public water supply, which is consistent with the statistics in the annual report about water in Croatia from 2019, according to which more than 90% of the population uses water from public water supply. [18]

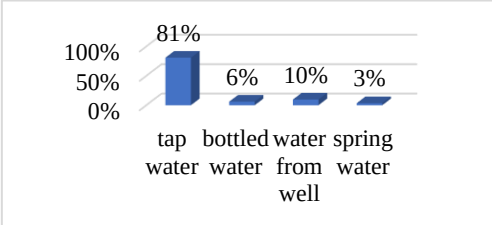


Figure 5: Main source of drinking water in their household

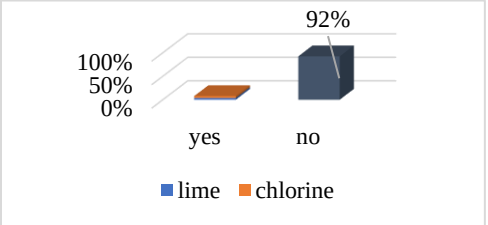


Figure 6: Treatment additives for water from well

Most responders (Figures 7, 8 and 9) consume clear (92%), odorless (85%) water while a couple of them drink water that is cloudy and white with a chlorine odor, which may be due to the use of substances that affect the water quality shown in Figure 6. Water test (Figure 10) is performed by 9% respondents, of which 15 people test tap water, 2 people test bottled water, and also 7 people test well water while none of the responders analyzes spring water.

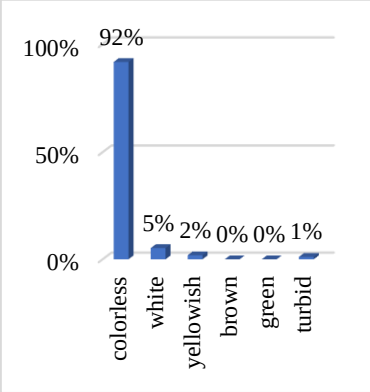


Figure 7: Color of water responders use for drinking

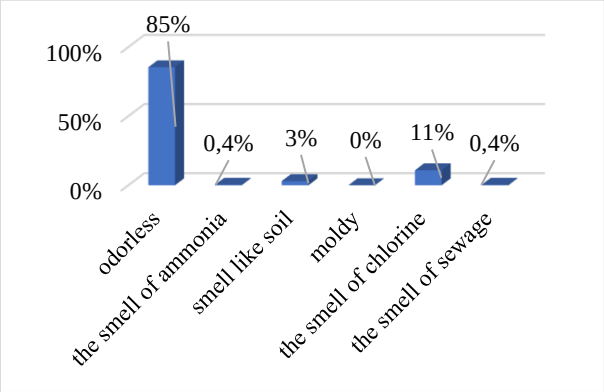


Figure 8: Smell of water responders use for drinking

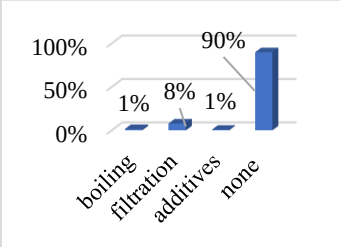


Figure 9: Using treatments to improve the quality of drinking water

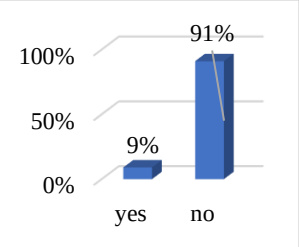


Figure 10: Testing the quality of water responders use for household consumption

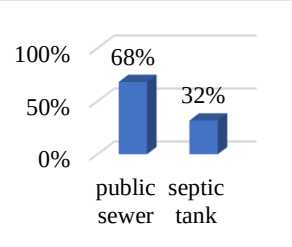


Figure 11: Where the drain water from responders household goes

Responders were asked do they consciously throw some of the substances into the drainage system. It can be seen how responders consciously insert into the drainage system cooking oil, fats (31%) and food residues (24%), which can lead to clogging of the drainage system. (Figure 12) There is a few respondents (27%) who are familiar with the quality of surface water in the area where they live, and the main source of information is the Internet or the media. (Figure 13 - 14) In previous study it has been shown that the information transparency of the water consumption of residents is the key factor that affects water-use behavior, [21] therefore, it is important to work on informing citizens.

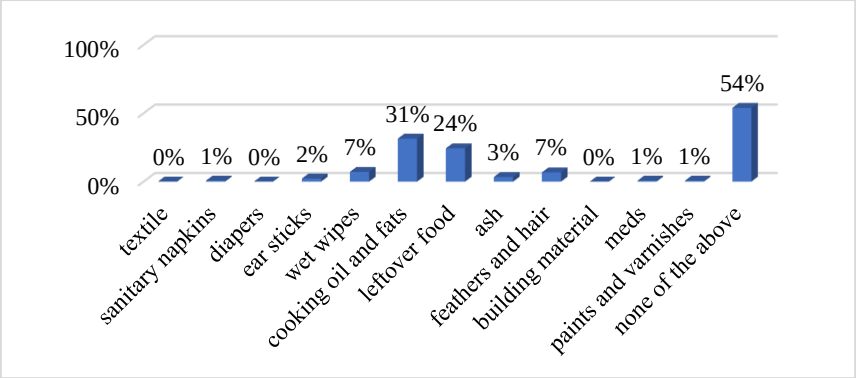


Figure 12: Consciously throw some substances into the drainage system

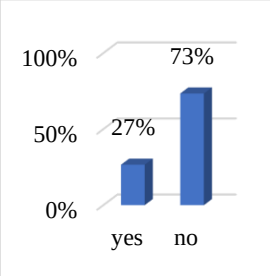


Figure 13. Knowledge of surface water quality in the county of responders

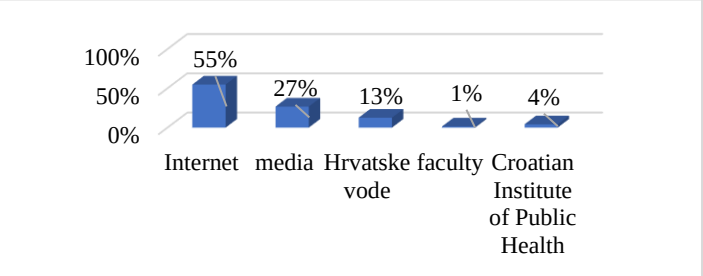


Figure 14. Source of information about quality of surface water

There is 69% of the responders which believe that they handle drinking water quantities responsibly, even though the available water resources are being destroyed at a high rate (Figure 15), which can be compared to research from Oklahoma where they are also only water professionals considered water quantity to be an issue, whereas the students and public considered it to be much less of an issue. [10]

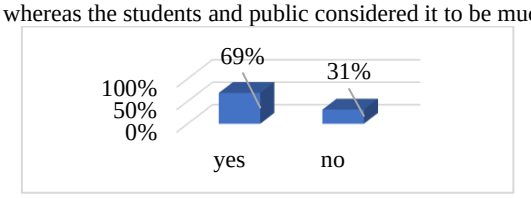


Figure 15: Responsible handling of drinking water quantities given that available water resources are being destroyed at a high rate

4. CONCLUSION

Sufficient quality water for human consumption is an essential item, so it is important to prevent and limit the destruction of these resources. Most responders use tap water and they are generally satisfied with the quality of water they use. The small majority of responders use for drinking water from wells and some of them add additives to increase its quality. It turned out that the responders are also satisfied with the availability of resources in Croatia, but a small number of citizens are familiar with the quality of surface waters in the area where they live, so it is necessary to work on informing them about that

issue. There is 69% of the responders which believe that they handle drinking water quantities responsibly, even though available water resources are being destroyed at a rapid rate.

5. REFERENCES

[1] Ahuja, S. (2021). Handbook of Water Purity and Quality (Second Edition), Academic Press, 1-18
[2] Cosgrove, W. J., Loucks D. P. (2015). Water management: Current and future challenges and research directions, Water Resour. Res., 51, 4823–4839
[3] Vojvodić, V. (2019). Uporaba vode u Europi – količina i kvaliteta suočavaju se s velikim izazovima, Kemija u Industriji 68, 7-8, 332–334
[4] Grzelj Šimić, V. (2016). Kontrola izvora onečišćenja voda, Hrvatske vode, Vol. 24, No.96, 147-160
[5] Mahler, R.L., Gamroth, M., Pearson, P., Sorenson, F., Barber, M.E., Simmons R. (2010). Information sources, learning opportunities, and priority water issues in the pacific northwest. Journal of Extension, 48, 2
[6] Adams, D.C., Aleen, D., Borisova, T., Boellstorff, D.E., Smolen, M.D., Mahler, R.L., (2013). The influence of water attitudes, perceptions, and learning preferences on water-conserving actions. Natural Sciences Education, 42, 114-122
[7] Borisova, T., et al. (2013). Differences in opinions about surface water quality issues in the southern United States:Implications for watershed planning process, Natural Sciences Education,42,104-113
[8] Evans, J.M., et al. Calabria J., Borisova T., Boellstorff D.E., Sochacka N., Smolen M.D., Mahler R.L., Risse, L.M. (2015.). Effects of local drought condition on public opinions about water supply and future climate change, Climatic Change 132, 2
[9] Gholson D.M., Boellstorff, D.E., Cummings, S.R., Wagner, K.L., Dozier, M.C., (2018). Outreach Preferences for Water Resource Information from Extension and Other Sources, Natural Sciences Education, Vol. 47
[10] Eck, C.J., Wagner, K.L., Chapagain, B., Joshi, O. (2019). A Survey of Perceptions and Attitudes about Water Issues in Oklahoma: A Comparative Study, Universities Council on Water Resources, Journal of Contemporary Water Research & Education, Issue 168, 66-77
[11] Augustine, E.E., Hanafiah, M.M., (2019). Awareness Level of Water Resource Conservation of University Students, Water Conservation and Management (WCM) 3, 2,18-21
[12] Corral-Verdugo, V., Frias-Armenta, M., Perez-Urias, F., Orduna-Cabrera, V., Espinoza- Gallego, N. (2002). Residential water consumption, motivation for conserving water and the continuing tragedy of the commons, Environmental Managemen, 30, 4, 527–535
[13] Corral-Verdugo, V., Frías-Armenta, M. (2006). Personal normative beliefs, antisocial behavior, and residential water conservation, Environment and Behavior, 38, 3, 406–421
[14] Matos, C.; Teixeira, C.A.; Bento, R.; Varajão, J.; Bentes, I. (2014.) An exploratory study on the influence of socio-demographic characteristics on water end uses inside buildings, Science of The Total Environment, 466, 467–474.
[15] Dolnicar, S., Hurlimann, A., Grün, B. (2012). Water conservation behavior in Australia, Journal of Environmental Management, 105, 44-52
[16] Kopiyawattage, K.P.P., Lamm, A.J. (2017). Using Public Opinions of Water Quality to Provide Direction for Extension, Journal of Extension, 55, 3
[17] Jones, A.Q., et al. (2005). Public perception of drinking water from private water supplies: focus group analyses, BMC Public Health, 5, 129
[18] Izvještaj o zdravstvenoj ispravnosti vode za ljudsku potrošnju u Republici Hrvatskoj u 2019., Croatian National Institute for Public Health
[19] Abdul-Razzak, M.J., Ali-Khan, M.Z. (1990). Domestic water conservation potential in Saudi Arabia, Environ. Manag., 2, 167–178
[20] Zuchowicki, W.; Kuczynski, W. (2008). Study on water consumption in apartment buildings in Koszalin, Przem. Chem. 5, 628–629
[21] Fan, L., Wang, F., Liu, G., Yang, X., Qin, W. (2014). Public Perception of Water Consumption and Its Effects on Water Conservation Behavior, Water , 6, 1771-1784

LEAD (Pb) CONTENT IN THE SOIL AND PEACH PRODUCED IN THE REGION OF MOSTAR

Munir Mehović, Sejit Bobar
University of Dzemal Bijedic in Mostar, Faculty of Education, Chemistry department,
University Campus 88104 Mostar
munir.mehovic@unmo.ba

ABSTRACT:

Peach is fruit crop characteristic of the Herzegovina region. The amount of peach produced for consumption and processing, greatly exceeding the Herzegovina population needs, and produced fruit has an impact on the quality of the diet to a wider geographical area. The aim of this work is to determine the content of lead (Pb), as well as potentially toxic metal in soil samples and peach fruits produced in the Mostar region, that consumption in raw form or in form of products, lead may be involved in human metabolism.

Soil samples were taken from a depth of 30cm and 60cm in locations with different modes of production (extensive, intensive - plantation farming and plantation near anthropogenic sources of pollution). From the same locations is taken representative samples of peach fruit. In soil samples and peach fruits samples were determined physicochemical properties and the content of lead. Lead content was determined by atomic absorption spectrophotometry, flame technique (FAAS).

Lead content in the peach is in range of 0,005 - 0,017 mg/kg and in soil from 19,75 – 36,66 mg/kg. Relation between lead content i peach, lead content in the soil, cultivation methods and the presence of anthropogenic pollution sources was not observed.

Keywords: soil, peach, lead, toxicity, diet

1. INTRODUCTION

It is known that any substance can be a cure or a poison, depending on the amount in which it is taken into the body. No chemical species has such a pronounced property as metals. One same metal in the body can act as an essential, necessary for the normal functioning of the body, as well as a highly toxic substance that can endanger the survival of the body. The only properties, that determine which role of metals will be in a living organism, are the concentration and appearance form of the metal.
Metals cannot be chemically decomposed. They are ubiquitous in nature in all geological spheres and the interaction of living organisms with metals is unavoidable. Sources of metals in the environment are natural - the effects on the body are generally not harmful and anthropogenic - that usually has a property of pollution. The amount of metal in cultivated soils immediately affects the plant species grown on it. In order to optimize agricultural production, man directly changes the properties and composition of the soil and so affects the fraction of mobile and potentially mobile forms of metals. In addition to the direct impact, man indirectly, with activities that have no direct connection with

agriculture (industry, transport, energy, mining, metallurgy), affect the quality of soil, hence to the quality of agricultural crops.

In soils, apart from atmospheric deposition, the most usual sources of contamination are lead containing solid wastes (domestic, ammunition, paint emission). Lead is non-volatile and therefore extremely persistent in soil [1]. The fate of lead in soils is dependent upon specific or exchange adsorption at mineral interfaces. Most lead is retained in soil as it is strongly adsorbed to organic matter, and only a limited fraction can be transported

Lead is naturally present in all soils. It generally occurs in the range of 15 to 40 parts lead per million parts of soil (ppm), or 15 to 40 milligrams lead per kilogram of soil (mg/kg) [2]. Pollution can increase soil lead levels to several thousand ppm. The major cause of soil lead contamination in populated areas is the weathering, chipping, scraping, sanding, and sand-blasting of structures bearing lead-based paint. Soil is a dynamic medium where Pb can persist for extended periods as compared to air and water [3,4] . The residence time for Pb in the soil at a depth of 20 cm can be centuries, and it is decades in the topsoil (5 cm) [5]. Lead is present on plant surfaces as a result of atmospheric deposition. Biological uptake from the soil or leaves may occur as indicated by the presence of lead in internal tissues [6].

Exposure to Pb can occur through inhalation of contaminated dust particles and aerosols or by ingesting contaminated food and water [7]. Lead poisoning in humans damages the kidneys, liver, heart, brain, skeleton and the nervous system [8]. The WHO recommended safe limits of Pb in wastewater and soils used for agriculture are 0.01 and 0.1 ppm respectively[9].

Peach [10] (*Prunus Persica*) belong to the group of stone fruits as well as plums, apricots, nectarines, cherries and sour cherries. This group of fruits has fruitage with a high sugar content (up to 11%) [11], organic acids, pectin and aromatic substances, vitamins and minerals. Since they have a thin protective surface skin, it is difficult to store them for a long time in fresh condition, and most often they are used as a seasonal fruit. As raw materials for further processing, they appear in the fruit pulp form and the frozen state, or processed into final products: fruit juices, concentrates, syrups, jams and marmalades.

2. MATERIALS AND METHODS

The Herzegovina is traditionally known as peach cultivation area, its processing and placement on the teritory of whole Bosnia and Herzegovina, as well as the region. Three peach cultivation sites were selected - Jasoč, Turajlovina and Rudine.

The sampling methodology and obtaining a representative soil sample implies that soil samples were taken at the intersection of the diagonals between the trees from which the yeild samples were taken and the adjacent trees on the plot. The soil was sampled at depths of 30 cm and 60 cm. A composite sample of about 5 kg mass was made from four samples from one depth and such samples were dried to air-dry sample. After drying, a laboratory sample of 1 kg was made from the composite sample by the method of quartering. For each locality, one sample from 30 cm depth and one sample from a depth of 60 cm were analyzed.

Peach fruits was sampled at the time of the most intensive harvest, that is when over 60% of the fruits were ripe. At the localities of Jasoč and Turajlovina, trees were selected from the central part of the plot, while the sampling location of Rudina were selected closer to the road, regardless of the size of the plot. A total of 3 kilograms of ripe fruits were harvested inside one tree, picking evenly from the lower, middle and upper branches. For each locality were made one sample of peach. A schematic representation of soil and peach fruit sampling is given in Figure 1.

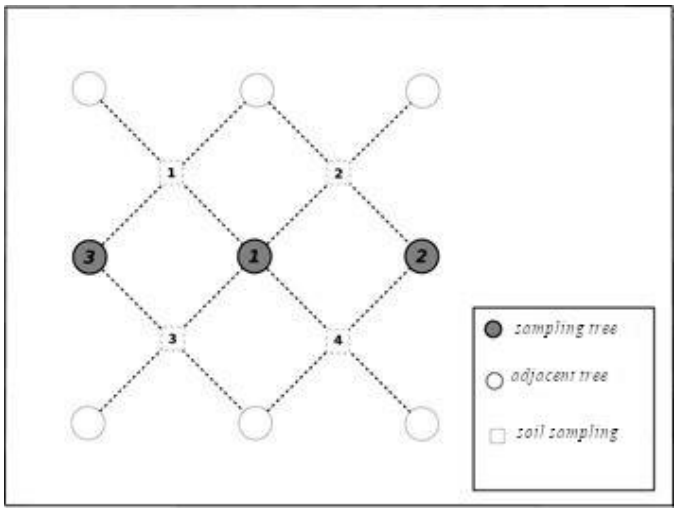


Figure 1: Soil and fruit sampling sheme

After air-drying, the soil samples was ground in an agate mortar and sift through a 2 mm plastic sieve. It was packaged in paper bags and sent to the laboratory for further analysis. Soil samples from 30 cm and 60 cm depth were measured for each locality. All parameters of soil were determined five times and the shown results represent the mean value of the measurement. The average value of metal content in the soil for each locality was determined as the mean of all measurements of metal content from one locality (5 measurements from 30 cm and 5 measurements from 60 cm).

The sampled peaches were transported frozen to the laboratory (properly packaged for 8 hours) for analysis. Prior to analysis, peach samples from one locality were ground into a homogeneous pulp which was used for further processing and measurements. All parameters of fruit were determined five times and the shown results represent the mean value of the measurement.

Laboratory analyzes include determining the physically-chemical parameters of soil and fruit and determining the total metal content as well. Six soil samples and three peach samples were analyzed. Of the physically-chemical parameters of the soil, the pH in water and in 1M KCl, the content of nitrogen, the content of phosphorus and potassium and the content of humus were determined. Of the the fruit, pH of the fruit, the content of dry matter, the content of total sugars, the content of vitamin C and the total acidity were determined. The metal content in soil and fruit was determined by the atomic absorption method, flame technique (FAAS). Lead was determined at a wavelength of 283,3 nm with a permeance of 0,7 nm. Content of lead was calculated according to modified Lambert-Beer equation.

$$I_p = I_0 \cdot 10^{-k \cdot b \cdot N_0} + I_e - I_r - I_b \qquad (1)$$

where is:
I_0 – intensity of input radiation
I_p – intensity of output radiation after passing through atomic vapor
N_0 – numbers of atoms in unexcited (ground) state
b – length of the radiation path through the atomic vapor
k – absorption coefficient
I_e – radiation of transition from excited to ground state
I_r – scattering of radiation
I_b – absorption of plasma and background absorption

3. RESULTS AND DISCUSSION

Soil analyzes was including control of the nutritional status of planted areas and metal content. Peach analysis was covering determining the chemical parameters (quality) of fruit samples and metal content.

3.1. Physical and chemical properties of soil

Table 1 presents the results of the analysis of physical and chemical properties of soil.

Table 1: Physico-chemical properties of soil

Locality	Depth	pH		N	P	K	Humus
	(cm)	H_2O	nKCl	(%)	mg P_2O_5/100g	mg K_2O/100g	(%)
Jasoč	0-30	6,29	5,54	0,07	4,00	15,10	0,00
	30-60	6,32	5,60	0,02	3,05	4,20	0,68
Turajlovina	0-30	5,34	4,74	0,04	2,60	10,80	0,17
	30-60	5,48	4,90	0,03	2,10	11,80	0,00
Rudine	0-30	7,41	6,65	0,21	4,10	18,40	2,75
	30-60	7,83	7,06	0,09	2,80	16,00	0,00

According to the active or current acidity (pH in H_2O), the soil from the locality Turajlovina belongs to moderately acidic soils, from the locality Jasoč to slightly acidic, while the soil from the locality Rudine was weakly alkaline [12]. For most metals, except for lead, an increase in the pH of the solution caused a decrease in their concentration. Lead showed an upward trend of release under alkaline conditions.

Exchangeable or potential acidity (pH in n - KCl) ranges from 4,74 to 7,06 and is a direct indicator of the state of the soil adsorption complex. The acidity of this species depends on the presence of H^+ ions and aluminim and iron ions that can be exchanged with adsorption complex. These elements in the soil occur as consequence of the introduction of a large amount of fertilizer in the form of neutral salts and indirectly indicate other conditions that determine the nutritional properties of the soil.

Obtained results of the total nitrogen content show that these soils are with a very significant deficiency of this element. Agricultural land should contain 0,1 to 0,3% of total nitrogen. According to the pH value, the form of nitrogen that plants prefer in such soils is in form $NH4^+$ ions, which is unfavorable because the higher concentration of ammonium ion is toxic to plant, that can be particularly harmful for young plants.

Soil research has shown a very low content of humus (organic carbon), so we can say that phosphorus in these samples is present mostly in inorganic form. In relation to the acidity of the soil, phosphorus is present in the form of Ca-phosphates, which are better soluble than sesyuioxide phosphate. According to the content of $CaCO_3$, localities of Turajlovina and Jasoč have unfavorable conditions for phosphorus, due to the almost complete absence of calcium carbonate. Rudine have too much $CaCO_3$, given the availability of phosphorus due to possible fixations. According to the limit values of available phosphorus in the soil (expressed as P_2O_5) with AL method (Gluhić, 2012) [13], the examined soils belong to the category of very insufficient soils with phosphorus.

An amount of about 50 mg of potassium per 100 g of dry soil consider sufficient for the cultivation of various plant species. According to the potassium content, all investigated soils can be classified as low supplied in relation to this element.

Obtained results of humus content, shows that all investigated soils are extremely insufficient in this nutritional factor. Long-term peach cultivation in Herzegovina show that plant culture successfully grown on heavy clay soils.

3.2. Physical and chemical properties of peach

OF the physico-chemical parameters of peach, dry matter, fruit pH, total acidity, total sugars and vitamin C were determined. The results of the analysis are presented in Table 2.

Table 2: Physico-chemical properties of peach

Locality	Dry matter	Fruit pH	Total acidity	Total sugars	Vitamin C
Jasoč	15,12	3,66	0,74	13,00	6,50
Turajlovina	13,05	3,46	0,77	12,00	7,80
Rudine	16,78	4,09	0,46	13,40	7,55

It can be observed that the values of dry matter, fruit pH and content are total sugar in peach fruits is in relationship, because the lowest values of the specified parameters of fruit quality were determined in one and the same peach sample (Turajlovina). Also, the highest values of the same parameters were determined in one fruit (Rudine). One of the possible reasons for the significantly higher content of total sugars in the examined samples may be the sort characteristics, while the other possible reason is the long drought period and the small amount of precipitation that preceded the harvest period.

3.3. Content of lead in soil and peach

It is done comparisson of the results of testing the content of lead (Pb) in soil samples from both depths (30 cm and 60 cm), the average value of lead content in the soil, as well as in peach samples. The results are presented in Table 3.

Table 3: Content of lead in soil and peach (ppm)

Locality	Soil			Peach
	Depth (cm)		Average	
	0-30	30-60		
Jasoč	23,62	19,84	21,72	0,017
Turajlovina	19,75	23,02	21,39	0,009
Rudine	36,66	14,14	25,40	0,005
MAC*	50,0			0,10

* - Maximum Allowable Concentration

According to the average content of lead in the soil at the locality Jasoč, the content of lead in peach fruits from the same locality represents 0,078% of the average amount of lead in the soil. At the Turajlovina locality, the peach fruit received 0,042% of average lead contained in the soil. The differences of the lead uptake by layers are negligible compared to the average values of lead at these two sites.

From the average lead content in the soil at the Rudine locality, 0,020% of lead reached the peach fruit. The determined differences by layers are 0,014% of 0-30 cm layer and 0,035% uptaked lead from 30-60 cm layer.

The soil samples of extensive production area (Jasoč) and intensive production area (Turajlovina) have a quite uniform content of lead by depth (difference less than 4 ppm), while the intensive method of production exposed to anthropogenic influence shows a difference of 22,52 ppm (159.26%) between higher arable and lower, root available, layers.

Expected highest lead uptake to fruits at the intensive production site near the anthropogenic source and the lowest lead uptake at the extensive production site has not been determined.

4. CONCLUSION

Based on the obtained research results, the following conclusions can be reached:

- Analysis of the lead content in the arable part of the land (0-30 cm) that is most exposed to external influences shows that the least lead content is in the land with intensive production, soil from extensive production site has a higher lead content, while land with intensive production exposed to anthropogenic impact has the highest lead content.
- Average values of lead content in the soil show the same trend as the lead content in the arable part of the land.
- The lead content in peach is the lowest in fruit grown by intensive production under anthropogenic influence, higher lead content is in fruit with intensive cultivation, and the most lead is in peach with extensive cultivation.
- Same trend shows the part of lead adopted in the fruit from the soil. The lowest percentage of lead in the fruit is accepted from the land with intensive production under anthropogenic influence, the higher percentage is adopted from the soil with intensive production, while the largest share of uptaked lead in the fruit is from soil with extensive production.
- Although application of intensive production methods and anthropogenic impact contribute to greater lead contamination of the soil, in this case, they also take to the lead immobilization in soil and reduce its uptake by the fruit.

5. REFERENCES

[1] Król, A., Mizerna, K., Bożym, M. (2020). An assessment of pH-dependent release and mobility of heavy metals from metallurgical slag. Journal of Hazardous Materials, Volume 384, 121502.

[2] https://ag.umass.edu/soil-plant-nutrient-testing-laboratory/fact-sheets/soil-lead-fact-sheet (accessed may 2021)

[3] Obeng-Gyasi, E., Roostaei, J., MacDonald Gibson, J. (2021) Lead Distribution in Urban Soil in a Medium-Sized City: Household-Scale Analysis. Environmental Science & Technology 55 (6), 3696-3705

[4] Hansson, S. V., Grusson, Y., Chimienti, M., Claustres, A., Jean, S., Le Roux, G. (2019). Legacy Pb pollution in the contemporary environment and its potential bioavailability in three mountain catchments. Sci. Total Environ. 671, 1227– 1236.

[5] Mielke, H. W., Gonzales, C. R., Powell, E. T., Laidlaw, M. A., Berry, K. J., Mielke, P. W., Egendorf, S. P. (2019). The concurrent decline of soil lead and children's blood lead in New Orleans. Proc. Natl. Acad. Sci. U.S.A. 116, 22058– 22064.

[6] Sharma P., Shanker Dubey R. (2005). Lead toxicity in plants. Braz. J. Plant Physiol. 17 (1).

[7] Kinuthia, G.K., Ngure, V., Beti, D. et al. (2020). Levels of heavy metals in wastewater and soil samples from open drainage channels in Nairobi, Kenya: community health implication. *Sci Rep* 10, 8434.

[8] Flora, S. J. S., Flora, G. J. S., Saxena, G. (2006). Environmental occurrence, health effects and management of lead poisoning. In: Cascas SB, Sordo J, editors. Lead: Chemistry, Analytical Aspects, Environmental Impacts and Health Effects. Netherlands: Elsevier Publication; pp. 158–228.

[9] Chiroma, T. M., Ebewele, R. O., Hymore, F. K. (2014) Comparative Assessment of heavy metal levels in soil, vegetables and urban grey water used for irrigation in Yola and Kano. International Refereed Journal of Engineering and Science 3(2), 1–9.

[10] Lambaša-Belak Ž. (2006). Tehnologija hrane, Visoka škola za turistički menadžment u Šibeniku, Šibenik.

[11] https://www.healthline.com/nutrition/stone-fruit-list (accessed june 2021).

[12] Resulović H., Čustović H. (2002). Pedologija, Univerzitet u Sarajevu.

[13] Gluhić D., (2012). Procjena plodnosti tla prema rezultatima kemijske analize tla, URL: http://www.gnojidba.info/meliorativna-gnojidba/procjena-plodnosti-tla-prema-rezultatima-kemijske-analize-tla/ (accessed june 2013)

MODERN APPROACH TO QUALITY IN HIGHER EDUCATION

Belma Islamović[1], Esad Bajramović[2]
[1,2] Faculty of Technical Engineering Bihac, University of Bihac,
Dr. Irfana Ljubijankića bb, 77000 Bihać
email: belma.islamovic15@gmail.com; bajramovic_e@yahoo.com

ABSTRACT:

In order to consistently implement the requirements of quality management, the higher education institution must determine the processes required for the quality management system, their application, as well as the sequence and interaction of processes at the higher education institution. This approach regulates responsibilities and authorities, determines how individual activities are to be performed, and how they touch and overlap. It also defines which functional means, staff, techniques and methods are to be applied as means in the processes of teaching scientific research and knowledge transfer. The aim of this paper is to indicate possible improvements in order to achieve continuous improvement and path to excellence.

Keywords: Quality, Higher education, Accreditation, ENQA standards, ISO standards

1. INTRODUCTION

A higher education institution that wishes to be among the best must decide which model of management system it wants to introduce, implement, maintain and constantly improve. In order to be among the best, it is necessary to educate the university management in the field of quality management systems (rector, vice-rectors, deans, vice-deans, department heads and directors of the institutes). The education plan should include Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG) and ISO standards (ISO 9000ff, ISO 14000ff, ISO 45000ff and other technical standards depending on the department) [1].
The curriculum of each faculty should study materials that raise the competencies of students in the field of quality management, project management, study of certain tools and methods of work and all technical standards required for these professions.
This concept represents and integrates market, technical, economic, organizational and ethical aspects of business into a multifunctional model, which is the path to excellence both in higher education institutions and in other organizations.
This integrated model promotes the already known method of leadership based on managerial leadership and participation of all employees in the process of creating a higher education institution developed with its own knowledge, giving new improvements every day in attractive syllabus innovations and in achieving faculty excellence and learning outcomes [1].

2. QUALITY STANDARDS

Quality in higher education institutions is a comprehensive term that includes a continuous process of evaluation, assessment, monitoring, guarantee, maintenance and improvement of quality of the higher education system [3,4].
Quality assurance, as a regulatory mechanism, focuses on accountability and improvement, information and evaluation using established criteria, but not in terms of ranking in an agreed consistent assessment.

2.1. BAS EN ISO 9001:2015

Standard BAS EN ISO 9001: 2015 is an international standard whose requirements define a quality management system whose implementation aims to increase the efficiency and effectiveness of the higher education institution and any other organization through the application of a process approach.

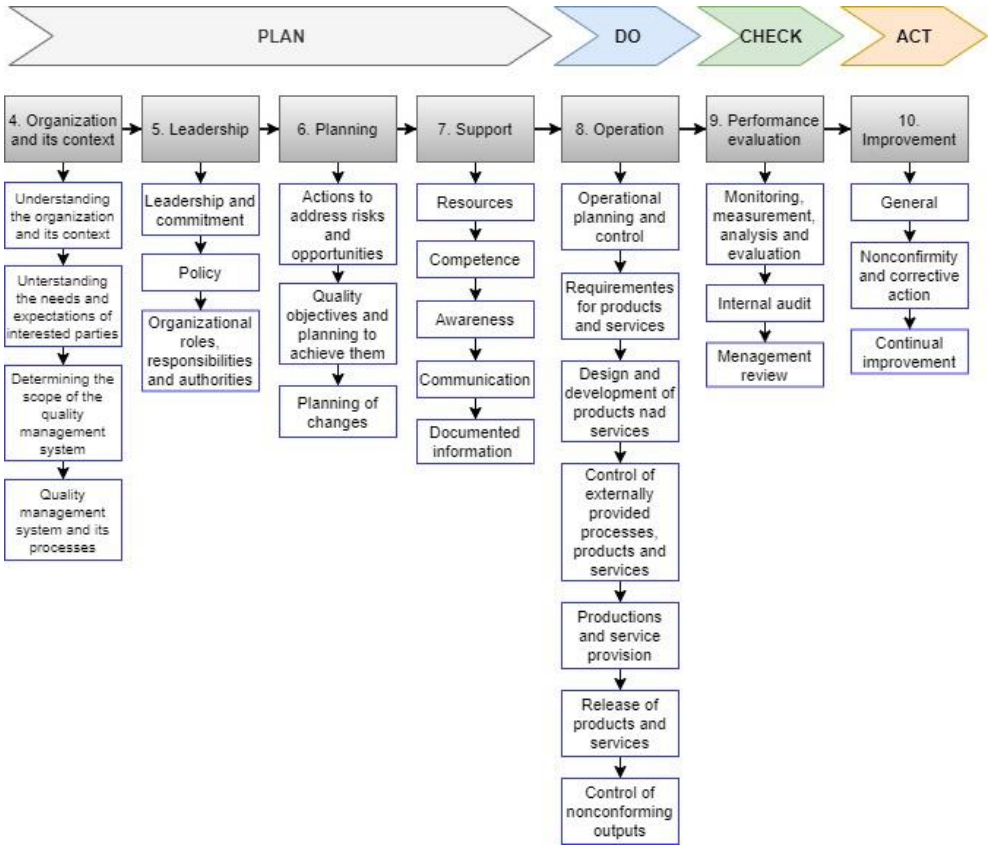


Figure 1: BAS EN ISO 9001 requirements

2.2. Standards and Guidelines for Quality Assurance in the European Higher Education (ESG)

Standards and Guidelines for Quality Assurance in the European Higher Education Area (hereinafter: ESG) were adopted by the ministers responsible for higher education in 2005, following a proposal prepared by the European Association for Quality Assurance in Higher Education (hereinafter: ENQA) in cooperation with the European Students' Union (hereinafter: ESU), the European Association of Higher Education Institutions (hereinafter: EURASHE), and the European University Association (hereinafter: EUA) [5].
Higher education, research and innovation play a key role in supporting social cohesion, economic growth and global competition. Given the desire for European societies to be increasingly knowledge-based societies, higher education is a fundamental component of socio-economic and cultural development. At the same time, the growing need for skills, abilities and knowledge requires higher education to respond to them in new ways.

The ESG is a set of standards and guidelines for internal and external quality assurance in higher education. ESGs are not quality standards, nor do they prescribe how quality assurance processes are conducted. They actually provide guidelines that cover areas that are vital to successful quality delivery and to successful learning environments in higher education. The ESG should be seen in a broader context that includes qualifications frameworks, the European Credit Transfer and Accumulation System (hereinafter: ECTS) and the Diploma Supplement, which also contribute to promoting transparency and mutual trust in higher education in the EHEA.

Quality assurance standards are divided into three parts [5]:

- internal quality assurance;
- external quality assurance, and
- Quality assurance agencies.

Standards and guidelines for internal quality assurance [5]:

- Quality assurance policy

Standard: Institutions should have a quality assurance policy in place that is part of their strategic management. Internal stakeholders should develop this policy and implement it through appropriate structures and processes, including external stakeholders.

- Development and approval of programs

Standard: Institutions should have processes in place to design and approve their programs. Programs should be designed to meet the goals set before them, including planned learning outcomes. The qualifications that result from the program should be clearly defined and listed, and refer to the exact level within the domestic qualifications framework for higher education and thus to the Qualifications Framework in the European Higher Education Area.

- Student-centered learning, teaching and testing

Standard: Institutions should ensure that programs are conducted in a way that stimulates students to take an active role in creating the learning process, and that this approach is reflected in the testing of students' knowledge.

- Admission of students, their progress through studies, recognition and certification

Standard: Institutions should consistently apply pre-defined and published regulations that cover all phases of the student "life cycle," such as student admission, progress through studies, recognition, and certification.

- Teaching staff

Standard: Institutions need to be convinced of the competences of their teaching staff. They should apply fair and transparent processes in employment and employee development.

- Learning resources and student support

Standard: Institutions should have adequate resources for learning and teaching activities and ensure that adequate and easily accessible resources for learning and student support are provided.

- Information management

Standard: Institutions should ensure that they collect, analyze and use relevant information for the purpose of effective management of their programs and other activities.

- Informing the public

Standard: Institutions should publish information about their activities, including programs, that are clear, accurate, objective, current, and easily accessible.

- Continuous monitoring and periodic review of the program

Standard: Institutions should monitor and periodically review their programs to ensure that they achieve the goals set before them and that they meet the needs of students and society. These audits should lead to continuous improvement of the program. Any action planned or taken as a result of these activities should be communicated to all interested parties.

- Periodic external quality assurance

Standard: Institutions need to go through an external quality assurance process in certain cycles in accordance with the ESG.

This paper does not include standards and guidelines for external quality assurance, and standards and guidelines of the Quality Assurance Agency.

2.3. Education in the European Union

The European process, owing to the extraordinary achievements of the last few years, is becoming an increasingly concrete and relevant reality for the Union and its citizens. Europe's knowledge is now widely recognized and an indispensable factor for social and human development. As an inevitable component for consolidating and enriching European citizenship, it gives its citizens the necessary skills to face the challenges of the new millennium together with an awareness of common values and common social and cultural space.

In the last few decades of the 20th century, there have been a number of very significant changes in the approach to higher education on the European continent. Considering the top results at higher education institutions in the USA, which significantly improved the way and form of organizing academic work, which has been developed at many American universities for a long time, especially after the 1950s, in an effort to initially approach and then surpass technological and economic development of the United States, strategic planners of European integration have come to know that one of the ways to achieve this is to get acquainted with the features of the more advanced educational systems of the United States. This commitment of the European Union, following the Maastricht Agreement (Netherlands, 1992) and the European Union plan, should contribute to the gradual transformation into the strongest political-economic and technical-technological integration in the world, capable of surpassing the previous leading areas in the world [5,6,7].

Guided by these facts, European universities have embarked on a radical transformation of higher education in the wider area of Europe. Basically, this process is comprehensive and active in terms of its conceptual starting points.

This process was further fueled by the fall of the Berlin Wall in 1989 and the collapse of communism in the countries of Central and Eastern Europe. At the same time, in 1988, the rectors of several of the oldest and most prestigious European universities in Bologna (Italy) met and adopted the Magna Charta Universitatum (Grand University Charter).

This document highlighted the need for greater cooperation among universities across Europe. However, its original signatories at the time were mostly from well-known university centers in Western Europe. The result of this approach is a series of ministerial gatherings from Bologna (1988) to the Yerevan Communiqué (2015).
The basic meetings and documents [1]:

- Magna Charta Universitatum, Bologna, 1988.
- Lisbon Convention, 1997.
- World Conference on Higher Education, Paris, 1998.
- Sorbonne Declaration Paris, 1988.
- BolognaDeclaration, 1999.
- Salamanca, 2001.
- Prague, 2001.
- Berlin, 2003.
- Bergen, 2005.
- London, 2007.
- Leuven, 2009.
- Budapest-Vienna, 2010.
- Bologna Policy Forum Statement, 2010.
- Bucharest, 2012.
- Statement of the Third Bologna Policy Forum, 2012.
- Yerevan Communique, Armenia, 2015.

By joining the Bologna Process in Berlin in 2003, Bosnia and Herzegovina has taken on the obligation to establish a quality system in higher education that promotes this process.

The Conference of European Ministers of Education adopted Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG) in Bergen in 2005, which established a single European methodology in this area, that was later accepted by Bosnia and Herzegovina.

2.4. Factors influencing quality in higher education

The quality of learning outcomes is influenced by many human and technological factors. The impact on the quality of learning outcomes is always the teaching staff (people), but since they are often different, it is a combination of human and technological factors that are interdependent.
Human factors imply the characteristics of participants in the processes such as education, knowledge, experience, abilities, and skills that differ from teacher to teacher. The quality of teaching staff should be better than the quality system, which means that the quality system is built by people [8,9].
Technological factors represent learning resources, equipment, materials, funding for innovation and development.
Two factors that should affect the quality of teachers are education and experience. However, experience has shown that students do not gain knowledge increased in proportion to teaching titles and experiences, which leads to the conclusion that there are different conditions for advancement in higher education institutions in Bosnia and Herzegovina. Still, advances in all higher education institutions are associated with significant implications for costs in higher education. Non-compliance with the Framework Law on Higher Education in Bosnia and Herzegovina is directly at the expense of the student population.

3. CONCLUSION

Those higher education institutions that wish to be among the best must determine the methods of measuring the efficiency and effectiveness of all processes and practically implement those methods. The higher education institution must use its knowledge to develop innovations in new methods, determine the way to prevent non-compliance and eliminate its causes.

The approach to the development and application of a modern quality management system as defined by ESG and ISO standards should include quality management education, implementation of standard requirements, definition of the needs and expectations of students and all other stakeholders, and setting quality policies and quality goals at the institution.

It is necessary to define the processes (teaching, scientific research and knowledge transfer) and the responsibility matrix necessary to achieve strategic goals.

The higher education institution must regularly find opportunities for continuous improvement of the efficiency and effectiveness of the system process. In order to implement all of the above, it is necessary to constantly manage the risks.

4. REFERENCES

[1] Vykydal, D., Folta, M., Nenadál, J. A. (2020). Study of Quality Assessment in Higher Education within the Context of Sustainable Development: A Case Study from Czech Republic. Sustainability. 2020-12(11):4769. https://doi.org/10.3390/su12114769.

[2] Bajramović, E. (2017). Model upravljanja ukupnim kvalitetom na visokoškolskim ustanovama. Doktorska disertacija, Univerzitet Džemal Bijedić u Mostaru, Mašinski fakultet.

[3] Binnawas, M.S.H., Khalifa, G.S.A., Bhaumick, A. (2020). Antecedents of Student's Behavioral Intentions in Higher Education Institutions. International Journal of Psychosocial Rehabilitation Vol.24, Issue 03, 2020. ISSN: 1475-7192. DOI: 10.37200/IJPR/V24I3/PR200942.

[4] Islamović, F., Bajramović, E.,Klarić, S., Šahinović, R., Bajrić, B. (2015). Poteškoće institucionalne akreditacije javnih visokoškolskih ustanova u Bosni i Hercegovini, 10th International Scientific Conference on Production Engineering DEVELOPMENT AND MODERNIZATION OF PRODUCTION Septembar 2015. Dubrovnik, Hrvatska.

[5] http://www.hea.gov.ba/dokumenti/bolonja/?id=6150 (posjećeno 15.07.2021.)

[6] Vorobyova, O. (2021). Effectiveness of management in the higher education. Innovative Solutions In Modern Science № 4(48). DOI 10.26886/2414-634X.4(48)2021.1. UDC 378.433.

[7] Tasdemir, C., Rado, G. (2020). Integrating sustainability into higher education curriculum through a transdisciplinary perspective. Journal of Cleaner Production Vol.265, 121759. https://doi.org/10.1016/j.jclepro.2020.121759.

[8] Bajramović, E., Hodžić, D., Bajramović. E. (2021). Social responsibility recognition and involvement of interested parties. Acta Technica Corviniensis – Bulletin of Engineering, Tome XIX, Fascicule 1, 13-16.

[9] Poturak, M., Mekić, E., Hadžiahmetović, N., Budur, T. (2020). Effectiveness of Transformational Leadership among Different Cultures. International Journal of Social Sciences and Educational Studies 7(3):119-129. DOI:10.23918/ijsses.v7i3p119.

ACCREDITATION OF MEDICAL LABORATORIES IN BOSNIA AND HERZEGOVINA AND SPECIFICS OF APPLICATION OF STANDARD EN ISO 15189:2012

Halid Makić, Emir Bajramović, Muamer Peljto
University of Bihac, Biotechnical faculty Bihac, halidmakicbtf@gmail.com
University of Bihac, Technical faculty Bihac, emir.bajramovic@unbi.ba
TUVADRIA doo Sarajevo, muamer.peljto@tuvadria.ba

ABSTRACT:

Accreditation is an effective way to recognize the laboratory and confirm the competence of the laboratory at the European and global level. In addition, due to periodic reviews of competencies, it influences the improvement of quality, while providing a high standard of services in health care institutions. Accreditation of medical laboratories in terms of ISO 15189 is focused on improving patient care, strengthening the overall quality management system in medical institutions, reducing error and risk control in laboratory work and controlling costs in the healthcare segment.
BAS ISO 15189 focuses on medical and clinical laboratories, and includes QMS elements, the technical competence of the laboratories, as well as their ability to prove reliable and accurate test results. Medical and clinical laboratories that can be accredited are laboratories for biological, microbiological, immunological, chemical, immunohematological, hematological, biophysical, cytological, pathological, genetics or other testing of materials obtained from the human body for the purpose of providing information for diagnosis, management, prevention and treatment of human diseases or human health assessment. The paper presents the process of accreditation of medical laboratories in Bosnia and Herzegovina, and the specifics of the application of ISO 15189.

Keywords: accreditation, ISO 15189, medical and clinical laboratories

1. INTRODUCTION

Modern health systems are focused on patient prevention, early diagnosis and determining adequate therapy. In this system, laboratories and laboratory data play an important role, providing integral data to doctors in the decision-making process, enabling them:
a) to recognize and identify risk factors and discover the predisposition of the disease,
b) confirmation or non-confirmation of the diagnosis,
c) patient management guidelines, and
d) monitoring the effectiveness of dose adjustment therapy (so-called personalized medicine) [1].

