INCREASING THE USE OF WOOD IN THE GLOBAL BIO-ECONOMY

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University of Belgrade
Faculty of Forestry

WoodEMA, i.a.
International Association for Economics and Management in Wood Processing and Furniture Manufacturing

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PREFACE

The University of Belgrade-Faculty of Forestry is honored to organise the 11th annual international scientific conference held in Belgrade, September 26th - 28th, 2018, under the auspices of WoodEMA, i.a. The conference was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia.

This proceedings of scientific papers contain 46 papers of 99 authors from 12 countries, as a results of their research in the field of economics, organisation, marketing, trade and environmental issues in wood and furniture industry.

The main goal of the conference is to transfer knowledge and experience from the field of bio-economy and management of the wood and furniture industry as reflected in the conference title: INCREASING THE USE OF WOOD IN THE GLOBAL BIO-ECONOMY. A special attention was paid to innovations in wood and furniture industry, the main competitive factor of the companies operating in these industries.

This is the second conference jointly organised by the University of Belgrade-Faculty of Forestry and WOODEMA Association. The first one was held in Belgrade too, from June, 25th to June 27th, 2008.

The organisers of the conference tried to continue the tradition started in Belgrade 2008 and they expect that this year's conference enabled the exchange of valuable information and knowledge among participants and will be useful for implementation of this knowledge in the future.

Editor

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PERCEPTION OF INTELLIGENT AND ACTIVE PACKAGING WITH REGARD TO PACKAGING FROM WOOD-BASED MATERIALS

Martina Nosáľová, Erika Loučanová, Ján Parobek

ABSTRACT

The importance of packaging functions is still growing and consequently, the companies tend to access to the packaging more innovatively and creatively, resulting in the creation of packaging with interactive features in the form of active and intelligent packaging. The paper focuses on the perception of active and intelligent packaging functions among different age categories of consumers in Slovakia with regard to packaging from wood-based materials. The analysis allows more specific suggestions for future research needs in the emerging topic area within the bioeconomy as well as recommendations for wood-based material use regarding the future development of packaging. According to the results as attractive is mostly perceived the containment and convenience function of packaging. Environmental issues affect consumers during their purchase and ecological function of packaging is influential. Wood is still perceived as environmental most friendly packaging material and therefore wood-based materials with specific properties have potential to be widely used as packaging material also an innovative way.

Key words: innovation, active packaging, intelligent packaging, functions of packaging, wood-based packaging.

1. INTRODUCTION

The packaging is one of the most important parts forming the product. Its size, shape, design, selected colour and font significantly influence the consumer decision-making process and thereby affect the marketability of the product itself (Kotler, 2001). It can be understood as a tool or set of tools to protect the products from a potential damage. It allows better handling, facilitates the marketing and consumption of products. The package moves through various stages of marketing and consumption. Accordingly, the package can be divided into three stages which are – transport, sales and consumer package. The transport package has the protective and rationalizing function during handling, storage and transport process (Zeman, 2005).

Traditional perception of packaging classifies the main functions of packaging into four basic categories: protection, communication, convenience and containment (Paine 1991, Robertson, 1993 In Yam et al. 2005), nevertheless, these functions are not totally exclusive – for example, the communication function of the package can also help to enhance food protection and convenience. The package is used to (Yam et al., 2005):

- protect the product against the deteriorative effects of the external environment,
- communicate with the consumer as a marketing tool,
- provide the consumer with greater ease of use and time-saving convenience,
- contain products of various sizes and shapes.

When creating product innovations it is necessary to think about the product at different levels whereas each level increases its value to the customer. Innovative packaging is the result of creative, unconventional thinking outside the usual framework of thought (Yam et al., 2005).

The result of an innovative approach to packaging is the creation of packaging with interactive features. Actually, two groups of such packaging systems are distinguished: intelligent and active packaging. They focus to improve packaging functions to meet current consumer demands, increased regulatory requirements, as well as increased interest in security. Active packaging represents a shift in the perception of functions, namely, the protection function of packaging has been shifted from passive to active (Yam et al. 2005).

Active packaging allows actively changes the condition of the package to extend shelf life or improve food safety while maintaining the quality of the food (Kačeňák, 2011). Intelligent packaging is a packaging system that is capable of carrying out intelligent functions (such as detecting, sensing, recording, tracing, communicating, and applying scientific logic) to facilitate decision making to extend shelf life, enhance safety, improve quality, provide information, and warn about possible problems (Yam et al., 2005; Kačenák, 2011; Sosnovcová, 2008).

Each company should monitor changes in consumer preferences when choosing the packaging and its launching on the market. It also must draw its attention to new technologies of packaging production. Through the packaging, it is also possible to reveal the relationship of the company to the environment and nature by finding whether the company uses scarce or recycled materials (Pajtinková-Bartáková, Gubíniová, 2012).

Choosing the adequate packaging material is an important task. It ensures full functionality of packaging and fulfills specific packaging tasks. At the present time wood is still very required material. Wood as renewable and ecology material has a lot of advantages and it is necessary to prefer it as the material also in the packaging industry. The key benefits of wooden packaging are a lifelong natural product with great design variety. We have to mention that wood has individual character, underlining quality awareness. It is a renewable, resource-friendly raw material that behaves completely CO2-neutrally in. In general, wood is used at all levels of transportation. Wood crates are one of the best materials for packaging. They are self-supporting structures that are the ideal choice for shipping various products, especially lightweight or breakable items. The advantages of wooden crates are that can be manufactured and repaired locally. Wood is relatively resistant to different weather conditions and is often used on more than one journey (Mujtaba, 2015). Wood-based packaging can save resources themselves as well as nature. Therefore the paper deals with the perception of intelligent and active packaging by Slovakia customers with regard to packaging from wood-based materials.

2. METHODOLOGY

Kano model method was used to determine how are the active and intelligent packaging functions perceived by Slovak customers. The aim of the Kano model is to capture customers' opinion according to the requirements of an observed object (Goodpasture, 2003). The methodology consisted of several steps:

- compiling questionnaire to individual functions of packaging innovations,
- questionnaire measures for gathering specifiable information,
- evaluation,
- processing the results in a matrix of the typology of perception of packaging innovations in terms of the functions by respondents and subsequent interpretation.

KANO questionnaire is compiled based on the monitored parameters, in this case, packaging functions – protection, communication, convenience and containment. According to packaging functions definition by Yam et al. (2005) we considered expansion of protection and containment function as a nature of active packaging and the expansion of communication and convenience function as a nature of intelligent packaging. The questionnaire consisted of pairs of positively and negatively conceived statements regarding the performance of these packaging functions. According to the methodological approach, respondents had an opportunity to respond every question (statement) on a scale from 1 to 5 representing a strong agreement to a strong disagreement with that question (statement) based on the draft.

The sample of respondents was set at 120 respondents in Slovakia, keeping the same proportion of respondents for each given age category.

In the following analyses, received responses are evaluated according to the cross rule (Table 1).

Table 1. The Kano Model

		Answer to the Dysfunctional Question					
		Like	Acceptable	No Feeling	Must-be	Do not like	Other
Answer to the Functional Question	Like	S	A	A	A	O	
	Acceptable	R	I	I	I	M	
	No Feeling	R	I	I	I	M	
	Must-be	R	I	I	I	M	
	Do not like	R	R	R	R	S	
	Other	"Other" responses are ignored					

*Source: Grapentine, 2015

The responses are subsequently evaluated by two-factor analysis based on age categories. Based on the Kano model, the findings were included in the following categories according to how respondents perceived intelligent and active packaging functions (Grapentine, 2015; Loučanová et al., 2016, Ducár et al., 2006, Regattieri et al., 2014):

- M (mandatory, must be requirements, primary, basic) – are obligatory requirements that customers consider as normal and are automatically expected. Identifying them is an elementary importance mainly because even though their fulfillment is reflected in customers' satisfaction, their deficit and failure are reflected in customers' dissatisfaction as they immediately realize it.
- O (one-dimensional requirements) – that are represented by those product attributes that lead to fulfillment and satisfaction in the event of non-compliance to customers dissatisfaction, i.e., the higher the degree of compliance with these requirements, the customers are more satisfied, but compared to the M-requirements customers automatically do not expect them.
- A (attractive requirements) – that have a clear and significant impact on customers satisfaction because it is a requirement that customers did not expect.
- R (reverse requirements) – are contradictory, they bother customers, as they require some additional action from them.
- I (indifferent requirements) – are requirements which do not have any influence on customers. This category involves the attributes that are not critical for customers and their pass or fail does not affect their satisfaction or dissatisfaction.
- S – are skeptical, questionable requirements

The results of Kano model divided the monitored packaging functions into categories of mandatory, attractive, indifferent and reverse functions. Subsequently, the comparison analysis, which aims to identify and measure comparable data, was used to identify the differences between customers' perceptions of intelligent packaging functions and customers' perceptions of active packaging functions.