Regardless of the quality of laboratory equipment, experience in laboratory diagnostics, selection of adequate methods, users of the results are concerned about whether the results of analysis and research are valid, what the results are and whether the results will help in patient care. For this reason, every medical laboratory should strive to ensure quality, accuracy of analysis results, safety, ie. quality in the

overall testing process, and efficiency of testing in terms of cost limitation. So, the laboratory aims not only to provide accurate results, but also to do the best for the patient. This is, above all, to give a reliable result within a reasonable time using appropriate laboratory procedures and respecting the ethics, confidentiality and safety of the patient.

In order for medical laboratories to be recognized in the environment, to provide quality and reliability of their services they must be accredited according to ISO 15189: Medical laboratories - Specific quality requirements and competencies.

Accreditation is an effective way of indicating the competence of a laboratory and recognizing the laboratory on a larger scale. Laboratories, through periodic reviews, influence the constant improvement of quality, and provide a high standard of services to their clients (patients and health care providers). The laboratory accreditation procedure according to ISO 15189 is aimed at improving patient care, strengthening the complete quality management system in the hospital, reducing errors and risk control, and controlling health care costs.

2. HISTORY

The first edition of ISO 15189 was published in 19993 relating to Medical Laboratories - Specific Requirements for Quality and Expertise, four years after the publication of the first edition of ISO/IEC 17025 relating to General Competency Requirements for Testing and Calibration Laboratories. It has quickly become an accepted standard used to accredit the competencies of medical laboratories. This was followed by additional newer editions, so that the published edition of 2007 already had a very similar structure to ISO/IEC 17025, and was applied to medical laboratories5. The accreditation procedure is the same as for testing and calibration laboratories, so an accreditation plan is made, an accreditation body is selected which must act in accordance with the relevant international standards and which must take into account the specific requirements of this field.

Until 2003, medical laboratories could be accredited according to ISO/IEC 17025, while from 2003, and if they wanted, they could switch to accreditation according to ISO 15189. So there is a great similarity between these two standards.

The further introduction of new versions of the standards has prompted the governments of certain countries to insist on the mandatory accreditation of medical laboratories. Following the publication of the revised ISO 15189 standard from 2012, in France all medical laboratories must be accredited by the Comité français d'accréditation (Cofrac) by 2020, a process that started in 2010. In Belgium, this is mandatory for certain disciplines [6].

When a laboratory is accredited, then according to the regulations of the International Laboratory Accreditation Cooperation (ILAC) and the European Co-operation for Accreditation (EA), laboratories may explicitly state in their reports services that are and are not within the scope of accreditation.

The main purpose of the ISO 15189 standard is that its application provides better services to patients and that they can expect all laboratory tests to be performed in accordance with the same quality principles. In accordance with the multilateral agreement on the recognition of accreditation between ILAC and EA countries, the national accreditation bodies of the countries responsible for accreditation in their countries must publish the scope of accreditation of each laboratory on their website. This allows for the laboratory to be checked whether the required service is performed under accreditation or not.

The implementation of ISO 15189 provides the foundation for quality in medical laboratories by linking the quality management system (QMS) with competence in all procedures and processes used in the overall testing procedure (TTP - total testing process) [7].
The third edition of the international/European standard BAS EN ISO 15189: 2018, translated into one of the official languages in B&H, is applied in B&H specifying the requirements for quality and competence in medical laboratories. It replaced the previous BAS EN ISO 15189: 2013 Medical laboratories - Requirements for quality and expertise [8].

3. COMPONENTS OF THE QUALITY MANAGEMENT SYSTEM ACCORDING TO ISO 15189

ISO 15189 is divided into management requirements focused on the quality management system [QMS] structure, function and efficient management of laboratory operations. Its quality system, policy and process management, and technical requirements focus on technical competence and related procedures and processes. In addition, ISO 15189 is a comprehensive standard that offers a comprehensive structure of laboratory operations. It applies to all divisions of medical and clinical laboratories. For the purposes of ISO 15189, medical and clinical laboratories include laboratories for biological, microbiological, immunological, chemical, immunohematological, hematological, biophysical, cytological, pathological, genetic or other testing of materials derived from the human body to provide information for diagnosis, management, prevention and treatment of disease or assessment of human health, which may provide an advisory service covering all aspects of the laboratory test, including interpretation of results and advice on further appropriate tests [9].

The significance and importance of the ISO 15189 standard is reflected in encouraging users to maintain an efficient quality management system integrated into all parts of their work, to ensure continuous improvement. Management review and internal audit requirements are necessary to ensure that the laboratory's activities are in accordance with the quality management system, efficiency and continuously meet customer requirements, thus ensuring that the laboratory's activities comply with the QMS, in order to determine opportunities for improvement before problems arise. In addition to the audit, which includes management and technical components, pre-test, test and post-test processes must be included.
They serve for:
- determining that all activities of the quality management system are covered, ie. whether we adhere to our own quality system.
- ensuring that the processes are efficient, ie. whether each consultation report requested by the physician is always additionally recorded.
- determining whether all possibilities for improvement are covered, ie. e.g. whether we can proceed with the second phase of the examination without the doctors giving us an order for the next examinations.

With constant support of the requirements of ISO 15189 standards, it is possible to continuously monitor the quality of technical requirements reflecting many elements, namely: staff, accommodation and environmental conditions, laboratory equipment, reagents and consumables, pre-test processes, test processes, quality assurance of test results, post-test process, reporting results, publishing results, and laboratory information management [8,10].

4. REQUIREMENTS OF STANDARD IN TERMS OF ACCREDITATION PROCEDURES

ISO 15189 takes into account all the needs of medical laboratories, the steps of the entire testing process, from the appropriate test request to the proper notification of laboratory reports and the role of

further clinical advice provided by laboratory experts. Attention is also focused on items in the intra-analytical phase (e.g. verification and validation of test procedures, measurement uncertainty, metrological aspects, etc.), and on pre- and post-analysis phases such as special characteristics of medical laboratories compared to test laboratories [11,12].

The standard requires the application of criteria and procedures to ensure the adequacy of the test requirements or how the laboratory provides an effective way to interpret the results and how concordance of interpretations between different physicians can be approved. All of these examples require specific knowledge of how a particular test result may affect its clinical use and factors that may affect data quality. Namely, in the laboratory, the staff must have both medical skills and the skills of technicians (medical and biochemical professions), as well as biologists, chemists and other professions; the competences of all different professionals working in the laboratory (e.g. technicians, nurses, biologists, chemists) are required. Care must also be taken to assess possible analytical interference and characteristics of the analysis, to assess measurement uncertainty, and to calibrate and maintain the equipment [13].

The ISO 15189 requirements, or clauses, fill merely 31 pages (plus a few pages of definitions and appendices). ISO 15189 is divided into management requirements (Part 4, focusing on the quality management system [QMS] structure, function, and effective management of laboratory operations, its quality system, guiding policies, and processes) and technical requirements (Part 5, focusing on the technical competency and related procedures and processes). Table 1 summarizes the content of the ISO 15189 standard, Parts 4 and Part 5 [8,9].

Table 1: Content of the ISO 15189 standard, divided into management requirements (Part 4) and technical requirements

ISO 15189 Management requirements (Part 4)	ISO 15189 Technical requirements (Part 5)
Organization and management responsibility	Personnel
Quality management system	Accommodation and environmental conditions
Document control	Laboratory equipment, reagents, and consumables
Service agreements	Preexamination processes
Examination by referral laboratories	Examination processes
External services and supplies	Ensuring quality of examination results
Advisory services	Postexamination processes
Resolution of complaints	Reporting of results
Identification and control of nonconformities	Release of results
Corrective action	Laboratory information management
Preventive action	
Continual improvement	
Control of records	
Evaluation and audits	
Management review	

ISO 15189 focuses on systems and processes such as QMS, and encourages system identification of processes and their interconnection. Evaluation of the implementation and efficiency of the process is a key element of a thorough assessment of accreditation according to ISO 15189. If the correct documentation on the structure of operations is created, it helps a lot to identify gaps in the process and eliminate immediate activities [13].

5. ACCREDITATION OF MEDICAL LABORATORIES IN BOSNIA AND HERZEGOVINA

Accreditation of medical laboratories according to BAS EN ISO 15189, Medical laboratories - Requirements for quality and competence - is carried out within the Accreditation System of Bosnia and Herzegovina, defined by the Law on Accreditation of Bosnia and Herzegovina ("Official Gazette of B&H", No. 19/01). By enacting the Law on Establishing the Institute for Accreditation of Bosnia and Herzegovina as an Independent State Administration Body, under the jurisdiction of the Council of Ministers of B&H (Official Gazette of B&H, No. 10/02), the implementation of the Accreditation System of Bosnia and Herzegovina was given to the Institute for Accreditation of Bosnia and Herzegovina.

The Institute for Accreditation of Bosnia and Herzegovina has adopted all procedures and regulations for conducting the accreditation of medical laboratories. Insight into the List of accredited bodies in Bosnia and Herzegovina for compliance assessment made on 2021-06-10, showed that only two laboratories were accredited. This is certainly a devastating fact considering the importance of accreditation and the large number of medical laboratories.

6. CONCLUSION

Accreditation according to ISO 15189 includes an independent assessment of laboratories to determine competence, impartiality and consistency. Accreditation covers the qualifications and capabilities of staff involved in medical laboratory analysis and testing, laboratory accommodation, equipment, reagents and supplies, pre-analytical, analytical and post-analytical factors, quality of consideration and post-analytical factors. The ISO 15189 standard is based on ISO/IEC 17025 (General Requirements for Test Competence and Calibration Laboratories) and ISO 9001 (Quality Management System - Requirements). This, therefore, includes elements of the quality system that are covered by ISO 9001 certification as general requirements of the testing laboratory.

A small number of medical laboratories are now accredited in B&H, and given the need to recognize laboratory findings at the international level, the competence of the laboratory and the recognition of laboratories on a larger scale are needed.

For medical laboratories, to be accredited by standard ISO 15189 is a challenge, but it is achievable.

7. REFERENCES

[1] Mario Plebani, Laura Sciacovell, ISO 15189 ACCREDITATION: NAVIGATION BETWEEN QUALITY MANAGEMENT AND PATIENT SAFETY, J Med Biochem 36: 225–230, 2017
[2] Tomá Zima, ACCREDITATION OF MEDICAL LABORATORIES – SYSTEM, PROCESS, BENEFITS FOR LABS, J Med Biochem 36: 1–6, 2017
[3] International Organization for Standardization (2003). *ISO 15189 Medical laboratories - Particular requirements for quality and competence.* Geneva: The Organization.
[4] International Organization for Standardization (2017). *ISO/IEC 17025 General requirements for the competence of testing and calibration laboratories.* Geneva: The Organization.
[5] International Organization for Standardization (2007). *ISO 15189 Medical laboratories - Particular requirements for quality and competence. 2nd ed.* Geneva: The Organization
[6] Marc H.M. Thelen, Florent J.L.A. Vanstapel, Christos Kroupis, Ines Vukasovic, Guilaime Boursier, Edward Barrett, Francisco Bernabeu Andreu, Pika Meško Brguljan,

Duilio Brugnoni, Maria Lohmander, Ludek Sprongl, Tatjana Vodnik, Irina Ghita, Michel Vaubourdolle and Willem Huisman, Flexible scope for ISO 15189 accreditation: a guidance prepared by the European Federation of Clinical Chemistry and Laboratory Medicine (EFLM) Working Group Accreditation and ISO/CEN standards (WG-A/ISO), Clin Chem Lab Med 2015; 53(8): 1173–1180

[7] Patricia Solis-Rouzant, Experience of implementing ISO 15189 accreditation at a university laboratory, The Journal of the International Federation of Clinical Chemistry and Lanoratory Medicine, eJIFCC2015Vol26No4pp270-273

[8] BAS EN ISO 15189:2018 Medicinski laboratoriji - Zahtjevi za kvalitet i kompetentnost

[9] Frank Schneider, M.D., Caroline Maurer, M.T., and Richard C. Friedberg, M.D., International Organization for Standardization (ISO) 15189, Ann Lab Med 2017;37:365-370

[10] Lippi G, Simundic A-M. European Federation for Clinical Chemistry and Laboratory Medicine (EFLM) Working Group for Pre-analytical Phase (WG-PRE). The EFLM strategy for harmonization of the preanalytical phase. Clin Chem Lab Med 2018;56:1660–6.

[11] Guzel O, Guner EI. ISO 15189 Accreditation: Requirement for quality and competence of medical laboratories, experience of a laboratory. Clin Biochem 2009;42:274-8.

[12] Thelen MH, Vanstapel FJ, Kroupis C, et al. Working Group Accreditation ISO/CEN standards (WG-A/ISO) of EFLM. Flexible scope for ISO 15189 accreditation: a guidance prepared by the European Federation of Clinical Chemistry and Laboratory Medicine (EFLM) Working Group Accreditation and ISO/CEN standards (WG-A/ ISO). Clin Chem Lab Med 2015;53:1173-80.

[13] Laura Sciacovelli, Ada Aita, Andrea Padoan, Giorgia Antonelli1, Mario Plebani, ISO 15189 accreditation and competence: a new opportunity for laboratory medicine J Lab Precis Med 2017;2:79

[14] Dennis Mok, Sharfuddin Chowdhury, Document review checklists for ISO 15189: 2012 internal auditing: an applied tool for medical laboratories, Australian Journal of Medical Science 37 (2), 48-55

[15] http://www.bata.gov.ba/Dokumenti/PD/PD-05-01.pdf (20.05.2021)

[16] http://www.bata.gov.ba/Akreditirana_tijela/Spisak-akreditiranih-tijela.pdf (20.05.2021)

COMPARATIVE DISPLAY OF THE ANTIMICROBIAL ACTIVITY OF THE *PINACEAE* FAMILY

Vildana Jogić*, Lejla Kličić, Subha Avdić

University of Bihać, Biotechnical Faculty
Luke Marijanovica 2, Bihac
*Corresponding author, e-mail vildana.ahmed@gmail.com

ABSTRACT:

Since the discovery of civilization, medicinal plants have played a significant role in the fight against disease, the treatment of health problems, and the knowledge about the value and importance of medicinal plants have been passed on from generation to generation. At the same time as testing the effects of medicinal plants on the human body, chemical tests were also carried out on the active substances in the plant, which were considered to determine the medicinal properties of a particular plant species. As a result of such tests, synthetic products are created that suppress natural herbs from human everyday life.However, following the recognition of the World Health Organization of herbal preparations as a medicine for the treatment of many health problems, there has been noticed a tendency for the growth and use of herbal preparations worldwide. The Pinaceae family includes plant species that occupy larger areas of the Una Sana Canton, including the wider region, and as such are available all year-round. Although every part of the plant of the Pinaceae family has its own healing properties, the needles are full of vitamin C and carotene, their resin helps to cure rheumatism, and buds are beneficial to the throat, yet they are not used enough by the local population, especially the younger generations. It is thought that the main reason is the lack of awareness about its numerous therapeutic effects and importance for human health.

Kywords: *Pinaceae*, healing properties, health, vitamin C, carotene.

1. INTRODUCTION

In recent years, there has been a significant increase in infectious diseases, and these diseases are the second leading cause of death in the world and the third leading cause of death in economically developed countries [1,2]. As many microorganisms have developed resistance to a number of antibiotics, today more and more scientists are looking for potential antimicrobials from a variety of sources to be used to combat these problems [3,4] Today, the World Health Organization includes medicinal plants as "... those plant species whose one or more parts contain a biologically active substance that can be used for therapeutic purposes or chemical-pharmaceutical synthesis" [5]. Recently, medical science is increasingly appreciating the results of treatment with medicinal herbs, and medicinal herbs are used as an ingredient in the production of synthetic drugs, then as a basic raw material for various cosmetic creams, fragrances, colognes, toilet soaps, toothpaste, and more, and in the food industry as spices in meat products, ready meals, and drinks [6]. Our habitats are rich in flora, our country is rich in quality herbs with maximum active substances that are found in certain plant organs and determine their healing properties, or toxicity, namely: alkaloids, glycosides, saponins, tannins, essential or aromatic oils, etc. [7]. More than 100 herbal species are prescribed by

pharmacopeias as official drugs for the production of galenic preparations. In particular, *Pinus nigra*, *Pinus sylvestris*, and *Picea abies*, some species in smaller and some in larger quantities, contain bitter substances, essential oils rich in turpentine, and resin whose building blocks help treat bronchitis, arthritis, rheumatism, poor circulation, asthma, flu, colds, shortness of breath, etc. [8]. (Their antimicrobial action is especially pronounced in the fight against bacteria from the group of *Streptococci*, which are widespread in nature and cause numerous diseases in humans.The spectrum of diseases caused by streptococcus ranges from sore throat to meningitis and gangrene. *Streptococci* are spherical, connected in pairs, usually immobile, do not form spores, and are the most common facultative anaerobes.There are about 20 of them in the genus, and the most important for humans are *Streptococcus pyogenes* and *Streptococcus pneumoniae* [8]. *Pyogenic streptococcus* (*Streptococcus pyogenes* group A) is one of the most important bacterial pathogens that cause human diseases. It is capable of causing numerous diseases with different localization that can be divided into three basic groups [10]. The study aimed to determine the antimicrobial activity of the family Pinaceae, ie species *Pinus nigra*, *Pinus sylvestris* and *Picea* abies on bacteria of the genus *Streptococcus*, group A by a discdiffusion method.

2.MATERIAL AND METHODS

2.1. LOCALITY

For the needs of the mentioned research, needle-like leaves of black pine, white pine, and spruce were collected from Bihać (Campus Grmeč and Žegar settlement) and Cazin (Nursery of USK woods) (Fig. 1).

Figure 1: Satellite image of the research site (https://www.google.ba/maps/)

2.2. DISC-DIFFUZION METHOD

The disc diffusion method is the oldest and still frequently used method for determining the antimicrobial activity of plant metabolites.In addition to the choice of method, it is very important to choose the appropriate solvent for the extraction of antimicrobial components from plants [11]. The most commonly used solvents for testing the antimicrobial activity of plant components are methanol, ethanol, and water, and in the conducted research, methanol was used as a solvent. The method is based on the principle of diffusion of the antimicrobial extract into a solid nutrient medium, where it has a more or less inhibitory effect on bacteria that have been previously sown on that medium. Cellulose disks are used, on which a sample extracted from plants is applied. Petri dishes are inoculated with cultures of microorganisms. 1 ml of the bacterial culture suspension is applied evenly to the substrate with a Drygal stick.Then cellulose disks soaked with plant extracts are placed. The samples prepared

in this way are incubated in the Selecta Incubator: 200/209. The extract diffuses from the application site into the substrate in all directions. The growth of the tested microorganism is prevented if it is sensitive to the action of the tested sample. The width of the inhibition zone (inhibition diameter) is proportional to the degree of sensitivity of the microorganism to the applied agent, ie to the antimicrobial effect of the tested extract. After incubation at 37 ° C, the first inhibition reading was performed after 24 hours and the final results after 48 hours.

2.3. SAMPLE PREPARATION

Chopped and homogenized needle-like leaves (10 g) of black pine, white pine, and spruce were extracted with 100 ml of 80% methanol. Thus submerged samples were obtained in a dark place and at room temperature for the next 24 h. After 24 h, the samples were squeezed and filtered with cotton wool and filter paper. The filtered samples were further processed using Rotavapor (Fig. 2). Rotavapor R-210/215 BÜCHI is a laboratory device in which methanol is extracted from the plant extract with active substances. The obtained extracts were stored in sterile sample bottles and stored in a refrigerator at 4 ° C.

Figure 2: Rotavapor and plant extracts

2.4. CULTURE PREPARATION

The streptococcal cultures used in this study were seeded on blood agar. Bacteria of the genus Streptococcus group A were used. For this study, a suspension of this culture was required, and it was made by taking bacteria from blood agar with the help of a sterile needle and putting it in saline (Fig. 3).

Figure 3: Preparation of a suspension of microorganisms

2.5. SEEDING MICROORGANISMS

A suspension of bacteria was seeded on blood agar in 5 Petri dishes, one of which was used for a blank, one for testing the antimicrobial activity of antibiotics, and three for testing the antimicrobial activity of extracts obtained from all three plants samples. 6 mm disks were immersed in the plant extract and placed on a seeded medium (Fig. 4). The same procedure was done for all three samples. The disks were submerged in water in the blank, and the disks immersed in the antibiotic suspension were placed in a Petri dish**.**

Figure 4: Immersion of discs in plant extracts and placement in Petri dishes with seeded Streptococcus sp.

3. RESEARCH RESULTS AND DISCUSSION

The results of antimicrobial activity of extracts of black pine, white pine, and spruce on the growth of bacteria of the genus *Streptococcus*, group A are shown below in Table 1.

Table 1: Results of antimicrobial activity on Streptococcus, group A

	Test plants	Inhibition zone - *Streptococcus*, group A	Interpretation
1.	*Pinus nigra*	***29,80***	Sensitive bacteria *** S
2.	*Pinus sylvestris*	28,31	Sensitive bacteria *** S
3.	*Picea abies*	25,78	Sensitive bacteria *** S

The largest zone of inhibition of all three tested extracts was black pine extract, whose diameter of the zone of inhibition was 29.80 mm, which indicates that bacteria from the genus Streptococcus group A are very sensitive to the active substances contained in this extract. A slightly smaller diameter of the inhibition zone was recorded in white pine extract and was 28.31 mm, and in spruce, the value of the diameter of the inhibition zone was 25.78 mm. It is important to note that all recorded values show that these microorganisms from the genus Streptococcus group A are sensitive to active substances from all three extracts (Table 2).

Table 2: Bacterial resistance to antibiotics

Inhibition zone	**Sensitivity labels**	**Interpretation**
do 10 mm	R*****	resistant bacteria
10 - 17 mm	I, 2******	intermediate sensitive bacteria
> 17 mm	S, 3*******	sensitive bacteria

***** **R** – resistant ****** **I** – intermediate *****S**– sensitive

Due to the significant increase in antibiotic-resistant strains of bacteria, the search for potential antimicrobial drugs has increased in recent decades [4]. Numerous studies in several countries have reported that compounds extracted from medicinal plants may be useful in the development of antibiotics [12]. One study confirmed higher antimicrobial activity of the plant extract compared to the commercial antibiotic, with the diameter of the inhibition zone of Ciproflaxacin being 29 mm against *Staphyloccocusasp.*, While the methane extract of the plant *Phyllanthus neurri* showed a maximum zone of inhibition of 30 mm [13]. Data on the antimicrobial activity of species of the family *Pinaceae* on the bacterium *Streptoccocus* group A are very poor, which makes this research even more significant.

In one study, the genus *Streptoccocus* was shown to be most sensitive to spruce resin followed by the genera *Staphylococcus* and *Enterococcus* [14], which was later confirmed by other scientists [15]. Studies conducted by [16] with extracts of coniferous essential oils on different species of bacteria proved that they have antioxidant and antimicrobial properties, where they tested antimicrobial activity on five species of bacteria *Bacillus subtilis, Bacillus cereus, Escherichia coli, Staphylococcus aureus,* and Streure high antimicrobial activity of *Pinus nigra* was found, which is in line with our research. In a study examining the biological activity and chemical composition of *Pinus nigra* essential oil from various plant organs, high antimicrobial activity was found, especially against Gram (+) bacteria Rh*odococcus sp., Bacillus sp.* and *Streptococcus* in test samples in the vegetation period March / September [17]. In a study examining the antimicrobial activity of species of the family *Pinaceae* and *Cupressaceae*, very low antimicrobial activity of essential extracts of species of the family *Pinaceae* was proven, except for Abies *bornmulleriana, Cedrus libanii, Pinus halepensis*, which is not in line with the results of our research [18]. The antimicrobial activity of essential oils of *Pinus pinaster* and *Pinus pinea* was confirmed in one study, with oils of these species having an inhibitory effect on 21 strains of bacteria [19].

3. CONCLUSION

Based on the conducted research and antimicrobial activity of certain species from the family Pinaceae on the genus Streptococcus group A, it can be concluded that in the study black pine showed the highest antimicrobial activity in regards to white pine and spruce on the genus Streptococcus group A.
Considering it is done on only one culture, it would be necessary to extend the research in the direction to examine the antimicrobial activity of these species to other types of microorganisms.

4. REFERENCES

[1] Mothana R. A. A, Lindequist U. (2005). Antimicrobial activity of some medicinal plants of the island Soqotra," Journal of Ethnopharmacology, vol. 96, no. 1-2, pp. 177–181.
[2] Luqman S., Srivastava S., Daroka rM. P., Khanuja S. P. S. (2005). Detection of antibacterial activity in spent roots of two genotypes of aromatic Grass Vetiveria zizanioides," Pharmaceutical Biology, vol. 43, no. 8, pp. 732–736.
[3] Selvamohan T., Ramadas V., Kishore S. S. S.(2012).Antimicrobial activity of selected medicinal plants against some selected human pathogenic bacteria, Advances in Applied Science Research, vol. 3, no. 5, pp. 3374–3381.
[4] Wigmore S. M., Naiker M., Bean D. C.(2016). Antimicrobial activity of extracts from native plants of temperate Australia,Pharmacognosy Communications, vol. 6, no. 2, pp. 80–84.
[5] Opletal, L., Volak, J. (2001). Biljke za zdravlje, STANEX d.o.o., Varaždin.
[6] Bajpali J., Lanzotti, V. (2008). The analysis of onion and garlic. - J. Chromatogr.,A. 1112: 3-22.
[7] Sengul M., Yildiz H., Gungar N., Cetin B., Eser Z., Ercisli S. (2009). Total phenolic content antioxidant and antimicrobial activitis of same medicinal plants. Pakistan Jurnal Pharmaceutical Sciences 22 (1): pp. 52 – 64.

[8] Sarić-Kundalić B., Dobeš C., Asselmeyer V.K., Johannes . (2011). Ethnobotanical survey of traditionally used plants in human therapy of east, north and north-east Bosnia and Herzegovina. Journal of Ethnopharmacology 133(3): pp. 1051-76.
[9] Lovrić M. (2016). Epidemiološke osobitosti streptokoknih infekcija u Splitsko-dalmatinskoj županiji. Master's thesis. University of Split, University Department of Health Studies.
[10] Stevens D.L. (1992) Invasive group A streptococcus infections. Clin Infect Dis. 14:2-13.
[11] Hammer K. A., Carson C. F., Riley T. V.(1999). Antimicrobial activity of essential oils and other plant extracts. - Journal of applied microbiology 86(6): pp. 985-990.
[12] Abouzeed Y. M., ElfahemA., ZgheelF., Ahmed M. O. (2013).“Antibacterial in-vitro activities of selected medicinal plants against methicillin resistant Staphylococcus aureus from Libyan environment,” Journal of Environmental & Analytical Toxicology, vol. 3, no. 6, pp. 1–10,
[13] Selvamohan T., Ramadas V., Kishore S.S.S. (2012). Antimicrobial activity of selected medicinal plants against some selected human pathogenic bacteria. Adv. Appl. Sci. Res. 3(5): pp. 3374-3381.
[14] Rautio M., Sipponen A., Peltola R., Lohi J., Jokinen J., Papp A., Carlson P., Sipponen, P. (2007). Antibacterial effects of home-made resin salve from Norway spruce (Picea abies). APMIS 115(4): pp. 335-340.
[15] Vainio-Kaila T., Kyyhkynen A., Rautkari L., Siitonen A. (2015). Antibacterial Effects of Extracts of Pinus sylvestris and Picea abies against Staphylococcus aureus, Enterococcus faecalis, Escherichia coli, and Streptococcus pneumoniae. Bio. Resources. 10 (4): pp. 7763-7771.
[16] Marjanović-Balaban Ž., Miletić, P. (2016). Utvrđivanje hemijskog sastava eteričnog ulja četinara iispitivanje mogućnosti njihove primjene u industriji, UDK 665.528.214.7:615, pp. 523 – 546.
[17] Stojiljković T. (2017).Biološka aktivnost i hemijski sastav etarskog ulja Pinus nigra (Pinaceae) poreklom iz različitih delova biljke, Prirodno-matematički fakultet, Univerzitet u Nišu, pp. 68-92.
[18] Eryılmaz M., Tosun A., Tumen I. (2015) Antimicrobial Activity of Some Species from Pinaceae and Cupressaceae. *Turkish Journal of Pharmaceutical Sciences*. 12 (3).
[19Hmamouchi] M., Hamamouchi J., Zouhdi M., Bessiere J.M. (2011). Chemical and Antimicrobial Properties of Essential Oils of Five Moroccan Pinaceae. Journal of Essential Oil Research, 13 (4).

POTENTIAL AND IMPORTANCE OF BIOMASS COGENERATION IN BIH

Hurem Nedim
1.Tehnički fakultet Bihać, ulica dr. Irfana Ljubijankića bb, hurem.tfb@gmail.com
2.Tehnički fakultet Bihać, ulica dr. Irfana Ljubijankića bb, vojics@gmail.com

ABSTRACT:

This paper aims to present the long-term cost-effectiveness of biomass cogeneration, the importance it has on increasing energy efficiency and reducing greenhouse gas emissions. The paper explains what cogeneration actually is and what its advantages are. The paper also presents an example of cogeneration, as well as the current situation, and the number of cogenerations in Bosnia and Herzegovina. The paper also presents the potential that Bosnia and Herzegovina has in biomass, and the raw material needed for cogeneration.

Keywords: cogeneration, biomass, energy efficiency, heat energy, electric energy.

1. INTRODUCTION

One of the leading energy challenges of 21.century for European Union countries for sure is energy independence by using new,clean CO2 neutral fuels, due to volatility in fossil fuel prices on the World market, and development of environmental awareness.Wood has always been a significant source of energy in all stages of human society development.In the middle of 19.century,the wood fuse almost 90% of energy for human needs.1900.near 50% of all industrial raw material is obtained from the woods,and in the last decade of 20.th century,share of wood for energy in developed countries has fallen below 5%.At the same time,the need for energy became bigger,what lead to situation in which global energy sistem based on fossil sources of energy,become all bigger weight to overall development. In order to overcome the situation, there has been a need to use renewable energy sources.That fact has been noticed by the many developed countries of the World,so the renewable energy sources become a significant segment of national energy strategies.

After intensive use of fossil fuels and their negative impact on the environment, biomass again becomes a significant energy source and interest in it begins to grow. In addition to environmental, the use of biomass provides a number of other socio-economic benefits, which are reflected in stimulating economic growth, especially in rural areas and reducing dependence on fossil fuels. Given that forests and forest land cover more than 50% of the territory of Bosnia and Herzegovina, it can be said that they represent one of the most important natural resources of this country. Regardless of the significant resource base in BiH, there is no strategic commitment to the production of fuel and energy from biomass. Currently, the most common use of forest wood biomass is in the form of firewood for thermal energy production. Given that the consumption of fossil fuels has an adverse effect on the environment, and that the prices of other energy sources are constantly rising, it is to be expected that the use of forest biomass for energy production will intensify in Bosnia and Herzegovina.

In the near future, the use of biomass in power plants is expected to double due to the application of incentive measures and the development of the domestic wood processing industry. The construction and operation of cogeneration plants on wood biomass will increase the share and enable the efficient use of renewable energy sources, and thus contribute to the fulfillment of the goals of the energy policy of Bosnia and Herzegovina. Currently, the development of several cogeneration plant projects in companies with relatively large quantities of wood residue is in various stages. Interest in the construction of smaller capacity plants exists in practically all wood processing companies, and energy plants that use wood biomass as fuel occupy a central place in numerous plans for heating the settlements.

2. BIOMASS IN BIH

Biomass as an energy source of renewable energy sources can be divided into wood, agricultural, non-wood and waste, within which there are:

- forest biomass,
- wood biomass,
- wood industry waste,
- agricultural masses (cereals, corn, wheat ...),
- non-wood breeding biomass,
- municipal and industrial waste.

For energy production, the most important source of biomass in Bosnia and Herzegovina is forest wood pulp and wood waste from the wood industry. Biomass obtained from agricultural production has significant energy potential, and the greatest potential of both biomasses, have in the areas of northern and northeastern Bosnia and Herzegovina. One of the main natural resources of Bosnia and Herzegovina is forests, so it is one of the richest countries in Europe in terms of forest cover in relation to the total area of the country.

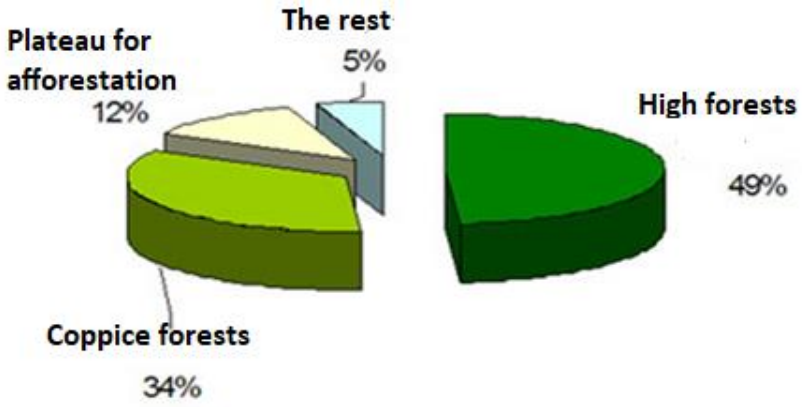


Figure 1: Structure of forest soil in Bosnia and Herzegovina

2.1. Available amount of biomass

Forest resources are the backbone of the economy in many local and rural areas and often the only source of income. Forest resources in Bosnia and Herzegovina are widely used for household heating (88.3% room heating and 54.5% individual central heating) and represent the largest source of renewable energy in Bosnia and Herzegovina, with a share of 57% in energy use.

According to available data estimated on the basis of analyzes and studies, the annual harvest in Bosnia and Herzegovina is about 4.5 million m3, of which 85% goes to market and 15% remains unused. Based on these data, the estimated potential of wood biomass in Bosnia and Herzegovina is about 1.3 million m3 of wood residue that can be used for energy purposes.

In the wood processing industry in Bosnia and Herzegovina, there are also significant amounts of wood residue from the production of veneer, sawn timber and furniture. Wood residues amount to about 0.7 million m3 per year. However, most wood processing companies in Bosnia and Herzegovina use wood residues to heat their premises or to dry wood. If wood residues remain, then they are sold to companies that produce pellets and briquettes.

3. DEFINITION AND ADVANTAGE OF COGENERATION

Combined Heat and Power is the process of combining the production of two useful forms of energy from one energy source. In most cogeneration systems, chemical energy is converted into mechanical and thermal energy. Mechanical energy is used to produce electricity, and thermal energy is used to produce steam, heat water or air Potential sites for cogeneration applications are located wherever there is a simultaneous need for electricity and heat.

Cogeneration enables:

- more efficient use of fuel energy,
- reduction of costs of electricity and heat production,
- reduction of carbon dioxide emissions per unit of energy produced,
- electricity production at the point of consumption,
- avoidance of transmission and distribution losses,
- greater security and flexibility of supply.

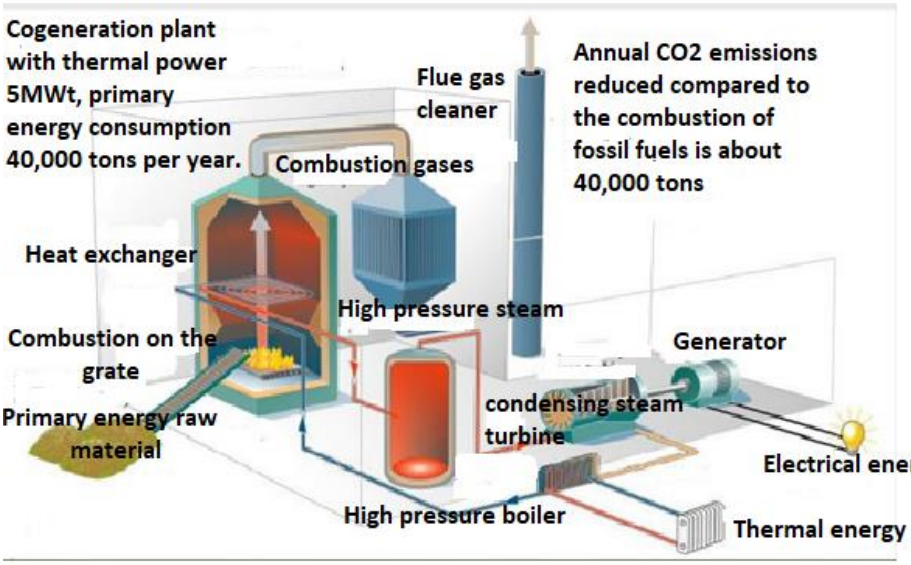


Figure 2: Diagram of a biomass power plant

We find a special advantage for the use of cogeneration in the production processes of the wood industry, where after processing the product we have waste that we actually use as raw material for simultaneous production of electricity and heat, which could be used directly in the production plant.

In addition to the possibility of using its own waste for the needs of the cogeneration system, there is the possibility of purchasing additional raw materials,forest biomass, which according to preliminary data remains unused after felling and removal of several valuable wood assortments. This way of providing biomass guarantees us a low price of input raw materials, and a sufficient amount of biomass for the production of electricity and heat,with prior agreement on the required quantities of delivery.

4. COGENERATION ON BIOMASS

Modern biomass energy utilization systems enable extremely high fuel efficiency, which can amount to over 90%. Modern bioenergy plants that incorporate state-of-the-art technological advances in energy conversion in the wood production chain are used in the wood industry, district heating system, cogeneration and for heating family houses. In biomass combustion processes, special attention is paid to combustion gases and solid residues with regard to their impact on the environment. Gaseous emissions of CO, NOX and other harmful substances in modern plants are reduced to a minimum. Measurements in existing bioenergy plants confirm that these emissions are significantly below the legally prescribed limit values. All types of biomass can be used as fuel, but wood and straw plants predominate. Such plants are generally automated. Biomass district heating systems are most often thermal systems with a capacity of 1 to 10 MW, and are often built to work in combination with existing fuel oil or coal systems. Forest mass of various origins is used as fuel. From the point of view of the use of thermal energy in the wood industry, low-pressure and high-pressure boilers and power plants are basically present. Biomass industrial water-tube boilers are made for larger industrial consumers and larger plants with a capacity of 2 to 50 MW.

Low-capacity cogeneration plants refer to multi-purpose facilities that produce heat and electricity from biomass and solid fuels through the cogeneration process. Cold water for cooling systems can also be produced in such power plants. The required heat power depends on the type of energy unit, and is mostly 20 - 20,000 kWe. The advantages of smaller biomass and biogas cogeneration plants are the reduction of fuel costs due to increased production efficiency and the preservation of the environment due to lower levels of waste materials. Modular design of cogeneration plants, ie. by building additional modules, such facilities can be further adapted to higher heat and electricity consumption. Furthermore, an additional advantage of smaller cogeneration plants relates to undemanding additional investments that are depreciated over several years. Small cogeneration plants are applied in large industrial, agricultural or public facilities and therefore it is easier to obtain the necessary operating permits. Due to the modular design of such plants, it takes little time for them to be put into operation.

Figure 3: Cogeneration on biomass in Livno

5. CONCLUSION

The conclusion is that the development of cogeneration plants in Bosnia and Herzegovina should be in everyone's interest and that concessions should be awarded in a transparent manner, incentive mechanisms should be established, and the possibility of investing in the local community and its inhabitants and other models.

The wider community should see its form of benefit from such projects through various ways such as: promoting the local labor market through job creation (eg for plant construction, for supplies or services of goods and goods, etc.), improvement of local infrastructure , opportunities for formal and informal trainings, investments in future energy projects (eg through a local foundation), lower energy prices (electricity and heat), energy efficiency measures in the housing sector, improvement of the environment (greening of areas, parks, etc.), providing funds to local institutions for the development of new environmental projects.

That cogeneration projects are a complex area is clearly shown by the number of realized projects in relation to the potentials that BiH abounds in. For the realization of such a project, it is necessary to act multidisciplinary,multisectoral and multi-institutional. This means that it is necessary to involve more sectors as well as institutions at the very beginning, and not at some final stage. In addition, the involvement of all relevant participants is very important, starting from higher levels of government, through the local community, investors, all the way to the non-governmental sector and ordinary citizens.

6. LITERATURE

[1] USAID, Energy investment activity- EIA project
[2] UNDP 2014, Mogućnost korištenja biomase iz šumarstva i drvne industrije u BiH
[3] IAE ENERGY STATISTICS
[4] http://www.ferk.ba/ 05.06.2021.
[5] http://www.usaideia.ba/ 07.06.2021.
[6] https://balkangreenenergynews.com/rs/ 07.06.2021.

SYNERGY ACTIVITIES OF PARTICIPANTS IN THE FIELD OF SUSTAINABLE CONSUMPTION AND PRODUCTION

Ljiljana Stošić Mihajlović
Academy of Technical - Educational Vocational Studies, Nis - Department in Vranje,
e-mail: ljiljana.stosic.mihajlovic@akademijanis.edu.rs

ABSTRACT:

Sustainable economic development is a subject of great interest, both in theory, by scientific researchers, and in economic practice, by economic policy makers and company managers, but also by modern consumers of various goods. The paper analyzes in more detail the activities of consumers, manufacturing companies and government agencies as key participants in the field of sustainable consumption and production of goods. Each participant in the supply chain is important in promoting the idea of sustainability with the possibility of manifesting the synergistic effect that is desirable. The initial assumption is that consumption is the driver of production, but so that without an open spiral of these two processes, there is no economic development of society. The point is in the qualitative step away from the production and consumption of material goods that negatively affect limited resources, to those that have a positive effect on them.

Keywords: sustainable consumption and production, market, organizations, logistics

1. INTRODUCTION

The main characteristic of modern consumerist society is the fact that people spend much, much more than they really need to meet personal and general needs. According to a report by the World Wide Fund for Nature, they show that a capacity of 1.5 Earths is needed each year to meet human needs [WWF, 2014]. According to projections, by 2040, total consumption is projected to be 170% of the Earth's biocapacity [Mariadoss, Tansuhaj & Mouri, 2011]. The formation of a predominantly consumer-oriented culture leads to the excessive exploitation of natural resources, which results in an ecological crisis of global proportions. The ecological crisis, in turn, leads to the deepening of political, climate, resource, security and other risks [Simurdić, 2010]. Also, the situation is further aggravated by the assessment that the population of the planet will increase significantly in the future, which leads to the conclusion that modern consumption practices in the coming decades can not ensure the sustainability of society. According to the basic procedure of sustainable development, meeting the needs of present generations without compromising the ability to meet the needs of future generations [WCED, 1987], means providing the necessary conditions for successful implementation of sustainability strategies at all levels of production and consumption. Only the consistent application of the synergy of participants in the production and consumption of goods plays an important role in achieving a balance in the relation social-ecological-economic systems. In order for sustainable production and consumption to come to life in practice, it is necessary not only to get acquainted with their basic postulates, but also the active, coordinated and coordinated engagement of all participants

in the process of implementing sustainable solutions, on a daily basis. The World Business Council for Sustainable Development [WBCSD, 1995] explains that sustainable production and consumption require the active participation of government, companies, households and all segments of society in preserving the quality of the environment, primarily efficient production and use of natural resources, in a way that minimizes waste. and optimization of goods. In accordance with the above, the aim of the paper is to point out the importance and role of the most important actors: consumers, companies and government representatives, who are recognized as three influential, significantly conditioned social groups, in the successful implementation of sustainable production and consumption. The application of sustainable solutions in everyday practice, whether for individual consumers or organizations, can bring multiple economic, social and benefits to the natural environment and society, and thus contribute to achieving a synergistic effect.

2. SUSTAINABLE PRODUCTION AND CONSUMPTION AS AN IMPORTANT ORIENTATION OF MODERN SOCIETY

Consumption is the main driver of production and the basic determinant of the future direction of growth and development of economic activities. In order for production and consumption to run smoothly, the most important condition that must be met is to ensure the availability of the necessary natural resources. During the last decades, especially the intensification of industrialization has had a negative impact on the natural habitat of man and the living world as a whole. Today, there are globally present topics, such as: excessive exploitation of non-renewable natural sources, the need for energy production from renewable energy resources, urbanization of human settlements, accumulation of waste in enormous quantities. These terms indicate the existence and development of a consumerist society [Munier, 2005]. The trend of ecosystem degradation is sure to continue exponentially in the future. Already in modern conditions, as the biggest challenge, but at the same time as the biggest chance, such a transformation of business is stated, which will enable the functioning of the economic system within the limits set by the ecosystem. Therefore, sustainable production and consumption are inevitable and mandatory in the fight against contemporary environmental problems [EC, 2008]. Namely, sustainable consumption and production imply "promotion of social and economic development within the limits of ecosystem sustainability, finding and, where necessary, breaking the links between economic development and ecosystem degradation, as well as improving the efficiency and sustainability of resource use and production processes. reduction of resource use, pollution and waste "[Sabapathy, 2007]. When sustainable consumption and production are viewed from the perspective of the actors responsible for their implementation, this concept is explained as "the contribution of the business sector, government, households and society as a whole in maintaining the quality of the natural environment, efficient production and use of natural resources, waste minimization and by optimizing products and services. Success in this business is predetermined by the introduction of major and substantial changes within existing laws, public regulations, business culture, business logistics and strategies, values, lifestyles and daily human habits [Huang & Rust, 2011; Schubert & Chai, 2012]. Sabapathy [2007] states that adequate implementation of sustainable production and consumption strategies primarily requires:

1) technological innovations;
2) improvement of existing business models, and
3) political determination.

This author also explains the techniques on which their application in modern practice is based, states the necessary preconditions for their successful realization, as well as the main drivers or benefits that can be achieved by respecting this concept. In order to ensure the full potential that sustainable business brings, it is necessary to engage all structures within each individual organization, up to the state level. This means: involving the public and business sector with the reorientation of corporate culture and all business processes and strategies with individual and group actions.