The comparison analysis was based on the customer requirements identification by Kano model. In the next step, the weight was assigned to these requirements. Every identified requirement represents value 1, which was multiplied by weight according to identified category as follows: must be = 3, attractive = 2, one-dimensional = 1, indifferent = 0, reverse = -1 (Loučanová, 2014, 2015). Based on the sum of values, we can compare customers' perceptions of active and intelligent packaging functions and we identify the target age group for active and intelligent packaging.

To conclude the recommendations and conclusions of the phenomenon of perception of packaging innovations in terms of their functions are made according to the Kano model.

3. RESULT AND DISCUSSION

Based on the literature review, currently, different authors deal with several ways of the packaging functions classification. The traditional perception of packaging classifies the main functions of packaging into four basic categories: protection, communication, convenience and containment. The importance of active and intelligent packaging means mainly significant expansion of two packaging functions: protective function – especially in active packaging shift from passive to active protection and information functions – especially as intelligent packaging providing information monitoring the packing conditions. According to that, we considered expansion of protection and containment function as a nature of active packaging and the expansion of communication and convenience function as a nature of intelligent packaging

For identifying the requirements of the packaging functions among respondents in Slovakia the Kano model was used. The survey results indicate different attitudes of respondents in Slovakia to intelligent and active packaging functions according to the age. The customer's value (table 2) was calculated as the sum of the points that have been assigned to the individual categories of the questionnaire, according to the methodology.

Table 2. The comparison analysis of perception of inteligent and active packaging functions by customers in Slovakia

Packaging funcions	*Age*														
	18-30			*31-40*			*41-50*			*51-60*			*61+*		
	R_e	*AP*	*IP*	R_e	*AP*	*IP*	R_e	*AP*	*IP*	R_e	*AP*	*IP*	R_e	*AP*	*IP*
Containment	*I*	*0*		*R*	*-1*		*A*	*2*		*O*	*1*		*A*	*2*	
Protection	*I*	*0*		*O*	*1*		*O*	*1*		*O*	*1*		*I*	*0*	
Communication	*I*		*0*	*I*		*0*	*O*		*1*	*O*		*1*	*I*		*0*
Convenience	*O*		*1*	*O*		*1*	*A*		*2*	*O*		*1*	*I*		*0*
Total		*0*	*1*		*0*	*1*		*3*	*3*		*2*	*2*		*2*	*0*

*Notes: R_e – Requirement, AP – Active packaging, IP – Intelligent packaging
*Source: authors' computation

The active and intelligent packaging functions are most positively perceived by the respondents aged 41 to 50, followed by older age groups (51 – 60, 61 and older), who are attributing the most significant values to these functions. As attractive is mostly perceived the containment and convenience function. Containment is a key factor for all other packaging functions. The containment function significantly contributes to protecting and preserving products during their distribution, keeping the product together, keeping product safety and storage. The convenience function encompasses all the packaging attributes that provide added value and convenience to the users of the product and/or package.

Active packaging is valuable mostly for the respondents aged 41 and older, for whom the active packaging represents attractive and one-dimensional requirements. They represent those active packaging attributes that lead to fulfillment and satisfaction and in the event of non-compliance to customers' dissatisfaction. The attractive requirements have a clear impact on customers satisfaction increase - the higher the degree of compliance with these requirements is, the customers are more satisfied. The younger ones (less than 40 years) are not affected by active packaging and their functions. These functions are indifferent to them, it involves the attributes that are not critical for customers and their pass or fail does not affect their satisfaction or dissatisfaction. To conclude the research results clearly indicate that the respondents in younger age are more oriented to the intelligent packaging. The generation of middle-aged is interested in intelligent and also in active packaging equally. And finally, the older age categories rather prefer only active packaging.

Active and intelligent packaging influence customer decisions mainly as a one-dimensional requirement, i.e. those active packaging attributes that lead to fulfillment and satisfaction and in the event of non-compliance to customers dissatisfaction – the higher the degree of compliance with these requirements, the customers are more satisfied. Occasionally they can be perceived as attractive requirements for the customers that have a clear and significantly increasing impact on customers satisfaction because they are requirements that customers did not expect.

Active and intelligent packaging besides expanding the packaging functions are also related to the choice of right packaging material to fit these functions and other consumers requirements. Consumers demand products that fit into their lifestyles and the packaging industry has to respond to this. Since the consumers increasingly tend to sustainable living, also the ecological function of packaging is very important. Also according to our findings, consumers in Slovakia perceive ecological function of packaging as attractive (Loučanová et al., 2017; Kalamárová et al., 2014; Šupín, 2014; Parobek et al., 2015, 2016). When monitoring environmental friendliness of the packaging material, according to our survey the eco-material used for packaging affects almost half of respondents (48 %). They prefer a recyclable material from a non-recyclable material and for environmental friendly they consider wood (90 %), paper (86 %), materials made of grass and straw (86 %), bamboo (52 %) and wood-based materials (47 %) (Loučanová et al., 2016; Kaputa et al., 2017; Olšiaková et al., 2016). For comparison according to Opinion Research (Glass Packaging Institute, 2010) consumers rate paper and glass packaging as the best for the environment; according to UK survey (Labels and Labeling – the world of package printing, 2018), paper and cardboard received the highest score for being better for the environment and easier to recycle and, in terms of practicality, easier to open and close, easier to store, lighter weight, more practical and safer to use.

Based on research results as well as observation of intelligent and active wood-based packaging in Slovakia, most recognizable on the market are the intelligent ones and the active ones are purchased automatically without awareness of the customers about their active features. There are still wide possibilities to use more wood-based materials as active forms of packaging, with use and support of excellent hygienic properties of wood, indicated by results from various R&D projects as stated the European Federation of Wooden Pallet and Packaging Manufacturers FEFPEB. As well as the results of the research demonstrate the consumers' interest in both active packaging and wood, paper or wood-based material as packaging material exists, we can conclude as also Lahti and Kamppuri (2017) emphasized, that wood-based materials like cellulose and other biopolymers provide new interesting alternatives for packaging applications.

4. CONCLUSION

The interest of the companies is to access to the packaging more innovatively and creatively regarding also an important task of choosing the adequate packaging material. Actually, wood as a renewable and ecological material has a lot of advantages, it is still very required material and therefore it is necessary to prefer it also in the packaging industry. In the paper, we monitored the perception of the active and intelligent packaging functions among different age categories of consumers in Slovakia with regard to packaging from wood-based materials. As attractive is mostly perceived the containment and convenience function, consumers consider also environmental issue of packaging and ecological issue affects their purchase. Consumers demand products that fit into their lifestyles and the packaging industry have to respond to this. Since the consumers increasingly tend to sustainable living, the ecological function of packaging is very important. Also according to our findings, consumers in Slovakia perceive ecological function of packaging as attractive. Wood is still perceived as environmental most friendly packaging material and there are wide possibilities to use more wood-based materials as active forms of packaging, with the support of excellent hygienic properties of wood. Therefore, more information is needed on the role of growing environmental awareness and preferences for wood as a renewable and recyclable material in the markets. Based on the analysis, we are able to more specifically point out potential pathways regarding the future development of packaging to a basic wood material, and make more elaborate suggestions for future research needs in this emerging topic area within the bioeconomy.

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CUSTOMER SATISFACTION SURVEY IN THE FURNITURE INDUSTRY

Robert Ulewicz

ABSTRACT

The article presents the results of client satisfaction surveys of the furniture industry in the Silesian and Lodz voivodships. In the respondents, the Servqual method was used as a tool for measuring the quality of services offered by furniture manufacturers. One of the basic sales rules is the awareness that customers do not buy the product or service itself, but the resulting set of benefits. This means subconscious thinking of customers about what is important to them in the product. The results of the Serqual surveys are to indicate the areas of customer satisfaction from the entire purchase and installation of furniture.

Keywords: Servqual, customer satisfaction, furniture

1. INTRODUCTION

The furniture industry in Poland is undergoing enormous changes connected with its dynamic development and the increase of customer requirements and awareness [4]. The goal of the furniture manufacturer is not only to create a product in the form of furniture, but to meet the client's expectations. These expectations are not just about buying furniture. This is the whole process in which we can distinguish between sub-processes: information-advertising, consulting, sales, purchase financing (installments, credit - deferred payment), assembly, service and more and more often offered the option of buying old furniture. Customer satisfaction is not limited only to material attributes - the appearance of furniture, their quality and functionality [15]. On satisfaction have influence intangible attributes such as the ability to communicate with the customer, sensitivity to customer needs and employees' competences (knowledge and skills) necessary to provide the customer service in a full range (consulting, sales, choice of financing method, transport, assembly, selection of warranty and insurance options) [10, 14, 16]. The question arises whether the furniture industry reacts quickly enough to the needs of the market, in particular to the client. To this end, SERQUAL was used as one of the methods for testing the quality of services.