3. ENTITIES IMPORTANT TO THE SUCCESS OF SUSTAINABLE PRODUCTION AND CONSUMPTION STRATEGIES

Problems and issues of sustainability can no longer, nor should they be viewed in isolation, because in modern conditions everything in the world is interconnected and mutually conditioned [UNGC, 2013, 31], while logistics activities accelerate business and life to unimaginable limits. However, based on the analysis of the available literature, it can be seen that there are three dominant groups of participants, whose actions are considered drivers and measures of success for the practice of sustainable production and consumption, namely [Closs, Speier & Meacham, 2010; Hult, 2011]:
1) companies,
2) consumers, and
3) the state
Each of these groups is guided in consumption by its own goals, interests and motives. Thus, for example, consumers strive to achieve the maximum level of satisfaction and happiness, while companies and the state try to reach the financial optimum [Huang & Rust, 2011]. Their mutual coordination and necessary correlation is established in the tendency of consumers to adopt the values of favorite brands [Stokburger-Sauer, Ratneshwar & Sen, 2012]. On the basis of which companies build their power of directing and modifying consumption patterns by building strong market brands.
When it comes to sustainable development as a current market trend, it is not uncommon for consumers to express indifference to new information and products as a result of firmly established attitudes and habits in the past [Maréchal, 2010].
In parallel, relevant studies indicate tendencies to build a sustainable lifestyle and care for the well-being of humanity in a particular segment of consumers [Pederson, 2000]. This attitude further facilitates the existence of initiative by companies, in terms of developing products that have less negative impact on the environment and that are ethically, aesthetically and cost-effectively [Bortolozzo, 2013].
The role of the government and all state institutions is crucial in this, which as creators of regulations and rules of market functioning can encourage, create conditions and reward a certain type of behavior of the business sector and the population [Huang & Rust, 2010].
Finally, when talking about the relations of these three groups in achieving the success of sustainable strategies, the question is often asked whether companies and the state should take the first steps and create conditions for sustainable behavior, or consumers are the main lever that stimulates and encourages companies to direct their business towards the concept of sustainability? In the following text, we will try to answer the question posed, from the point of view of each of the interest groups.

2.1. The role of consumers in sustainable development, sustainable consumption and production

In the context of sustainable development, the role of consumers can be said to be contradictory. Namely, at some point, they may be inclined to promote ethical behavior and respect for social norms [Shaw & Shiu, 2003]. This behavior can have a positive impact on the consumption of "green", ie. environmental products, by other members of the narrower and wider social groups to which they belong.
Numerous studies testify to the existence of consumer groups who are willing to pay a higher price for a product if they know that it will contribute to the preservation of their environment [Sloan et al., 2009].
However, the fact is that very often consumer decisions are primarily determined by concern for their own social status [Frank, 1999] and personal happiness [Huang & Rust, 2011], which may prove to be a lack of interest in the consequences their choices may have on the environment [Brown & Cameron, 2000].

2.2. The role of companies in the sustainability of development, responsible production and consumption

The mission and vision, goals, strategies and business programs of each company should incorporate the aspiration to establish economic, social and environmental well-being. However, the necessary balance has not yet been reached between theory and reality. According to a survey of general managers' attitudes, included in the United Nations survey program, which was conducted in 2019 in a total of 103 countries from all continents, more than 30% of surveyed managers believe that the world economy is on track to meet the needs of a growing population. environmental and resource issues. Based on this, we can conclude that the results of this research indicate that companies in practice do not play their role in sustainable development in the right way, although most respondents (93%) believe that sustainable business is the key to business success.

The main competitive advantage and the main strength of companies in determining the success of sustainable production and consumption, lies in the ability of companies to create such a supply that will have a direct impact on the shape of current and future market demand [Brennan, 2006].

In addition, since the main activities of most companies are the main logistics activities, such as: design, production, packaging and delivery of products and services, this indicates the fact that companies make up a significant part of the demand for scarce resources.

The company, as a consumer, when procuring the necessary raw materials for its own activities, can also set conditions for procurement to its suppliers, to encourage business partners to change the design of products and packaging, to initiate greater transparency of business, thus achieving full the integration of employees, investors, regulators and society, in an effort to embed sustainability deep into every business operation [Ernst & Young, 2020].

Finally, given that successful brands are followed by millions of loyal consumers, companies have the power, but also the responsibility to create trends and a sustainable lifestyle for future generations. All these facts indicate that the business sector should take a leading position in promoting environmental patterns of production and consumption, as follows: modifying the overall life cycle of products and services (design and engineering, management of purchase and use of materials, production, marketing, distribution, waste management); applying environmentally efficient principles in order to deliver increased value to consumers through sustainable use of resources; procurement of products and services that reduce the negative effects on the natural environment, in case the company is in the role of a customer; providing accurate, science-based environmental information to consumers and the public, with the aim of properly informing at all stages of the purchase process.

In this regard, significant items for doing business in the era of sustainable development are listed as follows:

1. an objective view of the changes and the possibilities that those changes provide;
2. turning sustainability into advantage and creating value on that basis - creating a chance for growth and differentiation;
3. monitoring and managing environmental performance, with quantification of the values and results of sustainable initiatives, as well as their impact on society;
4. investing in new technologies and innovative solutions;
5. Encouraging partnerships and close cooperation with the government sector, policy makers, industry-like companies, consumers and non-governmental organizations;
6. engaging in dialogue with all stakeholders;
7. Encouraging sustainable behavior of all business leaders and the public as an integral part of future progress.

Building a business on the concept of sustainability is not an easy path. The commitment of companies is only one side, while strong support and response from consumers, along with timely and correct decisions of state institutions, is the determining factor for reviving sustainable production and consumption strategies.

2.3. State institutions - sustainable development, responsible production and consumption

All activities at the level of one society function within the rules and procedures of the state apparatus. Thus, the decision of companies and consumers to form their business and way of life in accordance with the principles of sustainable development is decisively influenced by the intervention of state institutions and the nature of the policies they pursue. State regulation in this area is necessary, because it will lead to the right actions, and the right actions will guide us on the right path. This is confirmed by the United Nations survey from 2019, according to which there is a high level of agreement of CEOs in many leading global companies that the state has a leading role in shaping the environment according to the needs of achieving sustainable growth. This role is reflected in providing the necessary conditions to the private sector, in developing clear policies and signals to support sustainable development, as well as in forming a framework of measures at the global level that would have the same degree of importance for all market participants worldwide.

The World Business Council for Sustainable Development presented the role of state institutions as the most important lever for solving current environmental problems and promoting sustainable business, through the following activities:

• stimulating market forces and economic growth; actively promoting more efficient use of materials and energy; support for the process of recycling and reuse of materials; establishing a pricing system that incorporates environmental costs; providing flexibility in choosing effective solutions that support the process of continuous business improvement; minimizing trade barriers; supporting the practice of developing new technologies, innovations and developing common sustainable systems.

The state initiative in the field of combating unsustainable business strategies and behavior should be reflected in the adoption of laws, certain regulations, rules, taxes and penalties, but also in the form of assistance through subsidies, promotional campaigns and continuous education and information, with a focus on promoting sustainable consumption as the main goal [OECD, 2008]. As areas of importance for the establishment of regulation, the most important activities are: transport, land use, waste management and recycling, energy use, air, water and climate quality, construction of environmentally efficient facilities and development of green construction, as well as sustainable procurement [U.S. Environmental Protection Agency, 2009]. There are numerous examples of developed countries in which the state has taken the initiative to build a sustainable system of production and consumption.

3. CONCLUSION

In modern conditions, ecological systems maintain society, and according to forecasts, the number of people will increase rapidly in the future, which means that organizing the production and consumption process will have to meet the deteriorating ability to meet the needs of a highly consumerist society. . In addition, all environmental initiatives, programs and processes should be implemented at all levels of the global community, and in all spheres of life, in which state institutions, companies and consumers are cited as key actors.

Each of these groups of actors is invaluable for achieving future sustainable growth and development, and creating a society that can believe in the future of future generations. Through its mechanisms, the state must strongly support existing, but also provide conditions for launching new initiatives in the field of sustainable development, which will further enable the creation of such an environment that encourages both companies and consumers to actively engage and create their business and personal conduct according to such standards.

Modern human civilization currently does not have a "reserve" planet on which to live in the coming years, it is time to reconsider the priorities and take the only right path today, for a better tomorrow for generations to come.

4. REFERENCES

[1] Bowles, S. (2000). Endogenous preferences: the cultural consequences of markets and other economic institutions, Journal of Economic Literature, 36(1), 75–111.
[2] Bortolozzo, B. (2020). Consumers and Sustainability, www.pre-sustainability.com/consumers-and-sustainability
[3] Brennan, T. J. (2006). Green' preferences as regulatory policy instrument, Ecological Economics, 56(1), 144–154.
[4] Brown, P., Cameron, L. (2000). What can be done to reduce Overconsumption, Ecological Economics, 32(1), 27–41.
[5] Closs, D., Speier, C., Meacham, N. (2011). Sustainability to support end-to-end value chains: the role of supply chain management, Journal of The Academy of Marketing Science, 39(1), 101–116.
[6] Commission of The European Communities – EC, European Economic and Social Committee and the Committee of the Regions on the Sustainable Consumption and Production and Sustainable, eur-lex.europa.eu/legalcontent/EN/TXT/PDF/?uri=CELEX:52008DC0397&from=EN
[7] Ernst & Young. (2020). Six growing trends in corporate sustainability www.ey.com/Publication/vwLUAssets/Six_growing_trends_in_corporate_sustainabilit
[8] Frank, R. (2020). Luxury Fever: Why Money fails to satisfy in an Era of Excess, Press, New York,
[9] Huang, M. H., Rust, R. T. (2011). Sustainability and consumption", Journal of the Academy of Marketing Science, 39(1), 40–54.
[10] Hult, G., (2011). Market-focused sustainability: market orientation plus", Journal of The Academy of Marketing Science, 39(1), 1–6. ICLEI,
[11] Mariadoss, B. J., Tansuhaj, P. S., Mouri, N. (2011). Marketing capabilities and innovationbased strategies for environmental sustainability: An exploratory investigation of B2B firms, Industrial Marketing Management, 40(8), 1305–1318.
[12] Maréchal, K. (2010). Not irrational but habitual: The importance of 'behavioural lock-in' in energy consumption", Ecological Economics, 68(5), 1104–1114.
[13] Munier, N. (2009). Introduction to Sustainability: Road to a Better Future, Springer, Dordrecht, Netherlands.
[14] OECD, Promoting Sustainable Consumption – good practices in OECD countries, 2015; org/greengrowth/40317373.pdf
[15] Pederson, L. (2000). The Dynamic of Green Consumption: A Matter of Visibility", Journal of Environmental Policy Planning, 2(3), 193–210.
[16] Røpke, I. (2000). The Dynamics of Willingness to Consume, Ecological Economics, 28(3), 399.
[17] Sabapathy, J. (2007). Sustainable Consumption and Production – A Business www.cisl.cam.ac.uk/publications/publicationpdfs/sustainable-consumption.pdf
[18] Симурдић, М.(2010). Климатске промене, Европски покрет у Србији, Београд.
[19] Sloan, P., Legrand, W.(2009). Chen, J., Sustainability in the hospitality industry (1st ed.), UK: Elsevier Inc., Oxford.
[20] Stokburger-Sauer, N., Ratneshwar, S., Sen, S. (2012). Drivers of consumer-brand identification, International Journal of Research in Marketing, 29(4), 406–418.
[21] World Commission on Environment and Development, Brundtland Report: Our Common Future, 1987; pristup 6. 3. 2021. www.un-documents.net/ourcommon-future.pdf
[22] World Wildlife Foundation, Living Planet Report, 2014;pristup 18. 02. 2021. http://assets.worldwildlife.org/publications/723/files/original/WWF-LPR2014-low_res.pdf?1413912230&_ga=1.3648112.1328229779.1418892985
[23] World Business Council for Sustainable Development, Sustainable production and Consumption – A Business Perspective; pristup 11. 05. 2021. http://oldwww.wbcsd.org/DocRoot/MJJVQW8a73Vlr8j/sustainable-productionconsumption.pdf

PATHOGENIC CHARACTERISTICS OF THE INSOLATED STUDIES Alternaria spp.

Mehira Perviz[1], Vojislav Trkulja[2]
Agricultural Institute of USC, Omera Novljanina no.4., Bihać, p.zavodusk@hotmail.com

ABSTRACT:

Determination of pathogenic characteristics of carrot pathogen Alternaria spp. is essential for precise identification, characterization, determination of population structure, determination of routes of introduction and other numerous aspects of their phylogeography and epidemiology. During many years of research on the presence of Alternaria species in Bosnia and Herzegovina and the Republic of Serbia by isolation using classical methods, two species of the genus Alternaria were identified on carrot crops: Alternaria alternata (group A isolates) and Alteraria dauci (group B isolates). Within the study of pathogenic characteristics of selected isolates of Alternaria spp. artificial inoculation of seedlings of different plants from the Apiaceae family was performed. All isolates from both groups were pathogenic on all carrot cultivars, while all isolates from group B except on all carrot cultivars were pathogenic on parsley and parsnip. A high degree of aggression, however, was shown only by isolates of group A on seedlings of all examined carrot varieties. The ability of selected isolates to infect carrot root was examined by the method of artificial inoculation of carrot root. The test results showed that all isolates from group A on inoculated carrot roots showed low pathogenicity, while all isolates from group B on all inoculated carrot roots did not cause any pathological changes

Keywords: Alternaria spp., Alternaria alternata, Alternaria dauci

1. INTRODUCTION

Carrot [*Daucus carota* L. subsp. *ativus* (Hoffm.) Arcang.] is one of the most important vegetable plants, which is traditionally used in human nutrition worldwide as a useful and healthy vegetable rich in vitamins and mineral salts. Carrot production, however, has been expanding globally in recent decades, primarily in the United States and Europe, due to its great health, healing and nutritional value [1]. Carrot root is rich in bioactive compounds (carotenoids), dietary fiber, natural antioxidants with anti-cancer effects and other functional components with positive effects on human health [2], which is why carrots have a wide and various use in human nutrition. In addition, physical, chemical and biological processes are used to form new products from carrot by-products, such as various forms of extracted chemicals, biofuels, compost, food products and adsorbent materials. These new products are significat from both economic and environmental point of view [3].
Numerous pathogenic fungi endanger cultivation and production of plants from the family Apiaceae Lindl. among which fungi from the genus *Alternaria Ness* are of special importance.

Determining the pathogenic, morphological, breeding and molecular characteristics of these carrot pathogens is essential for accurate identification, characterization, population structure determination, determination of paths of introduction and other numerous aspects of their phylogeography and epidemiology. In this paper, the pathogenic characteristics of fungi of the genus *Alternaria Ness* were investigated, i.e. determination of the host circle of selected isolates of *Alternaria spp*. on seedlings and carrot root.

2. DETERMINATION OF THE HOST CIRCLE OF SELECTED *ALTERNARIA* SPP. ISOLATES ON SEEDLINGS OF DIFFERENT PLANT SPECIES OF THE APIACEAE FAMILY

Examination of the host circle of selected isolates of Alternaria spp. Was performed by artificial inoculation of seedlings of different plants from the family Apiaceae, namely: carrots (Daucus carota), parsley (Petroselinum hortense Hoffm.), celery (Apium gravelens), parsnip (Pastinaca sativa), dill (Anethum graveolens), anise (Pimpinella anisum), fennel (Foenicum vulgare), coriander (Coriandrum sativum) and cumin (Carum carvi).

Seedlings of forementioned plants were grown in greenhouse conditions and inoculated in the phase of 8 to 10 real leaves by spraying with a suspension of conidia prepared from monosporic cultures of the studied fungal isolates 10 days old. Pure cultures were grown on potato-dextrose medium in the dark at 25 °C [4] [5].

Seedlings of same plants, treated with sterile water, were used as a negative control. In order to provide conditions of high humidity, plants were covered with plastic bags after inoculation. Bags were removed after two days. Appearance of symptoms on inoculated plants was recorded. From the leaves of plants on which symptoms developed by re-isolation, it was confirmed that this occured as a consequence of the pathogenic activity of the studied isolates.

For the purposes of these studies, a scale according to [6] was used to evaluate the reaction of seedlings of plants from the family Apiaceae: (+) positive reaction, appearance of medium to large number of spots on inoculated leaves, or drying of seedlings; (±) appearance of individual spots on inoculated leaves; (-) negative reaction, no spots appeared on the inoculated leaves.

3. PATHOGENICITY TEST OF SELECTED *ALTERNARIA* SPP. ISOLATES AT THE CARROT ROOT

The ability of selected isolates to infect carrot root was investigated by the method of artificial inoculation according to [7] by making cuts on healthy and uniform carrot roots of the nantes cultivar. 10 days old monospore cultures of selected Alternaria spp. isolates , grown on potato-dextrose medium in the dark at 25 °C, were used for inoculation. The roots were first washed with tap water, then surface sterilized with alcohol, for 30 s. Excess liquid was soaked up with sterile filter paper, and the roots were then left to air dry for 1 hour.

A pyramid-shaped tissue incision was made in the carrot root using a sterile scalpel. A fragment of the colony of corresponding isolate was placed in the dent, and then the tissue incision was returned to its place. Inoculated roots were incubated in a humid chamber, at an average temperature of 23 °C, under conditions of natural day and night shift. As a control, carrot roots inoculated with pieces of sterile potato-dextrose medium were used. The experiment was set up in four repetitions. Pathogenicity of the tested isolates was assessed based on the reaction of carrot roots, depending on the size of the necrotic zone, 3, 5 and 7 days after inoculation.

For the purpose of these studies, the following scale was used to evaluate the reaction of carrot root: 1) - negative reaction, no pathological changes observed; 2) +/– no visible changes on the outside, visible slight tissue necrosis on the cross section; 3) + necrosis visible externally and in cross section; 4) ++ darkened incision and necrosis limited to the fragment, on the cross section necrosis 1–2 mm in depth; 5) +++ tissue surrounding the fragment also affected by necrosis, intense necrosis in cross section.

4. RESULTS

4.1. Pathogenicity of selected *Alternaria spp.* Isolates on different plant species of the Apiaceae family

The study of pathogenicity of six selected isolates of phytopathogenic fungi from the genus *Alternaria* on different plant species from the family Apiaceae was performed by artificial inoculation of eight varieties of carrots and one variety of parsley, celery, parsnips, dill, anise, fennel, coriander and cumin. Selected isolates showed different ability to infect test plants. Plants that were artificially inoculated developed two basic types of symptoms – spotting and leaf necrosis. Symptoms in the form of necrotic spots appeared 7-15 days after artificial inoculations. Formed spots were tiny, necrotic, and resembling spots on naturally infected carrot leaves. Only inoculated plants with symptoms from which pathogen was successfully re-isolated were considered sensitive to examined *Alternaria* spp. isolates.

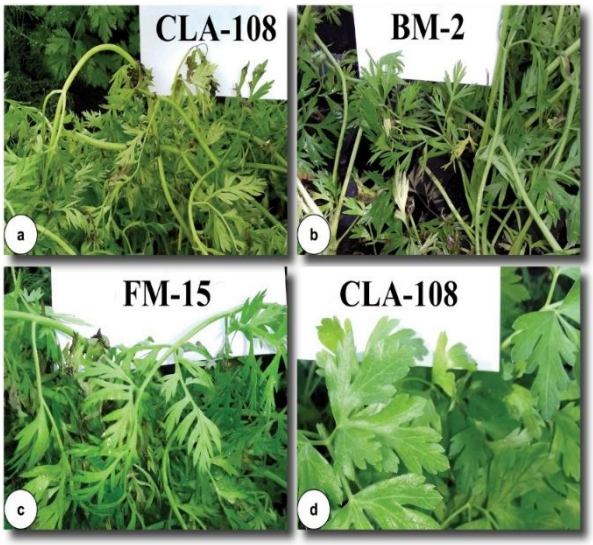


Figure 1: Leaf spot and necrosis of carrot leaves after artificial inoculation with examined isolates from group A, as follows: a) control isolate CLA-108 (A. dauci); b) BM-2 isolate; c) FM-15 isolate; d) no symptoms on parsley leaves inoculated with CLA-108 control isolate (A. dauci).

All examined isolates from group A (CLA-108, FM-15 and BM-2), including isolate CLA-108, identified standard for A. dauci, showed uniform effect on inoculated seedlings of all tested plants of the Apiacea family, their potential hosts (Fig. 1). Isolates caused the appearance of numerous necrotic spots on inoculated seedlings of all eight varieties of carrots, and showed strong specialisation since

apart from carrots they were not able to infect any other plant from the examined host circle under the conditions of the set experiment.

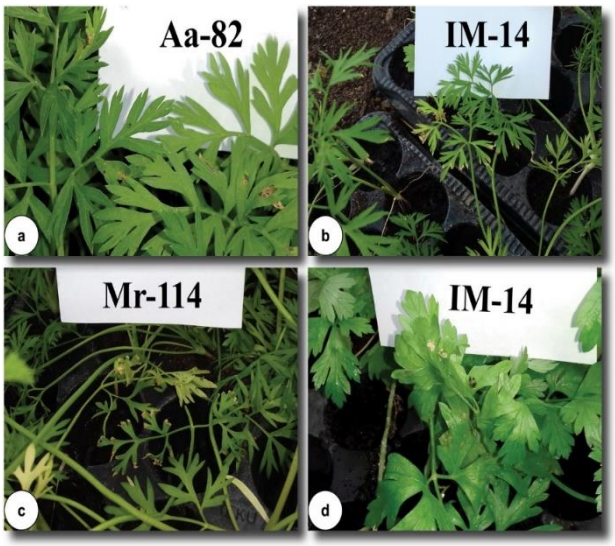


Figure 2: Leaf spot and necrosis of carrot leaves after artificial inoculation with examined isolates from group B, as follows: a) control isolate Aa-82 (A. alternata); b) isolate IM-14; c) Mr-114 isolate; d) symptoms on leaves of parsley, inoculated with IM-14 isolate.

All three examined isolates from group B (Aa-82, Mr-114 and IM-14), including isolate Aa-82, the identified standard for *A. alternata*, showed uniform effect on inoculated seedlings of all tested plants from the Apiacea family, their potential hosts (Fig. 2). Isolates caused the appearance of individual necrotic spots on inoculated seedlings of all eight varieties of carrots, as well as a fewer number of necrotic spots on the leaves of parsley (Fig. 2d) and parsnips seedlings. All examined isolates from group B showed a lower degree of specialisation compared to isolates from group A because, apart from carrots, parsley and parsnips, they were not able to infect other inoculated plants from the examined host circle under the conditions of the set experiment.

4.2. Pathogenicity of selected *Alternaria spp.* isolates on the carrot root

The study of pathogenicity of six selected isolates of phytopathogenic fungi of the genus *Alternaria* on carrot root was performed by artificial inoculation of healthy, uniform carrot roots of the nantes cultivar. Selected isolates showed different ability to achieve infection of the examined carrot roots. All studied isolates from group A (CLA-108, FM-15 and BM-2), including isolate CLA-108, identified as a standard for *A. dauci*, showed uniform effect on inoculated carrot roots (Fig. 3). These isolates showed low pathogenicity on inoculated carrot roots, which was manifested by small necrotic spots around the inoculation site, while no pathological changes occurred on the control carrot roots inoculated with sections of sterile potato dextrose.

Figure 3: Carrot root reactions after artificial inoculation with the studied isolates from group A, as follows: a) control isolate CLA-108 (A. dauci); b) BM-2 isolate; c) FM-15 isolate; d) all three studied isolates from group A (CLA-108, BM-2 and FM-15). Control (in all four pictures) - carrot roots inoculated with pieces of sterile potato-dextrose medium

All examined isolates from group B (Aa-82, Mr-114 and IM-14), including isolate Aa-82, the identified standard for A. alternata, exhibited uniform effects on inoculated carrot roots. These isolates did not cause any pathological changes on inoculated carrot roots as well as on the control, i.e. carrot roots inoculated with fragments of sterile potato-dextrose medium.

5. CONCLUSIONS

Results show that examined isolates of *Alternaria* spp. under conditions of artificial inoculation showed different pathogenicity (pathogenic and nonpathogenic) and degree of pathogenicity (+, ± and - or aggressiveness on seedlings of various plant species from the Apiacea family. All isolates of both groups (A and B) were pathogenic on all varieties of carrots, while all isolates from group B (Aa-82, Mr-14 and IM14) were pathogenic on parsley and parsnip ass well. A high degree of aggression, however, was shown only by isolates of group A (CLA-108, FM-15 and BM-2) on seedlings of all tested carrot varieties. These results, at the same time, indicate that none of the eight tested carrot cultivars showed resistance to examined *Alternaria* spp. isolates.

Results of the experiment indicate that the examined isolates of *Alternaria* spp. showed certain minor differences in terms of pathogenicity on inoculated carrot roots under the conditions of artificial inoculation. All isolates of group A (CLA-108, FM-15 and BM-2) on inoculated carrot roots showed weak pathogenicity manifested by the appearance of small necrotic spots around the inoculation site, while all isolates from group B (Aa-82, Mr -14 and IM14) did not cause the appearance of any pathological changes on all inoculated carrot roots, as well as on the control, i.e. carrot roots inoculated with fragments of sterile potato-dextrose medium.

6. REFERENCES

[1]. Zafar, M. M., Firdous, H., Mushtaq, M. S. (2018): A review on *Alternaria* leaf blight of carrot. The International Journal of Biological Research, 1 (1): 47–69.

[2]. Sharma, K. D., Karki, S., Thakur, N. S., Attri, S. (2012): Chemical composition, functional properties and processing of carrot – a review. Journal of Food Science and Technology, 49 (1): 22–32.

[3]. Barzee, T. J., El- Mashad, H. M., Zhang, R., Pan, Z. (2019): Chapter 12 – Carrots. *In*: Pan, Z., Zhang, R., Zicari, S. (eds.), Integrated Processing Technologies for Food and Agricultural By-Products. Academic Press, San Diego, CA, USA, pp. 297–330.

[4]. Strandberg, J. O. (1987): Isolation, storage and inoculum production methods for *A. dauci*. Phytopathology, 77: 1008–1012.

[5]. Pryor, B. M., Gilbertson, R. L. (2002): Relationships and taxonomic status of *Alternaria radicina*, *A. carotiincultae* and *A. petroselini* based upon morphological, biochemical and molecular characteristics. Mycologia, 94 (1): 49–61.

[6]. Bulajić, A. (2006): Identifikacija i taksonomski međuodnos vrsta roda *Alternaria* Ness patogenih za povrtarske i začinske biljke familije Apiaceae u Srbiji. Doktorska disertacija, Univerzitet u Beogradu, Poljoprivredni fakultet, Beograd, str. 1–134.

[7]. Fox, R. T. V. (1993): Principles of Diagnostic Tehniques in Plant Pathology. CAB International, Wallingford, pp. 1–204.

THE INFLUENCE OF THE METHOD OF GROWING LETTUCE (*LACTUCA SATIVA CAPITATA*) ON THE ACCUMULATION OF HEAVY METALS

Aida Džaferović, Azra Bakrač, Subha Avdić, Maida Delić
University of Bihac Faculty of Biotechnology, Luke Marijanovica bb, 77 000 Bihac, BiH
aida.btf@gmail.com

ABSTRACT:

In this paper, the contents of heavy metals (Pb, Cd, Co, Fe and Cr) in plant material was researched. The plant material that was used for these tests was lettuce (lat. Lactaca sativa capitata), grown in the traditional and conventional way. The aim of this research paper was to determine the influence of traditional and conventional cultivation methods on the contents of heavy metals. Concentrations of heavy metals were determined with theAtomic Absorption Spectrometry (AAS) method. The Pb concentration ranged from 0.087 mg / kg to 0.173 mg / kg. Detected iron (Fe) concentrations in the samples ranged from 0.169 to 0.101 mg / kg. It was observed that the lowest concentrations of heavy metals were detected for cadmium (Cd) , containing 0.001 mg / kg in the lettuce sample grown in the traditional way. Detected chromium (Cr) concentrations in the samples ranged from 0.003 to 0.011 mg / kg. The highest identified concentrations were found of cobalt (Co), in conventionally grown lettuce, whose value ranged from 2,326 to 2,474 mg / kg.

Keywords: lettuce, heavy metals, Atomic Absorption Spectrometry

1. INTRODUCTION

The presence of heavy metals in agricultural crops is an increasingly common phenomenon today, and it can have numerous negative effects on human health. Heavy metals are very dangerous to humans and other living organisms because they can cause cancer, blindness, loss of organ function, severe disease and ultimately act latently with a fatal outcome [1]. Plants that accumulate metals are directly or indirectly responsible for much of the dietary intake of toxic heavy metals by humans and other animals [2]. One of the mostcommon crops that has been tested for the presence of heavy metals is lettuce (Lactuca sativa L.), since it absorbs heavy metals very well from the soil and accumulates them. The absorption of heavy metals by a culture significantly depends on the genotypic characterization of the culture, the impact of the culture on the environment, and their interaction effect [3; 4; 5]. Also, some researchers have shown that the presence of Zn can inhibit Cd absorption and thus cause low accumulations of Cd in plants[6, 7]. The process of pollution in urban soil is intensified by the long-term presence of heavy metals [8]. A very common cause of contamination of agricultural soils with heavy metals are anthropogenic sources such as mine residues, waste disposals, urban wastewater, pesticides, sludge, fertilizers [9]. The use of agrochemicals can significantly affect the concentration of

heavy metals in the soil, and these results have been confirmed in agricultural areas of Abidjan that are contaminated by heavy metals [10].
One study proved that the use of fertilizers and wastewater is the source of heavy metal pollution of agricultural land [11]. The presence of heavy metals in vegetables is associated with the presence of heavy metals in the soil, and in a study conducted [12] the concentration of heavy metals was different in relation to certain plant organs. A recent study examining how lettuce absorbs certain heavy metals from municipal waste in the form of compost proved a very low risk of transferring heavy metals to plants that represent a concern for the food chain, even for growing vegetables on compost with high concentrations of heavy metals [13]. The aim of this study was to determine the concentration of certain heavy metals in lettuce (*Lactuca sativa* L.) from commercial cultivation and from organic cultivation (lettuce grown in greenhouses of the Biotechnical Faculty).

2. MATERIAL AND METHODS

2.1. Materials

The materials for this paper were two samples of lettuce grown in the conventional way and two samples of lettuce grown in the traditional way. The samples were numbered from one to four (tab1). Analyzes sample are shown on picture 1.

Table 1: Analyzed lettuce samples

Marking of samples	Way of growing lettuce
Sample 1	Conventionally grown lettuce
Sample 2	Conventionally grown lettuce
Sample 3	Traditionally grown lettuce
Sample 4	Traditionally grown lettuce

a) *b)*

Figure 1: Analyzes sample lettuce; a) Conventionally grown lettuce; b) Traditionally grown lettuce

2.2. Methods

Heavy metals (Pb, Cd, Co, Fe and Cr) were determined by the Atomic Absorption Spectrophotometry "Analytical Methods" FP-3 Analysis of Meat and Meat Products (2000), "Perkin Elmer" Aanalyst - 800 [14]. Sample preparation was performed by dry ashing.

This method is applied to samples that contain a large amount of organic matter. Sample preparation involves the decomposition and dissolution of organic and inorganic samples, in closed or open systems using thermal energy.

The samples were ashed for 24 h at 105 ºC. A weight of 2 g of each sample was annealed by gradually increasing the temperature to 450 ºC. The residue after annealing was dissolved with 5 cm^3 of concentrated HNO_3 and evaporated. The residue was then dissolved in 0.2% HNO_3 to 50 cm^3 [15]. The absorbances of the prepared samples were read by the Flame Atomic Absorption technique (Figure 2.). The conditions in which the analysis of heavy metals were performed are shown in Table 2.

Table 2: Recommended conditions for analysis on the Atomic Absorption Spectrophotometer (AAS)

Element	**Pb**	**Cd**	**Co**	**Fe**	**Cr**
Flame	air-acetylene	air-acetylene	air-acetylene	air-acetylene	air-acetylene
Wavelength (nm)	283,3 nm	228,8 nm	240,7 nm	243,3 nm	357,9 nm
Silt(nm)	0.7	0.7	0.7	0.7	0.7
Mode	AA-BG	AA-BG	AA-BG	AA-BG	**A**A-BG
Burner	10 cm	10 cm	10 cm	10 cm	10 cm
Nebulizer	High sensitivity	High sensitivity	High sensitivity	High sensitivity	High sensitivity
Signal Measuremet	Peak area	Peak area	Peak area	Peak area	Peak area
Calibration metods	Linear / zero	Linear / zero	Linear / zero	Linear / zero	Linear / zero
Stock Standar Solution. (mg/l)	Lead 1000 mg/l; St. 10,	Cadmium1000 mg/l ; St. 2	Cobalt 1000 mg/l; St. 3	Iron 1000 mg/l; St.5	Chromium 1000 mg/l ; St. 5

Figure 2: Atomic Absorption Spectrophotometer (Perkin Elmer)

3. RESULTS AND DISCUSSION

The results of heavy metal analysis in lettuce samples from conventional and traditional cultivation methods are shown in Table 3.

Table 3: Test results of heavy metals in lettuce samples

Elements	**Sample 1**	**Sample 2**	**Sample 3**	**Sample 4**
Lead (Pb)	mg/kg (ppm)	mg/kg (ppm)	mg/kg (ppm)	mg/kg (ppm)
1.	0.188	0.121	0.102	0.067
2.	0.180	0.189	0.152	0.051
3.	0.124	0.210	0.123	0.143
Mean	**0.164**	**0.173**	**0.125**	**0.087**
SD:	0.035	0.047	0.025	0.049
% RSD:	21.20	27.00	20.13	56.43
Cadmium (Cd)	mg/kg (ppm)	mg/kg (ppm)	mg/kg (ppm)	mg/kg (ppm)
1.	0.061	0.000	0.002	0.003
2.	0.006	0.000	- 0.001	0.005
3.	0.003	0.000	0.003	0.003
Mean	**0.023**	**0.000**	**0.001**	**0.004**
SD:	0.032	0.002	0.002	0.001
% RSD:	13.3	> 99.9	17.2	24.76
Cobalt (Co)	mg/kg (ppm)	mg/kg (ppm)	mg/kg (ppm)	mg/kg (ppm)
1.	2.768	2.327	2.328	2.328
2.	2.328	2.327	2.327	2.327
3.	2.327	2.326	2.327	2.327
Mean	**2.474**	**2.327**	**2.325**	**2.326**
SD:	0.254	0.001	0.000	0.000
% RSD:	10.27	0.029	0.020	0.0021
Iron (Fe)	mg/kg (ppm)	mg/kg (ppm)	mg/kg (ppm)	mg/kg (ppm)
1.	0.136	0.109	0.130	0.172
2.	0.117	0.111	0.127	0.169
3.	0.110	0.107	0.128	0.167
Mean	**0.121**	**0.109**	**0.129**	**0.169**
SD:	0.013	0.006	0.004	0.003
% RSD:	11.09	4.958	0.869	1.469
Chromium (Cr)	mg/kg (ppm)	mg/kg (ppm)	mg/kg (ppm)	mg/kg (ppm)
1.	0.005	0.010	- 0.001	0.000
2.	0.003	0.011	0.000	0.004
3.	0.002	0.014	0.006	0.005
Mean	**0.004**	**0.011**	**0.001**	**0.003**
SD:	0.002	0.002	0.004	0.003
% RSD:	45.80	19.15	23.6	95.90

Based on the results shown in Table 3, the difference in the values of heavy metals depending on the method of growing lettuce was determined. The contents of detected lead value (Pb) in the conventional method of cultivation showed slightly higher values compared to thetraditional. In sample no.1 the value of Pb was 0.173 mg / kg and in sample no.2 slightly lower 0.164 mg / kg. The contents of detected lead values (Pb) in the traditional cultivation method was 0.087 mg / kg (sample 4) and 0.125 mg / kg (sample 3). By comparing the contents of lead (Pb) in lettuce samples with the prescribed limit values, it was determined that the concentration of Pb does not exceed the prescribed limit values according to the Ordinance on maximum permitted amounts for certain contaminants in food "Sl. glasnik BiH broj 68/14“ [16] whose maximum allowed concentration for leafy vegetables is 0.30 mg / kg. The content of cadmium (Cd) in the samples showed low values, and in sample 2 it was not detected. Values ranged from 0.001mg / kg to 0.023 mg / kg. Our results are in accordance with the Ordinance above (0.20 mg / kg). The measured values of cobalt (Co) in the samples of conventional lettuce cultivation were 2,474 mg / kg (sample 1) and 2,327 mg / kg (sample 2), while samples 3 and 4 showed lower concentrations (2,325 mg / kg and 2,326). mg / kg). Detected values of iron (Fe) ranged from 0.109 mg / kg (sample 1) to 0.169 mg / kg (sample 4) and are in accordance with the Regulation on maximum permitted quantities for certain contaminants in food "Official Gazette of BiH" No 68/14. [16] (20 mg / kg). For chromium (Cr) in the above Ordinance, no data was given on the maximum permitted amounts, therefore the assessment of contamination for Cr is based on literature data where the chromium content in plants is 0.2 - 0.4 mg / kg. [17]. Our results are in accordance with the literature data and range from 0.001 mg / kg (sample 3) to 0.011 mg / kg (sample 2).

4. CONCLUSION

Based on the review of the literature and the results of the research of the content of heavy metals (Pb, Cd, Co, Cr and Fe) in lettuce grown in the conventional and traditional way, the following conclusions can be made:

- In all lettuce samples, the values of the tested heavy metals (Pb, Cd, Co and Cr) showed a higher value in the conventional cultivation method, only Cd in one lettuce sample was not detected.
- Fe values were higher in the traditional cultivation method.
- The content of heavy metals in the samples is in accordance with the Regulation on maximum permitted quantities for certain contaminants in food "Official Gazette of BiH" No 68/14.
- The general conclusion is that the extent of uptake of tested heavy metals by plants depends not only on the type of plant but also on the method of cultivation.

5. LITERATURE

[1] R. J. Alysia, Rebecca R., and V. Summer (2009). Phytoremediation. Available at http://www Georgia encyclopedia.2009.

[2] K. Kabata-Pendias, and H. Pendias. (1989). Trace elements in soils and plants, CRC Press, Boca Raton, Florida‖ pp 152–186.

[3] R. Zeng, Y. Mao, W.D. Cheng, F. B. Wu, and G.P. Zhang. (2008). Genotypic and environmental variation in chromium, cadmium and lead concentrations in rice. Environmental Pollution Vol. 153, pp 309–314,

[4] W. D. Cheng, G.P. Zhang, H. G.Yao, M.Wu, and M.Xu, (2006).“Genotypic and environmental variation in cadmium, chromium, arsenic, nickel, and lead concentrations in rice grains. Journal of Zhejiang University-Science B 7, pp 565-571.

[5] Y. Liu, G. T. Kong, Q.Y. Jia, F. Wang, R. S. Xu, F. B. Li, Y. Wang, and H. R. Zhou. (2007.) Effects of soil properties on heavy metal accumulation in flowering Chinese cabbage (Brassica campestris L. ssp. chinensis var. utilis Tsen et Lee) in Pearl River Delta, China. Journal of Environmental Science and Health, Part B 42, pp 219–227.

[6] D.C. Adriano, (1986). Trace Elements in the Terrestrial Environment Springer-Verlag Inc.: New York, pp. 1- 45.
[7] Z. Nan, J. Li, Z. Zhang and G. Cheng. (2000). Cadmium and zinc interaction and their Transfer in soil-crop system under actual field conditions. Sci. Total Environ. Vol.285pp187-195.
[8] L. Poggio, B. Vrščaj, E. Hepperle, R. Schulin and F.A. Marsan. (2008). Introducing a method of human health risk evaluation for planning and soil quality management of heavy metal-polluted soils, Landscape and Urban Planning, 88 (2-4) 64-72.
[9] C.R. De Kimpe and J.L. Morel, Urban soil management. (2000). A growing concern, Soil Science, 165(1), 31-40.
[10] J.K. Kouakou, B. Yves-Alain, E.S. Ahoua, B. Denis and O.D. Denezon. (2008). Diagnostic d'une contamination par les éléments traces métalliques de l'épinard (Spinacia Oleracea) cultivé sur des sols maraîchers de la ville d'Abidjan (Côte d'Ivoire) amendés avec de la fiente de Volaille, European Journal of Scientific Research, 21(3) 47- 487.
[11] Kabata-Pendias, A. and Pendias, H. (2001) Trace Elements in Soils and Plants. 3rd Edition, CRC Press, Boca Raton, 403.
[12] Seka Yapoga J., Yapo Ossey B.,Yapi Dopé A.C. (2015). Heavy Metals Contamination in *Lactuca Sativa L*. (Lettuce) from Two Agricultural Sites of Abidjan. International Journal of Pure and Applied Sciences and Technology. 27 (2): pp.59-64.
[13] Paradelo R., Villada A., Barral M. T. (2020). Heavy Metal Uptake of Lettuce and Ryegrass from Urban Waste Composts. International Journal of Environmental Research and Public Health. 17 (2887).
[14] Analytical Methods, Atomic Absorpcion Spectrometry FP-3 Analysis of Meat and Meat Product, Perkin Elmer Instruments LLC,Part No. 0303-0152, USA, Publication, August 2000.
[15] Somenath Mitra (2003). Sample preparation techniques in analytical chemistry, John Wiley & Sons, Inc., Hoboken, New Yersey.
[16] Regulation on maximum permitted quantities for certain contaminants in food "Official Gazette of BiH" No 68/14
[17] R. Kastori (1998). Fiziologija biljaka. Feljton. Novi Sad.

TRAFFIC NOISE INTENSITY AS A FACTOR OF ENVIRONMENTAL HARMFULNESS

Fatima Muhamedagić, Maida Delić
University of Bihac, Biotehnical faculty, Luke Marjanovica bb, 77000 Bihac,
fatima.muhamedagic@gmail.com

ABSTRACT:

In urban ecosystems, road traffic, among other sources, is one of the most widespread sources of noise and as such represents a serious environmental problem. This paper presents individual measurements of noise intensity in the city area of the city of Bihać at two control locations with the most frequent traffic flow. Control measurements were performed in the inner part of the city on Bedem – MB_1 and on the city bypass – MB_2. For individual measurements used a mobile dB meter Sound Level Meter – Datalogger PRO 318 Type II IEC 651. A total of 60 individual measurements were performed at both locations. The measured values were statistically processed (t – test). The measurement results showed that at the control locations of the measurements there are significant differences in variations in noise intensity.

Keywords: environmental problem, noise measurement, mobile meter

1. INTRODUCTORY ABOUT NOISE

Noise represents every unwanted sound we hear, that is, every unwanted sound represents noise. According to the legislation in various countries, the definition of environmental noise is identical. However, the experience and perception of noise is subjective, because for some people the sound may be pleasant (desirable) while for others it is unpleasant / undesirable – noise. It is known that a healthy human ear registers every sound in the frequency range from 20 Hz to 20 kHz. The science that deals with the study of sound is called acoustics. The unit for measuring sound – noise is the decibel (dB). The sound wave in the air propagates at a speed of 340 m/s, while through a liquid or solid body the speed is higher [11]. The paper presents the results of traffic noise measurements at two locations in the city of Bihac.

2. TRAFFIC NOISE

Because of the spatial branching of city streets and the road intensity, traffic noise is the most dominant factor that contributes to the overall noise levels in all urban areas. It is known that most of the noise source can be presented as point or line source. From a point source the noise propagates uniformly, while from a linear source it propagates cylindrically (Figure 1.). In practice a line source of noise represents the road. Today, traffic noise is one of the most important environmental pollutants.

The noise as an environmental factor is nowaday treated as an environmental problem. The severity of this environmental problem is evidenced by the fact that about 170 million EU people live in the so-

called „Gray areas" where noise levels can cause severe discomfort during the day (noise levels range between 55 and 65 dB) [12, 17]. Noise levels above 65 dB are considered unacceptable by scientists and medical experts because it disturbs people, disturbs sleep and has a negative impact on health [5, 17]. Research in the EU have confirmed that about 40% of the EU population is exposed to road traffic noise exceeding 55 dB (A). During the night, over 30% of its population is exposed to more than 55 dB (A), and at the day 20% exposed to more than 65 dB (A). Research in Croatia has shown that, in addition to other environmental pollutants, road traffic is dominant with a total share of about 80%. The largest amount of noise is generated by road traffic with about 50% in addition to rail 18% and air traffic 13% [8, 14].

Traffic noise is transmitted by air and one part is absorbed. The magnitude of the absorbed noise affects the reduction of air pressure levels (autenation). However, the distance from the noise source itself plays a more important role in attenuation than the absorption of noise in the air.

Today, there is a wide range of measuring instruments intended for measuring the intensity of traffic noise, the so-called. phonometers (noise meters). For field environmental noise measurements most commonly used weigher Type II IEC 651 (*International Electrotechnical Commission*).

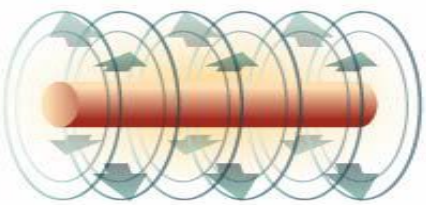


Figure 1: The line source

2.1. State of legal regulations on boise in BiH

There is no framework law on noise in Bosnia and Herzegovina and it is still in draft form. At the entity level within Bosnia and Herzegovina, the state of existing noise legislation is as stated in table 1.

Table 1: Overview of legislation on noise at the entity level

Entities	Existing legislation
Federation of Bosnia and Herzegovina	Law on Noice Protection, „Official Gazette of F BiH", no. 110/12 and other cantonal noise laws (Canton Sarajevo no. 10/04, Una Sana Canton no. 3/13, etc.
Republic of Srpska	Law on Environmental Noice Protection, „Official Gazette of RS", no. 36/09 and 88/10. Rulebook on Preventive Measures for Safe and Healthy Work During Noise Exposure, „Official Gazette of RS", no. 56/16.
Brcko District	There is no Law on Noice Protection yet

2.2. Condition of traffic vehicles in Bosnia and Herzegovina with special emphasis on the Una-Sana Canton

Although the number of registered vehicles in Bosnia and Herzegovina has been increasing in recent years, that number has been declining in the last two years. In the past 2020, a total of 1,108,711 road vehicles were registered in Bosnia and Herzegovina, which compared to 2019 (1,175,731 mip/v)

represents a decrease of 67,020 vehicles, or 5.7% [1, 2]. Table 2 shows comparative total number of registered road vehicles in Bosnia and Herzegovina for 2019 and 2020.

Table 2: Total number of registered motor vehicles in 2019 and 2020

Data / Entities	Number of registered motor vehicles in 2019	Number of registered motor vehicles in 2020	Difference in the number of registered vehicles (%)
F BiH	703.038	671.108	-4,54
RS	432.925	401.412	-7,28
BD	39.768	36.191	-8,99
Total	**1.175.731**	**1.108.711**	**-5,7**

Road traffic in the Una-Sana Canton plays a dominant role in the work of environmental pollutants. In the US Canton in the past 2019 and 2020, a total of 118.553 motor vehicles were registered, of which 108.709 passenger vehicles, 7.171 trucks, 439 buses and 2.234 motorcycles.
The growth rate of registered motor vehicles in the Bihac Section is much more pronounced than in other Canton Departments. Most registered motor vehicles are located in the municipality of Bihac 32.370, while in the municipality of Bosanski Petrovac their number is the lowest and amounts to only 2.998.

3. NOISE LEVEL CALCULATION METHODS

In European countries, there are several different methods used to calculate noise levels. Approaches to individual methods are different.

In Germany, the noise level is calculated using the RLS 90 guidelines that inherited the RLS 81 guidelines [3]. The German standard DIN 18005 for calculating road traffic noise is identical to the RLS 81 guidelines [7]. In the UK, the CoRTN (*Calculation of Road Traffic Noise*) method is used [16]. Switzerland – Swiss uses StL-86 method [15]. Austria calculates the equivalent noise level at the immission site according to its Austrian guidelines ÖAL 23 [13]. The French national method [6] strictly distinguishes the determination of noise levels in urban areas (*U-shaped roads*) from Open shaped roads. Croatia uses the German national calculation RLS-90 (*Richtlinien fuer den Laermschutz an Strassen*) method [10].

In Bosnia and Herzegovina, a uniform methodology for measuring noise intensity and evaluating noise levels has not been established at the state level, although it is possible to apply the German national method. In practice, noise standardization is often done in accordance with legal acts at the entity level – Fedaration of BH, Rebublic of Srpska and Brcko District. For example, in the F BiH, measurements are performed according to the group of standards BAS ISO 140 for field measurements, laboratory and other measurements. Noise measurement is performed with equipment – a phonometer that meets the recommendations of IEC 651 and 804 Type 1, and EN60804 with integration and averaging. Noise protection is carried both day and night [9].

- „day“ period from 06^{00} to 22^{00}
- „night“ period from 22^{00} to 06^{00}

In the EU countries and in Bosnia and Herzegovina (at the entity level) parameters that affect the calculation of road traffic noise levels are taken into account, and above all these are: reference value, vehicle speed, road curtain, longitudinal slope, trucks, traffic load, proximity of intersections, influence of air, influence of terrain, influence of distance, etc.

However, the mentioned methods of calculating noise levels do not observe the same time periods. For example, in some countries there are two time periods (Germany, Austria, Switzerland, France, BiH) in some three (Netherlands, Denmark, Sweden, Belgium, Croatia) while in some countries there are five (Slovenia). In Slovenia, two additional transitional periods from „day to night“ (from 06^{00} to 07^{00}) and „night to day” (from 19^{00} to 22^{00}) were regularly calculated.

According to the recommendations of the EU Directive [4], the total time period (24 hours) is divided into three day-evening-night periods. According to EU regulations, the day lasts twelve hours, the evening four and the night eight hours. The following reference values are usually taken as folows [4]:

- „day“ period from 07^{00} to 19^{00}
- „evening“ period from 19^{00} to 23^{00}
- „night“ period from 23^{00} to 07^{00}

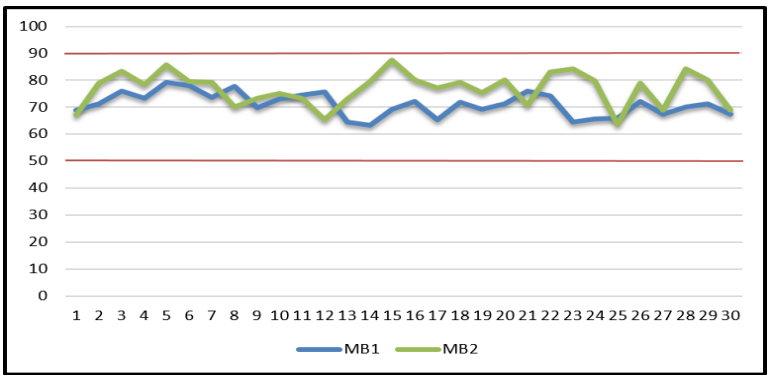
According to EU regulations, all member states should harmonize their legislation on noise in accordance with the guidelines of the EU Directive (2002/49/EC), which provided the basis for the harmonization of methods for calculating noise levels.

4. MATERIAL AND METHODS

Field measurements were performed at two control locations with the most frequent traffic flow: the location Bedem in the narrower part of the city – MB_1 and the location on the city bypass – MB_2. At each measuring point, there were several individual measurements during the day (from 06^{00} to 22^{00}). At each location, 30 individual, 15 minutes' measurements were performed. For individual measurements, a mobile dB – Sound Level Meter – Datalogger PRO 318 type II IEC 651 was used. A total of 60 individual measurements were performed at both locations. The height of the noise measurement was 1.2 - 2.0 m from the soil surface.

5. RESEARCH RESULTS WITH DISCUSSION

The measurement results showed significant differences in variations in noise intensity at the control locations. The measurement results represent the measured values of noise intensity given in Graph 1.



Graph 1: Measured values of noise intensity

The presented measurement results (Table 3) were processed by the Student's test (t-test) with a significance level of 0.1% ($t_{0.001}$).

Table 3. Statistical processing of measurements from the location MB_1 and MB_2

Location / Parameters	MB_1	MB_2
Min	63.2	63.5
Max	79.2	87.6
Average	71.203	77.045
St. error	0.811	1.138
Variance	19.085	37.537
St. deviation	4.369	6.127
Coeff. of variation	6.135	7.952
t value	-4.1804	0.00010317

6. CONCLUSION

The noise as an environmental factor is nowaday treated as an environmental problem. The severity of this environmental problem is evidenced by the fact that about 170 million EU people live in the so-called „Gray areas" where noise levels can cause severe discomfort during the day

There is no framework law on noise in Bosnia and Herzegovina, which is still being drafted. In practice, noise standardization is often done in accordance with legal acts at the entity level – Fedaration of BH, Rebublic of Srpska and Brcko District

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Road traffic in the Una-Sana Canton plays a dominant role in the work of environmental pollutants. In the US Canton in the past 2019 and 2020, a total of 118.553 motor vehicles were registered, of which 108.709 passenger vehicles, 7.171 trucks, 439 buses and 2.234 motorcycles.

The growth rate of registered motor vehicles in the Bihac Section is much more pronounced than in other Canton Departments. Most registered motor vehicles are located in the municipality of Bihac 32.370, while in the municipality of Bosanski Petrovac their number is the lowest and amounts to only 2.998.

The measured values of the noise level at the MB2 site were higher than the measured values at the MB1 site. The mean noise values at the MB2 lolability were 77,045 dB, and at the MB1 locality 71,203 dB

The minimum noise values at the MB1 and MB2 sites were approximately the same and ranged between 63.2 and 63.5 dB. The differences between the minimum noise values were 0.3 dB, and between the maximum values 8.4 dB (from 79.2 to 87.6 dB).

This paper can serve for further future research on traffic noise as well as modeling the noise map.

7. REFERENCES

[1] BIHAMK (2020). Information on registered road vehicles in BiH in the period Jan.-Dec. 2019.
[2] BIHAMK (2021). Information on registered road vehicles in BiH in the period Jan.-December 2020.
[3] Der Bundesminister für Verkehr, Abteilung Strassenbau: Richtlinien für den Laermschutz an Strassen - RLS 90, Ausgabe 1990.
[4] Directive EU (2002). Directive 2002/49/EC of European Parliament and of the Council releating to the assesment and management of environmental noise, Official Journal of the European Communities, L 189/12, 2002.
[5] EC (2006). European Commission: Action against noise: Green Paper

[6] Guide (1980). Guide du Bruit des Transports Terrestres – prevision des niveaux sonores, Centre d'Etudes des Transports Urbains.
[7] http://www.soundplan.com (on line: 26.062021)
[8] Jelčić, I., (1985). Traffic Medicine, Multigraf, Zagreb.
[9] Law on Noice Protection, „Official Gazette of Fedaration of BiH", no. 110/12
[10] Law on Noice Protection, „Official Gazette of Croatia", no. 5/07
[11] Lawrence, E. K. and Austin, R. Frey (1999). Fundamentals of Acoustics, 4th Edition, published by Wiley.
[12] Muhamedagić, F., Cero, M i Veladžić, M. (2020). Ecology and Sustainable Environmental Management, University of Bihac.
[13] Österreichischer Arbeitsring für Lärmbekämpfung, Maβnahmen zum Schutz vor Straβenverkehrslärm, ÖAL-Richtlinie Nr. 23, Mai 1983.
[14] Pavičevic, D. et.al. (2002): Environmental benefits of railways, Croatian Railways Infrastructure Union, Zagreb.
[15] Schriftenreihe Umweltschutz Nr.60, Computermodell zur Berechnung von Strassen-Lärm, Bedienungsanleitung zum Computerprogramm StL-86, Bern, 1987.
[16] SoundPLAN Noise Standards, Calculation of Road Traffic Noise (CoRTN), http//www.soundplan.com.
[17] WHO (1999). Berglund B, Lindvall T, Schwela DH. Guidelines for Community Noise. Geneva.

IS IT POSSIBILE TO IMPROVE THE QUALITY OF BASIC METHODS AND DATA FOR SUSTAINABLE FOREST MANAGEMENT PLANNING IN BOSNIA AND HERZEGOVINA?

Amina Selmanović, Vladimir Novotny, Ante Seletković, Igor Stankić
University of Zagreb, Zagreb, Croatia, aselmanov@sumfak.hr
Croatian Forest Research Institute, Jastrebarsko, Croatia, vladon@sumins.hr
University of Zagreb, Zagreb, Croatia, aseletkovic@sumfak.hr
Ekonerg – energy research and environmental protection institute, Zagreb, Croatia,
igor.stankic@ekonerg.hr

ABSTRACT:

The sustainable management of forest ecosystems in accordance with the principles and concepts of sustainable development implies planning using previous knowledge and experience, as well as modern methods and technologies. Integration of all decision parameters results in a large quantity of qualitative and quantitative data whose analog processing has not followed the trend of accelerated development for several decades. Geoinformation systems serve as a tool to ensure more accurate, efficient and faster implementation of the entire process that precedes the adoption of regulations for sustainable management of forest ecosystems. The digitization process of existing analog maps using ArcGIS 10.8 is described in this paper. The digitization of vegetation and soil maps were used for spatial GIS and statistical analyses. An example of analysis is the automatization when defining management classes as the basic spatial and classification units for operational planning in the BiH forest management system.
We can conclude that the use of available modern, state-of-the-art GIS techniques contributes to a better understanding of geographical and spatial forests distribution. This is important in both environmental planning and the development of forest management plans. Additionally, a systematic approach in the establishment of GIS databases for forest areas would achieve considerable savings of time and money in forest inventories and management. All available data and results of GIS analyses could be used as a base for more accurate information in decision making due to the fact that forest managers could take into account detailed three-dimensional characteristics of forests in real time.

Keywords: forest management, sustainable forest management, digitization, maps, management classes, GIS, GIS analyses

1. INTRODUCTION

The entire forestry science, including forest management, is based on principles of sustainable management, which in today's times of intensive technical and technological development and climate change are forced to evolve in the direction of multifunctional progressive sustainability. This kind of direction implies that while preserving existing forest ecosystems the emphasis must also be on their recovery, expansion and productivity increase [1]. In this way, sustainable development is raised one

step higher where its principles are not only fulfilled in full, but even more is sought to be achieved from them. Modern forest management requires constant planning with the interaction of a large quantity of qualitative and quantitative data [2]. Such integrated planning has been faciliated by the emergence and development of geoinformation technologies whose activities were originally recognized as part of forest management [3]. Geoinformation systems enable more productive forest management planning through easier collection, monitoring, analyzing and modeling of reference data [4]. By applying GIS, traditional forest management methods are becoming more sophisticated, facilitated and accelerated with great accuracy.

Sustainability and survival of forest ecosystems have a direct cause-and-effect relationship with the survival of human society. In order for this connection to become more concrete and effective, it is necessary for all people to be both informed and educated about the role and tasks of the forestry profession. Therefore, application of GIS technologies and establishment of GIS databases in forestry that are available to the entire public is necessary and a priority.

2. METHODOLOGY

The transformation from analog to digital form of maps is done by the digitization process. The digitization procedure requires the consideration of three necessary actions: analog map scanning, georeferencing of a raster map and vectorization of required content from the raster map [5]. Analog vegetation and soil maps of area „*Mala Spreča*“ were used for the purposes of this paper. The digitization process was conducted in *ArcGIS 10.8* program. The conversion of analog information such as maps, into digital format is necessary in order for the maps to be used by computers [6]. Scanning automatically captures map features, symbols and text as pixels and produces an automated image. As part of this operation, vegetation and soil analog maps were scanned in 300 dpi (dot per inch) on a high-precision scanner and stored in raster format. In this format, the map consists of a matrix of pixels organized into a grid where each pixel contains a value representing information. Placing digital graphic content in a particular coordinate system is known as georeferencing process. Official BiH coordinate system is *Gauss-Krüger* system of projections [7]. For the example area, Gauss-Krüger zone 6 was used, with the specific parameters such as follows:

- Projected Coordinate System: BiH_GK_6
- Projection: Transverse_Mercator
- False Easting: 6500000,0000000
- False Northing: 0,00000000
- Central Meridian: 18,0000000
- Scale factor: 0,99990000
- Latitude of Origin: 0,00000000
- Linear Unit: Meter
- Geographic Coordinate System: GCS_Bessel_1841
- Datum: D_Bessel_1841
- Prime Meridian: Greenwich
- Angular Unit: Degree

Both in real space and in GIS, each object is defined by its position, size and shape [8]. By georeferencing a raster map, each of its pixels are brought to the appropriate spatially referenced position. This process was conducted for vegetation and soil maps separately. The georeferencing process begins with the selection of reference points on a raster which are evenly distributed over the entire grid. Reference points are added with the *Add Control Points* tool from the *Georeferencing* toolbar. The number of reference points was 10, and allowed mean square error (*Total RMS Error*) [9] not higher than 5 meters for 1:25 000 map scale. Creating vector digital data implies copying data from an existing cartographic background into a digital form suitable for computer processing [10]. This is a procedure by which a vector image is obtained from a raster image. Once the graphic objects are obtained by vectorization, they can be moved and edited, and are prepared for spatial GIS analysis. By vectorization, graphic objects are associated with records from an attributive database. The attributive database was created by screening the vectorization of objects (*on-line vectorization*) by types and

categories. For the structure creation of the attributive table a few requirements must be taken into consideration, such as: attribute field names must be unique and start with letters without spaces and field properties must be predefined because they can't be changed later. The attribute table contains the identifier (*ID*), shape (*Shape*), and other attributes. The attributive tables belonging to layers of soil and vegetation were made in *ArcCatalog* while vectorization was conducted in *ArcMap*.

Table 1: Example of soil attributive table content

Description	***Attributes of Soil Map „Mala Spreča“***					
Name	OBJECTID	SHAPE	Soil Type Label	Soil Type Description	SHAPE Lenght	SHAPE Area
Type of Data	Object ID	Geometry	String	String	Double	Double
Example	1	Polygon	77 -23	Eutric cambisol on a serpentine	2328,88	66121,2

3. RESULTS

By completing digitization, analog maps were prepared for the use of Analysis tools and they were suitable for spatial GIS analysis. For the example of using vegetation and soil digitized maps, a cross-sectional overlap process was performed. This procedure can lead to forming basic types of forests. For this geometric overlap an *Intersect* analysis tool was used. The common properties of soil and vegetation layers which intersect are inscribed by the *Intersect* in output class of geoobject which makes them spatially referenced for processing. By merging characteristics of these two layers, new units of basic forest types were obtained. Every intersected type now has information on vegetation and soil type on specified areas with the label that belongs to them. The label consists of the combined name of soil and vegetation type. Labelling was automatically conducted by a *Field Calculator* with a query (*SQL expression*): *[Vegetation Type Label] &‟& [Soil Type Label]*. Each polygon with information on represented vegetation and soil type represents the basic forest type [11]. In the attribute table of basic forest types, it is easy to determine the area for each type, and thus the share in total research area.

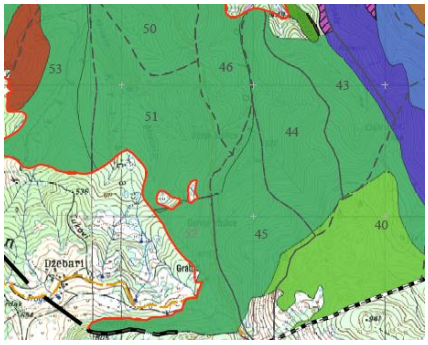


Figure 1: Segment of basic forest types map

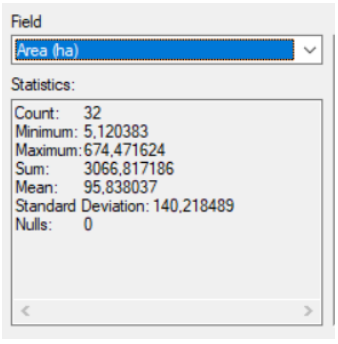


Figure 2: Basic statistics for extracted basic forest types polygons area in hectare

Table 2: Share of Basic forest types in total area

Total Area (ha)			**3,066.8172**
Basic forest types in total area (%)			
34k P2-1 (black pine crops on predominantly brown and shallow soil on peridotite)	**0.81**	**11n K2 S2** (coppice forests of beech on predominantly deep soil on carbonate and acid brown soil of silicate-carbonate substrates)	**0.32**
54 S2 (high forests of sessile oak with beech on predominantly deep soil of acidic silicate substrates)	**0.76**	**11n S2-3** (coppice forests of beech on brown and ilimerized soil of acidic silicate substrates)	**0.83**
536 S2 (high forests of common hornbeam on predominantly deep soil of acidic silicate substrates)	**1.18**	**533 K1 S2** (degraded sessile oak and hornbeam forests on predominantly shallow soil on carbonate and acid brown soil of silicate-carbonate substrates)	**0.29**
34,35 S2 (forests of black pine, white pine and sessile oak on predominantly deep soil of acidic silicate substrates)	**1.49**	**14n K2-1 S2** (coppice forests of beech with sessile oak on predominantly deep and shallow soil on carbonate and acid brown soil of silicate-carbonate substrates)	**0.42**
35k S3 (black pine crops on ilimerized soil of acidic silicate substrates)	**1.93**	**11n, 12n, K3** (coppice forests of beech and common hornbeam on ilimerized soil on carbonate and silicate-carbonate substrates)	**1.31**
34,35 K2-1 (forests of black pine, white pine and sessile oak on predominantly deep and shallow soil on carbonate and silicate-carbonate substrates)	**0.25**	**64n K2-1 S2** (coppice forests of black hornbeam, black ash and pubescent oak on predominantly deep and shallow soil on carbonate and acid brown soil of silicate-carbonate substrates)	**7.40**
51 K2-1 (high forests of sessile oak on predominantly deep and shallow soil on carbonate substrates)	**3.11**	**51n K2-1 S2** (coppice forests of sessile oak on predominantly deep and shallow soil on carbonate and acid brown soil of silicate-carbonate substrates)	**3.90**
14 K2-1 S2 (high forests of beech with sessile oak on predominantly deep and shallow soil on carbonate and acid brown soil of silicate-carbonate substrates)	**8.95**	**14n S2** (coppice forests of beech with sessile oak on predominantly deep soil of acid silicate substrates)	**0.83**
17 K1-2 S2 (high forests of beech with common hornbeam on predominantly deep and shallow soil on carbonate and acid brown soil of silicate-carbonate substrates)	**4.64**	**17n K1-2 S2** (coppice forests of beech with black hornbeam on predominantly deep and shallow soil on carbonate and acid brown soil of silicate-carbonate substrates)	**0.77**
536n P2-3 (coppice forests of common hornbeam on brown and ilimerized soil on peridotite)	**1.03**	**54n S2** (coppice forests of sessile oak with beech on predominantly deep soil of acid silicate substrates)	**0.92**
11n, 12n K2-1 (coppice forests of beech and common hornbeam on predominantly deep and shallow soil on carbonate and silicate-carbonate substrates)	**1.14**	**244k, 245k K2-1 S2** (spruce and white pine crops on predominantly deep soil on carbonate and acid brown soil of silicate-carbonate substrates)	**0.21**
12n P2-3 (coppice forests of beech and common hornbeam on brown and ilimerized soil on peridotite)	**0.17**	**12n K1** (coppice forests of beech with common hornbeam on shallow soil of carbonate substrates)	**0.57**
536n S3 (coppice forests of common hornbeam on ilimerized soil of acidic silicate substrates)	**0.21**	**11 S2** (high forests of beech on predominantly deep soil of acid silicate substrates)	**11.64**
11n S6 (coppice beech forests on pseudogley on clays, loams and gravels)	**6.59**	**11 K2-1** (high forests of beech on predominantly deep and shallow soil of acid silicate substrates)	**7.26**
12n S3-6 (coppice beech forests with common hornbeam on luvisol and pseudogley on silicate substrates)	**0.21**	**14 S2** (high forests of beech with sessile oak on predominantly deep soil of acid silicate substrates)	**21.99**
11n, 12n S2 (coppice forests of beech and common hornbeam on predominantly deep soil on carbonate and silicate-carbonate substrates)	**8.26**	**12 K2-3**(high forests of beech with common hornbeam on predominantly deep and ilimerized soil of carbonate substrates)	**0.61**

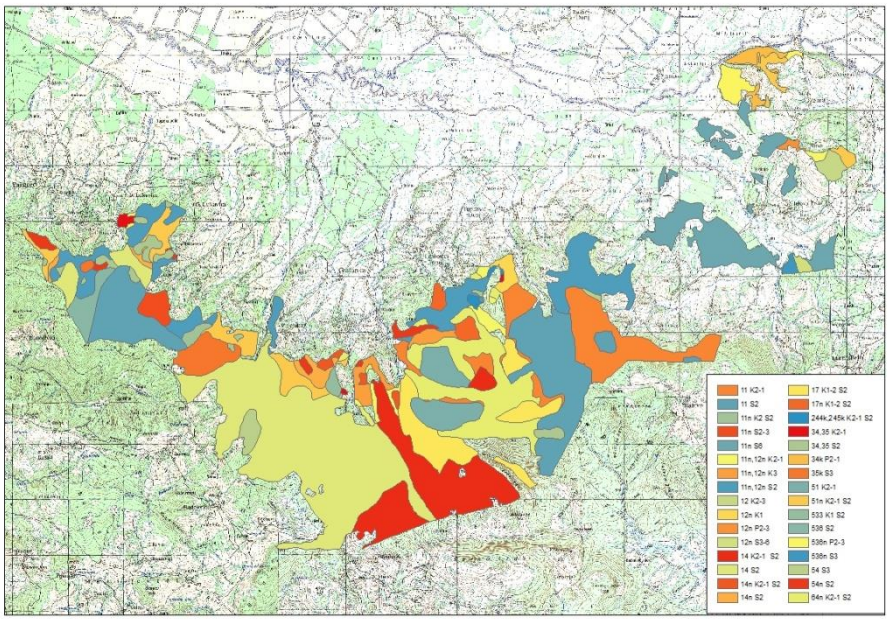


Figure 3: Basic forest types

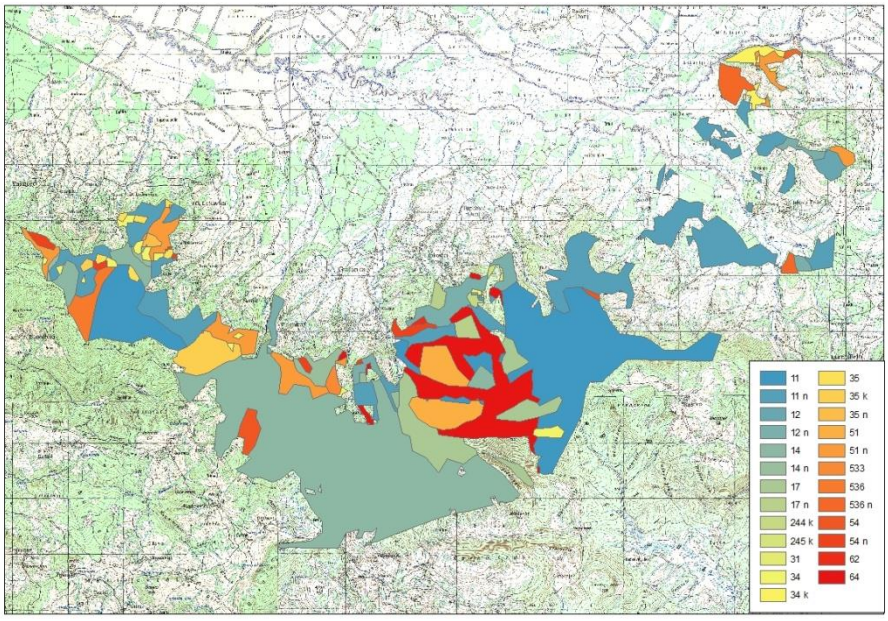


Figure 4: Example of extracted production forest types

Table 3: Share of Production forest types in total area

Total Area (ha)	**3,066.8172**
Production forest types in total area (%)	
11, 11n, 12, 12n, 14, 14n, 17, 17n (production types of beech forests)	**76.51**
244k, 245k, 34k, 35k (production types of conifers forests - crops)	**2.95**
31, 34, 35 (production types of pine forests)	**1.74**
51, 51n, 533, 536, 536n, 54, 54n, 62, 64 (production types of oak forests)	**18.8**

Further more, one of many possibilities is to conduct spatial and attribute extraction. For example, by using the *Select By Attributes* tool, it's possible to group basic forest types into associated production forest type. Also, with this tool it is possible to create query by establishing the appropriate *SQL expression*. However, for forming production forest types, production analysis [12] must be performed. Implementation of these procedures can lead to extraction of management classes which is the primary interest of forest management.

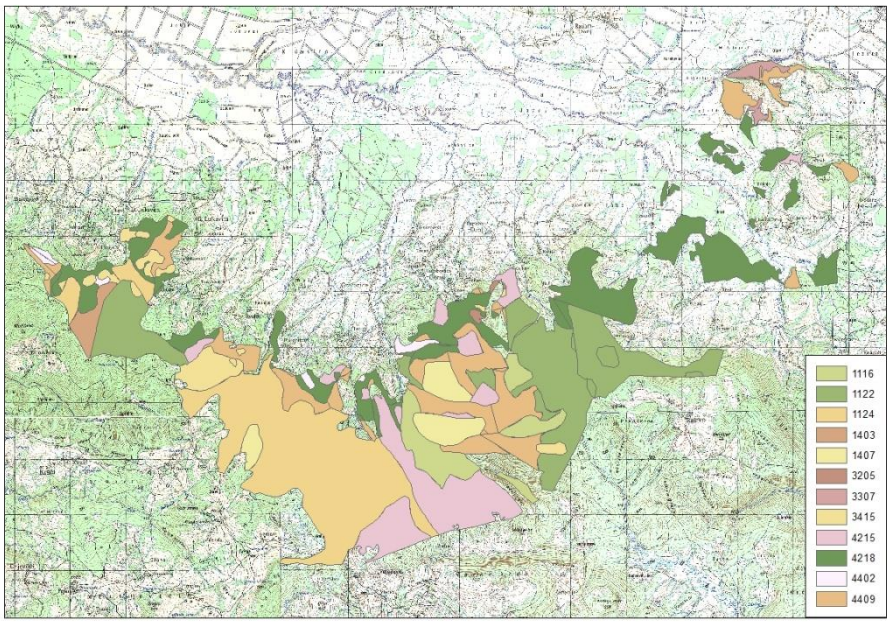


Figure 5: Example of extracted management classes

Table 4: Share of management classes in total area

Total Area (ha)	**3,066.8172**
Management classes in total area (%)	
1116 (Secondary beech forests in the beech and silver fir forest belt on predominantly deep calcocambisol and smaller areas on luvisol and their combination on firm limestones and / or dolomites)	**2.43**
1122 (Secondary beech forests in the beech and silver fir forest belt on predominantly deep district cambisol, luvisol and their combinations, on silicate and silicate-carbonate sediment substrates and on acidic eruptive rocks)	**24.57**
1124 (Secondary beech forests in the belt of beech and silver fir forests on deep district cambisol, deep colluvium on volcanogenic-sedimentary formation (hornstones, clays)	**19.56**
1403 (Sessile oak forests on predominantly deep eutric cambisol, luvisol and slope pseudogley on ultrabasic igneous substrates (peridotite-serpentinite))	**0.51**
1407 (Sessile oak forests on predominantly deep district cambisol, luvisol, pseudogley and their combinations on acid silicate and silicate-carbonate sediment substrates and acid eruptive rocks)	**1.26**
3205 (Forest crops of spruce pure or with silver fir, pine and douglas fir with estimated wood mass in the habitat of beech and fir forests with spruce on different soils and substrates)	**0.16**
3307 (White pine forest crops with black pine and mixture with estimated wood mass in the habitat of beech, fir and spruce forests (higher positions) on crystalline dolomite ranges)	**0.57**
3415 (Forest crops of pines with estimated wood mass on different soils and substrates)	**1.04**
4215 (Secondary coppice beech forests in the beech and silver fir forest belt and beech and fir with spruce on calcomelanosol, predominantly shallow calcocambisol and their combinations and on rendzina on firm limestones and dolomites and crystalline dolomites and marls)	**9.20**
4218 (Secondary coppice beech forests in the belt of beech and silver fir forests and beech and fir with spruce, spruce on district cambisol and deep colluvium on volcanogenic formation (hornstones, clays))	**26.30**
4402 (Pure coppice sessile oak forests on predominantly deep eutric cambisol and combination of eutric cambisol with luvisol and slope pseudogley on ultrabasic eruptive rocks (peridotite-serpentinite))	**0.19**
4409 (Mixed coppice sessile forests on predominantly deep district cambisol, combination of deep district cambisol with luvisol and pseudogley on silicate and silicate-carbonate sediment substrates and acidic igneous rocks)	**14.21**

4. CONCLUSION

Existing analog maps are the main source of the data needed for a Geographic Information System. Analog cartographic material is in operative use of forestry sector in BiH, and in order for this material to be interpreted and analyzed using computer and specialized software, it must be brought to a digital form. Use of GIS contributes to a better understanding of the geographical and spatial distribution of forest ecosystems on large areas which is necessary in developing sustainability orientated forest management plans [13].
The establishment of GIS databases for forest areas in BiH would achieve considerable savings of time and money in forest inventories and management, which is important in both environmental planning and the development of forest management plans.

The ability to perform automatic spatial analysis increases productivity and accuracy which is why it is desirable for data to be prepared for GIS spatial analysis. With a properly set up database, it is possible to perform various spatial and statistical analyses in GIS, starting from basic to advanced ones. All available data and results of GIS analyses could be used as a base for more accurate information in decision making due to the fact that forest managers could take into account detailed three-dimensional characteristics of forests in real time.

5. REFERENCES

[1] Čavlović, J. (2013). Osnove uređivanja šuma. Sveučilište u Zagrebu, Šumarski fakultet.
[2] Pernar, R., 1997. Application of results of aerial photograph interpretation and geographical information system for planning in forestry. Glasnik za šumske pokuse: Annales Experimentis Silvarum Culturae Provehendis, 34, pp.141-1189.
[3] Seletković, A., Pernar, R. and Lukić, N., Inventorying forest area using GIS. GIS in Research & Practice IInd part, pp.325-329.
[4] Pernar, R. and Storga, D., 2005. Possibilities of applying GIS in forest ecosystem management. Ekológia, 24(1), p.66.
[5] Longley, P.A., Goodchild, M.F., Maguire, D.J., Rhind, D.W. (2002). Geographical Information Systems and Science – 2nd Edition. England: John Wiley & Sons Ltd.
[6] Kušan, V., 1996. Pristup daljinskim istraživanjima i GIS-u u hrvatskome šumarstvu. Šumarski list, 120(3-4), pp.171-178.
[7] Federalna uprava za geodetske i imovinsko-pravne poslove (2019). Pravilnik o osnovnim geodetskim radovima. „Službeni list SR BiH“, br 22/84, 12/87, 26/90, 36/90; „Službeni list RBiH“, br. 4/93, 13/94.
[8] Drešković, N., Pobrić, A., Đug, S., Hasković, E., Suljević, D. (2007): Osnove geografskog informacionog sistema. Univerzitet u Sarajevu, Prirodno-matematički fakultet.
[9] Morad, M., Chalmers, A.I., O'Regan, P.R. (1996). The role of root-mean-square error in the geo-transformation of images in GIS. International Journal of Geographical Information Systems, 10:3, 347-353.
[10] Allen, D.W. (2007). GIS Tutorial. Spatial Analysis Workbook. California: ESRI Press.
[11] Lojo, A., Balić, B. (2005). GIS alati u optimiziranju oblika i veličine uzorka za inventuru šuma velikih teritorijalnih jedinica. Univerzitet u Sarajevu, Šumarski fakultet.
[12] Lojo, A. (2011): Formiranje gazdinskih klasa unutar šuma bukve i jele i šuma bukve i jele sa smrčom na krečnjacima i dolomitima. Disertacija. Šumarski fakultet Univerziteta u Sarajevu.
[13] Brooks, D. J., G. E. Grant. (1992). New approaches to forest management. Journal of Forestry, 90: 25-28

USE OF WIND STRENGTH AND FREQUENCY TO START WIND PARKS

Samira Hotić, Emina Medić, Osman Perviz
University of Bihać, Biotechnical Faculty
samira_hotic@yahoo.com

ABSTRACT:

Wind energy is one of the alternative, renewable and environmentally friendly sources of energy. Energy such as wind energy is extremely important in times of extreme atmospheric pollution. Of course, not all countries have equal opportunities to exploit the potential of wind.The production of electricity in this way flows without emissions of harmful gases into the atmosphere and is completely environmentally friendly as such. Although wind has great energy potential, its use is limited to locations where the installation of wind parks is possible and cost-effective..Therefore, wind park construction projects are complex and require a thorough assessment from a socio-economic and environmental point of view.

Keywords: alternative energy sources, wind energy, windmills, environment

1. INTRODUCTION

Wind energy is one of the alternative, renewable, affordable and environmentally friendly energy sources. The use of "clean" energy sources such as wind energy is extremely important in times of extreme atmospheric pollution due to the burning of fossil fuels, their excessive depletion and irrational use, and the consequent climate change (caused by greenhouse gas emissions) that the world is facing. The main disadvantages in the use of wind energy are certainly occasional operation, problem of accumulating large amounts of energy for periods without wind, high capital costs, technical performance, wind turbine design, network access, road communication, etc. Inevitable and negative environmental impacts tackle landscape disturbances, emitted noise, electromagnetic interference and impacts on wildlife, especially birds.

2. PRINCIPLES OF WIND ENERGY USE

The principle of harnessing wind energy is in the transformation of wind kinetic energy using a wind turbine into electricity. This process of producing electricity without emissions into the atmosphere, which maintains air quality, saves and protects water and ecosystems, does not generate waste, which preserves soil quality, contributes to climate protection, improving health and quality of life in general. In addition, reducing the use of fossil fuels ensures national electricity independence and stability in times of possible energy crises caused by interruptions in the supply of coal, gas and oil. Diversification of a country's electricity production is certainly desirable from the aspect of reducing dependence on fossil fuel imports and security of supply. Although wind has great energy potential with better opportunities due to technological advances in the manufacture of wind turbines (shape, materials, etc.), its use is limited to the location where the installation of wind farms is possible and cost-effective.

Many factors affect the choice of location for wind farms. The most important are the characteristics of the relief (height, obstacles), speed (and therefore the strength) and frequency of winds in a given area. However, other characteristics of the site must be taken into account in terms of spatial planning, habitat protection, visual impact assessment, noise levels, disruption of maritime and other transport routes, etc.

3. WIND VELOCITY

The movement (flow) of air masses has a vertical and a horizontal component.The vertical component refers to ascending and descending currents, while the horizontal flow of air masses is referred to as wind. Wind speed is described with 3 quantities: medium, current and fluctuating component.Mean wind velocityis the average wind speed over a period of time (e.g. hourly average, daily, monthly, seasonal).The fluctuating component of wind speed determines the longitudinal (horizontal) intensity of turbulence and thus describes the constant variability of wind speed [1]. The current wind speed component is expressed by the formula:

$$v_{current} = v_{medium} + v_{fluctuating} (1)$$

Speed and thus the strength of the wind are affected by the distance from the Earth's surface (height).The effect of wind deceleration due to the friction force decreases with increasing altitude, ie with increasing altitude, wind speed also increases (Figure 1).
This phenomenon is very important for estimating energy potential of wind.

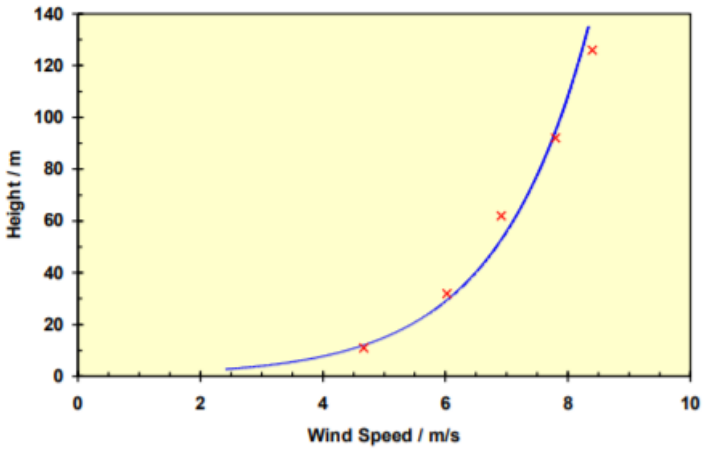


Figure 1: Measured wind speed profiles at different altitudes
(Malamateinos, C. et al, Handbook on Renewable Energy, pp 78)

The change in wind velocitywith altitude is explained by 2 basic principles: the law of the power profile and the logarithmic law. The law of profile is derived empirically:

$$v = v_0 \cdot \left(\frac{H}{H_0}\right)^{\alpha} (2)$$

where:
v - wind speed at height H,(m / s)
v_0 - measured wind speed at height H_0, (m / s)
H_0 - height at which the speed v_0,(m) was measured
H– height for which wind speed is calculated, (m)

α - surface roughness coefficient

According to the logarithmic law, the change in wind speed with the height of roughness is represented:

$$v = v_0 \cdot \frac{\ln\left(\frac{H}{Z_0}\right)}{\ln\left(\frac{H_0}{Z_0}\right)} \quad (3)$$

As the wind speed increases with height, the turbines are placed on high towers. The height of the towers is generally limited by structural performance but also by cost.

4. ENERGY AND WIND POWER

The principle of operation of wind turbines is in the partial conversion of kinetic wind energy into mechanical energy with the use of an air turbine which drives an electric generator in charge of electricity production [2]. The amount of energy transmitted by the wind to the rotor directly depends on the air density, the surface of the rotor and the wind speed.
Kinetic energy of a moving air currrent is proportional to its mass, and therefore dependent on the density of the air. In other words, the heavier the air, the more energy is obtained on the turbine. But with increasing humidity, its density decreases. Colder air is denser than warmer, so a wind turbine at the same wind speed will produce more electricity during the winter than during the summer. Atmospheric pressure decreases with increasing altitude, so at higher altitudes the pressure is lower and the air is less dense [6].
The kinetic energy of the wind is given by the expression:

$$dE_k = \frac{1}{2} \cdot dm \cdot v^2 \quad (4)$$

Wind power is caculated by differentiating energy over time, where we take the wind speed as constant:

$$P = \frac{dE_k}{dt} = \frac{1}{2} \cdot \frac{dm}{dt} \cdot v^2 \quad (5)$$

When the wind flows through the turbine and stimulates the rotation of the blades, the corresponding mass flow $\dot{m}$ at is given by the expression:

$$m = \rho \cdot A \cdot v \quad (6)$$

where:
$\dot{m}$ - mass flow, (kg / s)
ρ - air density,(kg / m^3)
A - area of the circle described by the blades,(m^2)
v - wind speed, (m / s)

Mass component is determined by the density ρ and the volume V:

$$dm = \rho \cdot dV \quad (7)$$

Volume is equal surface of the imaginary circle that the blades (propellers) of the turbine describe during rotation (Figure 2) multiplied by the part of the path x that the wind travels at a given moment:

$$dV = A \cdot dx \quad (8)$$

Traveled distance is equal to the product of speed and time, and the previous equation takes the form:

$$dV=A\cdot v\cdot dt \quad (9)$$

If we include the previous equation in equation (7), we get the expression:

$$dm=\rho\cdot A\cdot v\cdot dt \quad (10)$$

The final form of the equation for calculating the kinetic energy of wind is:

$$dE_k = \frac{1}{2}\cdot \rho \cdot A \cdot v^3 \cdot dt \quad (11)$$

The equation for wind strength is obtained if we derive the previous equation by the time t:

$$P = \frac{1}{2}\cdot \rho \cdot A \cdot v^3 \quad (12)$$

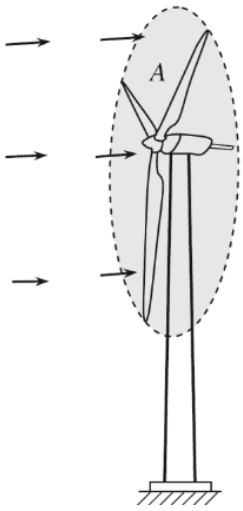


Figure 2: Circle that turbine blades describe during rotation
(Tong, W. (2010), Wind Power Generation and Wind Turbine Design, pp 10)

It can be concluded that the available wind power increases with the density of the air and with the length of the blades (surface of the circle that the blades describe by rotation). However, one of the most important laws for wind turbine operation is that wind power is directly proportional to wind speed to third power. Thus, small variations in wind speed change can result in large changes in wind power [3,4]. Surface of rotor increases with the square of radius of the rotor, so a twice as large turbine receives four times the amount of energy. However, regardless of the wind speed, increasing the rotor surface is a complex task as it increases the stress of the whole system and it is necessary to significantly strengthen the whole mechanical structure [6].

The wind turbine starts transmitting power from zero at a switching speed of about 3-4 m / s, up to the maximum value at nominal wind speeds. Above the nominal wind speed, the wind turbine continues to produce the same nominal power but with reduced efficiency until it is switched off, if the wind speed increases between 25 and 30 m / s. This is the turbine shutdown speed (Figure 3).

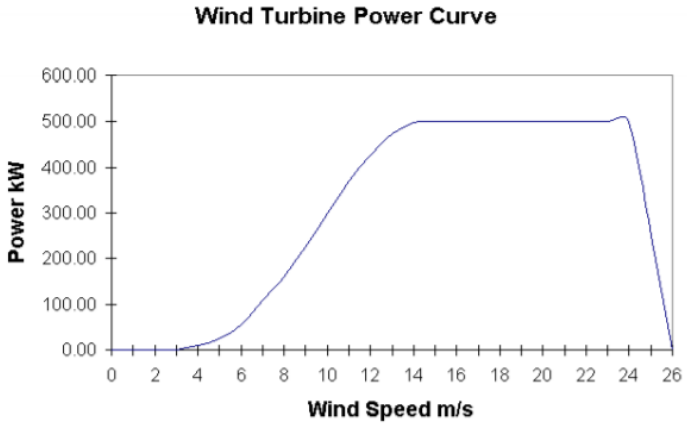


Figure 3: Wind speed – poower diagram of standard wind turbines (Malamateinos, C. et al, Handbook on Renewable Energy, pp 69)

Thus, when nominal power is reached at a rated speed usually of 12-15 m / s, it remains so until the wind speed exceeds the maximum cut-off value [8, 9]. Therefore, stable blowing of a sufficiently strong wind is a necessary condition for the profitable use of its energy. It is important that the current is as stable as possible, without turbulence and with a minimal probability of sudden storms [5]. The minimum wind potential of the location requires an average mean wind speed of about a minimum of 4 m / s, which is the speed of turning on the wind turbine [1]. Also, the efficiency of a wind farm is lost with high wind speeds when the wind turbine shutdown speed is reached. Therefore, locations with frequent gusts of strong, fast winds are not suitable for an efficient and cost-effective wind farm. It is concluded that by far the most suitable for achieving a high degree of wind farm utilization are those locations where wind velocity between nominal and the shutdown velocity are most frequent. It is at these velocities that power of the generator reaches its highest value. Eg. if the mean wind speed increased from 5 m / s to 10 m / s, production would increase by 171% [7]. However, wind is a fluctuating source of energy, so the cost-effectiveness of using wind energy is hampered by wind changes such as: periods of calm, a sudden jump in wind velocity and a relatively short time to use the maximum power of the wind farm.