The SERVQUAL method was developed by A. Parashurman, L. Berry, V. Zeithaml [13] in the late 1980s. The authors measured perceived services (P - perception) and customer expectations (E - expectation). This method allows to examine the quality of the service offer from the point of view of the client's decision-making process as well as from the service organization perspective, understanding the quality of the service as the difference between perception and expectations. Thanks to it, you can research buyers of services, direct contact staff and company management. Additionally, it can be used to segment the company's clients. The analysis allows to identify the target market and to identify the actions necessary to improve the company's image [1,11, 12]. Determining what should be improved requires an in-depth analysis of customer satisfaction from the course of service provision and from the level of its relationship.

A.Parashurman and the team have identified a model of five gaps (gaps) in the quality of the service:

- Gap 1 - the difference between the expectations of the consumer and the perception of these expectations by the managers.
- Gap 2 - the difference between the perception of the clients' expectations by the managers and the physical features of the service (standardization).
- Gap 3 - the difference between the specification of the quality of services and the actual level of the service provided.
- Gap 4 - the difference between the level of the service actually delivered and the information provided to the client about this service.
- Gap 5 - the difference between the client's expectations and the services he perceives.
- The factors that shape customer expectations include:
- oral communication,
- personal needs,
- previous experience, communication skills of service providers.

Five features have been established to ensure satisfying customer needs:

- tangibles – material housing of the service: equipping the company with appropriate equipment, devices, employees' clothing,
- reliability – reliability of the service: execution of the order according to the requirements, in a timely manner;
- responsiveness – reaction to market needs: in a reliable manner, in line with the client's expectations, speed of the company's operations and reactions;
- assurance – professionalism and reliability: substantive knowledge of the employee, tact and the ability to gain customer trust;
- empathy – empathizing with the client's needs, individualized approach, care, communicativeness, accessibility.

Finally, in order that the quality measurement using the Servqual method was carried out correctly, three questionnaires are used. The first one defines 22 conditions that may be important for the perfect performance of the service in a given organization on the market. In the second, the same 22 conditions become the criteria taken into account when assessing the performance of a given service by a particular organization. In the third one, the customer is asked to split 100 points at his own discretion into the five quality components listed in the questionnaire [19]. Determining the perceived quality of services consists in calculating the difference between the perception of the service and the ideal (desired, expected) level of services, which also allows to capture the gap that emerges between expectations and the perception of the service. It is possible thanks to this approach to capture those elements to which the greatest attention should be paid in terms of providing customer satisfaction [2,7,8].

Serqual surveys can be supplemented by research results based on the mystery customer technique. This type of activity may contribute to improvement of service standards and its standardization, and as a consequence translate into an increase in turnover on the domestic market [18]. Before starting the Mystery Customer type study, however, one should ask yourself what service areas should be inspected. Since we are dealing with a situation in which customers “do not queue up for furniture”, it is necessary to pay attention to the area of sales competences and product competence of sellers in furniture showrooms. In the eyes of the clients, the seller with a professional knowledge of the offered goods looks much better, can discuss the functional attributes of the presented products, as well as clearly present the terms of the transaction: warranty, post-warranty service, the possibility of returning the goods. These are the more important issues, the more expensive the purchase we make. Taking into account the area of sales competences, employees employed in the furniture showroom should be able to diagnose the needs, the client’s taste and choose the right assortment to meet his expectations. At the same time, the seller should be persuasive in his action and use a number of sales techniques. The last area, very often included in the Mystery Customer type study, is the aesthetics of the premises, housing conditions. Taking into account the specifics of the furniture industry, the most common location is large halls, you have to approach this issue quite individually. However, it is not advisable to completely marginalize this factor. During the Audit Mystery Customer, carried out in furniture sales outlets, surely you should pay attention to such elements as:

- Visual of furniture showroom,
- Attractors of attention,
- Bottlenecks,
- Enhancement areas,
- Hot shots.

In order to comprehensively analyze customer satisfaction, it is advisable to use both methods of testing the quality of services related to the sale of furniture.

2. CLIENTS OF THE FURNITURE INDUSTRY

The consumer research carried out indicates that as many as sixty-one percent of the surveyed customers purchased new furniture in the last three years. There was also a tendency to buy new furniture along with the increase in household income. Interesting is also the distribution of the purchase of types of purchased furniture in the last three years. The percentage share of the purchased types of furniture is as follows:

- living room furniture 40%,
- kitchen furniture 36%,
- bedroom furniture 35%,
- holiday upholstered furniture 29%,
- garden furniture 20%,
- children’s or youth furniture 20%,

- built-in or hallway furniture 18%,
- office furniture 6%,
- other 2%.

Poles most definitely buy furniture in network furniture stores. This response was indicated by as many as seventy percent of all persons participating in the study (respondents could indicate more than one answer). The next place in terms of frequency of shopping is not network furniture stores, the answer is nearly thirty percent of respondents. The third most popular shopping destination is the internet, twenty-eight percent answer. About twenty four percent of respondents decide to buy furniture in renovation and construction stores. However, this applies in particular to kitchen furniture, built-in furniture and garden furniture. About twenty-two percent of respondents buy directly at the producer or at the craft shop. Four percent of respondents buy furniture at marketplaces.

Analyzing a number of factors affecting shopping decisions, the functionality of the purchased furniture and its durability are of utmost importance to the consumer. In third place in terms of the importance placed the quality-price ratio of the product. An important factor is the high quality of the product, as well as the ability to match it to your individual needs have a big impact on their purchasing decisions [3,5,7].

Some factors considered generally relevant to the purchasing decision process have shown a smaller impact on the behavior of furniture buyers. This is the case, among others, in the case of fashion. The furniture brand also proved to be not playing a significant role in the decision-making process. The other conditions that have a relatively small impact on the behavior of customers in the furniture industry, is the recommendation of friends or family, the location of the store or the possibility of buying in installments. The process of selecting and purchasing furniture is preceded by an earlier recognition of the offer and the latest solutions. There are three sources of obtaining information on this topic: ready-made catalogs prepared directly by producers and sellers, websites and furniture sales outlets where customers have the option of physically looking at a furniture collection [17].

3. RESULTS OF THE SURVEY

The area of research carried out were furniture showrooms, craft workshops, marketplaces (purchased directly from the producer) in the Śląskie and Łódzkie voivodships in Poland, research on the quality of internet furniture sales services related to the whole area of Poland - an on-line questionnaire. The aim of the research is to examine the level of satisfaction of individual clients from the use of particular sales channels of furniture, i.e. furniture showrooms, craft workshops, marketplaces and online stores.

Each channel was examined separately by deliberately selecting the clients who use the given channel. Separate questions were prepared for each channel, but each of them examined five dimensions of the service: material dimension, reliability, reaction to customer expectations, professionalism and empathy. Customers of insurance companies were asked about an opinion based on their experience of how to buy furniture and they were presented in three dimensions:

- one - as a distribution channel from which customers would like to use in the future and how they imagine the quality of services provided by this channel,
- the second - which clients currently use and
- third - the minimum level of service provision accepted by the client.

The studies used a seven-level Likert scale where 1 means that the analyzed feature by the respondent is irrelevant - it is not important, while 7 is a very important feature. Also included is the so-called tolerance zone. In this perspective, the service buyer uses two categories of quality standards: the desired level of service quality and an acceptable level of service quality. The difference between these values is just a tolerance zone.

3.1. Furniture showrooms

Network and non-network furniture stores are the most popular among customers buying furniture. Furniture showrooms are the most popular furniture sales/distribution channel in Poland. The biggest differences between the expected current value regarding the quality of furniture sales services provided by a furniture showroom were observed in the area of empathy and professionalism. The lowest level of tolerance was found in the empathy (2.05) and material (2.11). Customers report the highest expectations in the area of response to customer expectations (3.72).

The smallest gap between expected and current quality was noticed in the area of reliability (1.95). The results obtained are shown in Figure 1, which also marks the tolerance zone.