5. CONCLUSION

Generally speaking, wind power generation is a relatively young industry when looking at commercial production in Europe. Wind energy production is constantly being improved by reducing costs and increasing efficiency. Since wind is free, the eventual price does not matter, but there are other specifics related to the frequency and speed of the wind. Testing of locations for wind farms is conducted through the assessment of mean speeds, dominant wind directions and other important characteristics of the site, using appropriate computer programs for modeling and simulation of wind The production of electricity from wind is therefore somewhat unpredictable, the occasional nature of the plant is the biggest problem and the efficiency as well as the cost-effectiveness of the wind farm is questionable. Wind speed increases with height and decreases with surface roughness (friction due to overcoming obstacles on the ground). That is why the turbines are placed on high towers, and the most common locations with good wind potential are sea surfaces or clear elevations. Wind power increases in proportion to the cube of wind velocity. The conversion of total wind energy on a wind turbine is impossible, and losses in the

system are inevitable. Losses are classified as aerodynamic, mechanical and electrical. The most suitable for achieving a high degree of wind power utilization are those locations with a medium wind speed between the rated speed of the generator and the shutdown speed. It is at these speeds that the generator power reaches its highest value. In addition to the frequency and wind speed of a given location, the wind power plant's utilization is also influenced by engineering solutions and technical performance: position, design, number, layout and performance of wind turbines, availability, adequate servicing and maintenance of equipment.

6. REFERENCES

[1] Zečević, I. (2019), Determination of energy potential based on wind speed measurements, Final thesis, Josip Juraj Strossmayer University, Osijek

[2] Poljarević, M. (2019), Conversion of wind energy into electricity in the laboratory for RES, Josip Juraj Strossmayer University of Osijek, Faculty of Electrical Engineering, Computing and Information Technology

[3] Grogg, K. (2005), Harvesting the Wind: The Physics of Wind Turbines, Carleton College, Physics and Astronomy Department

[4] Wagner, H.-J. (2012), Introduction to wind energy systems, International School of Energy, "New Strategies for Energy Generation, Conversion and Storage", Varenna

[5] Fett, E., Golemović, R. (2020), Determining the optimal shape of wind turbine foundations, University

[6] Špoljarić, M. (2011), Availability and risk of wind power plants, University of Zagreb, Faculty of Electrical Engineering and Computing

[7] Prka, M. (2019), Statistical analysis of wind and production analysis of the future wind farm at a given location, Josip Juraj Strossmayer University of Osijek, Faculty of Electrical Engineering, Computing and Information Technologies

[8] Orlović, N. (2017), Influence of wind power plant on voltage failures in the power system, Josip Juraj Strossmayer University of Osijek, Faculty of Electrical Engineering, Computing and Information Technologies

[9] Vurbić, I. (2015), Connection of a wind farm to the electricity transmission network, University of Zagreb, Faculty of Electrical Engineering and Computing

APPLICATION OF ÖNORM STANDARDS IN THE PRODUCTION OF FIREPROOF DOORS

Ibro Mustafić, Hasib Torić
University of Bihać, Faculty of Technical Engineering, Irfana Ljubijankića bb
77000 Bihać, mustaficibro@hotmail.com, hasib.toric.1993@gmail.com

ABSTRACT:

Fire protection is necessary for a series of facilities and its essential part is made of special doors that increase the safety and functionality of the space. This work gives an overview of the fire resistance classes EI2 30, EI2 60, and EI2 90, which are inherited from earlier classes of fire resistance T 30 (fire resistance), T 60 (high fire resistance), and T 90 resistant). Also, the basic norms (ÖNORM), which contain the provisions on the joints, test and mark the frames, shutters, and door wings in single and double output production of quality products are also mentioned. Materials used in the design of anti-barrier barriers according to ÖNORM must comply with the requirements of the selected fire resistance class and should not endanger the environment in the event of a fire, high temperature, or smoke.

Keywords: fireproof doors, smokeproof doors, self-closing, wing, door closer

1. INTRODUCTION

In the construction of all buildings and structures, special attention is paid to fire protection as well as the fulfillment of special norms. When the facility is handed over, it is usually assumed through measures: competent design, installation of fire protection systems and equipment, including doors. The basic role of fire doors is to protect people and material goods from the fire itself. Due to their construction, they are flame resistant and more breathable than ordinary ones. During a fire, they should prevent the spread of fire and smoke from the space in which it originated. If effective protection against the fire itself is established, the additional time required to evacuate people and property where the fire occurred will be obtained. Smokeproof doors, in addition to their function of preventing the spread of fire, must prevent the spread and passage of smoke and flue gases outside the protected room. Fire doors are classified according to how long they can withstand the effects of flames, high temperatures and remain airtight. We must consider that in recent years fire safety protection has increasingly become reliant on evidence-based reports and certification rather than the more prescriptive upgrading methods used ten or twenty years ago. It may be for this reason that guidance from the Fire & Rescue Service [1-3].

It's important to consider the use to which the building will be put and any inherent features that may affect safe egress in an emergency. Complexity of the building and the vulnerability of the building users must be considered as part of the fire risk assessment which in turn will determine the level of protection required from each fire door. Fire doors are rated by the duration during which they provide fire separation performance. The ratings are FD20 (twenty minutes, now not used any longer), FD 30 (thirty minutes) and FD60 (sixty minutes). Where asset protection is a requirement, ratings of FD90 up to even FD240 are possible but these are very much specialist products necessitating bespoke survey, design, manufacture, installation and maintenance [4].

This paper attempts to highlight the fire resistance classes and material used for the construction of fire-fighting elements according to ÖNORM.

2. FIRE RESISTANCE CLASSES

Fire doors can be classified according to several qualities. According to the Technical Regulations on Fire Protection Requirements, one of the criteria is the limit of fire resistance. This characteristic shows how long the door can withstand the action of fire.

Fire resistance classes are prescribed in ÖNORM EN 13501-2 - according to Table 1. For all constructions, the door starts with the letters EI, then the number corresponding to the fire stability time in minutes is given.

2.1 Class EI_2 90-C^1 S_m

The minimum fire resistance is 90 minutes. According to the construction characteristics, single-leaf and double-leaf doors can be distinguished. To determine which option is recommended for installation in a particular room, it is necessary to measure the width of the opening. In cases up to 1200 mm, single-wing models can be used. If the width is greater, then the width of double doors can be made equally and differently, whereas constructions of the first type are most often installed in rooms with a high degree of danger [5].

E - in this classification is derived from "Etanchèitè" and means closing the room. This indicates the ability of the space-separating component to withstand a fire from the side on which it originated. The passage of fire to the protected side was prevented.

I - (I_1, I_2) is derived from "Isolation" and describes the ability of a component to limit the transfer of flame and heat to the extent that there is no danger to humans or inflammation of flammable materials on the opposite side from the resulting fire. The average temperature rise of 140 ° C and the maximum temperature rise of 180 °C must not be exceeded. I_1 differs from I_2 in the position of the surface temperature sensor during the test.

90 - number indicates the time classification of fire doors. Classification times must be given in minutes for each of the above characteristics, with classification times 30, 60, 90 and 120 being the most common in Europe.

C - describes the self-closing property of the component and is derived from "Closing". Classes C0 to C5 define component self-closing cycles. For example, class C5 indicates very frequent use, class C3 indicates a moderate number of activities, class C2 is widely used in fire doors.

S - is derived from "Smoke" and means limiting the permeability of smoke and flue gases. The index "a" is derived from "ambient", which corresponds to the ambient/surrounding temperature. S200 or Sm means the impermeability of the smoke at surrounding temperature, as well as at a temperature of 200 ° C, on the outside and inside of the fire and smoke protection elements being tested [5].

2.2 Class EI2 60-C1 Sm

Minimum fire resistance 60 minutes. Doors of the second type of degree EI60 are considered a universal class of models intended for installation in buildings with different functional loads: private houses, offices, civilian buildings. The choice must focus on the width of the opening and the need to increase the space on the door [5].

2.3 Class EI_2 30-C^1 S_m

This class includes models that can withstand a flame for 30 minutes. The lowest degree of protection allows the installation of these doors on small surfaces [5]. Table 1. shows a comparison of the resistance classes used so far with the new European classification.

Table 1 [6]: Fire resistance classes

Fire resistance classes according to ÖNORM EN 13501-2	**Fire resistance period**	**Fire protection-technical relation**	**Previous fire resistance classes**	**Structural engineering relation used in Austrian legislation**
EI_2 30-C[2)]	$30 \leq t < 60$	fire retardant	T 30	fire retardant
EI_2 60-C[2)]	$60 \leq t < 90$	highly fire retardant	T 60	highly fire retardant
EI_2 90-C[2)]	$90 \leq t$	fire – conformed	T 90	fire aproved
E 30-C[2)]	$30 \leq t < 60$	smoke closure	R 30	smoke closure
E 60-C[2)]	$60 \leq t < 90$	-	-	-
E 90-C[2)]	$90 \leq t$	-	-	-

[1)] As ind the withdrawn ÖNORM EN B 3850:1996-03 or B 3855:1997-08 listed
[2)] The self-closing and the closing sequence controller can be at certain fire protection closures omitted.

NOTE:
The comarison in the columna „previousfire resistance classes“ or „fire resistance classes according to ÖNORM EN 13501-2“ does not represent a test-related equation.

Classification scheme of smoke protection according to the characteristic properties of the performance according to Table 2.

Table 2 [7]: Classification scheme of smoke protection

Charakteristic performance properties according to ÖNORM EN 13501-2	**Test temperatures**	**Leaks**
S_m -C	Ambient/surrounding temperature (20 ± 10) °C and high temperature (200 ± 20) °C	≤ 20 m^3/h (single lief) or ≤ 30 m^3/h (double lief)

In particular, the classification of Sm (positive test results at elevated temperature) also requires positive test results at room temperature, which means that the classification of S_m includes the classification of S_a [7].

3. FIRE DOOR MATERIALS

Materials used for the construction of fire-fighting elements according to ÖNORM B 3850 must meet the requirements of the selected fire resistance class and in the case of fire must not endanger the environment due to splitting or the formation of smoke.

All structural elements used in fire barriers must come from production with quality control which must be performed on the basis of the appropriate ÖNORM (if there is no ÖNORM regulation for the structural element, the appropriate DIN is used). The basic characteristics of these elements are that they are immune to heat, that the material from which fire-fighting structures are made must be resistant to thermal distortion, that they are non-toxic raw materials since in case of fire the door should not become a source of combustion products [8-9].

The main elements of fire doors are slightly different from the usual ones. As a rule, the base of the door contains a canvas, a box, a fastening mechanism and a lock. The canvas is usually made on the basis of metal ribs, which are subsequently coated with sheets of steel, glass or wood in wooden models. The main difference is in the specialized components and fireproof materials. This includes the following:

- **Seals** - each door in its design assumes gaps in the joints between the door and the box, fire extinguishing models allow the laying of different types of sealing materials around the entire contour. The most suitable options are with a covering of thermosetting tape, which foams under the action of temperature and completely closes the door, protecting it from toxic combustion products as it is seen in Figure 1.

Figure 1: Fire protection laminate red or black

- **Coatings** - the final surface of fire doors can be made of different types of materials such as powder coating, resistant to high temperatures as well as coating with fireproof laminate or veneer, wood or MDF boards impregnated with protective agents as it is seen in Figure 2 [10].

- **Insulation** - it fills the space between the canvas, because fire doors always consist of several layers. The insulator protects the net from heat and the most common option is mineral wool.

- **Floor seal** is a device primarily needed for protection against smoke and flue gases. In addition, it is an obstacle to noise, dust, drafts, heat loss, as it seen in Figure 3.

- Shutter - the installation of self-closing devices on fire doors is mandatory, because only in the closed position the structure fulfills its protective function. They can be floor, outdoor and built-in, as it is presented in Figure 4 [10].
Figure 2 showcases the final surface of fire doors, or the so called coating.

Figure 2: Different surfaces of the doors

Floor seal is presented in Figure 3.

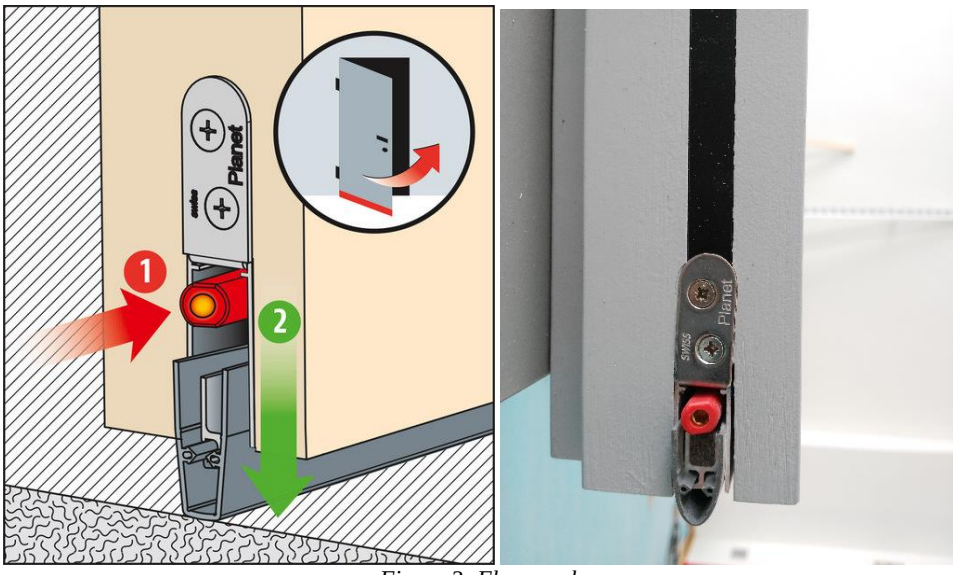


Figure 3: Floor seal

Figure 4 displays the abovementioned shutter.

Figure 4: Shutter

With double-leaf doors, it is necessary to install automation of the closing rules, which will eliminate the human factor in the suddenness during a fire.

4. CONCLUSION

According to statistics, during the fire, people suffer due to the fact that they fail to evacuate in time because the front door caught fire or it is so hot that the lock can't be touched and opened, or the door is deformed due to heat and is stuck. Therefore, in the construction of all facilities, special attention is paid to fire protection. This paper provides an overview of fire resistance classes according to ÖNORM, as well as the basic properties of fire doors and materials that characterize fire safety. Like any product that requires testing, fire resistance doors must be certified.

5. LITERATURE

[1] Jeong, J.-H. (2021). Prediction and Reduction of Alarm Sound Propagation Through Escape Stairways. Fire Technology. doi: 10.1007/s10694-021-01131-z.
[2] Cao, B. et al. (2021). Numerical study on the different prevention methods for fire and smoke in utility tunnel fire. IOP Conference Series: Earth and Environmental Science 675(1), 012045. doi: 10.1088/1755-1315/675/1/012045.
[3] Gravit, M., Nedryshkin, O. and Ogidan, O. (2018). Transformable fire barriers in buildings and structures. Санкт-Петербургский политехнический университет Петра Великого. doi: 10.18720/MCE.77.4.
[4] Upgrading doors to fire doors, https://www.firesafe.org.uk/upgrading-doors-to-fire-doors, Accessed (24.07.2021)
[5] https://blog.domoferm.com, Accessed (25.07.2021)
[6] Österreichisches Normungsinstitut: *ÖNORM B 3850 Feuerschutzabschlüsse Drehflügel-, Pendeltüren und -tore Ein- und zweiflügelige Ausführung*, 2004.
[7] Österreichisches Normungsinstitut: *ÖNORM B 3851 Rauchschutzabschlüsse – Drehflügel-, Pendeltüren und -tore Ein- und zweiflügelige Ausführung*, 2004.

[8] Österreichisches Normungsinstitut: *ÖNORM EN 1363-1 Feuerwiderstandsprüfungen Teil 1: Allgemeine Anforderungen*, 2000.
[9] Österreichisches Normungsinstitut: *ÖNORM EN 1334-1 Österreichisches Normungsinstitut: ÖNORM EN 1363-1 Feuerwiderstandsprüf ungen Teil 1: Allgemeine Anforderungen, 2000.*, 2009.
[10] Fire Safety, Technical Guidance Document B, Building Regulations. (2006). Published by the Stationery Office. Dublin

APPLICATION OF EPISTLE ANALYSIS OF EXTERNAL BUSINESS FACTORS IN IMPROVING THE STRATEGIC PLANNING OF CORPORATE COMMUNICATION OF CONSTRUCTION COMPANIES

Senija Sehanovic
"ARCON – in" d.o.o. Zenica, University of Zenica, 27, Zmaja od Bosne Street, Zenica, BiH
ssenija@arcon-in.ba; senija.sehanovic@unze.ba

ABSTRACT:

In all economies, construction sector is one of the sectors with the task, and the potential, to push the society and the economy forward. This also holds in times of challenges that, due to the COVID-19 pandemic, all world economies are currently going through. But in order to use the potential of construction companies, these companies have to plan their business, growth and development strategically. Within the development or improvement of general strategies, special importance should be given to the (sub) strategy of corporate communication. Precisely on its quality depend the image of companies, but also the level of their engagement and business success. It is imperative that quality strategic planning starts from research and analyses, which then form a quality basis for making decisions about business activities. EPISTLE analysis of external business factors of construction companies proves to be the analysis model most suitable for the construction sector. Like other qualitative analyses, EPISTLE analysis is a result of not only empirical research, but also theoretical knowledge, experiences, opinions and attitudes of the sector researcher or analyst. As such, this paper also discusses basic theoretical features of EPISTLE analysis. These initial concepts are then introduced into the specific conditions of business in the construction sector. A list of the most relevant factors and a sample of EPISTLE analysis is also given in this paper. A sample included the extract from the list of the listed most important external business factors that were identified as the most significant in a large market research of construction sector in Bosnia and Herzegovina (BiH).

Keywords: EPISTLE analysis, external business factors, corporate communication, construction companies

1. INTRODUCTION

In all economies, construction companies are carriers of investment development and drivers of society and the economy as a whole. Therefore, it is of an exceptional importance for the whole economy, just as it is for individual companies, that each construction company approaches its own business activities, sustainable growth and development strategically. It is especially important to approach strategically the companies' corporate communication. Strategy can provide a company

with acceptance by relevant groups of public and a positive and potent image and reputation, leading to an increased interest in company's products and services and better business results [1].

Each strategic planning process starts from research. Companies have to know under what circumstances they work and which business determinants affect them. That presents a quality basis for making analyses, conclusions and decisions about business activities. EPISTLE analysis of external business factors of construction companies proves to be the analysis model most suitable for the construction sector. It gives a basis for the development of a corporate communication strategy and observes the main dimensions of the general environment segmented as follows: economic (E), political (P), intercultural (I), social (S), technological (T), legislative (L) and environmental (E). As for a quality EPISTLE analysis theoretical knowledge of analyst is also important, a short theoretical context of the analysis is given in this paper. These initial concepts are then introduced into the specific business conditions in the construction sector. The paper then provides an extract of the most relevant external business factors of BH construction companies identified in a research of construction sector in BiH, and a sample of EPISTLE analysis conducted in the construction sector.

2. SHORT THEORETICAL FOUNDATIONS OF EPISTLE ANALYSIS OF EXTERNAL BUSINESS FACTORS

As a model of analysis useful for the construction sector, it is appropriate to use qualitative EPISTLE analysis. For analysts in the construction sector it is therefore important to know the theoretical basis of the analysis they perform. That is why a brief overview of the development path and basic features of the PEST/PESTLE/EPISTLE analysis of external business factors have to be addressed in this section. These initial concepts are then introduced into the specific conditions of business in the construction sector.

Analysis of the external environment is an analysis of relevant factors and influences that stem from outside the studied company. These factors are important enough to need to be monitored and included in the consideration when choosing company goals and strategies [2]. Theorists usually classify important factors of the external environment into the business and the general environment. The business environment is the one that the company encounters in its area of business. In the field of construction, the business environment implies the existence of forces that influence the company, which arise from the existence and actions of investors and buyers, suppliers of materials and equipment, subcontractors, existing and potential competitors, government and its bodies, media, unions, banks. The general environment determines the general business conditions and is similar for all companies operating in a particular geographical area. It affects the business environment as well as the companies that operate in it. The analysis of the general environment is most often performed using the so-called PEST/LE model that categorizes the impact of general environment variables into several main groups. The name of the model itself is an acronym for the initials of the main determinants of the general environment (Political, Economic, Social, Technological, Environmental and Legal Factors). The PEST concept was originally developed by Aguilar in 1967 and included a political, economic, social and technological environment. The concept is also referred to as STEP, SEPT, STEEP, which depends on the structure of the included main dimensions of the general environment. Subsequently, new dimensions of the general environment were added, such as Legislative and Environmental as the result of a better understanding of their importance for the company's business. The aim of the PEST/LE analysis is to assess and interpret the impact of general environmental factors, taking into account the interdependence of these factors too. The dimensions of the general environment overlap and development in one dimension affects the development of others [2, 3, 4, 5].

3. RESULTS AND DISCUSSION OF RESEARCH IN THE CONSTRUCTION SECTOR IN BOSNIA AND HERZEGOVINA – THE MOST IMPORTANT EXTERNAL BUSINESS FACTORS AND A SAMPLE OF EPISTLE ANALISYS IN THE CONSTRUCTION SECTOR

3.1. Research Methodology

A market survey [1] on construction sector, companies' corporate communication and its impact on companies' excellence in business was conducted in BiH during 2017 by the author of this paper. As only a strategic approach ensures sustainability of business, questions on strategic planning and management of business, as well as companies' research activities, were included in the survey. Within the survey, a special emphasis was put onto the strategy of corporate communication. The survey was conducted in the groups of the most relevant investors and active construction companies in BiH, and it was expended by a research of media. Survey responses were collected using a questionnaire technique (CAT1 telephone research). Due to a lack of databases with integrated, country-wide level of information about the companies in the construction sector, population size had to be estimated by cross-sectional pairing of different sources, in particular the Agency for Statistics of BiH [6,7], Institute for Statistics of the Federation of BiH and Republika Srpska Institute of Statistics. Out of the population of cca. 3000 active construction companies in the construction sector in BiH in 2016, 1.5% were surveyed in the sample that is deemed representative based on established statistical practice. Investors as the main stakeholders were surveyed separately, allowing for the same conditioning variables to be used in inferring the behaviour and attitudes on the population level. The size of the sample determined the use of appropriate statistics (in particular, t-statistics) for confidence interval estimation. Due to a low number of observations in multiple contingency table entries, chi-squared analysis was deemed inappropriate. As such, other statistical tests relevant for the structure of collected data were carried out to allow for inference developed in the discussion section, most importantly the Fisher's Exact Test and the Kruskall-Wallis test categories [8].

3.2. Results and discussion of research in the construction sector in Bosnia and Herzegovina – The list of the most important external business factors of construction companies in BiH and a sample of EPISTLE analysis

This section provides an overview of the most significant external business factors of construction companies, classified by groups (according to [2]). It is important to note that this review contains only an excerpt from the review of all factors that are identified as the most important by the construction sector research in BiH and which are included in the comprehensive EPISTLE analysis related to BH construction companies [1]. Important groups of external business factors included in the EPISTLE analysis of the BH construction sector sampled in this paper are: economic environment, socio-demographic environment, intercultural environment, political environment, legal environment, technological environment and natural-ecological environment. Within these groups, during the research, the following external business factors of BH construction companies were identified as the most important:

Economic environment – domestic economic situation in terms of number, quality and investment power of investors, financial capacity of companies in the sector, financial discipline of the company, market competition, domestic economic trends, tax policy and parafiscal levies, seasonality in business, existence of black economy, market cycles, international relations, availability of skilled labor, labor productivity, exchange rate, interest rates, presence of large banks and availability of money from international funds, strategic approach to business, business excellence.

Socio - demographic environment – media, image and reputation of the company, attitudes, habits and possibilities of consumers / investors, ethnic issues, demographic change, education, health,

fashion and fashion trends, demographic status in terms of investors and customers, availability of labour force in all geographical areas where the company operates or intends to do so.

Intercultural environment – shopping habits and consumer values, market values, employee attitudes, managerial style, organizational culture, ethics and motivation of employees and their involvement in lifelong learning. These factors must be taken into account in all markets in which the company operates.

Political environment – geopolitical position of the state, government payment policy, government policy in the segment of borrowing and its trade policy, political elections, (non)fulfillment of government commitments to international institutions, political instability and threat of conflict, internal political issues, government incentive policy to the sector and towards capital owners, government policy towards education and the judiciary, etc. In the BiH market, the political environment and its factors affect the business of all (including construction) companies more than necessary. The influence of factors from this environment is mostly limiting.

Legal environment (includes laws and other legal acts) – current legal regulation in the sector, existence of legal protection of construction companies from unfair competition, future legal regulation, regulatory bodies and processes, labor laws, VAT law, laws in the field of construction, the Law on Public Procurement of BiH, consumer protection, duration of legal proceedings, etc. Companies need to follow the legislation of countries in which they operate in order to adapt and properly identify its potential impacts.

Technological environment – the level of obsolescence or innovation of technology in the company, technology replacement, innovation potential, information and communication systems, patenting, information technology and integrated systems, transport, internet, the speed of change in software. Construction companies must be well informed about the offer of new technologies, especially in the field of information technology and technology on which the company's activity is based.

Natural - ecological environment (includes natural environment: air, soil, water, climate, biotic factors and cultural heritage) – natural resources, natural beauties, ecological issues, ecological regulation, corporate social responsibility etc. The construction sector has a great impact on the environment and this group of factors is extremely important for its business.

After a brief overview of external factors (by groups) identified during the BH market research as the most important for the construction sector and its participants, the following Table 1 shows how all these individual factors can be systematized and how to assess their impact on business. For the purposes of EPISTLE analysis, Table 1 needs to include at least: states - describes each individual factor and gives an aspect - the way it impacts the business of a construction company, all important notes related to the described factor (explanations and examples), all determinants of the potential impact of each factor as follows: high impact (H), medium impact (M), low impact (L) or indication that the impact cannot be determined. Then, the table must contain the identified implications and importance of each individual factor: duration of the impact (0-6 months, 6-12 months, 12-24 months and over 24 months). Statements about the type of impact on the company (positive, negative, neutral, unknown) also need to be included. In one column, it is advisable to give the trend of influence (influence "is increasing", "is not changing", "is decreasing" or is "unknown"). It is also important to indicate the relative importance of an individual factor, i.e. to state whether the factor is "critical", "very important", "important", "unimportant" or "unknown". A short sample of the table prepared for the needs of EPISTLE analysis (Table 1) includes all of the above, but only for one individual factor from each of the considered groups of factors (due to the brevity of this paper). It contains evaluations, views and interpretations of the author of this text which are a result of long professional engagement in management of construction companies in BiH. All data given in Table 1 are based on the results of the previously mentioned research. The Table can be adjusted to the knowledge of other researchers and analysts from other investment markets. To make one’s own analysis, it is suggested to use some of the programs for spreadsheet preparation and analysis. Easy and useful applicability in

testing the state of environmental factors and their impacts on construction companies in BiH and any other market in the world, gives this analysis a special value.

Table 1: A sample of EPISTLE analyses of external business factors of construction companies

Factors	**Notes – Aspect**	**Other notes**	**Potential impact**	**Implications and importance of the factor**	**Implications and importance of the factor**	**Implications and importance of the factor**	**Implications and importance of the factor**
1	2a	2b	3	4a	4b	4c	4d
Individual factors relevant to a particular company (1, 2, 3 etc.. - a factor from the list above.	**The aspect of factor – (The way factors act on business)**	**Additional notes - explanations and samples**	**The level of impact - H – high M – middle L- low U – unknown**	**Duration of impact 0-6 months 6-12 months 12-24 months 24 +**	**The impact Positive + Negative – Neutral lambda Unknown U**	**Trend of impact The impact is increasing > The impact is not changing = Impact is decreasing < Impact unknown U**	**Relative importance Critical Very important Important Not important Unknown**
	Political factors						
Political trends	Continued proliferation of bureaucratic institutions increases the inefficiency of the state apparatus and makes operations of the company more difficult.		**H**	**24+**	**-**	**=**	**Important**
	Economic factors						
Financial capacity of Company	Weak financial power of the company makes it impossible to obtain bank guarantees for big value contracts.		**H**	**24+**	**-**	**=**	**Critical**
	Social factors						
Demo-graphic changes	Huge outflow of young and qualified population abroad leads to changes in the age structure of the population, which changes the preferences and the way of spending of funds by buyers and investors.		**H**	**24+**	**-**	**>**	**Critical**
	Technological factors						
Inovation potential	Low innovation potential in the sector is the result of low profitability, which limits investment in new technologies.		**M**	**24+**	**-**	**=**	**Important**
	Legal factors						
Future legal regulation	Legal regulation is sinhronizing with EU regulatives. The process is too slow due to lack of political agreement in the country.		**H**	**12+**	**-**	**>**	**Very important**
	Intercultural factors						
Consumer values	Consumers are increasingly aware of and comply with		**H**	**24+**	**-**	**>**	**Important**

	consumer values in the EU; at the same time, they are raising demands from companies.						
	Ecological factors						
Natural resources	BiH is rich in natural resources for the production of construction materials.		**M**	**24+**	**-**	=	**Important**

4. CONCLUSION

Construction companies are by their nature engines of investment and development, and are a driving force for the economy as the society as a whole. Together with maximizing their own profits, these are all the more reasons why companies should approach their own business activities, sustainable growth and development strategically. Within the development or improvement of general strategies, special importance should be given to the (sub) strategy of corporate communication. Namely, on its quality depends not the image of companies, but also the level of their engagement and business success. Only a strategic approach, i.e. strategic planning based on research and analysis, ensures the growth, development and sustainability of business. EPISTLE analysis of external business factors proves to be a good basis for improving the strategic planning of corporate communication of any construction company. As it is very important for quality of any qualitative analysis such as EPISTLE, this paper includes its short theoretical foundations. The paper also gave a list of the most important external business factors in the construction sector that were defined as relevant through a market research conducted in Bosnia and Herzegovina. A simplified sample of EPISTLE analysis was also presented. This sample was prepared specifically for this paper so as to allow a concise version of the analysis to be shown. Although the presented sample includes just an extract of the all external factors relevant for construction companies in Bosnia and Herzegovina, it can serve as a useful tool for sector analysts and researchers to make a complete analysis for their companies' needs in any other invesment market.

5. REFERENCES

[1] Sehanovic, S. (2018). The Impact of the Corporate Communication on the Corporate Image of Construction Companies in Bosnia and Herzegovina, Doctoral Thesis. Tuzla: University of Tuzla, Faculty of Humanities and Social Sciences.
[2] Thompson, J., Martin, F. (2006). Strategic Management: Awareness and Change. Australia: Thompson Learning.
[3] Ho, J.K.K. (2014). Formulation of a Systemic PEST Analysis for Strategic Analysis. European Academic Research 2(5), 6478-6492
[4] Klein, H.E, Newman, W.H. (1980). How to Integrate New Environmental Forces Into Strategic Planning. Management Review, 19, 40-48
[5] Yuksel, I. (2012). Developing a Multi-Criteria Decision Making Model for PESTEL Analysis. International Journal of Business and Management, 7(24), 52-66
[6] Agencija za statistiku BiH (2016). Saopćenje: poslovne statistike; Indeksi proizvodnje u građevinarstvu u BiH, prvi kvartal 2017. Sarajevo: Agencija za statistiku BiH.
[7] Agencija za statistiku BiH (2016). Građevinski radovi: Sarajevo: Agencija za statistiku BiH.
[8] Sehanovic, S. (2021) Matrix for analysis of elements of corporate image in the construction sector in Bosnia and Herzegovina. Quality 2021, ISSN 1512-9268, Neum, B&H, 17-19 June 2021., pp. 233-238

EFFECT OF ADDITION OF WALNUTS TO ACACIA AND LINEN HONEY ON THE CONTENT OF TOTAL PHENOLS AND ANTIOXIDANT ACTIVITY

Samira Dedić[1*], Huska Jukić[2], Azra Bakrač[1]
[1]University of Bihac, Biotechnical Faculty, Luke Marjanovića 2, 77000 Bihać, BiH,
[2]University of Bihac, Faculty of Health Studies Nositelja hrvatskog trolista 4, 77000 Bihać, BiH,
*Corresponding author, e-mail samira.dedic@yahoo.com

ABSTRACT:

Honey is one of the elixirs of health, it is a natural saturated solution of sugar, which contains more than 350 important ingredients for the body. The most common ingredient is invert sugar, ie a mixture of glucose and fructose formed by hydrolysis of sucrose and water. It also contains certain minor ingredients: proteins, enzymes, phenolic acids, flavonoids and carotenoids, lipids, vitamins (B, C, A, K and E), minerals (iron, copper, manganese, silicon, chlorine, calcium, potassium, sodium, magnesium), amino and organic acids It serves as a source of natural antioxidants and has been proven to have antibacterial, anti - inflammatory, anti - allergic, antimutagenic, antiviral and anticancer properties. All these properties are the result of the ability of flavonoids to act as free radical scavengers, inhibit specific enzymes and stimulate some hormones and neurotransmitters, and also act indirectly by protecting vitamin C from oxidation. Honey is also consumed in combination with walnuts and various types of dried fruits (figs, plums, cherries, quinces, cranberries, apricots, etc.). The aim of this study was to investigate the contribution of the addition of walnuts to the content of polyphenols, flavonoids and antioxidant activity of honey. Our results indicate that the addition of walnuts to acacia and linden honey improves the antioxidant activity of honey by enriching phenolic components.

Keywords: antioxidant activity, DPPH, phenolic components, honey, walnuts

1. INTRODUCTION

Honey can be used as a functional food because it is extremely rich in antioxidants. The flavonoids in honey have antioxidant efficacy because they can directly capture free radicals, and they also act indirectly by protecting vitamin C from oxidation [1]. It is often used as a substitute for sugar, and the mixture must contain more fructose than glucose, while the sucrose content must not exceed 5% and spontaneously go into equilibrium by crystallization of excess glucose in solution [2].
Acacia honey contains more fruit sugar than grape honey and therefore remains uncrystallized for a long time. The source of phenolic components in honey, mostly flower nectar and propolis, and to a lesser extent pollen, which originated as a secondary product of plant metabolism, are included in plant defense mechanisms [3], and research has confirmed that dark honey has a higher content total phenols and consequently higher antioxidant activity [4]. Different physicochemical and sensory properties

depend primarily on botanical origin, geographical location, climatic conditions, bee breeds, and different plant origin and further handling of honey [5]. Antimicrobial and antiviral activity of honey has been proven by scientific research, where low water activity inhibits bacterial growth which contributes to the antibacterial effect [6]. The antimicrobial activity of honey is associated with hydrogen peroxide, obtained in a reaction catalysed by glucose oxidase, and phenolic components, although the inhibition of microorganisms by these components varies depending on the botanical origin of the nectar [7].

Apitherapy is the medical use of bee products that has become the focus of attention as a folk and preventive medicine for the treatment of diseases and their symptoms, as well as promoting overall Research has shown that walnut shows several Studies that have studied the consumption of walnuts in animals and humans believe that walnuts could be considered a potential medicinal food or nutracetic [10, 11, 12].

Increasing interest in nuts may be due to its biochemical composition: polyunsaturated fatty acids, especially (linoleic, oleic acid) and high protein values [13]. They are also a good source of flavonoids, phenolic acids and related polyphenols, pectins and sterols Catanzaro et al. (2018) [14] report that the phenol content in walnuts is conditioned by both genetic and environmental factors, while Wianowska et al. (2016) [15] report that the content of flavonoids and phenols in walnut extracts depends on the varieties used. Labuckas et al., in 2008 [16], conducted a study and established the concentration of phenol and phenolic acids in walnuts by extraction using methanol solutions of 19.1 ± 9.6 mg of gallic acid equivalent (GAE) in walnut kernel extract According to Wianowska et al. (2016), the flavonoid content in walnuts ranges from 0.280 mg QE/g FW to 2.570 mg QE/g FW. A much higher concentration of GAE was found in the epidermis surrounding the nucleus (370 ± 140 mg GAE/g).The nutritional composition varies within different varieties. It can also be affected by the cultivar, genotype, different soil on which it grows and different environment [15]. It is believed that walnut polyphenols can increase neurogenesis and reduce oxidative and proinflammatory processes in brain cells [17], and show antibacterial agents [18], antifungal properties [19] and cardiovascular benefits [20, 21].

According to our knowledge, this is the first antioxidant study honey activities with walnuts. In 2015, Vulić et al conducted research on the antioxidant activity and sensory properties of acacia and linden honey with dried cherries. The aim was to evaluate the content of total phenols, flavonoids and antioxidant activity of acacia and linden honey with walnuts before and after three months of storage [22].

2. MATERIALS AND METHODS

Previous research shows that the content of total phenols, flavonoids and antioxidant activity depends on several factors: in this case the type and origin of honey, walnut varieties, geographical location, applied extraction techniques, type of solvent, methods for determining antioxidant activity, data processing method and others factors. Acacia and linden honey were used to prepare honey samples by mixing 50 g of honey and 50 g of walnuts. The ground walnuts are mixed with honey with a wooden spoon. After mixing, the mixture was poured into glass jars, covered with a lid, wrapped in dark paper to protect from light and left to stand for about two weeks. During this time the mixture is stirred 3-4 times. After 14 days the mixture was analyzed. The analysis was performed on six samples of acacia and six samples of linden honey from 2020. and twelve samples (six samples of acacia and six samples of linden honey) with the addition of walnuts. There were a total of 24 samples. Changes in honey after five months of storage were also investigated.

Total phenol content of sample was determined with Folin-Ciocalteu method [23], and the results were calculated from the calibration curve of gallic acid (Figure 1). Total phenol content is expressed as mg/100 g gallic acid equivalents (GAE) of sample. 0,2 mL of sample, 1,8 mL of distilled water, 10 mL of Folin-Ciocalteu reagent and 8 mL of sodium carbonate solution was transferred with a pipette into a test tube. After the sample had been allowed to stand for 2 hours at room temperature, photoLlab 6600

UV-VIS WTW Spectrophotometer was used at 765 nm to measure the absorbance. A modified colorimetric method with $AlCl_3$ was used to estimate total flavonoid content [24], and standard quercetine solution was used to make the calibration curve (Figure 2).

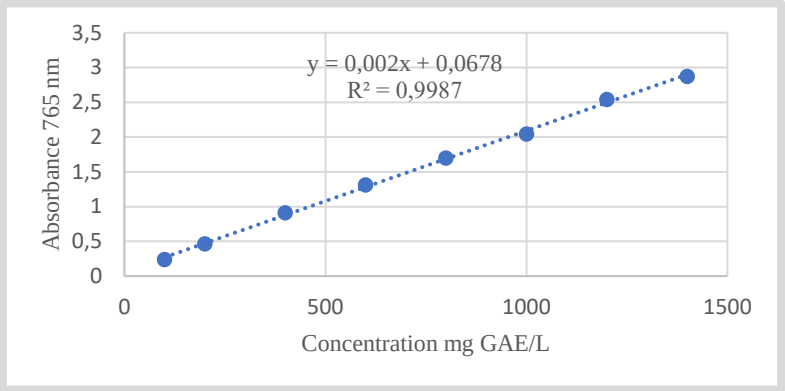


Figure 1: Standard curve for total phenol content determination

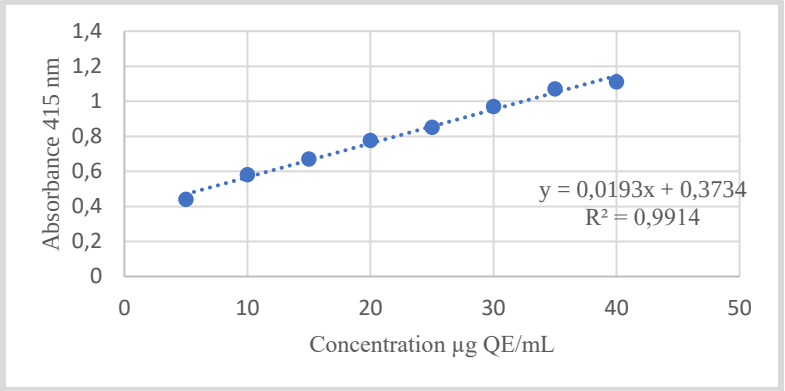


Figure 2: Standard curve for flavonoid content determination

Antioxidant activity was tested by modified DPPH assay [25] DPPH radical is a stable nitrogen radical with dark purple colour and adding antioxidants induces discolouration because the free radical is reduced into light yellow diphenylpicrylhydrazyl. The decrease in the absorption is measured spectrometrically at 517 nm.
200 µl of sample, 3,8 ml of methanol, 1 ml 0,5 mM of DPPH solution was transferred into a test tube and methanol was used as blank. Test tubes were left in the dark for 20 minutes. Afterwards, absorbance was measured at 517 nm.

The free radical scavenging capacity is calculated according to equation 1 [26].

$$\text{Degree of neutralization of DPPH radicals\%} = 100 - [(A_U - A_B) \times \frac{100}{Ak}] \quad (1)$$

A_U - Absorbance of the sample at 517 nm. The sample is an ethanolic solution of the extract and DPPH radicals.
A_B - Blank absorbance at 517 nm. Blank is an ethanolic solution of the extract without the addition of a solution of DPPH radicals.
A_K - Absorbance control at 517 nm. The control is a solution of DPPH radicals without the addition of a sample. An EC50 value (sample concentration required to neutralize 50% of the initial DPPH radical concentration) was determined for all tested samples.

3. RESULTS AND DISCUSSION

The total phenolic contents in honeys were determined from the regression equation of gallic acid calibration curve, and expressed as mg of gallic acid equivalents per 100 g of honey. Similarly, total flavonoids in honeys were determined from the regression equation of quercetine calibration curve, and expressed as mg of quercetine equivalents per 100 g of honey.

Table 1: Content of total phenols and flavonoids of honey with and without the addition of walnuts

Sample	Total phenols (mg GAE/100 g)	Flavonoids (mg QE/100 g)
Acacia honey	22.13 ± 1.05	16.29 ± 0.78
Acacia honey after storage	21.43 ± 1.24	15.54 ± 0.98
Acacia honey with walnuts	40.89 ± 1.31	18.78 ± 0.64
Acacia honey with walnuts after storage	39.64 ± 1.17	18.14 ± 1.01
Linden honey	27.05 ± 1.27	17.55 ± 1.05
Linden honey after storage	26.39 ± 0.76	16.85 ± 0.93
Linden honey with walnuts	55.07 ± 1.23	22.55 ± 0.94
Linden honey with walnuts after storage	54.65 ± 1.38	22.00 ± 0.87

Savatović M. S. et al., in their research, analyzed three types of Serbian flower honey (acacia, linden and "Homolj") to determine the content of antioxidants, total phenolic compounds and flavonoids, as well as their antioxidant activity. The highest content of total phenols (27.44 mg GAE/100 g), flavonoids (9.78 mg QE/100 g), reducing abilities as well as scavenger activity on DPPH radicals were obtained in the case of linden honey [27]. Based on the literature, it can be said that the most common flavonoids in honey are: pinocembrin, apigenin, campferol, quercetin, pinobanxin, luteolin, galangin, hesperitin and isoramnetin [28]. In addition to flavonoids, honey contains other phenols, most of which are phenolic acids such as gallic, coumaric, caffeic, ellagic and ferulic, and their esters [29].

Table 2: Antioxidant activities of honey with and without the addition of walnuts

Sample	EC50 DPPH (mg/mL)
Acacia honey	290.29 ± 11.20
Acacia honey after storage	302.16 ± 12.03
Acacia honey with walnuts	2.54 ± 0.12
Acacia honey with walnuts after storage	2.66 ± 0.06
Linden honey	190.35 ± 4.98
Linden honey after storage	193.24 ± 5.12
Linden honey with walnuts	1.19 ± 0.04
Linden honey with walnuts after storage	1.23 ± 0.09

Pycia et al in their research reported that the examined walnut (Juglans regia L.) of different varieties had significantly different physicochemical properties, antioxidant potential and content of bioactive components such as polyphenols and tocopherols. The highest content of total phenols was (2.07 g GAE/100 g). In their research for the preparation of the extract, they performed an alkaline hydrolysis procedure [30]. Pereira et al. recorded a total polyphenol content in nuts of 6.07 to 9.10 g GAE/100 g [31].

The antioxidant constituents of J. regia walnut samples in the Ogunmoyole study, et al., include total phenols, flavonoids, and vitamin C. The phenol content in J. regia was estimated at 35.22 ± 0.75 mg GAE/g for ethanol and 20 , 26 ± 0.55 mg GAE/g for the aqueous extract, while the flavonoid content was estimated at 20.02 ± 0.12 mg QE/g for ethanol and 14.82 ± 0.15 mg QE/g). In addition, the vitamin C content was 18.22 ± 0.45 mg/g and 10.18 ± 0.21 mg/g for the ethanolic and aqueous extracts of dried J. regia, respectively [9].

Shah et al (2015) claim that methanol nut extracts contain a higher phenol content (94.39 ± 5.63 mg GAE/g FW) than aqueous walnut extracts (27.92 ± 1.40 mg GAE/g FW). Furthermore, methanol nut extracts show the highest antioxidant activity (EC50 of 0.250 mg/ml), followed by water extracts (EC50 of 0.325 mg/ml) in the Fenton reaction (0.199 ± 0.023 and 2.991 ± 0.740, respectively) [32].

Savatovića M. S. et al., In their research give EC50 values for linden honey determined on the basis of reducing ability and scavenger activity on DPPH radicals are 24.17 mg/ml and 51.34 mg/ml. Also, the antioxidant content is highest in linden honey and is 5.45 mg QEAC/100 g (expressed in mg of quercetin equivalent - QEAC per 100 g of honey) and 7.82 mg of AEAC/100 g (expressed in mg of ascorbic acid equivalent - AEAC per 100 g of honey) [27].

4. CONCLUSION

Linden honey and the same enriched with the addition of walnuts showed better antioxidant activity compared to acacia honey and the same enriched with walnuts, before and after storage. The content of total phenols in linden honey was (27.05 ± 1.27 mg GAE/100 g) and flavonoids (17.55 ± 1.05 mg QE/100 g), while in the same honey enriched with walnuts the content of total phenols was (55.07 ± 1.23 mg GAE/100 g) and flavonoids (22.55 ± 0.94 mg QE/100 g). The EC50 values of the Linden honey, determined based on reducing power and DPPH radical scavenging activity, were 190.35 ± 4.98 mg / ml and linden honey enriched with walnuts 1.19 ± 0.04 mg/ml. It can be concluded that all honey samples maintained good antioxidant activities for five months, however, it is very important to take care of the proper storage and storage of honey. After longer storage, it is necessary to conduct basic analyzes, in order to protect consumers.