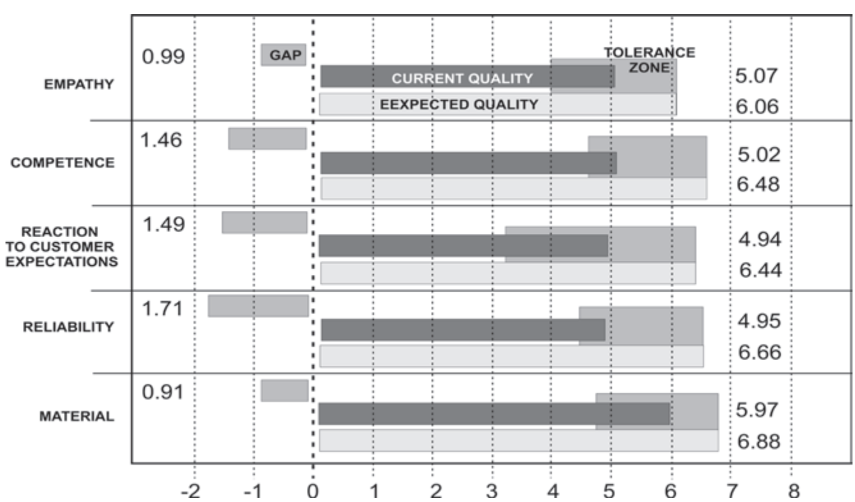

Figure 1. The gap between the current and expected quality of the furniture sale service provided by a furniture showroom

Table 1. The level of customer satisfaction with the sale of furniture in the furniture showroom

The dimension of the service	Furniture showroom		
	Average rating	Weight	Sub-CSI
Empathy	5.07	15	10.86
Competence	5.02	18	12.90
Reaction to customer expectations	4.94	35	24.70
Reliability	4.95	17	12.02
Material	5.97	15	12.79
Customer Satisfaction Indeks			73.27

3.2. Craft workshops

In the case of a difference between the current and expected quality of sales services provided by the craft workshop, the highest was observed in the category of competence (2.25). Customers have high expectations for this category (6.82), however the current value is much lower (4.57), although it is in the sphere of tolerance, which starts at 4.40. The smallest gap was found in the case of the dimension - response to customer expectations (1.25), the tolerance zone was 2.25. In the case of empathy, expectations were at level 6.51, however, the current value was 4.77, the tolerance zone starts at 4.50.

The results obtained for the craft workshop are shown in Figure 2, which also shows the tolerance zone.

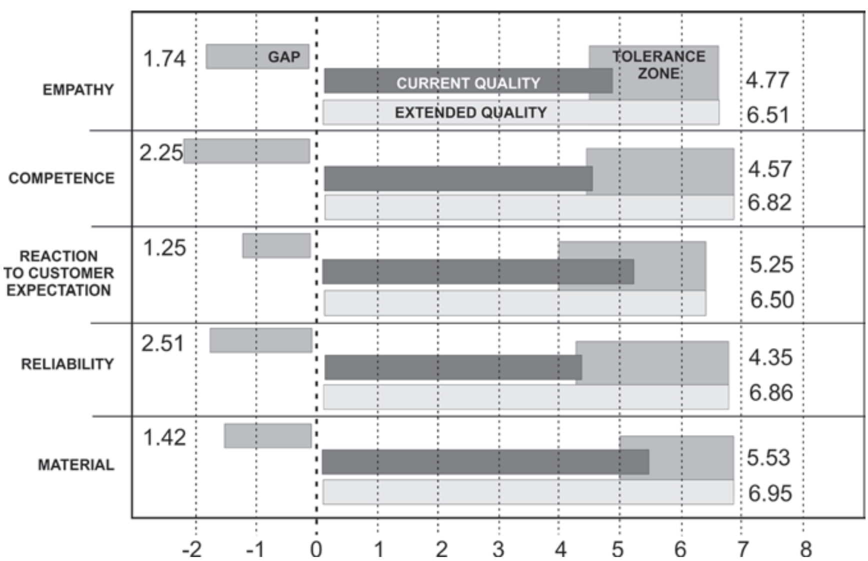

Figure 2. The gap between the current and expected quality of the furniture sale service provided by the craft workshop

Table 2. The level of customer satisfaction with the sale of furniture in a craft workshop

The dimension of the service	Craft workshop		
	Average rating	Weight	Sub-CSI
Empathy	4.77	11	7.49
Competence	6.82	22	21.43
Reaction to customer expectations	5.25	30	22.50
Reliability	4.35	22	13.67
Material	5.53	15	11.85
Customer Satisfaction Indeks			76.94

3.3. Marketplaces

In the case of a difference between the current and expected quality of sales services provided at marketplaces, the greatest was observed in the reliability category (2.16). Customers have high expectations towards this category (6.56), however the current value is much lower (4.40), although it is in the sphere of tolerance, which starts at 4.25. The smallest gap was found in the case of the dimension - professionalism (0.83), and the area of reliability is the biggest tolerance zone, where the zone starts from 4.30 and response to customer needs 4.05.

The results obtained for marketplaces are shown in Figure 3, which also shows the tolerance zone.

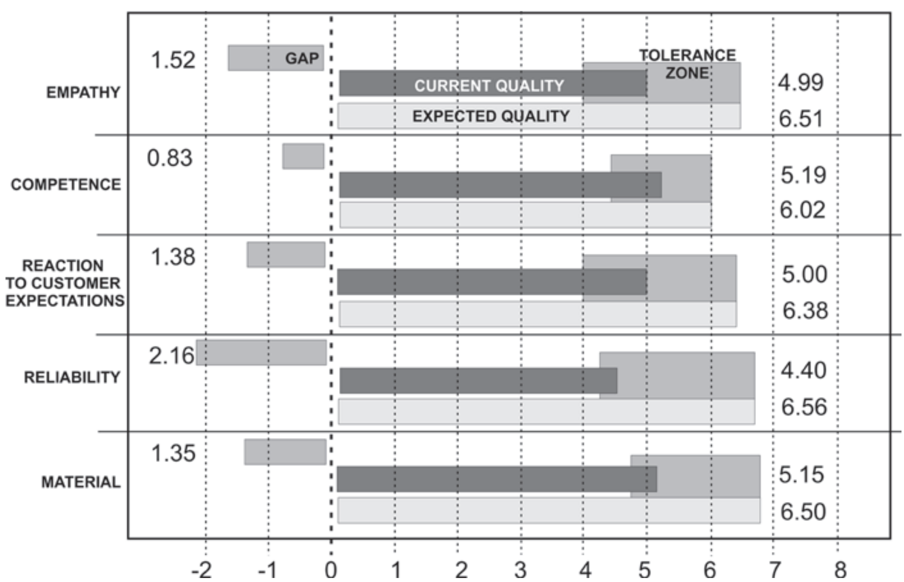

Figure 3. The gap between the current and expected quality of the furniture sale service provided at marketplaces

Table 3. The level of customer satisfaction with the sale of furniture at the marketplace

The dimension of the service	Marketplace		
	Average rating	Weight	Sub-CSI
Empathy	4.99	14	9,98
Competence	5.19	23	17,05
Reaction to customer expectations	5.00	27	19,28
Reliability	4.40	24	15,08
Material	5.15	13	9,56
Customer Satisfaction Indeks			70,95

3.4. Internet

The third most popular shopping place turned out to be the Internet, reaching 28% of responses. Indeed, people between the ages of 26 and 35 and people with higher education (43%) buy more frequently than others on Internet. This shows that younger customers are definitely more open to online offerings and online shopping. In addition, 41% of respondents are considering the purchase of furniture in this channel in the near future. More and more people have access to the Internet and more and more people use it as a convenient form, which this measure provides. The biggest gap was created in the area of reliability (1.61), the lowest in empathy (1.10). In addition, in the area of reliability, the tolerance zone begins already at 3.70, while in empathy, 2.90.

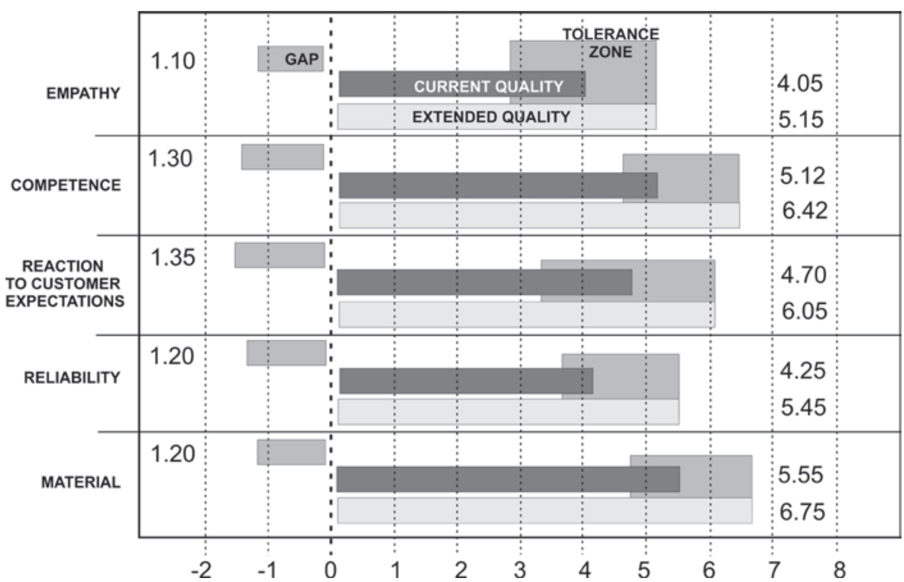

Figure 4. The gap between the current and expected quality of the furniture sale service provided via the internet

Table 4. The level of customer satisfaction with the sale of furniture on the Internet

The dimension of the service	Internet		
	Average rating	Weight	Sub-CSI
Empathy	4.05	10	5.78
Competence	5.12	21	15.35
Reaction to customer expectations	4.70	23	15.44
Reliability	4.25	25	15.17
Material	5.55	21	16.65
Customer Satisfaction Indeks			68.39

CSI Customer Satisfaction Index is one of the basic qualitative tools measuring the effectiveness of marketing activities and allows you to measure the level of customer satisfaction in relation to predefined categories recognized by buyers as the most important ones [9,20]. In order to calculate it, the average of all results obtained while assessing the quality of the company's operations is used (basic formula). In order not to disregard the fact that some aspects of the activity may be more important to clients than others, the partial satisfaction with the appropriate meaning weight is multiplied and the partial satisfaction gained in this way (extended formula) is added. The satisfaction index should answer the question: "To what extent does the enterprise succeed in satisfying customers in terms of n requirements which are most important to them?". Thanks to this approach, it will be possible to compare the indicators, while changing the priorities of the clients, but the number of attributes assessed unchanged, and it will be possible to analyze this indicator among different target groups of buyers of the same product or service. Respondents were also asked to allocate appropriate weights to individual categories (100 points in total).

Sub-Customer Satisfaction Indeks = sum of points awarded by customers in individual categories x weight / number of categories considered

CSI Customer Satisfaction we calculate according to the formula:

CSI = Sub-CSI1 + Sub-CSI2 + SUB-CSI3 + SCB-CSI4 + Sub-CSI5

where:
Sub- CSI – Sub-Customer Satisfaction for the dimension

1-epatia
2- competence
3-reaction to customer expectation
4-reliability
5- material

4. Conclusion

The development of technology is constantly contributing to changes when it comes to shopping habits of customers. With each passing year, you can see an increase in sales of furniture via the Internet. However, this distribution channel is currently characterized by the smallest level of customer satisfaction index Figure 5. Observing the current situation of e-commerce, it should be noted that in the near future one should expect further development of furniture sales through mobile devices. An important role in the development of this distribution channel will be played by the level of customer satisfaction.

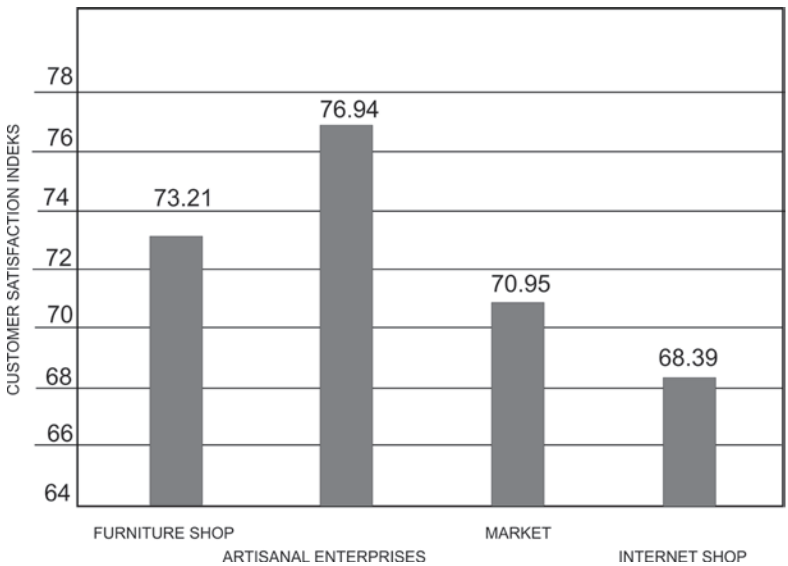

Figure 5. Customer Satisfaction Index using individual sales channels for furniture

When analyzing CSI (Figure 5), online stores have the lowest CSI factor - 68.39%. Highly by customers 76.94%, craft workshops were assessed in which you can directly purchase and adjust the piece of furniture to your preferences directly at the manufacturer. Small enterprises were accepted under the concept of a small craft workshops with up to 49 employees. Furniture showrooms as the most used shopping destination enjoy satisfaction at the level of 73.21%.

It was assumed that CSI level from 0 to 35% is considered unsatisfactory, level from 36 to 50% - not satisfactory, from 51-65% - average satisfactory, level from 66 to 85% - satisfactory and level from 86 to 100% - very satisfactory. The overall CSI of all channels is 72.37%, which is why it should be considered satisfactory.

The SERVQUAL method presented in this article may be used for customer satisfaction surveys from the furniture purchase process, however, it is necessary to take into account the specifics of the furniture market and local habits of the inhabitants of a given region. In Poland, it is still very popular to buy furniture at marketplaces where furniture manufacturers or dealers are exhibiting, this distribution channel was rated in third place at level of 70.95% .

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INFLUENCE OF BIO-ECONOMY ON THE DEVELOPMENT OF WOOD AND WOOD PRODUCTS CONSUMPTION

Mikuláš Šupín, Michal Dzian

ABSTRACT

Wood is used as a raw material to produce a wide range of products in the primary woodworking industry - mechanical processing: sawnwood, wood-based panels (veneers, plywoods, particle boards, OSB, fibre boards), etc., in the pulp and paper industry - chemical processing: wood pulp, paper, paperboard, etc., in the secondary wood processing industry: furniture, prefabricated buildings etc., structural wood products: wood-plastic-composites, biopolymers, etc. Furthermore, wood, wood products and by-products are used for energy purposes as fuels: fuelwood, woodchips, wood residues, pellets, bioethanol.

This paper deals with the analysis of the wood consumption from point of view wood production, export and import wood, the market development of this commodities and influence of bio-economy.

Policy harmonization still needs to allow room for each country situation in terms of wood availability and utilization. The emphasis in industries using wood-based biomass as raw material is moving toward the green economy. New opportunities are arising to versatile use of wood biomass and side streams. Renewal of the wood products is based on knowledge that is created by research, development and innovation processes. The bio-economy generates new economic growth and wellbeing as well as responds to major global phenomena such as the challenges presented by climate change. For companies, the bio-economy brings new business and an opportunity to produce higher value added products. For consumers, the bio-economy means an opportunity to choose a more sustainable lifestyle.

Key words: bio-economy, renewable resources, biomass, wood consumption, wood products trade

1. INTRODUCTION

Bio-economy implies a shift from fossil resources (oil) to renewable resources (biomass). This means that development and production of new products from biomass must happen in a sustainable manner. Compared to earlier use of biological resources, todays' bio-resources from farming, forestry and fishery will be used in technologically advanced productions. This will provide a wider range of products and create new jobs. (Bioeconomy and European Forest Week, 2017).

The development of the bio-economy has become a major policy focus within and among countries, each developing their own national strategy.

The EU defines bio-economy as “sustainable production and processing of biomass for food, health products, fibre products, industry, and energy”.

The U.S. definition encompasses health, agriculture, bioenergy, and food within the bio-economy, while the EU definition encompasses food, agriculture, forestry, and marine resources. There is a shift in the EU from researching the content of biological resources to the optimization of industrialized processes. (Bioeconomy and Forest Pedagogics 2016).

A “Bio-economy” is possible define as “the knowledge” based production and use of renewable resources to provide products, processes and services to all sectors of future sustainable economy.

A sustainable bio-economy needs the close cooperation between economical areas which usually do not work together (agriculture and forestry, food industry, chemical industry, plastics and plastic processing industry, wood processing industry, construction industry, energy industry and machinery and plant engineering). (Brack, D. 2018), (Maťová, H., Kaputa, V. 2018).

Current research is looking at sustainable utilisation of natural resources. All products are part of a biological, chemical and physical cycle, and reused time after time. This is how a circular economy works, as opposed to our current economy, which is linear. Circular economy focuses on extensive use of renewable materials, renewable energy, and to avoid wasting resources by exploiting them in the best possible manner. (Parobek, J. et al. 2016 a), (Paluš, H., Parobek, J., Dzian, M., Šupín, M. 2018)

Wood is surrounding us in our daily life. However, do we actually notice it? Have you ever considered how much wood we actually use? This activity is significant for both the youngest, and the older. The forest and wood industry relied in the past on their reputation of providing environmentally friendly and sustainable products. However, competition with other materials and customers has created the need to provide facts to support this traditional reputation. (Loučanová, E., Kalamárová, M., Parobek, J. 2015), (Parobek, J. et al. 2016 b).

Researchers in wood science and wood technology are increasingly being asked to consider how forest products research provides for sustainable choices. Where resources, time, and skills at working across disciplines are present, research that integrates ecological, economic, and social dimensions of forest management may address some important issues related to sustainable forest management.

The integration of social science represents a non-traditional approach to wood products research. It reflects a growing recognition that we cannot talk about issues of sustainability without talking about people. Integrated research about wood utilization that includes social science may enhance the relevancy of forest product research in contemporary debates about sustainable forest management. (Maťová, H., Dzian, M., Triznová, M., Šimo-Svrček, S. 2017).