4. REFERENCES

[1] Kapš Peter, (2013). Liječenje pčelinjim proizvodima Apiterapija, Geromar, Udruga Dobar život, Zagreb
[2] Vahčić N. i Matković D., (2009). Kemijske, fizikalne i senzorne značajke meda.
[3] Flanjak I., (2021). Antioksidativni kapacitet meda i promjene tijekom procesiranja i skladištenja. Doktorski rad. Prehrambeno-tehnološki fakultet Osijek, Osijek, 2012.
[4] Vallianou, N.G., Gounari, P., Skourtis, A., Panagos, J., Kazazis, C. (2014). Honey and its AntiInflammatory, Anti-Bacterial and Anti-Oxidant Properties. Gen. Med. 2, 132. DOI: 10.4172/2327-5146.1000132.
[5] Lachman J, Hejtmankova A, Sykora J, Karban J, Orsak M, Rygerova B, (2006). Contents of Major Phenolic and Flavonoid Antioxidants in Selected Czech Honey. Czech Journal of Foos Sciences 28:412-426, 2010.
[6] Zamora, M.C., Chirife, J., Roldán, D. (2006). On the nature of the relationship between water activity and % moisture in honey. Food Control, 17, 642–647

[7] Beuchat, L.R., Taormina, P.J., Niemira, B.A. (2001). Inhibitory activity of honey against foodborne pathogens as influenced by the presence of hydrogen peroxide and level of antioxidant power, International Journal of Food Microbiology, 69, 217–225.
[8] Inoue, K., Murayama, S., Seshimi, F., Takeba, K., Yoshimura, Y., Nakazawa, H. J. (2005). Sci. Food Agric. 2005, 85, 872-878.
[9] Ogunmoyole, T., Kade, I.J., (2011). Korodele, B. In vitro antioxidant properties of aqueous and ethanolic extracts of walnut (Juglans regia). J. Med. Plant Res. 2011, 5, 6839–6848.
[10] Šoškić, M.M., (2009). Orah i lijeska, 3. izd., PZ Agro-hit, Bjelovar. str.10
[11] Taha, N.A., Al-Wadaan, M.A., (2011). Utility and importance of walnut, Juglans regia Linn: A review. Afr J Microbiol Res 5: 5796-5805.
[12] Hayes D., Angove M.J., Tucci J., Dennic C., (2015). Walnuts (Juglans regia) Chemical composition and research in human health. Crit Rev Food Sci Nutr 56:1231-1241.
[13] Savage G.P., (2001). Chemical composition of walnuts (Juglans regia L.) grown in New Zealand. Plant Foods Hum Nutr 56: 75–82.
[14] Catanzaro E., Greco G., Potenza L., Calcabrini C., Fimognari C., (2018). Natural products to fight cancer: a focus on Juglans regia. Journal List, Toxins (Basel), 10 (11): 469.
[15] Wianowska D., Garbaczewska S., Cieniecka-Roslonkiewicz A., Dawidowicz A.L., Jankowska A., (2016). Comparison of antifungal activity of extracts from different Juglans regia cultivars and juglone. Microbial Pathogenesis, 100: 263-267.
[16] Labuckas D.O., Maestri D.M., Perelló M., Martínez M.L., Lamarque A.L., (2008). Phenolics from walnut (Juglans regia L.) kernels: Antioxidant activity and interactions with proteins. Food Chem., 107(2): 607-612
[17] Poulose S.M., Miller M.G., Shukitt-Hale B., (2014). Role of walnuts in maintaining brain health with age. J Nutr 144:561-566.
[18] Emira N., Mejdi S., Najla T., Hafedh H., Riadh K., Amina B., (2011). Anticandidal, antibacterial and antioxidant properties of *Salvadora persica* and *Juglans regia L*. extracts. J. Med. Plants Res., 5(17): 4138-4146.
[19] Emira N, Mejdi S, Hafedh H, Eulogio V, Amina B (2010). Antifungal properties of *Salvadora persica* and *Juglans regia* L. extracts against oral *Candida* strains. Eur. J. Clin. Microbiol. Infect.Dis., 29: 81-88.
[20] Sabate J, Fraser GE, Burke K (1993). Effects of walnuts on serum lipid levels and blood pressure in normal men. N. Engl. J. Med., 328:603-607.
[21] Abbey M, Noakes M, Belling GB, Nestel PJ (1994). Partial replacement of saturated fatty acids with almonds or walnuts lowers total plasma cholesterol and low-density-lipoprotein cholesterol. Am. J. Clin. Nutr., 59: 995-999.
[22] Vulić, Jelena J., Jasna M. Čanadanović-Brunet, Gordana S. Ćetković, Sonja M. Djilas, Vesna T. Tumbas Šaponjac and Sladjana M. Stajčić, (2015). Polyfloral, linden and acacia honeys with dried cherries after three months of storage – antioxidant and sensory evaluation. BIBLID: 1450-7188 (2015) 46, 103-114
[23] Dewanto, V., Wu, X., Adom, K.K., Lui, R.H. (2002). Thermal processing enhances the nutritional value of tomatoes by increasing total antioxidant activity. J. Agric. Food Chem., no. 50., pp: 3010-3014.
[24] Khlifi, D, Hamdi, M, El Hayouni, A, Cazaux, S, Souchard, JP, Coudere, F, Bouajila, J. (2011). Global chemical composition and antioxidant and anti-tuberculosis activities of various extracts of Globularia alypum L. (Globulariaceae) leaves. Molecules, 2011, 16, 10592-10603.
[25] Molyneux, P. (2004). The use of the stable free radical diphenylpicryl-hydrazyl (DPPH) for estimatingantioxidant activity. Songklanakarin J Sci Technol, 2004, 26, 211-219.
[26] Stanojević Lj., M. Stanković, V. Nikolić, Lj. Nikolić, D. Ristić, J. Čanadanovic-Brunet, V. Tumbas, (2009). Antioxidant Activity and Total Phenolic and Flavonoid Contents of Hieracium pilosella L. Extracts, Sensors, 9 (2009) 5702-5714.

[27] Savatović S. M., Dimitrijević D. J., Dilas S. M., Čanadanović-Brunet J. M., Ćetković G. S., Tumbas V. T., Štajner D. I. (2011). Antioxidant activity of three different Serbian floral honeys. Acta Periodica Technologica 4242: 145-155 (14) (PDF) The Antioxidant Activity of Maltese Honey.

[28] Beretta, G., Granata, P., Ferrero, M., Orioli, M., Facino, R.M. (2005). Standardization of antioxidant properties of honey by combination of spectrophotometric/ fluorometric assays and chemometrics. Analytica Chimica Acta, 533(2), 185- 191.

[29] Pasupuleti, V. R., Kumara, T. K., Naguib, S., Siew, H. G. (2016). Biological and therapeutic effects of honey produced by honey bees and stigles bees: a comparative review. Brazilien Journal of Pharmacognosy 26, 657-664.

[30] Pycia K., I. Kapusta, G. Jaworska, A. Jankowska, (2018). Antioxidant properties, profile of polyphenolic compounds and tocopherol content in various walnut (Juglans regia L.) varieties. European Food Research and Technology https://doi.org/10.1007/s00217-018-3184-3. Received: 10 July 2018 / Accepted: 28 October 2018 © Springer-Verlag GmbH Germany, part of Springer Nature.

[31] Pereira JA, Oliveira I, Sousa A, Valentão P, Andrade PB, Ferreira ICFR, Ferreres F, Bento A, Seabra R, Estevinho L (2007) Walnut (Juglans regia L.) leaves: phenolic compounds, antimicrobial activity and antioxidant potential of different cultivars. Food Chem Toxicol 45:2287–2295

[32] Shah T.I., Sharma E., Shah G.A., (2015). Anti-proliferative, cytotoxicity and anti-oxidant activity of Juglans regia extract. American Journal of Cancer Prevention, 3(2): 45-50

THE ROLE OF NATIONAL LIBRARIES IN SPREADING INFORMATION AWARENESS AND ACADEMIC ENGLISH IN LIGHT OF SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENTS CASE STUDY: THE NATIONAL LIBRARY IN THE UNITED ARAB EMIRATES

Asmaa Saad Assim
Senior Specialist Knowledge Management and Learning Media Resources
Faculty of Resilience
Rabdan Academy, Abu Dhabi, UAE
asmaa65@gmail.com
Ratko Knezevic
University of Bihac, Bosnia and Herzegovina
Faculty of Health Studies/Technical Faculty
kratko1962@gmail.com

ABSTRACT:

This study aimed to introduce the concept of information awareness and its importance and to shed light on the reality of information awareness in the Arabic society, as it is one of the important and fundamental aspects of the process of personal-development and continuous education. It also sheds light on the extent of its connection with libraries of all kinds, and the National Library in particular, because it is the national treasury that preserves the country's heritage and its intellectual wealth. The purpose of this study was to publicize the concept and importance of information awareness and Academic English highlighting that reality in the Arab society. It is an important and essential aspect of the process of development, self-education and continuing education and the extent to which it relates to libraries of all kinds and to the National Library, in particular, because it is the national treasury for the preservation of the country's heritage and intellectual tender. This study also aimed to introduce the role that the National Library (Dar Al Kutub) plays in the United Arab Emirates in building a knowledge society and to identify the reality of information awareness among its employees and all of the beneficiaries of that library. Another goal was to identify the future aspirations in developing programs for spreading information awareness, knowing the type and experience of the workforce in terms of their knowledge of technical skills and the most important developments in the methods of spreading information awareness required by the knowledge society. The study used the descriptive and analytical methods to collect data on the employees of the National Library and the beneficiaries of its services. A questionnaire has been prepared for this purpose. The two researchers also searched in foreign and Arab databases for the purpose of reviewing previous studies on the subject of the study. The researchers hoped to reach results upon which recommendations were based that contribute to enriching the reality of information awareness in the Arab world in general and in the UAE in particular.

Keywords: Information awareness, information skills, analysis of information awareness, information literacy, national libraries, Academic English, the national book house.

1. INTRODUCTION

Libraries in general are cultural institutions providing their services to all members of society and national libraries in particular have been considered as the national treasury for the country's heritage and the intellectual and creative giving of their individuals. This treasury has been considered an asset for future generations and an area for preserving the country's heritage, history and achievements at various levels, locally, regionally and internationally.

The role of the National Library is to obtain everything published or written about the country, whether printed, such as books, periodicals of all kinds, university letters, newspapers, reports, state files, maps, documents, conference proceedings, and everything that is read or heard from recordings or videos, film slides, magnetic discs, etc.

The National Library is the official library of the state and it carries out very important tasks including the implementation and follow-up on the legal deposit, preservation and maintenance of information resources as they are the intellectual wealth of the state. Due to the importance of the national libraries' role, a specialized cadre to manage them is often to be found, so the National Library has a librarian with experience in the field of libraries with a specialized and highly qualified work team.

Given the importance of the role of national libraries as a repository and treasury for the preservation of the national heritage and the country's history, the two researchers shed light on what national libraries have been, their tasks and their role in spreading information awareness, with special reference to the role of the National Library in the United Arab Emirates.

1.1. The study problem and its inquiries

Enabling community members to increase their skills to deal with the needs of cultural life is a common concept in all societies with different cultures and the presence of literacy skills and an understanding of how to apply and use those skills and information obtained from basic reading is part of the scope of informational literacy which is a culturally specific concept. The societal changes taking place, which are accelerating and developing daily with the application of technology in the societies now require skills and a high range of knowledge for a person to be able to keep pace with the speed and momentum of information available to community members, in addition to preserving heritage and history. It is a necessity to get acquainted with the efforts made by national libraries in general and the National Library in the UAE in particular in preserving heritage and their role in spreading information awareness.

Based on the above, this study aimed to answer the following questions:

1- What is information awareness and why is it important?
2- What are the national libraries and what is their role in spreading information awareness?
3- What is the availability of information awareness among the employees of the National Library in the UAE and the beneficiaries of its services?
4- Identify the experiences and skills of the National Library employees and their knowledge of the technical skills necessary to spread information awareness.
5- What are the proposals that could contribute to enhancing information awareness among the employees of the National Library and the beneficiaries of its services?

1.2. The Importance of the Study

The National Library in any country is the central library of the state and the cultural and informational centre that reflects the nation’s heritage and its scientific, literary and cultural development. It is also considered the national heritage treasury preserving the national heritage, the heritage of the people of the country, their intellectual and creative giving and achievements, in order to be an asset for future generations to learn about the heritage and culture of own country on various levels. From here, the

importance of research appears, as well as the need to develop national libraries, develop the services they provide to the state in general and to members of society as well, and identify the role of national libraries in spreading information awareness.

The importance of the study can be summed up in three main points:

1- Learn about the reality of the National Library
2- Learn about the services it provides to the country and its people
3- Understand the role of the National Library and its contribution to spreading information awareness

1.3. Study Objectives

The main objective of this study was to give a comprehensive picture of national libraries and the extent of their contribution to spreading information awareness. The study also aims to identify the extent of information awareness among the National Library's employees in the UAE and the beneficiaries of its services. These goals are to be achieved by shedding light on the following points:

- Observe the activities and events of national libraries.
- Knowing the plans and activities that these libraries have implemented and will implement in the future to contribute the spreading of information awareness.
- Evaluating the indicators and the extent to which national libraries benefit from modern technology and internet applications in spreading information awareness.

Scope of study and limitations:

1- Subject limitations
2- Spatial limitations
3- Time limitations

1.4. Research and Study Methodology

Due to the nature of the subject of the study, the two researchers chose the descriptive and analytical approach that relies on collecting information and data by distributing a questionnaire to a sample of the beneficiaries of the National Library services in the UAE, and then organising the information and analysing it to know the role of national libraries in developing and disseminating information awareness. In addition to that, they would conduct an interview with some officials concerned with information awareness in the National Library.

1.5. Procedural definitions

1- The National Library:

It is a library established by the state and is considered as a repository for storing and preserving the history and heritage of the state, as it collects and preserves the national intellectual heritage in all its forms, such as books, magazines, newspapers, reports, state files, maps, pictures, audio-visual information resources, databases, or any other media.

They are collected through a special law called legal deposit. It is the law obliging the author, publisher, or printing press to deposit one or more copies of the publication in the National Library free of charge and within certain conditions, and the publication will be assigned a deposit number.

National libraries differ from public libraries in that they do not usually allow citizens to borrow these publications and information resources.

The national libraries contain valuable and rare manuscripts, books and important works, as well as the most recent publications.

2- Information awareness:

The term information awareness is translated into many terms, including:

Information culture
Information literacy
Information awareness

Several organizations specialized in the field of library and information science have defined it, such definitions include:

I. The Definition of the American Library Association Presidential Committee on Information Awareness:
In its 1989 report, it defined the concept of information awareness: "An information conscious person is a person who is able to perceive when he needs the information and has the ability to locate, evaluate and use it".

II. Definition of the Australian Council of University Librarians:
It is the set of capabilities that require individuals to understand and determine when they need information, to locate, use and evaluate the required information efficiently.

III. Definition of the National Forum for Information Awareness:
It is the ability to know when there is a need for the information to be able to distinguish and locate the information, evaluate and use it.

It is noted from the above-mentioned definitions that there is a common objective link, which is the emphasis on searching for, evaluating and using information in the right way. In addition to the use of information and multimedia technologies this helps those looking for that information to develop critical thinking, make decisions and develop planning methods in solving problems. It also contributes to the self-development of individuals. Hence, it is evident that information awareness and its development help in developing many capabilities of individuals, which consequently define the concept of information awareness, which includes access, evaluation, management, and communication of information.

This study relied on the definition of the Australian Council of University Librarians.

3- Informational skills:
It is defined as the competencies required to achieve the informational culture of individuals, which is the ability to understand the need for information, the ability to locate the required information, access to the appropriate resources available, the ability to deal with technologies to access that information, and then the ability to evaluate and organize the information and use it in the best way.

1.6. Previous studies

The study conducted by Professor Umniah Khair Tawfiq entitled "*Information awareness among researchers in Alexandria Governorate"*, 2004 showed that a large percentage of researchers to some extent have the ability to determine their information needs and it also clarified that there are difficulties these researchers face while searching for information, especially the difficulties related to libraries and their services. The study also revealed the researchers' reduced ability in documenting bibliographic data on sources. It recommended the necessity to teach the subject of scientific research and to provide training courses, in addition to the necessity of libraries to provide references for guiding and educating researchers in this field.

Ahmed El-Sayed prepared a paper presented as a working paper at the Arab Federation for Libraries and Information Conference held at the Library of Alexandria in December 2004 under the title of "*The role of the librarian in developing cultural awareness of society through public libraries*". The research dealt with the development of the library specialist's profession and the importance of his role in the field of scientific research and the field of knowledge in the era of Modern technology. It also discussed

the modern challenges in the field of libraries and information and the role of the librarian in dealing with them in the best way contributing effectively to the development of scientific research, increase the culture of society and eradicate cultural illiteracy.

Another study conducted by Professor Dalia Yahya Al-Shafei entitled "*Information illiteracy in the university community in Cairo"*, 2005 dealt with the problem of information illiteracy in the Egyptian university community, the extent of availability of information skills among students and the role that faculty members and librarians play in eradicating information illiteracy in order to identify its manifestations, determine its causes and determine the ways to treat this phenomenon. The study also proved the reasons for the spread of information illiteracy, one of which is the lack of information skills among students and the lack of a unified basis between academic libraries in which to define the library and its services. The study recommended the necessity of integrating information literacy programs within the programs of developing, improving and reforming education in Egypt.

Professors Younes Shawabkeh and Walid Ali conducted a study entitled "*Attitudes of first-year students in United Arab Emirates universities towards information literacy programs in university libraries*" in 2006. In this study, they tried to identify the trends of first-year university students at the beginning of each semester in order to find out the strengths and weaknesses of the program to develop it in line with the development of education and the development of university libraries in the field of information technology. The results of the study indicated that students' attitudes towards information literacy programs were positive in the areas related to identifying the university's libraries and their sources, methods of acquiring research skills and the use of automated indexes, but they were less positive with regard to ways of using automated services and special groups.

There have been many studies related to this topic.

It is evident from the foregoing that the subject of the current study has not been dealt with in its current form by any researcher in the UAE before, hence the importance of this study.

2. CONCEPT OF INFORMATION AWARENESS

"The term information awareness is used to express what is known as information literacy and although this last term is the most common in the West. There are those who fear that some learners will not accept information awareness programs because of it, because the term implies the illiteracy of the recipients of these programs and their need to erase their illiteracy. Perhaps that is what led to the creation of other terms such as information awareness or information culture in the Arab world or information efficiency in the West.

There are multiple definitions of the concept of information awareness However; one can see that all these definitions shared identifying key skills and points, including:

The ability to locate information.

The ability to manage information efficiently.

The ability to use information effectively for multiple purposes.

In addition to the skill of using information technology and multimedia as well as familiarity with the issues and difficulties that hinder the effective dissemination or circulation of information

These skills allow users to build specific capabilities that can be summarized as follows:

1- Making right decisions
2- Ability to solve problems
3- Self-development
4- Managing information efficiently
5- Communication skills and creativity

2.1. Information awareness standards

Many organisations have set special standards for information awareness and the researchers decided to adopt the standards of the International Federation of Library Associations and Institutions (IFLA), which are as follows:

Firstly: Access

1- Accessing information effectively and efficiently
   - The skill in recognising the need to obtain information
   - Decision and initiative to do something to obtain information
   - Expression and determination of the need for information
   - Beginning the process of searching for information
2- Location of information
   - Identify and evaluate potential sources of information
   - Developing information search strategies
   - Access to selected information sources
   - Gathering available information

Secondly: Evaluation

1- The ability of the beneficiary to evaluate the information efficiently
   - Analysing, studying and extracting information
   - Generalisation, interpretation and explanation of information
   - Selecting and gathering information
   - Evaluation of accuracy and relevance of the information retrieved
2- Organisation of information
   - Categorisation and classification of information
   - Gathering and organising the retrieved information
   - Determine the best and most useful information

Thirdly: Usage - Using the information accurately and creatively

1- Using information
   - Creating new means for communicating, reviewing, and using information
   - Using information retrieved from the application
   - Learning and assimilating information and adding it to personal knowledge
   - Displaying information production
2- Communication and ethical use of information
   - Understanding the ethical use of information
   - Respect the legal use of the information
   - Linking scientific output with intellectual property
   - Using gratitude and acknowledgment criteria and methods for sole proprietorship

2.2. Information awareness of individuals

The American Association of School Librarians and the Australian and New Zealand Foundation for Informational Awareness stated that a person was informatively aware when he was able to:

1. Realise own need for information and determine the amount of information he needs.
2. Gather information very efficiently.
3. Evaluate the information gathered.
4. Display the information.
5. Use the information he gathered to find solutions to the problems they face.

In general, the information awareness skills required for an individual to be informatively aware can be summarised as follows: The person realises that he needs the information and realises the size and nature of the information he was looking for. One must also have sufficient knowledge of the sources of information of various forms and diversity, the ability to analyse, process and display the information with high efficiency, and then the ability to save and retrieve it whenever there is a need for it. The ethical and legal matters in dealing with information and in the way it is presented and used should be taken into account. From here it becomes clear how important it is for a person to be informatively aware. Information awareness of individuals represents the main pillar in developing self-education skills and continuing education.

3. THE NATIONAL LIBRARIES

There are many definitions from many specialised bodies and some professors in the field of library and information science. They described the nature of national libraries and their functions and most importantly distinguished them from other types of libraries. However, these bodies and institutions have agreed that national libraries were the official and national repository for preserving the intellectual, literary, scientific, cultural and historical production of that country. They have been making them available for the coming generations to consolidate the meanings and values of inheritance for the people of the country.

Among the most important and comprehensive of these definitions:

Prof. Dr. Abdul Aziz Muhammad Al-Nahari mentioned in his study entitled "*National Libraries: History - Functions - Reality"* that the old prevailing concept is that the national libraries are the repository or warehouse that includes books, historical documents, newspapers and old publications. However, this concept began to change, especially during the European Symposium in 1958, whose main interest was to research all matters of concern to national libraries, their problems and their future. The attendees in this symposium agreed unanimously that the role of national libraries was a leading and main role for the culture of any country, hence the definition of national libraries as active institutions that played a leadership role with three objectives:

1. Maintaining the national culture
2. Developing by all possible means the methods and systems of library resources in the country for the sake of the whole society.
3. Establishing relations, cooperation and cultural exchange with the libraries of other countries.

Among the important definitions included in the Arab Encyclopaedia of Terminology for Library, Information and Computer Sciences in its third volume, written by Ahmad Muhammad al-Shami and Sayyid Hasbullah. The national library was determined by a competent government agency to be the national library of the state, and it was financed by the government of that country. The mission of the library includes comprehensive collection of national intellectual production (which is often a result of the deposit system), compilation, preservation and maintenance of the national bibliography. As well as the comprehensive collection and organisation of international publications to serve scientific groups, issuance of bibliographic tools, coordination of a network of national libraries and provision of library services to the national government or some of its agencies.

3.1. The functions of National Libraries

"The public function that any national library performs as stated in the study of Professor Dr. Abdul Aziz Muhammad Al-Nahari is to collect, preserve and maintain the heritage and intellectual production of the country. Therefore, the functions of national libraries are represented by three basic priorities:

Priority 1:

1. Acting as the central authority for collecting national intellectual production.
2. Assuming the role of a depository library.
3. Publication of the national bibliography.

4. Development and maintenance of a national bibliographic information base.
5. Take on the leadership role of the nation's libraries.
6. Assuming the role of the National Bibliographic Centre.
7. Collecting foreign intellectual production

Priority 2:

1. Collecting, preserving and organising national manuscripts.
2. Allowing other libraries and private entities to provide information to benefit from the National Library index.
3. Conducting special studies of technical library methods.
4. Providing library services to government agencies.
5. Providing specialised training.
6. Production of the unified national index.
7. Acting as a centre for exchanging published works "inside and outside the country."
8. Acting as the central authority responsible for communicating and exchanging information with international data banks.

Priority 3:

1. Providing the necessary assistance in information handling technology "methods and techniques".
2. Providing special books for the blind and the handicapped.
3. Formulating national standards for information circulation systems.
4. Providing listing services for national periodicals and newspapers.
5. Managing a program for preparing indexed bibliographic data as part of the printed book.

3.2. The UAE National Library

The National Library was established in the UAE in 1981 and has been an important resource for researchers and thinkers since then. The activities of the Library include all regions of the Emirate of Abu Dhabi and include many scientific, intellectual and literary activities and events. Among the most important activities of the National Library was the opening of libraries in various areas and residential complexes to be accessible to all. In addition to spreading science and culture in the Emirati society, the other goals of the national Library are as follows: Achieving Arab, Islamic and international intellectual production by relying on its original sources of knowledge with a focus on issues related to the UAE, establishing and organising an easy access channel for information sources, supporting and encouraging the local publishing movement and translation of international books, encouraging talented Emirati authors and researchers by publishing their books and academic works.

Since 1988, the national Library has been responsible for collecting, preserving and displaying ancient Arab and Islamic manuscripts. It currently owns around 4,000 manuscripts distributed among various branches of science, literature, religion and arts.

3.3. The National Library’s services

One of the most important services provided by the National Library to the beneficiaries is the automatic index that provides the beneficiaries with the ability to search for information on all titles and sources available in all branches. The electronic shopping service, which is the main source for purchasing the Authority’s publications, and in addition provides adequate information to facilitate the automatic search process within the website, which is done either by searching by the title, the global classification number, or the author. The National Library publishes various titles and on a number of topics with a focus on the history of the UAE. Among the most prominent publications of the National Library is the series "*Pioneers of the Arab east*" to publish Arabic literature and translations that document aspects of life in the Arab world. The National Library also translates international references and manuscripts.

The National Library has established many branches in various parts of the Emirate of Abu Dhabi to provide its services to the largest group of researchers and users.

Among the most important projects undertaken by the National Library in Abu Dhabi is the Kalima Project, which is an ambitious non-profit initiative to finance translations into Arabic, publish and distribute high-quality works of classic and contemporary literature and make them available to readers, beneficiaries, and scholars. Qalam project was to develop, support and encourage talented and creative people of the United Arab Emirates in the field of writing and authorship by publishing and distributing their literary works, whether they were short story collections, novels, plays or poems.

4. STUDY RESULTS AND DATA ANALYSIS

Firstly, the personal interview questions:
Mr. Jumah Muhammad Ali Al Dhaheri, Head of the Library Administration Unit, was interviewed and kindly answered the researchers' questions, as follows:
The National Library in the Emirate of Abu Dhabi provides many services to the beneficiaries, providing the appropriate atmosphere for studying, reading, borrowing and guidance. The staff in the library and its branches teach the beneficiaries how to search in the automated index, in addition to providing internet and photocopying services. The National Library also coordinates many cultural activities such as lectures, seminars and workshops according to an updated annual strategic plan and under the supervision of the National Library administration.
This annual plan includes specialised activities and programs to develop information awareness among workers and beneficiaries. Mr. Jumaa clarified that these activities are announced internally and also through newspapers. In his question about whether the National Library or any of its branches has a training plan to develop information awareness among the beneficiaries or training courses for the beneficiaries on the principles of research and evaluation of information sources, he answered that it did not currently have a specific plan. As for the specialised workers in the house or its branches, they received continuous training courses to develop information awareness. The last question directed to Mr. Jumaa was whether the National Library or any of its branches conducted annual statistical studies on the evaluation of the efficiency of its performance in the field of developing information awareness. The answer was that currently there were no such statistics.

Secondly, analysis of the survey results:
Approximately 150 questionnaires were distributed between the National Library and one of its branches. The questionnaire was also published on one of the social media platforms, Facebook, with the aim of reaching the largest percentage of beneficiaries. Due to the timing of the distribution of the questionnaire in the summer season and during the summer vacation, most of the beneficiaries and even workers were outside the country. Therefore, the two researchers decided to publish it on Facebook to reach the largest possible number of them, noting that the questionnaire concerns those who live in the UAE and those who visit the national Library or one of its branches frequently. Google forms were used to create an online survey. The total number of responses to the questionnaire was 77, and the results were as follows:
Question 1: determining the gender, male or female
Chart 1 shows the percentage of library visitors based on gender with males having a slightly higher percentage than females. Their ages range between twenty years, which is the least used group, and forty years and above, which is also a very small percentage. The highest percentage was at the age of thirty-five, as shown in Chart 2.

Chart 1

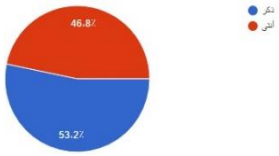
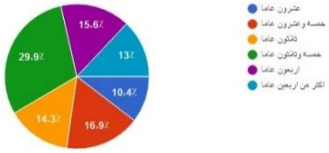


Chart 2



Regarding Question 2 for determining age groups

Question 3: Do you frequently visit the National Library?

The beneficiaries were asked whether they were frequently visiting the Library or one of its branches, and the answer was by a majority that they do not visit it frequently, as shown in Chart 3.

Chart 3

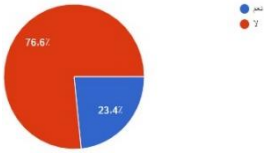
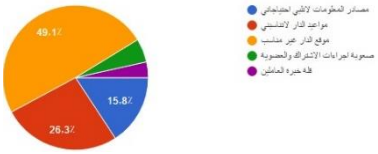


Chart 4



Question 4: what are the reasons for not visiting the Library frequently?

It is concerned with knowing the reasons that prevent them from visiting the Library frequently. The majority answered that the website of the National Library and its branches does not suit them and some added that the branches were often far from the areas of residence. Another group of beneficiaries answered that the working hours of the Library or its branches were not suitable for them, as they conflicted with their own working hours, because many of the beneficiaries were employees, and it was difficult to leave their work and go to the library. (Chart 4) Some of the beneficiaries explained other reasons that prevent them from visiting the Library frequently, including their lack of knowledge of the locations of other branches and how many branches there are. Some mentioned the distance, which was around 450 km, this was a very far distance that hinders and limits visiting the Library or its branches frequently. Some of them live outside the Emirate of Abu Dhabi, which is where the library and its branches are located, so it is difficult for them to visit the Library frequently.

Question 5: for what reasons do you need the information?

The beneficiaries were asked about the reasons for their need for information. Was it for the purpose of preparing research or writing reports or just to follow developments or general culture. The majority answered for the purpose of preparing research which gave the impression of the availability of a suitable atmosphere and various sources for this purpose. (Chart 5). The second major reason was general culture and the third was for the purpose of preparing reports, while others gave other reasons such as to study and prepare for academic exams.

Chart 5

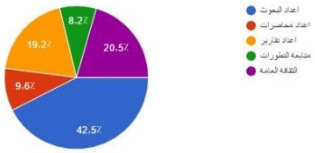
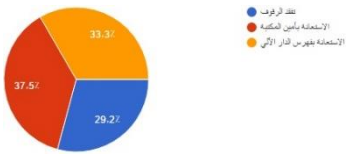


Chart 6



Question 6: what are the means that you use to obtain information?

The beneficiaries were asked about the means they use to obtain information. The percentages of responses were close to a large extent. The percentage of beneficiaries who said that they asked the

librarian for assistance was 37.5%, who inspected the shelves themselves 29.2% and who used the Library's automated index 33.3%. Others added that they did not use the library's resources and were satisfied with using their personal academic books. They only use the library as suitable location for studying and others answered that they used all available means and according to their need. (Chart 6 shows these percentages).

Question 7: Do you always succeed in obtaining information?

The beneficiaries were asked about whether they always succeed in obtaining information and what are the reasons that help them in obtaining the required information, the majority 54.5% responded they were not able to access the information, Chart 7.

Chart 7

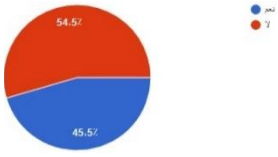
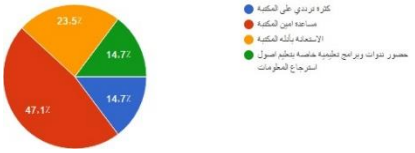


Chart 8



Question 8: what are the factors that helped you succeed in reaching the information you need?

The percentage of beneficiaries who answered that they were successful in obtaining the required information was 45.5%, and for the reasons of their success in obtaining that information. The percentages varied between 47.1% for those who seek the help of the librarian and the library workers, and 23.5% for those who use library guides and indexes. In addition, others who visit the Library frequently, attend seminars, courses and educational programs, and these two groups have equal percentages of 14.7%, as shown in Chart 8. Some beneficiaries added other reasons, including extensive experience in this field and being specialists in library and information sciences.

Question 9: What are the difficulties you face when searching for information?

The beneficiaries were asked about the difficulties they face while searching for information, 32% answered that they rarely face difficulties in determining the information they need, 21% answered they sometimes face difficulties, 16% answered they never face difficulties, 6% answered they usually face difficulties and 0% answered they always face difficulties. The percentages of responses for lack of knowledge of the types of information sources are as follows, sometimes 35%, rarely19%, often 10%, never 8%, and always 0%. The percentages of responses for difficulty in identifying appropriate sources of information for research were as follows, Sometimes 32%, rarely 19%, often 16%. Never 8%. Always 0%. The percentages of responses for the difficulty in using some databases were relatively close between rarely, often and never, ranging between 9% and 13%. The highest percentage 43% was for sometimes found it difficult to use some databases. Regarding the difficulty of dealing with electronic sources, the highest percentage was sometimes 35% and the lowest percentage was always 2%. The percentage of responses for difficulty in choosing the appropriate keywords to conduct the search was equal between sometimes and rarely at 27%. This indicates that the majority of database users are sufficiently familiar with how to search, use search methods and choosing the appropriate keywords to some extent. For difficulty in formulating a search strategy. The highest percentage of answers was sometimes 34%, and the lowest percentage was never 7%. For lack of experience in using references. The highest percentage is sometimes 33% and the lowest percentage is always 1%. These percentages indicate that the majority does not know how to use references and search for appropriate references. Regarding the difficulty of documenting the sources of information, the majority answered sometimes 38% and rarely 18%. As for the two options never and often, the percentage was very close, never 9%, often 8%, and a very small group 1% answered always. The charts below explain these percentages.

Chart 9

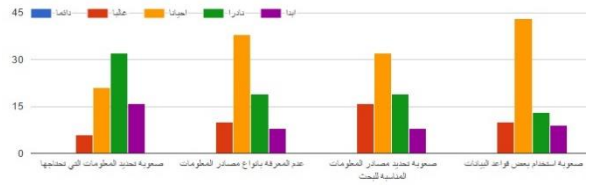


Chart 10

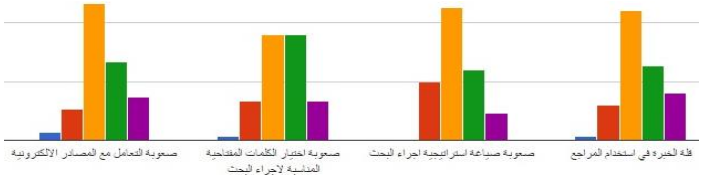
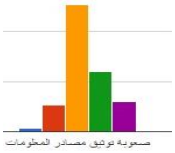


Chart 11



Question 10: To what extent do you use the information sources available in the library?
The beneficiaries were asked about the extent of their use of the information resources available in the library, such as printed books, electronic books, printed periodicals and electronic periodicals. The majority of their answers were higher in the use of printed books 54%. In second place in terms of preference, came electronic books at 42%. The printed periodicals came in third place in terms of preference at 34% and electronic periodicals by a somewhat similar rate to electronic periodicals, which was 31%. This indicates that the majority of scholars and researchers still prefer to use printed-paper books. The lowest percentages were for reference books, dissertations, research, and educational aids. Most of them were responded when needed. As for reference books, 33% of the responses were when needed. The responses for dissertations and scientific research were very close at 23% and 21% respectively for the response when needed. As for educational aids, the highest percentage was never used by 28% and rarely 22%, and this indicates the users' lack of awareness of the importance of educational aids. The charts below explain these percentages.

Chart 12

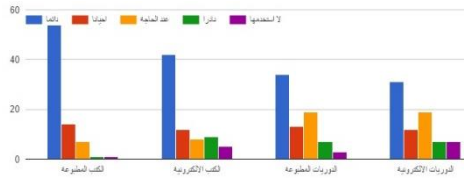
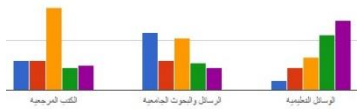


Chart 13



Question 10: Do you prefer to use paper or electronic information sources? The beneficiaries were asked about the nature of the sources that they prefer to use, paper or electronic, or both, the majority answered with both, 63.6%.

Question 12: In the event that you do not use the electronic resources, what are the reasons?
When asked about the reason for not using the electronic resources, the majority answered there was a difficulty in determining the appropriate databases to conduct the search. The other difficulty was to choose and determine the appropriate keywords to conduct the research and reach the required results accurately. Some of them stated that the reason was lack of experience in using databases to extract the required information. The diagram below illustrates the percentages. Hence, we see the lack of information awareness in this area and the need to focus on this aspect for researchers. When asking the beneficiaries about whether there are other reasons that contribute to their reluctance to use electronic means or databases to conduct research, some pointed out the difficulty or inability to assess the credibility of these sources. Chart14 explains these results and percentages

Chart 14

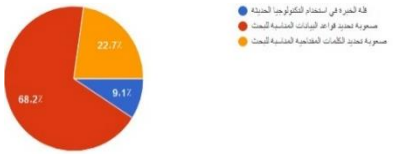


Chart 15

Question 13: if you use electronic information sources, do you use them yourself or seek the help of a specialist in the library?

The beneficiaries were asked, if they use electronic information sources and databases, do they use them themselves or seek help from specialists. The vast majority, 62.9%, responded I use it myself, and very few sought help from the library workers, and they accounted for 37.1%.

Question 14: If your answer to the previous question (I use it myself), would you do it through?

When asked about how they use these resources, the answer was by trying and experimenting 37.8%, and the highest percentage through self-education is 40%. Here it appears from these results that the beneficiaries prefer the method of trying and experimenting over asking specialists, either because they are not aware of the efficiency of workers and their fundamental role in spreading informational awareness to the beneficiaries, or some of them may feel embarrassed or shy to ask. Another reason may be the lack of information awareness of the beneficiaries about the role of the librarian or the limited view of the librarian that he is only a bookkeeper. In the field of other methods, please mention them, some comments and responses received were by librarians, who are proficient in searching and using databases. Chart15

Question 14: What are the reasons you use electronic information sources and internet networks?

The beneficiaries were asked about the reasons for their use of electronic information sources and Internet network. The answer of the vast majority was "to conduct research" with a rate of 46.8%, which indicates that the beneficiaries are specialized researchers and that the library provides the appropriate environment for conducting research and also has various sources and specialized databases that benefit researchers. As for the other answers, they varied between following scientific developments 16.9% and teaching purposes 14.3%, and the lowest percentage was for education and distance education at 7.8%. Other answers included electronic shopping, social communication and entertainment, (Chart16)

Chart 16

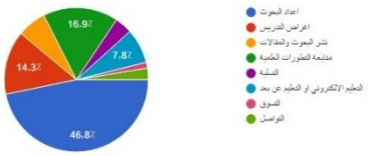
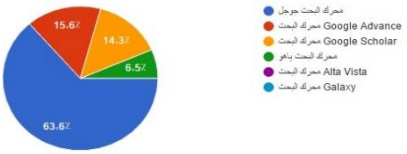


Chart 17



Question 16: What search engines do you prefer to use when searching for information?

A question was also asked about which search engines the beneficiaries prefer to use to find out the extent of their knowledge and information awareness of the electronic search methods. The highest percentage was for the use of Google search engine, at 63.6%, and Google Advance came in second place, 15.6%, while the Google Scholar search engine came in third place with 14.3%, which is somewhat close to the Google Advance search engine. By linking the results of the two questions, we see that the majority of beneficiaries use electronic information sources and Internet networks to conduct research and use the Google search engine in the search and retrieval process of information. Here, the lack of information awareness about the difference between search engines and about choosing the appropriate search engines to conduct research appears.

Question 17: Does the National Library organize programs to develop information awareness?

The researchers wanted to shed light on the services provided by the National Library and its subsidiary libraries and the extent of the beneficiaries' knowledge of these services or training programs. The beneficiaries were asked a question about whether the National Library organizes programs to develop information awareness or not. 68.8% of the beneficiaries responded they “did not know”, which is a large percentage, while only few of them knew about the existence of such programs at a rate of 31.3%. This indicates that the Library and its subsidiary libraries must take into account the diversification or use of other advertising means in addition to what they are currently using, namely internal bulletins and newspapers to inform the beneficiaries of such programs. Chart 18 explains these percentages.

Chart 18

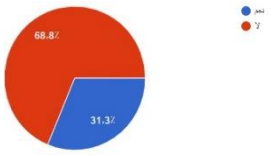
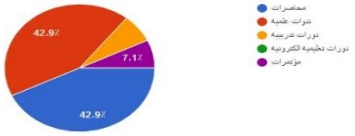


Chart 19



Question 18: What are the activities that the National Library organizes to develop information awareness?

A question was also asked about what training programs are offered by the National Library. The majority of the responses were at an equal rate between lectures and scientific seminars at a rate of 42.9%. This indicates the lack of diversity in these programs and thus may not attract many interested in attending other events that may be of an entertaining nature and at the same time educational and indicative too. The group that attends such events is a specific category of researchers or specialists.

Question 19: Have you attended any of the activities that the National Library organizes to develop information awareness?

In order to find out the extent of the beneficiaries' interest in these activities and services provided by the National Library or its other subsidiaries, a question was asked to the beneficiaries about their attendance to such activities, and the highest percentage of responses was 88.4% who did not attend any of the activities carried out by the Library. A small percentage of 11.6% attend continuously, which is a very small percentage. This result is related to the previous 2 questions about their lack of knowledge of the programs and activities that the library provides, or the type of these programs that may not be suitable for their ages or are not within their specialization or interests. As for the group who attended these activities and events, they answered a question asked about how they knew about such activities. The majority 66.7% responded “by chance” and others 33.3% responded through a friend. The percentage of Bulletins, e-mail or advertisements is 0%.

Chart 20

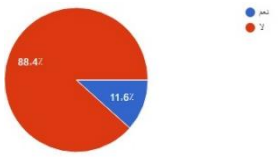
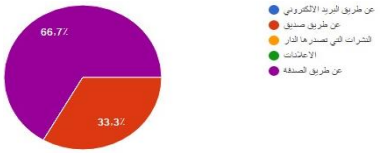


Chart 21



Question 20: Do you think you are informatively aware?

The two researchers asked the beneficiaries whether they thought they were informatively aware, a large percentage of (62.3%) answered Yes. They think that they are informatively aware, while the others (37.7%) do not think they are informatively aware. Chart 22 explains these percentages.

Chart 22

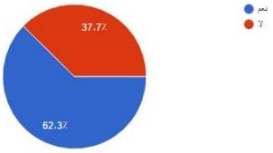
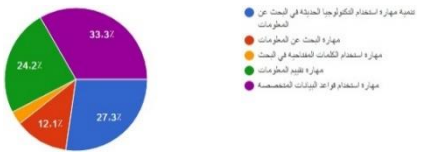


Chart 23



Question 21: What are the skills you need to increase your information awareness?

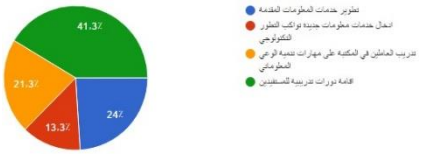
By asking the group that answered no, they were asked what skills they need to increase their information awareness and the answers were as follows:

The highest percentage was 33.3% for the skill of using specialised databases, and the second place at 27.3% was for the development of the skill of using modern technology in searching for information. These two skills are important in searching for and retrieving the required information accurately. Then the beneficiaries expressed their need to develop the skill of assessing information at the rate of 24.2% and the skill of searching for information at 12.1%. This skill is also largely related to the development of the skill of using modern technology and the skill of evaluating the information that they obtain through their search in databases. Chart 23 explained the mentioned percentages. In the field of other skills, some responses demanded their need for all the mentioned skills at a rate of 7%.

Question 22: In your opinion, what is the role that the National Library should play to develop information awareness among the beneficiaries?

A question was also directed to the beneficiaries about their opinion of the role that the National Library should play to develop information awareness of the beneficiaries. The answers were, with a high percentage, by holding training courses for the beneficiaries 41.3%, developing information services in general by 24%, training the library workers on the skills of developing information awareness among the beneficiaries 21.3% and introducing new information services to keep pace with technological development by 13.3%. From here, it becomes clear that the beneficiaries need training courses on how to search, and what are the appropriate databases for conducting the search and then the process of evaluating the information they obtain. Chart 24 explains these percentages.

Chart 24



As for the last paragraph, by adding other proposals, some recommendations were made to build new branches to facilitate access to beneficiaries, to establish training courses, and to include evaluation of beneficiaries' programs.

5. RESULTS

1- The results of the study showed through analysing the data that a large percentage of the beneficiaries visited the Library or one of its branches for the purpose of conducting research, and the other category that follows it was those looking for general culture or for the purpose of preparing reports.

2- The results of the study showed that there was a large group of beneficiaries who had clear deficiencies in how to use databases or choose databases and deal with them. The other group found it difficult to determine the appropriate keywords to conduct the search, which led to difficulty in obtaining the required information.