Over 60 per cent of the world's forests – 2.4 billion hectares – are primarily or partially used for the production of wood and non-wood forest products. Wood fuel, including charcoal, accounts for about half of total global roundwood production, and industrial roundwood for the other half. Most wood fuel is used in its country of production, mainly in rural areas and in developing countries, for heating and cooking. Forests fulfil far more functions than simply the production of wood and non-wood products. Indeed, they are vital to achieving global sustainable development. (Parobek, J. et al. 2014), (Parobek, J.; Paluš, H. 2008), (Kaputa, V., Paluš, H., Dzian, M. 2017), (Šupín, M. 2013), (Parobek, J.; Paluš, H.; Loučanová, E.; Kalamárová, M.; Glavonjić, B. 2016).

To be a responsible citizen in the future one has to gain enough insight to all perspectives of forests - economic, biologic and social. This knowledge is critical future responsibility.

2. METHODS

The bio-economy utilizes new knowledge of life sciences to produce a wide range of products from the living organisms and the waste they generate, and is a major component of sustainable development. In pursuing these objectives and developing a strong bio-economy, agricultural, forestry, wood processing industries and resource economics research is essential to the development of policies that will guide the evolution of the bio-economy.

Economic analysis and decision tools are especially apt for researchers pursuing sustainable development goals, namely, economic growth subject to environmental and sociological constraints.

The analytic and synthetic methods were used to assess the market situation. Analysis of foreign market development was done based on the data from EUROSTAT, FAOSTAT, statistical offices and institutes of the international organizations selected countries regarding productions, exports, imports, consumptions and the most significant countries with which renewable resources, mainly wood solid biomass are traded. Secondary sources of the data from reports of international organizations and associations referring to wood biomass were also used in this paper.

The first section of the paper identifies major features of sustainable development's economic perspectives and presents tools to analyze and quantify the bio-economy. The second section introduces economic research on measuring the bio-economy and designing policies to steward it towards sustainable development objectives. The final section outlines the research for resource economics aimed at pursuing sustainable development and establishing a strong bio-economy sector for wood products mainly global wood production, consumption and trade of wood.

3. RESULTS AND DISSCUSION

The forestry and wood industry has been operating according to the principles of the circular economy for a long time already. Wood is a renewable resource and products made from it are recyclable. Wood processing side streams are further processed via industrial symbioses into high-grade products.

World forest products trade has grown rapidly in volume and value. The trend of rapid growth in both international trade of forest products and a concern for forests continues in the 21 century. These two trends are connected. Forces causing trade growth are linked to the loss of native forest resources in some countries and the accumulation of non-native forest resources in other countries. Factors increasing trade include relaxation of trade barriers, income growth, and improvements in wood growing, harvest, and manufacturing technologies. But environmental concerns are increasing as consumer preferences change, as native forests recede and plantation forests become more prominent.

Consumer awareness of bio - product options is essential, because consumers ultimately choose which of the alternatives available are most suitable for them. Wood-based solutions offer promising possibilities not only for sustainability conscious, but also for quality-oriented consumers.

As the scope of products, services and environments – in which wood as a raw material plays an important role – is widening at an accelerated pace, the role of consumers has to be taken into account in new ways.

Wood-based solutions respond to the challenge and offer promising possibilities. For instance, in the construction of multi-storey wooden houses, the use of ready-made modules accelerates the construction time at the building site and drastically reduces waste. The resulting cost savings enable construction companies to offer affordable high-quality housing to lower income consumer segments. The design and use of wooden interior elements is not only about decoration, but serves acoustic and sound-proofing purposes. The use of wood in interior solutions has proved to be a healthier choice and more pleasing to the eye.

In fact, wood-based products have surprising applications in encouraging healthier habits. Derivatives made from hemicelluloses, for example, xylitol has been demonstrated to prevent tooth decay when used after meals.

Policy-makers can facilitate the growing use of sustainable products and services with regulation and thus increase their market penetration.

The analyses revealed several findings, which are listed in this paper.

In most countries wood products are a ubiquitous part of modern life, being used in the construction of buildings, in furniture and cabinets, for the manufacture of paper, newsprint, tissues and packaging and many other products. In many countries wood is also used for heating and cooking and in some for electricity generation.

It is not surprising, then, that one of the main drivers of demand for wood products is population, currently growing, at a global level, at 1.1 per cent a year. (UN DESA WPP 2018). Not just its overall size but also its rate of growth, levels of urbanisation, migration and changing age structures. As well as the size of the population, its density in any given country, particularly in terms of density per unit of forest, provides a good indication of the pressure on forests in many countries.

Wood prices appear to have had a negligible impact on the supply of coniferous and deciduous assortments of wood. The existence of different explanatory effects for both types of wood suggested that their supply was partially linked to the different factors. The supply of wood was influenced by the volume of both incidental and actual felling. The results show that coniferous wood was elastic to the volume of incidental felling and to the rotation age of stand. On the other hand, non-coniferous wood was elastic to the volume of actual felling and to the costs items.

Demand for wood products is significantly affected by changes in income, in complex and interconnected ways. All else being equal, increasing income – often characterised as the ‘growth of the global middle class’ – tends to be associated with rising demand for wood products (apart from wood fuel, where generally demand falls), particularly those used in construction and housing.

The highest rate of growth as income rises is generally seen in the consumption of paper and paper products, including packaging. Consumption of paper products now appears to be falling in the US, however, and is growing only very slowly in Europe, suggesting that peak consumption may have been reached, probably connected with the increasing use of IT and social media and declining newspaper readership.

High-income and more highly educated populations also tend to be more sensitive to the environmental and social impacts of consumption and more willing to pay for ecosystem services. This may feed through to a greater propensity to demand recycled or certified sustainable wood products. Further changes in patterns of demand can be expected in the future, including, for example, a move away from plastics, particularly products such as single-use plastic bags. This may have the effect of increasing demand for paper packaging.

Developments are significantly affected also by business behaviour and public policy, which themselves relate to each other, which also considers efforts in producer countries to exclude illegal timber from supply chains, which can also affect the demand for wood products. One important set of policies affecting demand is the incentives put in place in several countries, mainly in the EU, for renewable electricity, heat and transport. This has led to a rise in the consumption of wood fuel, chips and especially wood pellets in many EU member states, and growth in the exports of pellets from North America and Russia mainly for the European market and Vietnam for Korea and Japan.

Developments in technology also affect the demand for wood products. These include developments in wood processing technology allowing improved rates of recovery and the use of small-dimension timber, mainly improvements in sawmilling technologies, the production of sliced veneer and reconstituted boards and panels. Also includes improvements in reuse and recycling, for example through the wider use of recovered paper or reconstituted wood products. This may be further encouraged by the adoption of circular-economy models focusing attention on the efficiency of resource use, including the 'cascading' use of wood, using it in the following order of priority: manufacture of wood-based products, extending the products' service life, reuse, recycling, use as bio-energy and finally disposal.

The key determinant of demand is the availability on the market of alternatives to wood, such as concrete or brick for construction, or metals or plastics for other products. The extent to which alternatives are used varies not only with their price but with local culture and habits and public policy. The recent growth in concern over the impacts on plastics on ecosystems and human health may encourage the greater use of paper for packaging.

4. CONCLUSION

It is possible to conclude from the analysis that the wood-based bio-economy certainly has the potential to make a substantial contribution to the transition from a fossil-based economy to a sustainable bio-based circular economy, providing certain conditions are met:

- The state has to create stable, long-term framework conditions for the development of the wood-based bio-economy. These comprise the direct promotion of innovative applications and technologies as well as steadily increasing costs for the fossil-based competitors. For this, coordination with global economic developments is just as essential as ensuring long-term political approval of the transformation towards sustainability.
- A learning bio-economy policy is pursued which considers the uncertainties associated with a higher demand for biomass for energy-related and material uses, and attaches great importance to the sustainability assurance of bio-based economic activity.
- Consumers recognise added social value in sustainable bio-based products, articulate a higher willingness to pay for those products, and are open to innovation. A consistent sustainability-oriented pricing policy, but also communication and information on the part of policy makers and businesses operating in the bio-economy.
- Businesses look for long-term development opportunities, focus on innovation and quality, and form political alliances which confront the supporters of maintaining "fossil development paths" in the political sphere, too (not just on markets).

- A clearly outlined, genuine field of bio-economy policy and a consistently pronounced, corresponding field of bio-economy law is forming.

The bio-economy generates new economic growth and wellbeing as well as responds to major global phenomena such as the challenges presented by climate change.

For companies, the bio-economy brings new business and an opportunity to produce higher value added products.

For consumers, the bio-economy means an opportunity to choose a more sustainable lifestyle.

The bio-economy now has very broad significance. Bio-economy products that are based on wood include, in addition to paper and paperboard, for example, sawnwood, wood panels, biofuels, and textiles or pharmaceuticals made from wood fibre.