3- Some of the beneficiaries had clear shortcomings and confusion between the concept of using electronic information sources and searching in electronic information sources, and this difference

appeared through their use of the Google search engine instead of using the search engine Google Scholar or Google Advance, which affects the search results in terms of quantity and quality.
4- The results of the study showed that there was difficulty in formulating and using the appropriate keywords for conducting the research, which led to imprecision in the retrieved data and thus wasting a lot of time in searching.
5- The lack of training courses concerned developing information awareness among the beneficiaries
6- Failure to advertise the locations of the National Library's branch libraries and their lack of presence in easily accessible areas.
7- Failure to advertise training courses and lectures held by the Library or its branches located in the Emirate of Abu Dhabi.
8- The number of working hours in the Library and its branch libraries was not appropriate and did not meet the requirements of the beneficiaries.
9 - The restriction of the programs offered by the Library to scientific lectures and seminars, which may not be suitable for all groups of the community of beneficiaries leading to the reluctance of some to frequent such events.
10 - The absence of a fixed plan assessing the effectiveness of the programs and services provided by the Library to beneficiaries and the absence of an element for evaluating the performance of employees.
11- The organisation of events, programs and courses was restricted to the library management only, which led to lack of knowledge of the beneficiaries' requirements because the administration usually did not have direct contact with the beneficiaries.
12- The lack of a clear plan for training in the field of developing information awareness among the beneficiaries, and the courses and lectures that were usually held are random.

5.1. Recommendations

1- Continuous development of the Library's website through which the locations of the branch libraries and how to access them are announced. Through it, the courses, lectures and seminars held by the Library are also announced to the beneficiaries. In addition to using various advertising media for this purpose, such as social media.
2- Establishing an annual plan for training programs for beneficiaries on how to use databases, how to evaluate search engines, and the mechanism for selecting keywords, and diversifying these programs to serve all groups, and not be limited to researchers or specialists. As well as activating the role of workers in building this plan, and not limiting it to the management.
3- Reconsidering and increasing the number of working hours, as it currently coincides with the official working hours of most of the beneficiaries. The Library and its branches do not open their doors during the official and weekly holidays, which leads to a reluctance to visit these libraries.
4- Setting a strategic plan to support activities to develop information awareness and providing specialists in this field to participate in the planning and development of special programs for the foundations and principles of scientific research.
5- Conducting an annual evaluation of the programs, courses and lectures prepared by the Library for the beneficiaries. As well as conducting an annual evaluation of the workers in the Library or its branches to identify and determine the strengths and weaknesses. This will help in developing and reaching the best results for the services provided to the beneficiaries.
6- Providing additional services to beneficiaries, such as responding to inquiries, through the use of communication means, library communication programs, or by e-mail.
7- Providing the service of borrowing and cooperative acquisition by building communication relationships with academic and educational institutions to exchange experiences and information sources.

Arabic reference list

الوعي المعلوماتي .أ، ضياء.
Retrieved from
http://iman-dia.blogspot.ae/p/blog-page_5318.html
المكتبة الوطنية -هيئة أبوظبي للسياحة والثقافة. Retrieved January 30, 2016, from http://tcaabudhabi.ae/ar/national-library/pages/default.aspx .
احمد محمد، حسب الله، سيد .الموسوعة العربية لمصطلحات علوم المكتبات والمعلومات والحاسبات .ج 3ن-ز .2001
العمران، حمد بن ابراهيم .الوعي المعلوماتي.2005 .
توفيق، امنية خير .الوعي المعلوماتي لدى الباحثين في محافظة الاسكندرية :دراسة ميدانية لتحليل الاتجاهات – .الاسكندرية :جامعة الاسكندرية)اطروحة ماجستير(، 2004.
الهدابي ,ا .ع .ا .مكتبة الامارات الوطنية .(1st ed.) ابو ظبي :وزارة الثقافة والشباب وتنمية المجتمع.2014 .
بامفلح ,ف .س .,و مليباري ,ف .معا نحو جيل معلوماتي واع .الوعي المعلوماتي-Retrieved from http://information-literacy-sa.weebly.com/3/category/all/1.html
جرجيس ,ج .,و عبد الله ,خ .ع .س .المهارات والكفايات المهنية الواجب توافرها في خريجي أقسام المكتبات والمعلومات في الجامعات العربية . 2013.
درويش، محمد جمال الدين .التخطيط للمجتمع المعلوماتي – .القاهرة :المكتبة الاكاديمية.2000 ,
دياب، مفتاح محمد .محو الأمية المعلوماتية قي قضايا معلوماتية :اتجاهات حديثة في دراسة المعلومات – .عمان :دار صفاء، 2007.
عبد العال، عبير هلال محمد .دور المكتبات في محو الأمية المعلوماتية البيئية دراسة مسحية لأنشطة عينة من المكتبات العامة بمحافظتي القاهرة والجيزةAJ=oES6rQEACAA/books?id=google.ae .
عبد الهادي، محمد فتحي، جمعة، نبيلة خليفة .المكتبات العامة – .الطبعة – .1القاهرة :الدار المصرية اللبنانية، 2001.
عبد الهادي، محمد فتحي .دور اختصاصي المكتبات والمعلومات في مجتمع المعلومات– .مج 11 2004.
عزمي، هشام .ثقافة المعلومات في القرن الحادي والعشرين .مجلة سيبريرين ع 8. http://www.cybrarians.info/open.htm/journal/no8
علي، اماني حسن .منظومة المكتبات الفرعية التابع لدار الكتب والوثائق القومية :دراسة ميدانية.2010 .
عيسى، عماد والسيد، اماني .دور المكتبات العامة في تنمية الوعي الصحي ومكافحة الأزمات الصحية العالمية :دراسة استكشافية مقارنة لبرامج وأنشطة المكتبات في ضوء وباء الأنفلونزا.—في :المؤتمر العشرون للإتحاد العربي للمكتبات والمعلومات تحت عنوان "نحو جيل جديد من نظم المعلومات والمتخصصين :رؤية مستقبلية"، الدار البيضاء -المغرب، 11-9ديسمبر.2009
فارمر، ليزلي و ستريسيفيك، ايفانكا .استخدام البحث في الترويج لمحو الأمية والقراءة :إرشادات للمكتبيين، 2011.
قاسم، حشمت .المعلومات والامية المعلوماتية في مجتمعنا المعاصر .دراسات علم المعلومات – .الطبعة 2 1995.
مجاهد، أماني جمال .تقييم دور المكتبة في ظل المعطيات العصرية الحالية .
http://www.shatharat.net/vb/showthread.php?t=2132
يونس الشوابكة، وليد على "اتجاهات طلبة السنة الأولى في جامعة الاما ا رت العربية المتحدة نحو برنامج الثقافة المعلوماتية في مكتبات الجامعة ." نشرة جمعية المكتبات المتخصصة فرع الخليج ، مج 1، 2006.

English reference list

A. Blas, E. (2014). Information literacy in the 21st century Multicultural classroom: Using Soc...: EBSCOhost. *Education Libraries*, *37*(1-2), Retrieved from https://web.b.ebscohost.com/ehost/pdfviewer/pdfviewer?sid=28657e82-f7ac-45e9-b908-95eb171549c6%40sessionmgr102&vid=11&hid=107

Awadhi, S. Al, & Ur Rehman, S. (2012). Evaluation of an information literacy course: Insights and perspectives.: EBSCOhost. *LIBRI*, *62*, 355–362. Retrieved from https://web.b.ebscohost.com/ehost/pdfviewer/pdfviewer?sid=28657e82-f7ac-45e9-b908-95eb171549c6%40sessionmgr102&vid=7&hid=107

Bashiru, S. (2012). Short communication use of library statistics to support library and Adviso...: EBSCOhost. *African journal of library, archives and information science*, *22*(1), 67–71. Retrieved from https://web.b.ebscohost.com/ehost/detail/detail?vid=14&sid=22c10756-6ad8-4fa3-80d4-0614412cda70%40sessionmgr112&hid=107&bdata=JnNpdGU9ZWhvc3QtbGl2ZSZzY29wZT1zaXRl#AN=76480392&db=a9h

Evaluation of an information literacy course: Insights and perspectives.: EBSCOhost. (2012, January). Retrieved January 30, 2016, from https://web.b.ebscohost.com/ehost/pdfviewer/pdfviewer?sid=28657e82-f7ac-45e9-b908-95eb171549c6%40sessionmgr102&vid=7&hid=107

Harding, J. (2008). Information literacy and the public library.: EBSCOhost. *Australian library journal*. Retrieved from https://web.b.ebscohost.com/ehost/pdfviewer/pdfviewer?sid=5d10a2dd-0648-4dd4-8dd0-3e43114a13bd%40sessionmgr111&vid=4&hid=107

Lau, J. (2006). *GUIDELINES ON INFORMATION LITERACY FOR LIFELONG LEARNING* final draft*. Retrieved from http://www.ifla.org/files/assets/information-literacy/publications/ifla-guidelines-en.pdf

SEMANTICAL ADAPTATION OF FREQUENCY GERMANISMS IN THE FIELD OF CONSTRUCTION

Hatidže Burnić
Technical Faculty Bihać, Dr.Irfana Ljubijankića, hatidze_b@hotmail.com

ABSTRACT:

The paper presents the representation of germanisms in the field of construction and their frequency in the Bosnian language. The paper also includes the results of the analysis of the semantic adaptation of selected germanisms. The main goal is to determine the semantic changes that German loanwords, ie germanisms, undergo during the takeover and adaptation to the Bosnian language system, including the primary and secondary phase of adaptation.

Keywords: germanisms, construction, semantic adaptation

1. INTRODUCTION

For the needs of the analysis of frequent Germanisms in the Bosnian language, a corpus of over a thousand Germanisms was formed.[i] The corpus went through several stages of collection and was used for many analyzes of the influence of the German language on the Bosnian language from different aspects. In this paper, the focus will be on the analysis of the semantic adaptation of borrowed words of German origin, ie. Germanisms in Bosnian.

The theoretical basis of this paper is primarily the study of Rudolf Filipović Jezici u kontaktu, ie his terminology and model of language borrowing to which most Germanists refer.
Filipović points out three basic elements about language borrowing, from which every language research should start. Relying on the opinion of Uriel Weinrich, Filipović points out that the languages in contact are those that are alternately used by the same speaker. He calls this person bilingual, and this phenomenon bilingualism. The consequence of this phenomenon that one speaker uses several languages is called interference.

The element (word) X as pronounced by the speakers of the language of the donors is called a model, and the borrowed element as pronounced by the speakers of the language of the recipients is a replica. When two language systems come into contact with each other, words are taken from one language to another. The two languages involved in this process are called the language of the giver and the language of the recipient.

When receiving lexemes from the language of the donor to the language of the recipient, in our case from German to Bosnian, certain changes occur at different levels.

2. TAKING AND ADAPTING FOREIGN WORDS TO ANOTHER LANGUAGE SYSTEM

Foreign words are often when taken in such a phonological, orthographic, or morphological form that does not correspond to the recipient's language system. In this case, the process of adjustment or adaptation takes place. The word changes as much as it takes to fit in better with the new system. According to R. Filipović, the levels at which changes can and do not have to occur are: phonological, morphological, semantic and lexical (Filipović 1986).

Adaptation is a long-term process, and it undergoes primary and secondary changes until their final form, according to which primary and secondary adaptation differ.
The task of the analysis of adaptation processes is to describe what changes the foreign word went through in the primary phase, ie. from the moment of borrowing to the formation of the basic, ie final form - which in contact linguistics is called a replica - and which changes occur on the replica in the secondary phase, ie. from the moment of integration into the language system of the recipient onwards. Different language levels also require different approaches to the problem. All theorists of contact linguistics agree that the loanword must first go through the process of forming a phonological form. Namely, the phonological systems of the two languages never completely coincide, so the phonological elements of the donor's language are replaced by domestic ones that are most similar in articulatory-acoustic properties, and the problem of phonological mismatch is solved by omitting or inserting domestic phonological elements.

Phonological adaptation is always followed by morphological. Each foreign word at the time of transition to a new language system brings with it the morphological characteristics of the type of word to which it belongs. As morphological systems are different, the loanword must harmonize its morphological features and adapt them to the rules of the recipient's language. This may, but does not have to, reshape the basic shape of the loanword.

The adaptation of Germanisms at the semantic level is specific in that it belongs to the realm of the human mind, as opposed to the phonological and morphological adaptation that can be characterized as mechanical adaptation (Talanga 2002).

3. PROCESSING THE ANALYSIS OF THE ADAPTATION PROCESS OF GERMANISMS AT THE SEMANTIC LEVEL

In this paper, the emphasis is placed on the analysis of the process of semantic adaptation of Germanisms in the Bosnian language, both in the primary and the secondary phase. Germanisms that are frequent in the field of construction have been singled out from the corpus of work. These are : anlaser, bager, blenda, blic, blinker, borer, bormašina, majsloborer, brener, bunt, butan, bremza, cange, centrifuga, cvikcanga, col, dihterica, dihtung, dizne, druker,fah, farba, farbar, feder, firnis, flek, freza, fuga, futer, gelender, glanz, glečer, gus, hauba, heftarica, heklanje, hoblerica, kanta, keder, klema, kugla, kramp, kran, krankamera, ler, liferovati, lotra, maler, malter, mesing, planka, pumpa, rajf, rajsnegla, ram, remen, sajla, šalter, šeraf, šerafciger, škare, šlauf, šlajfati, šlajfmašina, šlic, šmirg-papir, šnajder, šperploča, špic, štafelaj, štemajzl, štela, štemati, štepati, štimati, štos,šuster,švercer,urar, vaga, vaservaga, vinkla, zihernadla, žaga.

In this analysis, we will adhere to the principles and methods of R. Filipović, ie Hope's system of division, which Filipović accepted in his analysis. As at other levels, Filipović uses a three-part classification.

Based on the comparison of the meaning of the model with the meaning of the replica, Filipović classifies changes into three categories: zero semantic extension, narrowing of meaning, and expansion of meaning. This division is based on the distinction between primary and secondary adaptation.
The primary adaptation includes zero semantic extension (no difference in meaning between model and replica), narrowing of meaning in number (change from multiple meanings to one meaning), and narrowing of meaning in the semantic field (change from general meaning to special meaning).

Secondary adaptation involves expanding the number of meanings and expanding the field of meaning. In the secondary adaptation, changes related to metaphor, metonymy, pejoration, and ellipse also occur (Sočanac 1992).

3.1. Zero semantic extension

Zero semantic extension occurs when the meaning of the German loanword (replica) after entering the Bosnian language system remains unchanged and fully corresponds to the original meaning of the German model. Filipović changes the meaning of this type of name and the transfer of meaning. This is especially true of terms whose meanings are precisely defined. These are, for example, professional names from various fields, such as technology, gastronomy, construction, sports, agriculture, and others, as well as names of members of different movements, teachings, and directions or nouns that denote the bearer of a trait or composition. By taking over these objects and their expressions, their meaning is taken over or retained. Analyzing Germanisms from the corpus of selected professional terms in the field of construction, it can be seen that in most cases these are models that have one or a smaller number of meanings, and only one specific meaning is conveyed. It is rare for multiple meanings of a single word to be transmitted into the language of the recipient. Thus, the zero semantic extension can be divided into two groups.

The first group consists of models with one assumed meaning, such as in our corpus:
anlaser < Anlasser (trigger) bager < Bagger (material extraction vehicle), blinker < Blinker (artificial fish bait), borer < Bohrer (auger and drill), bormašina (drill that manually drills metal, wood, etc.), bunt < Bund (roll), butan < Butan (gaseous hydrocarbon), bremza < Bremse (brake), dihtung < Dichtung (bung), dizna < Düse (conical narrowing of the liquid or gas flow pipe), druker < Drucker (printer), feder < Feder (spring), feler < Fehler (error), firnis < Firniss (a product that dries quickly and creates a protective layer on a wooden base), felga < Felge (car wheel), freza < Fräse (shaking machine), fuga < Fuge (connection between elements), futer < Futter (canvas inside clothes), gelender < Geländer (fence), glanc < Glanz (shine), glečer < Gletscher (glacier), hauba < Haube (bonnet), kanta < Kanne (dish), keder < Köder (bait), kramp < Krampe (gardening shovel), ler < Leerlauf (engine idle), remen < Riemen (belt), sajla < Seil (iron rope of braided wire)...

It should be noted in particular that the models of our corpus, which also belong to this group, are often compound words composed of several words. This means that they have already been given an attribute in the German language, with the aim of specifying one meaning of the word. These compounds were entirely transferred and functioned as the basic form so that they were adapted as such in the phonetic and morphological level and fully integrated into the Bosnian language.
Several models of compounds from our corpus with one assumed meaning: vaservaga < Wasserwage (device for determining the horizontality of surfaces), cvikcangle < Zwickzange (pliers with cutting clips), centrifuga < Zentrifuge (stroj ili dio stroja koji radi djelovanjem centrifugalne sile), rajsferšlus (a zipper on clothing or the like), rajsnegla (a nail with a wide head for attaching something), šerafciger (screwdriving and unscrewing tools), šlajfmašina < Schleifmaschine (grinding device) štekdoza < Steckdose (socket), zihernadla (a needle with a clasp that secures something)

The second group consists of models with two or more assumed meanings:
blic < Blitz (do something quick and add a light-producing camera),
flek < Fleck (stain and darkened spot),

šalter < Schalter (window in the business room, electrical switch),
fah < Fach (compartment and specialty),
špic < Spitze (the top, the peak of the season or the like, the core of the stone fruit and the type of dog)
šlajfati <schleifen (by grinding seem to obtain perfectly straight edges and brake)

3.2. Narrowing of meaning

During the primary adaptation, there may be a narrowing of the meaning in the number (change from several meanings to one meaning) and a narrowing of the meaning in the field of meaning (change from a general meaning to a special meaning).
blenda < Blende (the rotating part of the camera and projector, Duden 1/7)[ii]
farba < Farbe (color, Duden 1/4)
filc < Filz (type of nonwoven fabric, Duden 1/8)
šlic < Schlitz (slot, Duden 3/4)
štos < Stoss (pile, Duden 5/6)

An exception is one example where in German models with more meaning there is a transfer of more specific meanings into the Bosnian language, such as Germanism kugla > Kugel. Model kugla < Kugel has three transferred specific meanings: the meaning of a geometric body, the meaning of a planet, and the meaning of a firearm. In this case, all three meanings that Duden records as meanings are transferred to the Bosnian language.

3.3. Expansion of meaning

In the secondary phase, the integrated foreign word can retain its meaning in the language of the recipient, and it can also acquire new meanings that do not exist in the language of the donor, and it is an extension of the meaning. At this stage, the loanword loses precision, and gains in a breadth of meaning (Filipović 1986: 169-170). To expand the meaning, two basic conditions are required: full phonological, morphological, and semantic integration of the loanword into the system of the recipient's language and its free use within that language. Therefore, the expansion of meaning is a phenomenon of exclusively secondary adaptation. Secondary semantic adaptation involves expanding the number of meanings and expanding the field of meaning. Filipović (1985: 179), starting from Hope's definition, lists four types of changes depending on the way the meaning changes. Thus, there are four basic types: a) metaphor (similarity in meaning), b) metonymy (connection in meaning), c) folk etymology (similarity in form), e) ellipse (connection in form).

3.3.1. Metaphor

To illustrate the influence of metaphor, we can use the example of Germanism šlauf < Schlauch. In the primary phase of the adaptation, two meanings were transferred from the German language: "hose" and "swimming belt". The second meaning served as a basis for expanding the meaning, ie creating a new metaphorical meaning of the word šlauf in the sense of "layers of fat around the waist". In the Bosnian language, the loanword šlauf is used with all three different meanings. The first two meanings were transferred in the primary adaptation and words with these original meanings became frequent in the Bosnian language and with their productivity, in the Bosnian language system, a new metaphorical meaning was formed.

In addition to metaphor, the word can remain of neutral meaning or acquire a pejorative nuance. Mostly with the use of metaphors, pejoration follows. In our corpus, in most cases, Germanism šlauf in the sense of "layers of fat around the waist" is used in a pejorative sense.
Other examples that have, in addition to the original meanings, newly created metaphorical meanings with a nuance of pejoration are: ispumpati (extract all the money from someone), krampati (work hard),

liferovati (betray, squeal), peglanje (annoy), šerafiti ili ošerafiti (hit someone or humiliate), štela (relationships, acquaintance), štos (hoax), švercer (smuggler).

Examples of loanwords that have acquired a metaphorical meaning, but do not have the nuance of pejorization, are e.g. the word blenda with the neutral meaning “screen or partition”.

Phrases by their nature have a metaphorical meaning. Phrases created using one integrated loanword and recorded in the research corpus are the following: imati klikere (to be smart), imati lufta (to have time), imati šlifa (elegance) ispeglati stanje (fix), iz cuga (in one go), kao na feder (valuable), malo morgen (never), nasjesti na štos (be deceived), ubaciti u ler (get the engine out of gear).

3.3.2. Metonymy

The loanword whose meaning has expanded, among other things, and under the influence of metonymy factors is, for example, Germanism štapići (salty snacks of oblong shape).

The German loanword štap < Stab was taken into Bosnian with the meaning "piston" or "aid for work or walking". In this form and with these meanings, the word štap becomes as active and subject to change at different levels as any domestic word. By adding the suffix -ić, which forms a diminutive in the Bosnian language, a new word štapić (noun in the singular) was formed. By adding the suffix -i which forms the plural of štapići in the sense of elongated snacks of small sticks. The term štapići is used in various compounds with the meaning of the shape of a small stick, such as. fish sticks, magic stick, conductor's stick ...

3.3.3. Folk etymology

Folk etymology is a linguistic factor whose action is most often present in the process of borrowing words. Non-integrated or incompletely integrated words, or still parts of words, rely on native words at the formal-linguistic and semantic level. During the adaptation, the words are closer to a local word in terms of voice and content.

In the case of the loanword auspuh > Auspuff , the tube on motor vehicles filled with meaning came j, the first parts of the word aus- were taken over, while the second part of the word - puff was completed. The second part - puh, therefore, originated from folk etymology, relying on the Bosnian word puhati.

3.3.3. Ellipse

By applying the ellipse, the following Germanisms were obtained from German compounds:
gepek < Gepäckraum, hauba < Haube (Motorhaube > Haube), kombinirke < Kombinierzange, ler < Leerlauf, lozinka < Lösungswort, lug >Laugenbad, pegla < Bügeleisen, , šiber < Schiebedach, štok < Türstock, šverc < Schwarzhandel, treger < Gepäckträger, urar < Uhrmacher, ziherica < Sicherheitsnadel.

3. CONCLUSION

After the analysis, we can conclude that German words are represented in a relatively large number in the analyzed corpus and that there is no area where German loanwords are not used.

By classifying Germanisms according to the corresponding thematic areas, we came to the result that Germanisms are the most represented and most frequent in the field of household and culinary arts and then in the field of technology and construction.

The results of research on the adaptation of analyzed Germanisms at the semantic level show how much more complex the adaptation of Germanisms in this field is since it is not a mechanical adaptation, but that this area belongs to the human mind.

Changes in the meaning of adapted Germanisms can be divided into three types: zero semantic extension, narrowing of meaning in number, and narrowing of meaning in the field of meaning.
In the primary phase, the analyzed Germanisms in the field of civil engineering are mostly taken over into the Bosnian language with their specific meanings, considering that in most cases it is a technical term such as e.g. borer, šeraf, kran.

Unlike a primary adaptation where the beginning and end are clearly defined, the secondary adaptation is clearly defined as far as the beginning is concerned. The ending cannot be determined, as the replica may change during the development of the Bosnian language. These changes are no longer associated with the German language because they are always related only within the Bosnian language system and according to its rules. This is proved by the examples of Germanisms in which, in the phase of secondary adaptation, the meaning was expanded by using metaphor, metonymy, pejoration, folk etymology, and ellipse.

In the end, we can conclude that every Germanism in the secondary adaptation becomes a model that can serve to create both new lexemes and new meanings. Therefore, the process of secondary adaptation remains open as long as Germanism is used in the Bosnian language.

4. REFERENCES

[1] Anić, Vladimir-Goldstein, Ivo (1999): Rječnik stranih riječi. Novi liber, Zagreb.
[2] Čedić, Ibrahim et al. (2007): Rječnik bosanskog jezika. Institut za jezik, Sarajevo.
[3] Bernardić, Angela (2008): Anteil von Germanismen in den modernen Sprachen im Raum von Bosnien und Herzegowina, Mobilität und Kontakt, str. 51-63, Zadar.
[4] Burnić, Hatidže (2011): Germanizmi u štampi Bosanske krajine, magistarska teza, Mostar.
[5] Drosdowski, Günther (1989): Deutsches Universalwörterbuch. Dudenverlag, Mannheim.
[6] Duden (2001): Herkunftslwörterbuch. Dudenverlag, Mannheim.
[7] Duden (2003): Universalwörterbuch. Dudenverlag, Mannheim.
[8] Filipović, Rudolf (1986): Teorija jezika u kontaktu. JAZU- Školska knjiga, Zagreb.
[9] Isaković, Alija (1993): Rječnik karakteristične leksike u bosanskome jeziku. Svjetlost, Sarajevo.
[10] Klaić, Bratoljub (1974): Veliki rječnik stranih riječi. Zora, Zagreb.
[11] Kapetanović, Amir (2005): Historizmi i semantičke promjene. Rasprave instituta za hrvatski jezik i jezikoslovlje 31, Zagreb, str. 153-163.
[12] Memić, Nedad (2006): Entlehnungen aus dem österreichischen Deutsch in der Stadtsprache von Sarajevo. Peter Lang, Frankfurt am Main.
[13] Senahid Halilović, Ismail Palić, Amela Šehović (2010): Rječnik bosanskoga jezika, Filozofski fakultet, Sarajevo.
[14] Skok, Petar (1971): Etimologijski rječnik hrvatskoga ili srpskoga jezika. JAZU, Zagreb.
[15] Sočanac, Lelija (1992): Morfološka adaptacija anglicizama u talijanskom jeziku, Filologija 20/21, Zagreb.
[16] Striedter-Temps, Hildegard (1958): Deutsche Lehnwörter im Serbokroatischen. Otto Harrassowitz, Wiesbaden.
[17] Talanga, Tomislav (2002): Pučka etimologija među nekim njemačkim posuđenicama. Jezikoslovlje 3.1-2, Osijek, str. 193-216.
[18] Tošović, Branko (2009): Die Unterschiede zwischen dem Bosnischen/Bosniakischen, Kroatischen und Serbischen. LIT-Verlag, Wien

[i] The corpus consists of collected Germanisms within my master's thesis "Germanisms in the press of the Bosnian Krajina", where Germanisms from the most widely read newspapers in the Bosnian-speaking area of the Bosnian Krajina are excerpted.

[ii] The corpus consists of collected Germanisms within my master's thesis "Germanisms in the press of the Bosnian Krajina", where Germanisms from the most widely read newspapers in the Bosnian-speaking area of the Bosnian Krajina are excerpted.

BENEFITS AND SIGNIFICANCE OF INTRODUCTION AND IMPLEMENTATION OF FSSC STANDARDS IN FROZEN BERRIES PACKAGING PLANT

Halid Makić, Husejin Keran, Aida Džaferović, Samira Dedić, Faris Muminović

University of Bihać, Biotechnical faculty, Luke Marjanovića bb, 77000 Bihać,
halidmakicbtf@gmail.com

ABSTRACT:

The production and distribution of agri-food products is global, so international bodies such as the World Health Organization (WHO), the Food and Agriculture Organization (FAO) and the European Commission (EC) itself are increasingly encouraged to pay attention to food safety. At the same time, the interest of companies in the agri-food sector to ensure product quality and safety is growing. In order to meet this growing demand for food safety, a number of concepts and methodologies are emerging that are focused on preventing and predicting situations of intentional contamination, fraud and food subterfuge. One way for companies to show commitment to such a situation is to certify production according to the Food Safety System Certification (FSSC 22000). The FSSC 22000 standard was created as a combination of ISO 22000 and Publicly Available Specification (PAS) 220, published and recognized as a reference for food product certification for the food industry. FSSC 22000 certification applies to all companies in the entire food chain.
The paper presents the benefits and importance of FSSC standards in agri-food companies, and the process of introduction and implementation in the plant of packaging of frozen berries.

Keywords: FSSC 22000, certification, food safety, standard

1. INTRODUCTION

Food safety is defined as the prevention of the dangers posed by food at the time of consumption. FSSC 22000 consists of international certification whose main goal is to ensure the supply of safe products to consumers around the planet. The growing demand for quality and safety in products demanded by consumers has put great pressure on organizations to take more effective measures with regard to food safety and quality [1]. Food safety means safe and healthy food in all its production processes, ie ensuring that it will be exclusively beneficial for the end consumer when prepared or consumed according to the intended use.

Food quality is multidimensional and relative and quality assurance is a guarantee that the agreed specifications are met. Functional, physical, organoleptic properties, nutrient content and consumer protection are parameters of food quality. The consumer is key to defining quality, where consumer requirements must be met.

Food safety assurance systems are necessary to ensure food safety and demonstrate compliance with regulatory and customer requirements, where stronger application of quality assurance systems globally strengthens the position of companies and improves their competitiveness.
The HACCP system focuses mainly on ensuring technological requirements, while ISO 9001 focuses more on quality management. ISO 22000 standard aimed at managing food chain safety was published in 2005. According to this standard, control is established for every aspect of the production process, and all operational procedures and management actions must be documented. It is designed to prove to customers that a food company has achieved a basic level of food quality and safety assurance by formalizing and documenting its quality management system. In general, food industry companies apply quality assurance systems such as HACCP, ISO 9001 and ISO 22000, which have a widely accepted international acceptance of control activities, processes, procedures and resources according to these standards [2].

[3] states that the production and distribution of the food industry has a global scale, which is why food safety is a concern for international bodies such as the World Health Organization (WHO), the Food and Agriculture Organization (FAO) and the European Commission itself.

The World Health Organization (WHO) and the Food and Agriculture Organization (FAO) define food safety as the prevention of food hazards at the time of consumption [4].
Food organizations that introduce and implement a quality management system should designate critical control points for hazard analysis, as required by HACCP and ISO 9001.

However, as hazards can occur at any stage of the food production chain, safety and quality have become a concern for the entire production chain, from primary production to the time of distribution. According to [5], in order to meet this growing demand for food safety, a number of concepts and methodologies are emerging that focus on preventing and predicting situations of intentional food contamination, fraud and subterfuge. One way for companies to show commitment to such a situation is to seek certification such as food safety system certification (FSSC 22000). In addition to HACCP and ISO 9001 standard, there is also FSSC 22000 (Food Safety System Certification) on the market, which is recognized by the Global Food Safety Initiative; presents a certification scheme for food safety management systems based on ISO 22000 and ISO / TS 22002-1.

The FSSC 22000 standard is based on standards established by the International Organization for Standardization (ISO), focusing on food safety for the entire production chain, from ingredients and materials that come into contact with food to the final product of animal and plant origin [6].

The three basic postulates of the FSSC are:
1. improving food quality and safety,
2. ensuring consumer protection, and
3. strengthening consumer confidence [7]

With regard to requirements, FSSC 22000 describes and elaborates in detail the following: infrastructure elements, adequacy and accessibility of equipment, including cleaning, and maintenance, installation installation for utilities - water, energy and other utilities, management of purchased materials, staff hygiene product information.

In addition, the application of FSSC 22000 includes a food safety management system operating in accordance with ISO 22000, specifications for services such as transport and maintenance and supervision of personnel in the application of food safety principles, and, preliminary programs as prescribed in BSK-PAS 220 (British Standards Institution-Publicly Available Specification) [7].

2. BENEFITS AND SIGNIFICANCE OF INTRODUCING FSSC 22000 STANDARDS

Motivations for standard certification can be classified into two categories: internal and external motivations. Internal relate to organization, improving management systems, increasing productivity, increasing company revenue, increasing employee awareness; while external ones relate to marketing and increasing market share. Research has shown that 91% of motivation was related to external issues; companies reported that a major factor in the decision to certify their system with FSSC 22000 was related to increased competitiveness and customer retention [8].

The importance of FSSC 22000 is primarily reflected in the improvement of food safety standards from the scientific and technical aspect, consumer protection and increasing market competitiveness, ie the possibility of entering the international market. FSSC 22000 is a proven management system aimed at protecting food safety risks that can be internal and external, FSSC 2200 compliance with relevant laws and regulations and customer requirements, continuous process improvement and thus business organization, FSSC 22000 is a Global Food Safety Initiative accredited-internationally recognized [7].

The FSSC system is a network of interconnected elements that combine to prevent the harmful effects that food could cause to an individual's health. The elements that are an integral part of the system are: programs, plans, policies, procedures, practices, processes, methods, goals, controls, responsibilities, documents, records, and resources [9].

The crucial benefits of introducing the FSSC 22000 standard are multiple, and some of them are: reduced risk of hazards and incidents; increase reputation and attract customers; optimization of own resources while minimizing costs; possibility of access to international markets; ensuring the collective responsibility of all employees and implementing an effective system of self-control; building trust in the supply chain; with FSSC 22000 the company can prove that its products and services are of high quality; simplification of food safety studies and improvement of documentation and procedural activities; and ensuring quality business. Compliance with the requirements of the standard ensures international recognition and compliance with globally accepted business practices. In order to successfully implement the FSSC 22000 standard, it is necessary for companies to comply with some of the following parameters: the existence of other certificates, the existence of good management, access to financial resources, technical knowledge of employees, and the existence of external consulting contracts.

However, in addition to these positive factors, there are certain difficulties in the implementation of FSSC 22000, and some of them are: lack of technical knowledge of employees - obstacles in interpreting and applying requirements, difficulties in spreading quality culture, high costs in applying standards, lack of models or examples necessary documentation, lack of organizational infrastructure, lack of top management, and resistance to change — the way people think and act [8].
Companies that compete in local markets and have the prospect of expanding their markets must develop a strategy that allows them to use their own resources, and gain a competitive advantage over other competitors. Competitive advantage can be defined as the value interval created between the willingness of the customer to pay and the opportunity cost of the supplier.

All operations necessary to implement FSSC 22000 must be accurate, documented and verified. There are also additional requirements for the implementation of FSSC 22000, some of which are: service and material management, natural resource management, food fraud prevention, product formulation, allergen management, environmental management and the certification process. The audit process for obtaining the FSSC 22000 certification is based on the ISO 22000 framework and takes place over a three-year period [10].

2.1. Introduction and implementation of the FSSC 22000 standard in the frozen berry packaging plant

The application of the FSSC system is accompanied by an infrastructure management system whose requirements are covered by legal regulations and EU regulations. Some of the requirements required by the FSSC standard regarding infrastructure are: construction and layout of facilities, layout of premises, including working auxiliary rooms for employees, power supply and other connections, suitability of equipment and its availability for cleaning and maintenance-cleaning and sanitation of the facility, and hygiene staff. The lack of adequate infrastructure leads to major shortcomings that are very difficult to eliminate or with large subsequent investments. It is necessary to perform regular cleaning inside the facility, ie to take sanitation measures, with a change in the range of cleaning and disinfection agents and a change in the sanitation plan, and the results of the measures taken are determined by analyzing the microbiological cleanliness of the premises and hands of employees [11].

The next step is to define resource management responsibilities, product planning and implementation (comprehensive prerequisite programs-PRP), detailed hazard analysis, selection of risk assessment methodology, detection of operational prerequisite programs-OPP and critical control points-CCP, determining the method of validation and verification, and improvement system. The next aspect is traceability, that is, the possibility of tracing the raw materials used for food production through all stages of food production. In addition to traceability, it is sometimes necessary to perform a product withdrawal operation, and it is carried out at the moment when it is determined that the food is unhealthy and that as such it must not reach the final consumer.

In order to ensure food safety in all real situations, the document "Emergency treatment" was adopted, which contains the technical characteristics of the equipment used, the responsibility of employees in informing and making decisions, alternative supply options, contracted capacities and notification modules. The specificity of FSSC 22000 is a food protection requirement, often referred to as bioterrorism, which represents a total effort to prevent food contamination by physical, chemical, biological or radiological contaminants that may occur in food, and is a disruptive and highly undesirable factor; risk analysis is carried out and improvement measures are proposed [11].

Critical control points are a step in which control can be applied and are essential to prevent or eliminate food safety hazards or to reduce them to an acceptable level. There are also critical limits for each critical control point, and the critical limit is the maximum and / or minimum value according to which a biological, chemical or physical parameter must be controlled in the CCP to prevent, eliminate or reduce to an acceptable level food safety hazards. Some examples are: pH value, humidity level, pasteurization; therefore the mentioned values must be within the control limits. In the process of fruit freezing, there are several stages that must be controlled: the entry of raw materials into the refrigerator, inspection of fruit at the reception, entry of fruit into the packaging space (fruit cooling) to preserve quality to avoid fruit shock, inspection and packaging of fruit in primary packaging , labeling and packing of fruit in secondary packaging, storage of packaged fruit at a temperature of 1 to 3ºC, removal of fruit from storage and loading into trucks and shipment of fresh fruit to customers in a controlled temperature. Operational Prerequisite Programs are a requirement for FSSC 22000 and are located between Prerequisite Programs (PRPs) and Critical Control Points (CCPs). These activities control hazards at a particular step of the process, as opposed to PRPs that manage them throughout the operation. The most common critical points in the process of fruit freezing are mainly at the entrance of raw materials and storage of packaged fruit at a temperature of 1 to 3ºC, and a metal detector. Suitable examples include: sanitation efficiency, temperature control, systems for monitoring the efficiency of sanitation and hand hygiene of employees, and e-monitoring of pests [12].

Sanitation combines the procedures of cleaning and disinfection in the food industry. The word itself comes from the Latin word sanitas which means healthy. In the food industry, sanitation means creating

and maintaining hygienic, healthy production conditions, which means removing impurities and microorganisms from equipment, work surfaces and the like. This reduces the possibility of product contamination. Cleaning removes visible impurities of various origins from equipment, devices, work environment, etc. It is a technological process that makes a dirty, unhygienic, and therefore unusable surface clean, hygienic and reusable. Impurities in the food industry can be of organic (fat, protein, blood) and inorganic origin (rust, scale) [13].

The main source of cross-contamination are cleaning tools and accessories. Studies have shown that 47% of cleaning tools are positive for Listeria monocytogenes. According to the requirements of FSSC 22000 standards, the equipment must be: hygienically designed, suitable for the purpose, and stored in hygienic conditions to prevent contamination. All remediation programs are established under the supervision of the GFSI Global Food Safety Initiative, to ensure that all parts of the facility and equipment are cleaned and rehabilitated according to a set schedule, including cleaning of equipment originally used to clean the facility and equipment. Remediation is a condition for preventing microbiological contamination.

In order to maintain and demonstrate the effectiveness of the food safety management system, it is necessary to determine the scientific basis of the assumptions used in the system, the validation process, and verification of all system components should be performed to assess whether the system works as implemented or corrections are necessary. As the ISO FSSC standard also requires the establishment of a specific HACCP plan for a frozen fruit processing plant, it needs to be done for the specific conditions of each plant in order to develop a model to improve the safety, sanitation and quality issues of frozen fruit processing plants. As with any standard, it is necessary to make a HACCP plan, verification procedures and record keeping system in the process of processing frozen food [14].

3. CONCLUSION

The FSSC 22000 standard is intended for harmonization of the agri-food safety management system based on HACCP specifications and the ISO 9001 quality management system. The FSSC 22000 standard is the fifth certification program approved by the Global Food Safety Initiative and as such applies three integrated approaches such as a management system, which is integrated into the general system of the company, and based and harmonized with the standards ISO 9001 (quality management system) and ISO 14001 (environmental management system), then the methodology of hazard identification and risk management based on HACCP principles, and instructions for needs in the sales process as defined in section ISO 22000 - 7.2. Proper design and application of the principles of the FSSC standard can result in improved production in frozen berry packaging plants, international trade, customer safety, and the supply of healthy food products.

4. REFERENCES

[1] Peretti APR, & Araújo WMC. (2010). Abrangência do requisito segurança em certificados de qualidade da cadeia produtiva de alimentos no Brasil. Gest. Prod., São Carlos, 17(1): 35-49.
[2] Mamalis, S; Kafetzopoulos, P.D; Aggelopoulos, S. (2009). The New Food Safety ISO 22000 Assessment: Comparison and Correlation with HACCP and ISO 9000:2000. The Practical Implementation in Victual Business, Technological Educational Institute of Kavala, Department of Business Administration, Greece.
[3] JMCF.(2013). Implementação da NP en ISO 22000:2005 – sistemas de gestão de a segurança alimentar num lagar de azeite tradicional. 124 f. Tese (Mestrado em segurança alimentar) – Faculdade de Medicina Veterinária.Universidade Técnica de Lisboa. Lisboa
[4] Who - World Health Organization. (2009). FAO - Food and Agriculture Organization of the United Nations. Codex Alimentarius: Food hygiene Basic texts.(4º ed.). FAO and WHO. Rome.Italy.

[5] Codex Alimentarius Commission. (2011) Codex Alimentarius: Procedural Manual. WHO/FAO 20ª ed. Rome. Italy.
[6] Foundation FSSC 22000. (2016). Strengths and Benefits FSSC 22000. Foundation for Food Safety Certification, Netherlands.
[7] Condrea, E; Constantinescu, G. (2015). Particularities of FSSC 22000-Food Safety Management System. 'Ovidus' University of Constanta, Faculty of Economics Sciences, Romania, Journal of Environmental Protection and Ecology 16.
[8] Cantanhede, V; Pereira, S.K; Barreto, W.D. (2018). FSSC 22000 Packaging Implementation: a Plastics Industry Research, Universidade Federal do Rio de Janeiro-UFRJ, Rio de Janeiro, RJ, Brazil, Polimeros, 28 (1).
[9] Singh, M.K. (2015). A study on implementing Food Safety Management in Bottling Plant, Department of Management Studies, Indian Institute of Technology Roorkee, India.
[10] Martins, P.B; de Oliveira, C.E; Carraro, C.N; Entelman, A,F. (2020). FSSC 22000 certification: Study of Implementation in a Brazilian Agroindustrial Cooperative located in the Southwest Region of the State of Sao Paulo, University Federal of Sao Carlos Business School with Training line in Agroindustrial Systems, vol. 22 (4).
[11] Uršulin-Trstenjak, N; Levanić, D; Šušnić, S; Šušnić, V. (2016). Učinkovitost preduvjetnih programa u mesnoj industriji definiranih zahtjevom sustava FSSC 22000, Sveučilišni centar Varaždin, Sveučilište Sjever, Prvi hrvatski časopis o mesu, Vol. XVIII No. 4.
[12] (https://www.fssc22000.com/wp-content/uploads/19.1210-Guidance_ISO-22000-Interpretation_Version-5.pdf).
[13] Marinović, M. (2011). Praćenje ostataka kemijskih sredstava za čišćenje i dezinfekciju u ispustima uređaja za sanitaciju i u otpadnim vodama prehrambene industrije, Specijalistički rad, Sveučilište Josipa Jurja Strossmayera u Osijeku, Institut Ruđer Bošković, Zagreb.
[14] Smith, D.L. (2019) Global Food Safety Initiative scheme audit requirements regarding cleaning tool and utensil selection and maintenance-a review, Vikan A / S, Department of Hygiene, Skive, Denmark; Quality Assurance and Safety of Crops and Foods 11 (7)

POSSIBILITIES OF SLUDGE DISPOSAL FROM WASTEWATER TREATMENT PLANT IN CONCRETE INDUSTRY

Jasmina Ibrahimpašić[1], Halid Makić[1], Edvin Bolić [2], Lejla Arifović[3]

[1] Biotehnički fakultet/Univerzitet u Bihaću, Ulica Luke Marjanović 2,77 00 Bihać, Bosna i Hercegovina, btf@unbi.ba
[2] Tehnički fakultet/Univerzitet u Bihaću, Ulica, dr. Irfana Ljubijankića bb, 77 00 Bihać, Bosna i Hercegovina, tfb@unbi.ba
[3] JP "Vodovod"doo Bihać, Ulica Ivana Frane Jukića bb, 77000 Bihać, vodovod@vodovod-bihac.ba

ABSTRACT:

Wastewater treatment creates significant amounts of sludge that require further disposal following legislation. Sludge is a complex composition and is a dispersion of organic and inorganic substances in the water. In the framework of sustainable development, based on the principle of circular economy, sludge recycling almost entirely closes the wastewater treatment cycle, generating negligible amounts of waste that needs to be disposed of in the environment.

In this paper, we based on the application of sludge or ash obtained by incineration of sewage sludge (ISSA) in the concrete industry. The obtained ash was used for the production of concrete samples, prepared from the following ingredients: aggregates of dolomite origin, cement from the manufacturer Cemex, water from the city water supply. Concrete samples were prepared in which part of the cement (15 and 30%) was replaced with ash, obtained by sludge incineration. After "nurturing" the samples in water for 28 days, the results of the research showed that the ash used as a substitute showed certain binding properties.

Keywords: wastewater, sludge, ISSA, concrete

1. INTRODUCTION

Wastewater treatment creates significant amounts of sludge that require further disposal in accordance with legal regulations.

Sludge separated in wastewater treatment procedures must be adequately treated and disposed of in an environmentally friendly manner and in accordance with legal regulations. Sludge disposal is an expensive and environmentally sensitive process.

There are two methods of disposal of the resulting sludge for agricultural purposes, eg as fertilizer and non-agricultural purposes, eg concrete industry (Jamshidi et al., 2012). Namely, regardless of the fact that in the process of wastewater treatment there are relatively small amounts of sludge / 1 to 2% of sludge in relation to the amount of wastewater, its disposal is a large financial expense and costs about 20 to 60% of total operating costs of water treatment plants (Alqedra et al, 2011).

As such, sludge treatment is considered a very significant and dangerous problem in many countries due to its high operating costs and rigid environmental regulation as it can pose a danger to humanity. According to the researchers (Yague, 2005), the use of dry sludge as a concrete additive was used, and the mechanical properties and durability were examined. By adding 10% sludge in proportion to the

amount of concrete, the mechanical strength is significantly reduced, making it unsuitable for medium to high strength reinforced concrete. However, it can be used for low-strength bulk concrete, such as low-traffic road substrates and sub-foundations, and as a filler. As an admixture in concrete, ash from sewage sludge from wastewater treatment plants is used. Solid material left over from the wastewater treatment process is used for ash production. The specific sludge production in wastewater treatment varies in the range of 35 to 85 g of dry solid per population equivalent per day (Jamshidi et al., 2011). Sludge separated in wastewater treatment procedures must be adequately treated and disposed of in an environmentally friendly manner and in accordance with legal regulations.