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PURCHASING FACTORS FOR FURNITURE AND CONSUMER GOODS

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ABSTRACT

The paper investigates factors influencing consumers' purchase decision of the two groups of products. One group of respondents expressed preferences when buying furniture and the other group when buying consumer goods (authors do not consider furniture for a kind of consumer goods in conditions of Slovakia). The preferences of both groups were compared, and discussion brings findings on a level of influence (respectively differences and similarities) of selected purchasing factors in those two groups of products.

Keywords: purchasing factors, consumer goods, furniture, consumer behaviour

1. INTRODUCTION

Consumer decision process consists of five stages: need recognition, search for information, evaluation of alternatives, purchase decision, and post-purchase behaviour (Kotler, Keller, 2012). New technologies, wider products offer, is causing a change in customer behaviour (Greenberg, 2010). A customer has more information, and it leads to the higher rate of competition among companies (Triznová, 2014). In order to keep long-term relationships with customers, companies need to define consumer journey precisely and build value in each part of it (Buttle, 2010), (Greenberg, 2010), (Triznová, 2014). That's why the deep understanding of consumer psychology, (Loudon, Della Bitta, 1993), and defining the factors that are affecting each part of the decision-making process is needed. (Lehtinen 2007), (Triznová, 2014). Knowing which factors are affecting decision-making process, helps companies to keep the customers satisfied (Luo, 2010), which can lead to repetitive purchasing (Parobek et al., 2015). Consumer forms criteria according to which compare of each product. Some factors are more important and have a greater impact on consumer decision. Usually, it is price and quality (Oblak et.al, 2017, p. 38 – 39). There might be also other factors like a web page, guaranty service, supply services, packaging and others (Parobek et al., 2015). The survey conducted in Slovakia, found out, that the price was no longer the most significant factor towards wood as a material of the products (Olšiaková, Loučanová, Paluš, 2016, p. 137). Another research in Croatia and Slovenia aimed at furniture buyers resulted, that the factors that have an impact on buyers are: price, payment possibilities and quality in Croatia, and in Slovenia it is: quality, price and after-sales services (Oblak et al, 2017). Since this paper is aimed at factors affecting consumer buying decision, we decided to compare two main groups: furniture buyers and consumer goods buyers. The factors with the highest impact on the buying decision-making process were searched within those groups.

2. MATERIALS AND METHODS

An electronic questionnaire survey was used to collect information from furniture buyers and consumer goods buyers in Slovakia. Two different questionnaires from two independent research studies were used for data analyses. Requests with the same meaning were chosen from these two consumers' buying behaviour studies. The following purchase decision factors like price, quality, environmental attributes, country of origin, brand, recommendations (not commercial) and advertising (promotion) were analysed. The food, clothing, personal care goods, household suppliers, and footwear were introduced to respondents as consumer goods. The questions regarding the decision-making process (in both questionnaires) were measured with a Likert type scale. Snowball sampling as a non-probability sampling method was used to spread the questionnaires in both cases. The survey process began in the spring and ended in the summer 2016 in the case of furniture buyers. Data from consumer goods buyers were collected during the February 2018.

For the evaluation of the collected data, a frequency analysis and cross-tabulations were used. To examine relations between the variables in contingency tables, the Pearson's chi-squared test was used at a level of significance $p < 0.05$. To assess the degree of association between two variables in contingency tables we used Cramer's V coefficient and the Pearson contingency coefficient. The tested hypothesis was based on the assumption that there are the different attitudes between two independent samples of respondents according to factors influencing their purchase behaviour (the furniture buyers and consumer goods buyers).

3. RESULTS AND DISCUSION

Analysed were responses from 453 respondents in the case of furniture buyers and 711 respondents representing consumer goods buyers. The six statistically significant differences were revealed in the frame of all the analysed questions. There is not statistically significant difference in preferences for the factor "quality of product" between the samples of respondents. Product quality requirements are not dependent on the surveyed product categories and consumers are demanding for quality products since over 80% of them in both samples considered it for important factor.

As for factor "**recommendations (not commercial)**", there is statistically significant dependence ($p = 0.0000$) between respondents buying furniture and respondents buying consumer goods. The strength of relation is moderately strong according to the contingency coefficient ($C = 0.442$) and the Cramer's V ($V = 0.492$). More than three-quarter of respondents buying consumer goods considered recommendations as an important factor in contrast with nearly one-third of respondents buying furniture. Such a big difference can be explained by the nature of the furniture – its style, design, colour, used materials, fashion and by consumer's lifestyle, needs, and preferences. Also, a length of product's utilisation in a household plays a role in considering recommendations or own opinion. Further factors are mentioned in related studies. Sproles (1974) noted that the fashion phenomena belong among factors which influence major consumer purchase decisions in products such as furniture, home furnishings, housing architectural design etc. Perry (2007) cited by Podner (2013) stated that buying furniture can be seen as an emotional purchase. Podner (2013) also concluded that furniture manufacturers and furniture retailers not only sell their product, but they are providing a way for consumers to spend time comfortably with family and friends in their homes. Overall, it could be stated that "a taste and a style" of the consumer play important role in buying behaviour and can overcome rational reasons and recommendations.

In case of the factor "**price**", a statistically significant dependence was found on p=0.0000. Moderately strong dependence was proved (C = 0.4 and V = 0.436). Overall, 6.46% of respondents do not consider the price as an important factor when buying furniture in contrary to respondents when buying consumer goods (36.29%). Approximately 80% of respondents perceived the "price" as important factor which influences their furniture buying decision and 38.26% of the respondents when buying consumer goods. Price of furniture as a durable good is higher than an average price of consumer goods that's why it might be more important for furniture buyers. Olšiaková, Loučanová and Paluš (2016) compared the changes in chosen consumers' requirements for wood products in 2004 and in 2014 in Slovakia. They stated that the most important wood products parameters influencing consumers' behaviour are mainly the quality and the material. The price as an influencing factor is no longer the essential customers' requirement. For nearly 85% of our respondents when buying furniture are important quality of product (manufactured quality), and price followed by country of origin. Other factors are important for less than one-third of respondents (environmental properties, recommendations (not commercial), brand, and advertising (promotion).

Surprisingly, the price of consumer goods is on the sixth place (from total of seven factors). Only approximately 38% of respondents perceived a price as an important factor when buying consumer products. We can speculate, that this finding is linked to nature of consumer goods (food, personal care products, clothes, footwear, household supplies, etc.) since most of those products are closely related to the health and well-being of individuals, who are focusing on other product features and purchasing factors instead of price. The factors: quality of the product, recommendations (not commercial), brand, country of origin and environmental properties are important buying behaviour factors for more than 58% of the respondents. The price and the advertising (promotion) took into consideration approximately 38% of respondents in this goods category.

Statistically significant dependence (p = 0.0000) was found in case of the factor "**brand**", where the contingency coefficient was 0.374 and the Cramer V had value of 0.403 what is moderately strong dependence. Nearly 39% of respondents when buying furniture did not consider "brand" as an important purchase factor and more than 35% of them had a neutral attitude. In contrary, almost two-thirds of respondents when buying consumer goods claimed that this factor is important. Similar findings about a brand (the study was aimed at a brand in general) were revealed in the study of Križanová and Štefániková (2013). They stated that more than 50% of Slovak customers are affected by a brand. The Slovak customers perceived a brand as "quality assurance or as a part of the image and purposeful stylisation of a member of a social group". They also found that "a large percentage of consumers build brand loyalty in a long-term and relatively high percentage of consumers remain loyal to the brand even after their disappointment with the product quality" (Križanová, Štefániková, 2013, p.32 – 33).

As for factor "**environmental attributes**", there is a statistically significant dependence (p=0.0000) between respondents buying furniture and respondents buying consumer goods. The strength of relation is weak (C = 0.283 and Cramer's V = 0.295). Surprisingly, nearly one-third of respondents who buy furniture did not consider this factor as important, while more than 37,5% of respondents had a neutral opinion. As mentioned in the study of Kaputa et al. (2018) approximately one-third of the respondents in Slovakia and Croatia had an indifferent attitude towards environmental attributes of furniture. This finding indicates that there is a fair number of consumers who do not consider the environmental issues of furniture production. Approximately 15% respondents who buy consumer goods have expressed that environmental attributes of consumer products are unimportant for them. On the other side, more than 58% of respondents (consumer goods) took into consideration the environmental attributes of goods during purchase while only 30% of furniture buyers had the same attitude. Consumer goods are closely related to a health of respondents. So, buying "healthy products" could be perceived as "healthy for the environment" as well.