Stabilized and dehydrated sludge containing 18 - 35% dry matter before final incineration is usually dried, primarily with the aim of increasing energy efficiency during incineration (Donatello and Cheeseman, 2013). Sludge containing 75 - 95% dry matter is then introduced into an incinerator, and ash (ISSA) is obtained (*Incinerated Sewage Sludge Ash*), in the form of finely granulated waste material (Donatello and Cheeseman, 2013).

Heat treatment reduces the total mass of sludge (dehydrated to a level of approximately 20% dry matter to 85% while reducing the volume by up to 90%,(Lynn et al. 2015), thermally destroys toxic organic components, minimizes unpleasant odors and facilitates final disposal, and it is possible to obtain energy (Tantawy et al., 2012).

Incineration of sludge occurs primarily to oxidation, ie combustion of organic matter, reduces odors; the volume of the sludge is greatly reduced and the sludge has a calorific value. According to research (Jamshidi et al. 2013) mixtures of concrete with 5% and 10% ash content from sludge show smaller reductions in mechanical properties. By increasing the ash content in the sludge to 20%, a reduction in compressive and compressive strength of about 20% was obtained.

The environmental and economic benefits of using ISSA in concrete can be very significant but it depends on the end use and the scale of production. From the research (Vouk at al, 2015) the results obtained using ISSA in cement-based materials are technically feasible, but they also have certain limitations. Partial replacement of portland cement with ISSA leads to an increase in air content and a decrease in workability. This can be compensated by the addition of a superplasticizer. Using ISSA as a cement replacement in mortar mixtures results in equivalent bending and compressive strength to those reference samples, when the cement replacement is <10% and CEM II / B-M (S-V) 42.5N is used. Mourtada et al. (Mourtada et al, 2019) investigated the impact of the use of dry and wet sewage sludge in concrete mix on its physical and mechanical properties as a new way of disposing of sludge produced from wastewater treatment plants .: according to the obtained results, a slight impact on the strength of the concrete mixture when using dry or wet sludge with (5, 10 and 15%) cement mass, however, the use of sludge with 20% cement mass reduces the strength by 61.6% for dry sludge and by 68.5% for wet sludge.

In order to reduce the damage to the environment and ensure acceptable favorable costs, the solution of aggregates required in concrete production (Limaai et al, 2016) conducted research and analyzed the implementation and feasibility of this solution. The use of 5% sludge content in concrete aggregate and showed that sludge can be used as aggregate in concrete pavements and roads.

The use of ash from WTP (wastewater treatment plants) sludge incineration in the concrete industry proves feasible and justified from a technological, economic and environmental point of view (Vouk, et al., 2015).

2. EXPERIMENTAL

A sample of sludge for analysis was taken from the Bihać Waste Water Treatment Plant (WWTP). The wastewater treatment plant is designed as a process with activated sludge - extended aeration with the production of only excess sludge. Excess sludge is collected and separated on the waterline, later treated on the sludge line, by thickening in a gravity thickener by thickening in a gravity thickener and finally dehydrated on a belt filter press (before its final disposal outside the plant). This method of wastewater treatment is widespread, and one of the important characteristics is the simplicity of the sludge line.

Sludge samples were obtained from the drying site, which were located in aerobic (outdoor) conditions for a period of time. To identify the composition of sludge, thermogravimetric analysis of dry sludge was performed in the laboratory of the Faculty of Metallurgy, University of Zenica. Thermogravimetric analysis (TGA) is a technique that measures the amount and rate of change of sample mass as a function of temperature and/or time in a controlled atmosphere. A sludge sample was prepared by placing a 5o 20 g sample in an aluminum dish and placing it in a thermograph. After which the results were read.

Figure 1: Testing equipment

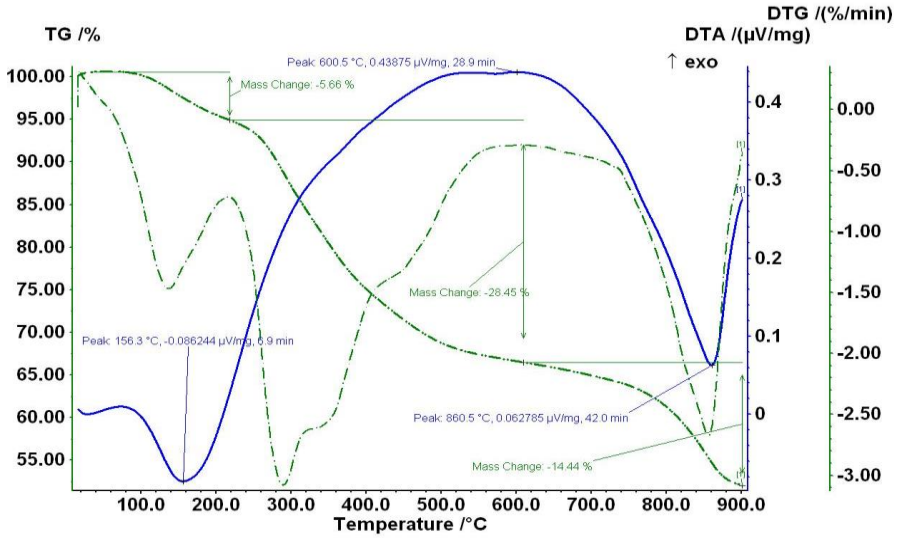


Figure 2: Sludge sample thermogram

TCA analysis showed that the sludge sample is of complex structure, with wide peaks and contaminants present, and that the process of thermal decomposition reaches a temperature of 900 oC. After that, the sludge samples were subjected to the annealing process in a muffle furnace for annealing at a temperature of 400 to 800 oC in the Laboratory of the Biotechnical Faculty, and then placed in the open until complete mineralization (cessation of smoke).

Figure 3: Incineration of samples in an annealing furnace

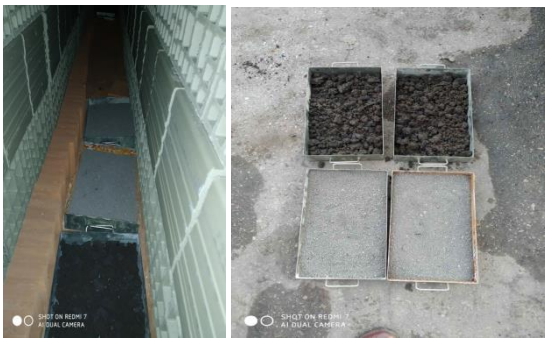


Figure 4: Tunnel kiln for baking brick products for burning sludge

After that, the sludge samples were burned in a tunnel kiln for brick products, lined with fireclay, where a temperature of up to 900 ° C is achieved, owned by the company "I-CRNI" d.o.o. The granules of ash that resulted were then pulverized into a finely powdered substance.

Mix design and concrete mixing

The tests were performed in the Laboratory for testing building materials at the Technical Faculty of the University of Bihać.

For the production of concrete specimens, used Portland cement.Portland cement produced by CEMEX Croatia, Type CEM II/B-S42,5N and quantity used of 300kg/m^3.

Gravel and sand we used crushed in ‘’Ikic’’ Company's with ratio of mixing given in Table 1.

Table 1: Gravel andsand used crushed with ratio of mixing

Crushed rock	Ratio
0.-4.	35%
4.-8.	16%
8.-16.	24%
16.-32.	25%

Water/cement ratios were evaluated (W/C=0.6)

Two samples of mark P1 were made according to the presentedmixing in Table 1, then three samples of mark P2 were made with a replacement share of 15% of burnt ash in the mass of cement used in

P1. The third sample marked P3 was made with a replacement percentage of 30% of the burned ash in the cement mass used in P1.

Figure 5: Prepared concrete samples

The specimens were left for one day in the mold at the laboratory conditions (23±2°C).Then theywere removed and immersed in water until tested in compression.

Compressive strength

The compressive strength was determined following the EN 12390-3. The test was performed on 15×15×15 cm^3. Results for shown in Table 2.

Table 2: Compressive strength

Ashes	Specimen	Force kN	Compressive strength 28 days MPa	Everage MPa
0%	P1	585	24.7	23.5
	P1	530	22.37	
15%	P2	584	24.65	24.3
	P2	520	21.95	
	P2	626	26.43	
30%	P3	697	29.42	27.7

3. RESULTS AND DISCUSSION

Monzo et al. (1997) observed a moderate increase in the compressive strengths of the analyzed samples with the addition of ash. In general, considering the strength of the obtained concrete, two significant trends can be distinguished: by increasing the proportion of ash replacing cement, the strength of concrete decreases, and by increasing the fineness of ash particles, the strength of formed concrete

increases. A significant role plays in the applied process of ash production: type of furnace, temperature, the influence of various additives during incineration, etc. (Vouk et al., 2015).

The ash, created by burning sludge from the wastewater treatment plant, was used as a substitute for 15 and 30% of cement in the actual production of concrete elements. The manufactured elements meet all the prescribed technical requirements.

Examining the state of knowledge in the field of research, it can be concluded that the impact of the applied heat treatment procedure on the physical and chemical characteristics of ash, and technology of preparation and treatment of concrete / concrete elements has not been fully investigated and that there exists significant opportunity for additional research.

4. CONCLUSIONS

- The conducted research confirmed the results of a significant number of previously conducted laboratory tests.
- The use of ash in the production of concrete elements with application in the field of water management, according to the described procedure, indicates the closure of the wastewater treatment cycle, which generates almost negligible amounts of waste, which is one of the basic assumptions. economy, where the waste of one industry becomes the raw material of another.
- The use of ash obtained from WWTP sludge in the concrete industry proves feasible and justified from a technological point of view. Taking into account the results of leaching tests, the obtained concrete products with embedded ash prove to be safe for use from environmental and human health.
- With the possibility that the ash would be available to concrete plants free of charge, and that its use reduces the need for raw materials from nature, the justification of this procedure is confirmed from the economic and environmental aspects.
- With the rapid development of sanitary hydro technics and environmental awareness in general and with the rapid growth of the number of constructed WWTPs, the problem of sludge disposal is becoming increasingly important.
- Although a significant number of different technological possibilities for sludge disposal are available today, almost all of them have high costs.
- The positive results of this research are of special interest for the field of water management with the aim of sludge disposal.
- The technology of preparation and processing of concrete / concrete elements has not been completely researched, which gives a significant opportunity for further research.

5. REFERENCES

1. Alqedra, M., Arafa, M., Mattar M. (2011); Journal of Environmental Sci Technol, 4 (4) pp. 354-365 (1994-7887), 12
2. Daniel de Almeida Limaa, Charles Zulanasb (2016); Use of contaminated sludge in concrete Procedia Engineering 145 1201 – 1208
3. Donatello, S.; Cheeseman, C.R.: (2013); Recycling and recovery routes for incinerated sewage sludge ash (ISSA): A review. Waste Manage. 33, pp 2328-2340.
4. Foladori, P. Gianni A.,. Ziglio, G., (2010); Sludge Reduction Technologies in Wastewater Treatment Plants, IWA Publishing, ISBN: 9781843392781

5. Ghada Mourtada, RabieHisham , AbdEl-Halim, Ehab Helmy Rozaik (2019); Influence of using dry and wet wastewater sludge in concrete mix on its physical and mechanical properties, Ain Shams Engineering Journal10(4), 705-712
6. Jamshidi, M. Jamshidi, a,N. Mehrdadi, A. Shasavandi, F.Pacheco-Torgal, (2013) ;Mechanical Performance of Concrete With Partial Replacement of Sand by Sewage Sludge Ash From Incineration, Materials Science Forum Vols. 730-732 pp 462-467
7. Jamshidi, M., Jamshidi, A, . Mehrdadi, N. (2012); Application of sewage dry sludge in concrete mixtures, Asian Journal of Civilengineering (building and housing) vol. 13, no. 3, pp 365-375
8. Lynn, C.J.; Dhir, R.K.; Ghataora, G.S. & West, R.P. (2015.): Sewage sludge ash characteristics and potential for use in concrete. Construction and Building Materials,98, 767-779.
9. Monzo, J.; Paya, J.; Borrachero, M.V.; Bellver, A; Peris-Mora, E.: (1997); Study of cement-based mortars containing spanish ground sewage sludge ash. *Stud. Environ. Sci.* 71, pp 349-354,
10. Tantawy, M.A., El-Roudi, A.M., Abdalla E.M., Abdelzaher, M.A((2012.);Evaluation of the pozzolanic activity of sewage sludge ash. Chemical Engineering, , Aricle ID 487037, pp 8
11. Vouk, D., Nakic, D., Serdar, M., S. Donatello, C.R. Cheeseman (2017); Evaluation of using sewage sludge ash in the cement industry: Case study of Zagreb, Croatia WA Specialist Conference On Sludge Management SludgeTech
12. Vouk, D., Nakić, D., Stimer, N. Serdar, M., (2015); Mogućnost zbrinjavanja mulja koji nastaje u procesu obrade otpadne vode u betonskoj industriji, Hrvatske vode 23, 94 277-286
13. Yague A, Valls S, Vazquez E, Albareda F. (2005); Durability of concrete with addition of dry sludge from waste water treatment plants, Cement and Concrete Research, 351064-73.

CE MARKING OF TRAFFIC NOISE REDUCTION ELEMENTS

Asmin Veladžić, Aida Veladžić
Avcon d.o.o. Sarajevo, Branislava Nušića bb, 71000 Sarajevo
asmin@avcon.ba

ABSTRACT:

The paper will present the conformity assessment of elements for reducing traffic noise in accordance with the European harmonized standard EN 14388 and the Regulation on construction products number 305/2011. The regulation defines the conditions for the placement of products on the EU internal market, as well as the methods and systems of assessment to demonstrate the consistency of the characteristics of construction products.

Keywords: Conformity assessment, Quality, CE mark, Noise reduction elements.

1. INTRODUCTION

In many countries around the world, there are laws relating to health and human safety. The purpose of these laws is to create a safe working and living environment and to eliminate unsafe procedures and processes. Work and living space should be designed and constructed to meet human safety and environmental standards, including noise protection [1].

Research conducted in EU countries has shown that about 80 million people (20% of the population) live and work in areas where noise levels are higher than 65 dB, and that about 170 million people live and work in so-called gray areas where noise levels are between 55 and 65 dB [2]. The results of research related to noise and its harmful effects are contained in the European Directive 2002/49/EZ.

The most common noise sources are: various types of construction works, various forms of road, rail and air traffic noise, parking lots, sports and other facilities, residential and occasional buildings, household appliances, amusement parks, sports shooting ranges, industrial plants, etc. Research [4] has shown that traffic noise accounts for 81% and noise from all other sources (industry, construction and free time activity noise) for 19% of all ambient noise.

2. TRAFFIC NOISE

Noise is a sound - something that we can hear or that can he heard. Sound is a longitudinal mechanical wave that can travel through solids, liquids, and gases. In the narrow sense, the mechanical waves registered by the human ear are called sound. These are longitudinal waves with a frequency of 16 Hz to 20,000 Hz, which can vibrate the eardrum and thus produce a sense of sound. Sound waves below 16 Hz and above 20,000 Hz are called infrasound and ultrasound. Noise is too loud or unpleasant sound

(any change in pressure that the human ear can detect), which changes the normal state of the environment in a particular area by causing an uncomfortable feeling [5].

If the noise is not reduced or persists for a long time, it can cause significant damage to the quality of life of people or other living beings. The term noise refers to noise caused by human activity (traffic, industry, entertainment, etc.). Noise has a negative impact on the health of hearing, body and mental state of the people. The negative impact of noise on the people's quality of life is a growing problem today, especially due to the constant development of traffic systems. Given this, it is necessary to conduct regular monitoring of the road traffic and, if necessary, to apply adequate protection measures.

2.1. Types of noise

By origin, noise in the human surroundings can be divided into industrial noise and environmental noise. Noise can be permanent, intermittent and impulsive. Permanent noise occurs in spinning mills and power plants. The characteristic of permanent noise is that the sound pressure level and the frequency spectrum are, in one place, constant over time.

If the sound pressure levels and the frequency spectrum change in one place, then it is intermittent noise. This is the most common type of noise, and we find it e.g. in the eccentric press. A sound event of short duration and relatively high sound pressure is referred to as impulse noise. Each beat should be considered as an impulse noise.

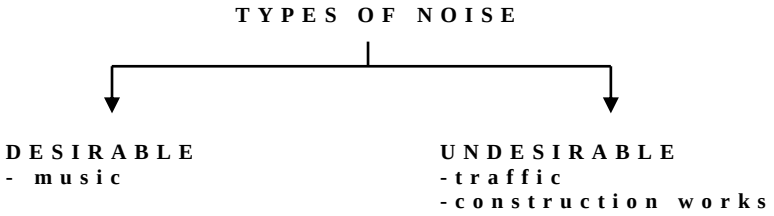


Figure 1: Types of noise

The profession says that over 80% of harmful sound comes from traffic noise, i.e. noise as a result of roads, railways and air traffic. Due to the noise harmfulness and the significant increasement of harmful sound emissions, there is a need to reduce noise emissions on roads, specially the noise from city roads traffic.

The main guidelines for reducing noise emissions in urban areas are as follows:

- spatial planning,
- road planning,
- selection of the highest quality materials for road construction,
- selection of the highest quality materials for the construction of facilities exposed to noise,
- noise source reduction / vehicle noise reduction,
- construction of walls for noise protection - sound barriers and
- legal regulations - speed limits.

Noise protection walls are construction and technical protection measures by which the noise load caused by road traffic is reduced to a insignificant extent or reduced to such an extent that it does not exceed the permissible value of sound emission in protected areas or facilities [3].

3. CONFORMITY ASSESSMENT OF TRAFFIC NOISE REDUCTION ELEMENTS

The purpose of installing noise protection walls is to mitigate the effects of noise pollution in urban areas and create a positive impact on human environment. The designer defines the locations of the protective walls, the height of the walls and the quality of noise absorption based on the noise calculation model. Protective walls are installed mainly in urban areas where the noise level caused by motor traffic exceeds the permitted legally prescribed noise level. Noise protection panels can be divided into transparent and non-transparent.

Types of non-transparent noise protection panels:

1. aluminium noise protection panels (Figure 2)
2. wooden noise protection panels
3. stone noise protection panels
4. reinforced concrete noise protection panels
5. panels with green plantings
6. noise protection walls made of reinforced embankments and gabions

Types of transparent / reflective noise protection panels:

1. noise protection panels (Figure 3) made from polycarbonate or acrylic sheets
2. reinforced noise protection panels made from polycarbonate or acrylic sheets

Figure 2: Aluminum panels [7]

Figure 3: Transparent / Reflective panels [7]

Noise protection panels can be made of various materials, depending on the design requirements. One of the basic conditions is to meet the prescribed conditions on noise absorption and reflection. Another important thing is the standardization of the panel's dimensions and the adequate fastening of the panels to the pillars.

The following must be taken into account when selecting materials and production:

- **Type and quality of materials**

Quality control includes verification of used materials in line with the design requirements including static calculation, precipitation erosion and wind action in accordance with regulations, laws and OTU for applied materials and structures.

Panel walls must meet the requirements for normal and breaking load (loads from possible damage) in terms of quality conditions, especially mechanical bending to the wind, according to ZTV-Lsw 88 (German technical approval for acoustic barriers).

Panel walls are prefabricated elements; they must be of modular dimensions and must be able to be easily installed in girders. General requirements for acoustic protective panels - barriers to reduce road traffic noise, must meet the requirements of EN 1793-2:1997 and in terms of sound insulation should fall into category Bx. Protective panel walls must be UV resistant. A condition of a minimum durability of protective panel walls of, for example, 10 years is set, and it is necessary to strictly adhere to the maintenance conditions of panel walls specified by the manufacturer.

- **Sound insulation**

The sound insulation of the panel wall is conditioned by the necessary noise reduction on the protected objects. A criterion is set for the sound insulation of walls, which must be a minimum amount of Rw (dB) for all types of walls (category B according to EN 1793-2:1997).

- **Sound absorption**

The sound absorption of the walls is conditioned by the need to limit the noise on the opposite side from the protected one, if there are also buildings that needs to be protected from the noise. During the construction of highways, it is legally prescribed that the alternative road for vehicle traffic must be available. This road is being built parallel to the highway. In such cases, noise protection of protected buildings is provided by the construction of both sides absorbing walls. The absorbent properties of the wall must fall into category A (according to EN 1793-1:1997).

- **Permissible noise levels on roads**

The maximum permissible noise levels in outdoor space are determined in accordance with the space purpose according to the Ordinance on the maximum permissible noise levels in the environment in which people work and travel NN 145-04.

In order for a product to be placed on the market, the manufacturer must carry out the procedure of assessing the conformity of the product with the harmonized standard and the Regulation on construction products 305/2011. The conformity assessment procedure must be carried out in order for the product to be CE marked. This label confirms that the product meets the minimum safety requirements prescribed by the legislator. Organizations that comply with the requirements of standards and regulations have a great advantage because they enter the market with an annual turnover of about 1500 billion euros. The following table shows the tasks of the manufacturer and the notified body in the process of assessing the conformity of the product.

Table 1: Assignment of AVCP tasks for noise barriers under system 3 [5]

Tasks		Content of the task
Tasks for the manufacturer:	Factory production control	Parameters related to essential characteristics of Table ZA.1
	Determination of the product-type on the basis of type testing, type calculation, tabulated values or descriptive documentation of the product.	Durability
Tasks for a notified testing laboratory:	Determination of the product-type on the basis of type testing, type calculation, tabulated values or descriptive documentation of the product.	Resistance to loads Sound absorption Sound insulation Shatter properties Light reflectivity

When placing a certain product on the market, manufacturers are obliged to compile the appropriate documents for that product (Declaration of performance, CE mark, etc.). An integral part of these documents is information on the identification number of the Notified Body. The European Commission publishes a list of such Notified Bodies in the NANDO Information System, which is a database where information on the Notified Bodies of all EU Member States and Turkey is available, which is attached by Decision 2006/654/EC. A review of the NANDO database shows that EN 14388: 2005 is currently being implemented by 35 Notified Bodies.

The following table shows the results of the initial type test of the product carried out by the Notified body.

Table 2: List of required properties displayed by the noise-reducing panels, as determined by the initial type test [6]

Requirement/Property	Tested per	Performance		
		3.96m x 1.00m	4.96 m x 1.00 m	4.96 m x 1.50 m
Sound absorption DL_a	EN 1793-1:97	to 100		
Sound insulation DL_R	EN 1793-2:97	100 - 500		
Resistance to Loads				
Self-weight of a noise-reducing element - wet - reduced wet - dry	EN 1794-1:11, annex B.2	NPD 0.409 kN/m^2 0.245 kN/m^2	NPD 0.289 kN/m^2 0.274 kN/m^2	NPD 0.375 kN/m^2 0.277 kN/m^2
Maximum normal (90^0) load an acoustic panel can withstand (wind and static load); design wind load	EN 1794-1:11, annex A.3.3	1.40 kN/m^2	1.22 kN/m^2	0.98 kN/m^2
Maximum vertical load a panel can withstand (load panels above)	EN 1794-1:11, annex B.3.2	4.87 kN/m	4.51 kN/m	4.43 kN/m
Maximum normal (90^0) load an acoustic panel can withstand (dynamic load from snow clearance)	EN 1794-1:11, annex E.2	15 kN / 2 m x 2 m	9.56 kN / 2 m x 2 m	NPD
Resistance to impact from stones	EN 1794-2:11, annex A	Satisfies requirements		
Resistance to brush fire	EN 1794-2:11, annex A	Class 1		
Risk of falling debris	EN 1794-2:11, annex B	NPD		

Based on the results of the initial test, the manufacturer draws up a declaration of performance and a CE mark. The model of the declaration of performance is given in the Regulation on construction products No. 305/2011. The declaration of performance is a mandatory part of the technical documentation submitted during the application for approval of the material with the report of the testing laboratory, as well as the Technical Instructions and the Safety Data Sheet.

After placing the CE mark on the product, the manufacturer is obliged to ensure constant factory production control. According to Regulation 305/2011, for the elements of sound barriers that belongs to the system of conformity 3, the control of the essential characteristics of the construction product or the factory production control is carried out by the manufacturer.

The factory production control system must define the competencies, authorities and responsibilities of the personnel involved in the factory control system. The factory production control system consists of manuals for factory production control, procedures, instructions and other elements which explain the receipt of input raw materials, production process, control during the production process, as well as control of finished products.

The manufacturer must identify the elements within his manufacturing process that may affect the conformity of the product with the required technical specifications. The manufacturer must plan the production process in such a way that the finished product complies with the requirements of the product standard EN 14388.

Within the factory production control system, the manufacturer must determine the inspection/control of the equipment, raw materials or other input components of the production process as well as the control of the finished products. The frequency of these inspections is defined in such a way that we have ongoing compliance with the specified requirements [4, 5, 6].

4. CONCLUSION

This paper presents the procedure for conformity assessing of elements for reducing traffic noise. The importance of carrying out this procedure is very high and is reflected in the safety of the product placed on the EU market. The basic characteristic of the single market of the European Union is the free movement of people, capital, goods and services, but also the fact that products placed on the market must meet the basic requirements of health, safety and consumer protection as well as the environmental protection. The CE mark is a "product passport" so that the product can enter the EU market. This label confirms that the product meets the minimum safety requirements prescribed by the legislator.

However, the question whether new product will be accepted in the market depends on many other factors, such as the attractiveness of the product (is the product made based on the results of relevant research and / or development of technology), unit price, delivery time and others. The positive results that come from research and development of technology are the main reasons why the most successful countries in the world invest the most in these areas.

5. REFERENCES

[1] Mijović, B. (2008). Applied Ergonomics, Polytechnic in Karlovac.
[2] Lakušić,S., Dragčević,V., Rukavina, T. (2003). A review of European traffic noise regulation, Građevinar 55. 349-356.
[3] Špelić, M. (2015). Traffic noise protection, Polytechnic of Karlovac
[4] Bajramovic, E., Bajramovic, E., Islamovic, F. (2021). Conformity assessment of metal framing elements. - Journal of Physics: Conference Series
[5] Institute for Standardization of B&H (2015). EN 14388 Traffic noise reducing devices – Specifications
[6] Bajramovic, E., Džidić, S. (2017) Application of 2011 to Precast Concrete Elements, 5th International Conference “Contemporary Achievements in Civil Engineering, Serbia
[7] https://www.kohlhauer.com/en/node/69 (15.04.2021)

DETERMINATION OF TOXIC HEAVY METAL CONTENT OF CADMIUM AND LEAD IN CIGARETTES USING ATOMIC ABSORPTION SPECTROSCOPY

Ekrem Pehlić[1], Minela Ćejvan[2], Emina Mujčinović[3]
[1]Faculty of Health Studies, University of Bihać, pehlic_ekrem@yahoo.com
[2] Faculty of Health Studies, University of Bihać, minelazapcevic@gmail.com
[3]HI Health Center Bihać, Una-Sana Canton, eminamujcinovic74@gmail.com

ABSTRACT:

Consummation of cigarettes and other forms of tobacco are enjoyed by people regardless to racial, sexual or religious affiliation, occupation and social status. The purpose of this paper was to determine the content of heavy metals in cigarettes and cut tobacco using different types of cigarettes from different manufacturers and to compare the concentrations of heavy metals for different types of tobacco. Cigarette and tobacco samples were prepared by wet digestion in a Anton Paar Multiwave microwave oven. Destruction of the samples took place in a mixture of Nitric acid (HNO_3) and Hydrogen peroxide (H_2O_2) in Anton Paar Multiwave 3000. Samples (0.5 g) were weighed into teflon dishes with 1 mL of H_2O_2 and 6 mL of HNO_3. The analyzes were performed on an atomic absorption spectrophotometer "Perkin Elmer" AAnalyst-800 with Zeeman correction by flame technique. The lowest measured concentration for cadmium is in sample number 5 (0.0100 mg/kg). Concentration of lead in all samples, both in cigarettes and in cut tobacco, were below the standard concentrations. Considering that according to the EU Regulation on the health safety of consumer goods, including cigarettes, the Maximum Residue Limits (MRL) for lead are 10 mg/kg. It can be concluded that the measured concentrations for lead are significantly below the MRL because they amount <0.001 mg/kg. Cadmium concentrations in all samples were quite low, but since it is a heavy metal that belongs to First group of carcinogenic elements for humans (according to the IARC - International Agency for Research on Cancer) it is necessary to be extremely careful and reduce or completely stop use cigarettes.

Keywords: cigarettes, human health, heavy metals, AAS

1. INTRODUCTION

Heavy metals are naturally present in the earth's crust with different concentrations in different areas of the earth's surface [1]. The elements uptake by plants depends on the physiological properties of the plants themselves, growing conditions, soil properties, meteorological conditions, and especially on the nutrient ratio. According to the International Agency for Research on Cancer (IARC), Pb, Cd, As, Ni and Cr are carcinogenic to humans [2]. These metals are present in tobacco leaves and their concentrations vary according to the geographical area where the tobacco is grown, according to the treatment of fertilizers and tobacco plant varieties [3]. It was also found that the concentrations of heavy metals in the ash of tobacco leaves were lower compared to cigarettes. The mobility of contaminants depends on their type and soil pH. For example As and Se are more mobile in alkaline soil reaction,

while Hg, Pb, Cd and Zn are more mobile in acidic soil. Accumulation of lead in plants depends on the distance of plants from the emission center, land cover with plants, length of vegetation, direction and intensity of wind, etc. The deposition of lead in most plants is more intense at the root compared to aboveground parts. The great power of the roots in the accumulation of lead could be a kind of protection of the above-ground part. Lead in higher concentrations inhibits root elongation and leaf growth, inhibits the process of photosynthesis and affects the morphological and anatomical structure of plants. Increased consumption of tobacco and cigarettes is associated with health consequences and therefore it is necessary to conduct research on the content of heavy metals in cigarettes. Metals, distributed in smoke, although present in lower concentrations, are responsible for health anomalies in active smokers [4]. In addition to the harmful neurotoxin nicotine, each cigarette contains more than 4,800 other harmful substances. Cigarette smoke contains, among other things, arsenic, tar, benzene and especially cadmium. Smokers have twice the intake of cadmium than non-smokers [5]. Long-term consequences: kidney damage, osteoporosis, greatly increased risk of cancer, etc. By absorbing these elements through the roots, heavy metals reach the plants, and through them to the final product, and thus into the body of animals and humans. From wastewater today is a large number of anthropogenic influences on the presence of heavy metals in the environment. The most important anthropogenic sources of metals in the aquatic ecosystem are certainly wastewater that is discharged untreated. Heavy metals from wastewater can enter the plant in several ways: by irrigation, through groundwater, spraying plants with wastewater and the like. There are more and more metal smelters and thermal power plants whose chimneys emit large amounts of certain metals in the form of gases, smoke, etc. All of them most often reach plants through precipitation and accumulate. They can also reach by air circulation. Heavy metals such as mercury, lead, arsenic, aluminum, copper, nickel, manganese, cadmium, chromium, molybdenum and others are required in human body as trace elements, but their increased concentration is undesirable and dangerous. The accumulation of these toxins in fat cells, bones, endocrine glands, brain, hair or in the central nervous system, often results in harmful health consequences, and often severe diseases. The World Health Organization (WHO) has produced extensive studies that have considered and pointed out the dangerous effects of heavy metals on human health. Directive 2001/37 / EC of the European Parliament and of the Council on the harmonization of the laws, regulations and administrative provisions of the Member States on production regulates the sale of tobacco products [6]. Heavy metals are toxic and tend to stay longer in the body, especially in organs and tissues for which they have an affinity, for example bones, kidneys, liver or brain. As a rule, they enter the food chain where their bioaccumulation and biomagnification occur. Some of the heavy metals are necessary in smaller quantities in order for physiological processes to take place in the body. Heavy metals can also enter food from food production and packaging equipment or packaging or through food packaging [7]. Soil contamination with heavy metals is not easy to determine and differs in different soil types. In recent years, more and more attention has been paid to the contamination of soil, water, air, and thus food with heavy metals [8].

Heavy metals come to the soil mainly through anthropogenization. Cadmium is taken into the body through the lungs and digestive tract, and is present in the blood in erythrocytes. Cadmium is excreted in the faeces and urine very slowly. When there is a lack of zinc in the diet, the body can make up for the storage of cadmium instead of zinc, and if the daily intake of zinc is high, cadmium is excreted. Heart disease and hypertension are the result of increased amounts of cadmium in the body [9]. It is insidiously deposited in the kidneys and arteries, causing high pressure, and in smokers it leads to emphysema [10]. Excessive intake of cadmium causes changes in the bones, because cadmium displaces calcium and the bones become brittle. The main source of cadmium pollution is the uncontrolled disposal of industrial waste containing cadmium, but also wastewater from urban areas. The production of inorganic elements and chemicals, plastics, paints and varnishes, especially ironworks, smelters and foundries are pollutants of the environment with cadmium.
The Rulebook on Maximum Permitted Quantities of Certain Contaminants in Food (Official Gazette of BiH, No. 37/09) doesn't define limit concentrations of heavy metals [11]. Lead is a highly toxic trace element. The human body can tolerate only 1 to 2 mg of lead without toxic effects. It is a poison that

damages primarily the bloodstream, nervous system and kidneys, and then the liver and affects reproduction. The retention time of lead in the blood is 3 to 6 weeks, so that the accumulation does not occur in the blood. Acute poisoning is manifested by abdominal colic, encephalopathy (brain dysfunction), myelopathy (pathological condition of the spinal cord) and anemia. Acute lead poisoning attacks the central nervous system and probably causes hyperactivity in children. Lead poisoning is called Saturnism. Lead poisoning can also occur when a food can can be soldered with tin, which contains certain amounts of lead. In addition to food stored in lead-coated containers, the use of lead containers for food preparation, the source of lead poisoning can be cosmetics, cigarettes (because lead-containing insecticides are used in tobacco), coal burning, use of lead-based paint or plaster. From lead mines and smelters, and through factory chimneys and exhaust gases, lead enters the atmosphere, through which it reaches water and soil and then plants and animals. Existing legislation such as: Law on Restricted Use of Tobacco Products (Official Gazette of the Federation of BiH No. 35/98) and Law on Tobacco of Bosnia and Herzegovina (Official Gazette of BiH No. 32/10), don't regulate maximum concentrations of heavy metals in cigarettes and tobacco products [12,13].

2. MATERIAL AND METHODS

2.1. Material

Eight samples were used in the paper, i.e. eight different types of cigarettes (four types of cigarettes and four types of cut tobacco).
Cigarette samples:

1. West silver (Imperial tobacco, Macedonia)
2. York light (TDR d.o.o Rovinj, Croatia)
3. Royal blue (FDS - Tobacco factory, Sarajevo, Bosnia and Herzegovina)
4. Filter 160 (TDR d.o.o Rovinj, Croatia)
5. Tobacco Cut Gold (FDS - Tobacco factory, Sarajevo, Bosnia and Herzegovina)
6. Tobacco Chesterfield Red (F6 CIGARETTENFABRIK GMBH&CO.KG, Germany)
7. Tobacco Walter Wolf Flavour (TDR d.o.o Rovinj, Croatia)
8. Tobacco Imperial Classic Red (Imperial Tobacco, Poland)

2.2. Metod

The paper determines the concentrations of heavy metals in cigarettes originating from EU and non - EU manufacturers. The samples are marked with numbers from 1 to 8 according to Table 1.

Table 1: Types of cigarette and tobacco samples

No.	Sample name	Country of origin
1.	Cigarete West silver	Macedonia
2.	Cigarete York Light	Croatia
3.	Cigarete Royal Blue	Bosnia and Herzegovina
4.	Cigarete Filter 160	Croatia
5.	Tobacco Cut Gold	Bosnia and Herzegovina
6.	Tobacco Chesterfield Red	Germany
7.	Tobacco Walter Wolf Flavour	Croatia
8.	Tobacco Imperial Classic Red	Poland

In the samples were determined heavy metals Cd and Pb. The analysis was performed by the method of atomic absorption spectrophotometry "Analytical Methods" FP-3 Analysis of Meat and Meat Products (2000). The analyzes were performed on an atomic absorption spectrophotometer "Perkin

Elmer" Aanalyst-800 with Zeeman correction, flame technique. Atomic absorption spectrophotometry (AAS) is an optical method based on measuring the absorption of electromagnetic rays by atoms in the ground state [14]. Most routine analyzes require a flame temperature of around 2400 °C, which can be achieved with, for example, air-acetylene mixtures. The sample for analysis in the liquid state is introduced into the flame by means of a nebulizer, thus achieving the dispersion of the liquid into fine droplets. Samples were prepared by wet digestion in a Anton Paar Multiwave microwave oven. Samples (0.3 g) were weighed into Teflon dishes and 1 mL of H_2O_2 and 6 mL of HNO_3 were added. Microwave digestion is performed by first heating for 10 minutes, then burning for 10 minutes, and finally the cooling process, which shows the flow diagram on the oven display, diagram no. 1. After incineration, the solution becomes clear and is quantitatively transferred to 50 mL volumetric flasks and made up to the mark with ultrapure water. The same procedure is used for the blank, but without the sample. Certified standards for Cd, Pb and Cr of 1000 mg/L (Perkin Elmer, USA) were used to calibrate the instrument. Working standards are prepared by diluting certified standards. After preparation, the sample is introduced into the apparatus using a nebulizer and the samples are read under the recommended conditions [15]. The conditions in which the analysis of heavy metals was performed are shown in Table 2.

Table 2: Recommended conditions for analysis on AAS

Element name	*Flame*	*Wavelength (nm)*	*Burner*	*Calibration method*	*Stock Stand.Solution (µg/ml)*
Cd	Air-acetylene	228,8	10 cm	Linear/zero	Cadmium 1,000
Pb	Air-acetylene	283,3	10 cm	Linear/zero	Lead 1,000

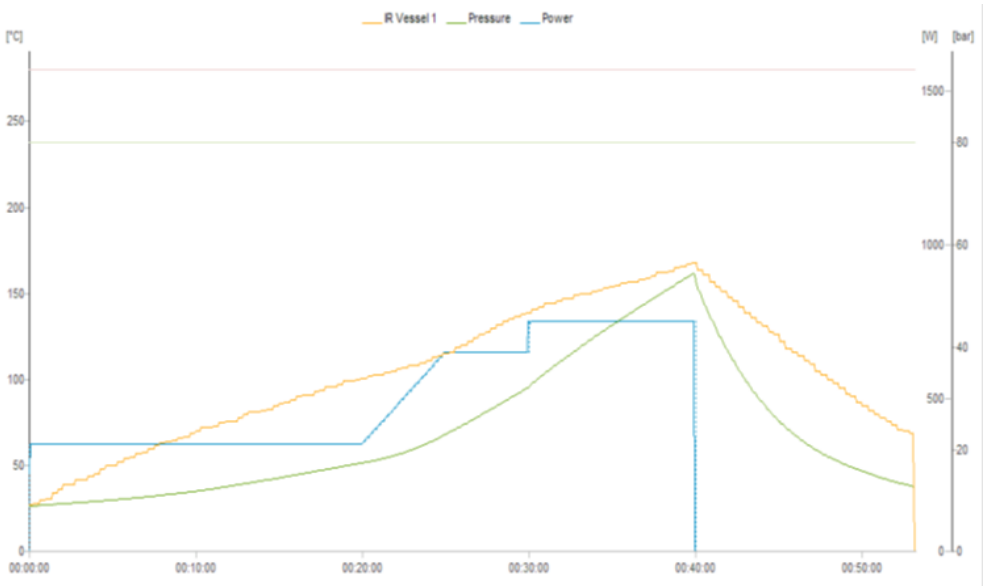


Chart 1: Incineration phase processes

3. RESULTS

Atomic absorption spectrophotometry with Zeman correction obtained values of heavy metal concentrations of cadmium and lead in cigarettes and cut tobacco purchased from different manufacturers, as shown in Table 3. Pb concentrations were below the AAS decay and applied methods while Cd concentrations were measurable in the samples used.

Table 3: Heavy metals concentrations in samples in ppm (mg/kg)

No.	Heavy metals concentrations ppm (mg/kg)	
	Cd	Pb
1.	0,0085	<0,001
2.	0,0075	<0,001
3.	0,0092	<0,001
4.	0,0100	<0,001
5.	0,0100	<0,001
6.	0,0117	<0,001
7.	0,0114	<0,001
8.	0,0134	<0,001

Concentrations of heavy metal Cd ranged from 0.0057 to 0.0134 mg/kg in cigarettes and cut tobacco, as shown in Figure 1. All values of Pb concentrations were less than 0.001 mg/kg.

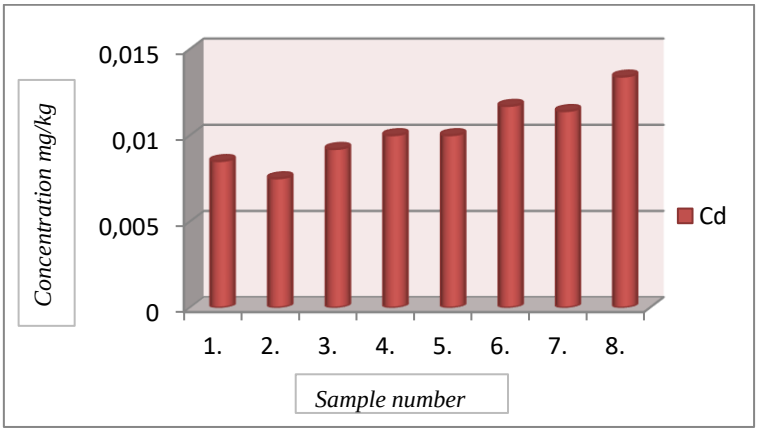


Figure 1. Cd concentration in cigarette and tobacco samples

The values of lead concentration in all samples, both in cigarettes and in cut tobacco, were below the detection concentrations of the device. Considering that according to the EU Regulation on health safety of consumer goods, including cigarettes, the Maximum Residue Limits (MRL) for lead is 10 mg/kg, it can be concluded that the measured concentrations for lead are significantly below the MRL because they are <0.001 mg/kg. The lowest measured concentration for cadmium was in sample number 5 (0.010 mg/kg), and the highest measured concentration was for zinc in sample number 4 and was 0.0228 mg/kg.

4. CONCLUSION

Legislation in B&H for heavy metals in cigarettes has not been adopted, but there is a Law on Restricted Use of Tobacco Products which regulates the limited use of tobacco products, obligations of manufacturers, ban on advertising and sale of tobacco products and other issues to protect and improve public health from harmful effects tobacco products („Official Gazette of the Federation of B&H", No. 6/98). Also, in Bosnia and Herzegovina The Law on Tobacco is in force, which regulates the production, purchase, processing, processing and trade of raw tobacco in the sheet, and production and trade of tobacco products, but doesn't define the values of heavy metal concentration in tobacco and application of the EU Directive is in force. Cadmium and lead concentrations in all samples were quite low, but since these are heavy metals that belong to First group of carcinogenic elements for humans (according to the IARC - International Agency for Research on Cancer), it is necessary to be extremely careful and reduce or reduce stop using tobacco and tobacco products altogether, because in addition to heavy metals, the particularly harmful ingredients of cigarettes are tar and nicotine (Directive 2001/37 / EC).

5. REFERENCES

[1] Bošnir J. Čulig J. - Metals and semimetals in the environment, Medical Polytechnic Zagreb, (2005).
[2] Gustavo F.S.V., Karina S.G. and Hose Antonio M. (2010) - Assessment of carcinogenic heavy metal levels in Brazilian cigarettes, Environmental Monitoring and Assessment 181(1-4):255-265.
[3] Abdulkadir L., Yavuz Y. and Cengiz D. - Determination of trace metal and mineral levels in the tobacco and cigarette samples using by FASS, Journal of The Chemical Society of Pakistan, No. 2, Vol.35, (2013).
[4] Yebpella G.G., Shallangwa G.A., at all - Heavy metal content of different brands of cigarettes commonly smoked in Nigeria and its toxicological implications, The Pacific Journal of Science and Technology, No.1(12), p.p 356, (2011).
[5] Mench, M.J. - Cadmium availability to plants in relation to major long-term changes in agronomy systems. Agriculture, Ecosystem and Environment 67 : 175-187. (1998).
[6] Directive 2001/37 / EC of the European Parliament and of the Council on the approximation of the laws, regulations and administrative provisions of the Member States relating to the manufacture, presentation and sale of tobacco products, (2001).
[7] Šarkanj B., Kipičić D., Vasić Đ., Delaš F., Galić K., Katalenić M., Dimitrov N. and Klapec T. - Chemical and physical hazards in food, Osijek (2010).
[8] Pehlic E., Šapčanin A., Ljubijankić S., Srabović M., Nanić H. - Determination of heavy metal concentration Pb and Cd in honey by AAS, Balkan Journal of Health Science, Volume 3 / Number 2: 43-50. (2015).
[9] Waqar Ashraf M. - Levels of heavy metals in popular cigarette brands and exposure to these metals via smoking, The Scientific World Journal article ID729430, (2012).
[10] Sofilić T. - Ecotoxicology, University of Zagreb, Sisak (2014).
[11] Rulebook on maximum permitted quantities of certain contaminants in food, Official Gazette of BiH, No. 37/09, (2009).
[12] Law on Restricted Use of Tobacco Products and basic provisions, Official Gazette of the Federation of B&H 35/98, (1998).
[13] Law on Tobacco of Bosnia and Herzegovina, Official Gazette of B&H No. 32/10 (2010).
[14] Đorđević J., Maćej O., Atomic absorption spectrophotometry and its application, Faculty of Agricultural, Zemun, (1982).
[15] Rouessac, F. and Rouessac, A. - Chemical Analysis Modern Instrumentation Methods and Techniques, University of Le Mans, France, (2007).

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Općina Bosanska Krupa

Općina Ključ


TÜV
DOO KOV-GRAD
BUŽIM
KOV GRAD


BOSANKAR


JELA-GRMEČ d.o.o.
Bosanska Krupa


AUSTROTHERM
termoizolacija

ŠPD Unsko – Sanske Šume

Bihaćka pivovara

Sanny Boy d.o.o. Bihać

ACMA GROUP d.o.o. Bosanska Krupa

Općina Bužim

Hara d.o.o. Visoko


GRAWE
osiguranje d.d.


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