The contingency analysis proved the statistically significant difference (p = 0.0000) between the two samples in the factor "**country of origin**". The relationship strength is weak (C = 0.271 and Cramer V = 0.281). When buying furniture this factor was unimportant for nearly 36.5% of respondents while only 17.86% of respondents who buying consumer goods had the same opinion. Country of origin took into consideration more than 38% of respondents when buying furniture. Approximately 60% of respondents when buying consumer goods claimed that this factor is important. This fact can be explained by the nature of consumer products (food, cosmetics, etc.). The previous study performed in Slovakia by Kaputa and Šupín (2010) showed a lower percentage of respondents (27%) that considered the country of origin as an important attribute when making furniture buying decisions.

An "**advertising (promotion)**" was another factor affecting buying decision. The analysis in the contingency table proved the statistically significant difference (p = 0.0000) between the samples in the case of the factor "advertising (promotion)". The strength of relation is weak (C = 0.199 and the Cramer's V = 0.203). More than half of respondents when buying furniture did not consider the factor advertising as important, and only 23,17% of them perceived this factor as important. Almost 38.5% of respondents when buying consumer goods considered "advertising" as an important factor and approximately one-third of them did not.

There are some interesting findings in the case of neutral attitudes toward analysed factors. More than one-third of respondents (furniture buyers) had the neutral attitudes toward the following factors: environmental properties, brand and recommendations (not commercial). Nearly one-quarter of them saw the country of origin and advertising (promotion) as neutral factors when buying furniture. As for the case of consumer goods buyers, less than one-third of them marked the option “neutral influence” in the case of advertising (promotion), environmental properties and price. The smallest percentage of neutral answers among furniture buyers were in the case of quality and the price (less than 14.2%) and in the case of consumer goods: quality and recommendations (not commercial) – less than 16.5%).

4. CONCLUSIONS

According to Paluš and Parobek (2013), Parobek et al. (2016) and Paluš, Šulek, Parobek (2007) the Slovak primary and secondary wood processing industries are export-oriented due to the low domestic consumption of final products. Šupín (2014) stated, that to overcome reduced market demand should small and medium enterprises from the wood processing industry develop such marketing strategies, which can stabilise their relations to customers and permanently monitor customer behaviour. Loučanová et al. (2015) stated that the innovations in the company are focused on customer satisfaction and also influence company’s performance on the market. Consumer satisfaction is closely linked with the whole buying process and as Triznová (2014) concluded: customers’ expectations and needs need to be meet, in order to build long-term relationships with them and also involved customers in co-creation of the product. To follow the above-mentioned recommendations, we suggest to monitor changes in consumer buying behaviour in conditions of the Slovak wood processing industry and implement findings into marketing strategies of wood processing companies.

The studies of Olšiaková (2006) and Olšiaková and Kusá (2008) carried out in Slovakia investigated the influence of selected marketing mix tools on the behaviour of the consumer when choosing furniture, support the outcomes of this paper. Olšiaková, Loučanová, and Paluš (2016) monitored changes in consumer requirements for wood products including furniture in terms of consumer behaviour in the years 2004 and 2014 and revealed interesting changes in consumers’ behaviour. Paluš, Maťová, Kaputa (2012) compared consumer preferences for joinery products and furniture in Slovakia and Poland and introduced results from wide portfolio of investigated attributes. All the above-mentioned studies also support the outcomes of this study.

As for **consumer goods buyers** in this survey, the most important factors are: 1. Quality, 2. Recommendations (not commercial), 3. Brand, 4. Country of origin, 5. Environmental properties, and the last within surveyed factors is Price. Nadányová (2015) concluded in her study that Slovak consumers when purchasing food products (consumer goods), they are oriented on products 1. Quality, 2. Price, 3. Brand, 4. Country of origin and 5. Recommendations from friends. She also concluded that Slovak respondents are currently focusing on the quality of foods offered in domestic market because of low-quality of imported food. Comparing our results and results of Nadányová (2015), the difference is in the order of factors: Price and Recommendations. This could be explained by the range of research, she focused only on food products.

The sample of **furniture buyers** considered as important the following factors: 1. Quality (84.77%), 2. Price (79.47%), 3. Country of origin (38.19%), 4. Environmental properties and Recommendations, 5. Brand, and 6. Advertising. Kaputa and Šupín (2010) found that the most relevant purchasing decision factors when buying furniture in Slovakia were:1. Quality (94.5%), 2. Price (87.1%), 3. Design of the furniture, 4. Colour, 5. Safety, 6. Warranty, 7. Environmental attributes, 8. Brand, 9. Country of origin (27.3%). Comparing the factors' percentage of those two studies, only the factor country of origin has a higher percentage in our research. Oblak et al. (2017) conducted research about factors of buying decision of furniture products in Slovenia and Croatia. In Croatia, the factors are 1. Price, 2. Payment facilities, 3. Quality, 4. After sales services (delivery, assembly), 5. Manufacturers reputation. In Slovenia, the factors are 1. Quality, 2. Price, 3. After sales services, 4. Payment facilities, 5. Manufacturers reputation. Surprisingly, in Croatia, the factor quality of the furniture is on the third place in contrast to studies conducted in Slovakia (our research and the study of Kaputa and Šupín, 2010) as well as in Slovenia. But, this outcome is not in contrast with the results from the study made by Pirc et al. (2008). Here, Croatian consumers most often assess Croatian furniture as high quality and well designed, but also as expensive.

The statistically significant differences with moderately strong relations were revealed in these factors: recommendations (not commercial), price, brand and with weak relations: environmental attributes, country of origin, and advertising. Overall, the surveyed respondents of both samples are equally sensitive to the quality of a product (not statistically significant difference). The respondents (furniture buyers) are price sensitive. For more than half of them, the advertising is not an important factor. More than one-third of them had indifferent attitudes towards environmental attributes, brand, and recommendations. The respondents (consumer goods buyers) took into consideration recommendations (not commercial), brand, country of origin, and environmental attributes. Price and advertising are not important for more than one-third of them. Neutral attitudes toward advertising, environmental attributes and price expressed more than one-quarter of them.

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STREET FURNITURE IN CROATIA AND SLOVENIA – PARK USERS REQUIREMENTS FOR (WOOD) URBAN EQUIPMENT

Andreja Pirc Barčić*, Leon Oblak, Darko Motik, Teja Bizjak Govedič, Aida Kopljar, Anđela Vuković

ABSTRACT

Urban equipment, in generally, with an accent to street (wood) furniture creates the settings for resting, sitting and eating, but also for socializing, playing, and talking. Such settings may be of great importance to the elderly people, those with limited mobility, adults who have small children, to young people, but also to business people. In the context of urban equipment, wood is a very usual choice of materials for street furniture. The role of street furniture has been emphasized in developed parts of the world (e.g., the United States, Europe, and Japan). Under the influence of rapid urbanization and globalization, global warming, and a growing emphasis on humanism, urban landscape design (including street furniture) is facing unparalleled challenges and requirements in the 21st century. However, comprehensive studies on street furniture are rare. In order to give some contribute to the research activities regarding a street furniture and also maybe to provocate stakeholders involved to these activities the aim of the paper was to find out the opinions of urban equipment users with an accent to park wood furniture in Croatia and Slovenia. The street (wood) furniture analysed in this paper was related to tables, benches, and dust bins.

Key words: wood urban equipment, wood furniture, market research, Croatia

1. INTRODUCTION

Urban equipment, in generally, with an accent to street (wood) furniture creates the settings for resting, sitting and eating, but also for socializing, playing, and talking. Such settings may be of great importance to the elderly people, those with limited mobility, adults who have small children, but also to a joung people (students and/or schoolars) and on the other hand, also to business people. In the context of urban equipment, wood is a very usuasl choice of materials for street furniture, because it is a netural friendly material, it has lots of visual, functional, and design advantanges. According to Wan (2008) street furniture refers to objects and facilities located in urban public spaces that provide various services and functions to the public and it is one of the essential elements of the urban environment that contributes to humans and their activities. Even more, street furniture plays a significant role in determining the quality of an urban environment and in representing the image of a city. Of all the urban landscape elements, street furniture has the closest contact and interaction with humans. The role of street furniture has been emphasised in developed parts of the world (e.g., the United States, Europe, and Japan)

Under the influence of rapid urbanisation and globalisation, global warming, and a growing emphasis on humanism, urban landscape design (including street furniture) is facing unparalleled challenges and requirements in the 21st century. However, comprehensive studies on street furniture are rare.

In order to give some contribute to the research activities regarding a street furniture and also maybe to provocate stakeholders involved to these activities the aim of the paper was to find out the opinions of urban equipment users with an accent to park wood furniture in Croatia and Slovenia. The street (wood) furniture analysed in this paper was related to tables, benches, and dust bins.

1.1. Street (WOOD) furniture characteristics

Street furniture create the settings for resting, sitting and eating, and social encounters with others which accoriding to Deakin *et al.* (2007) may be of great importance to the elderly, those with limited mobility, and adults who have small children; but in addition to their functional aspect, items of urban furniture such as benches and tables in parks and squares can also be socially significant. However, Main and Greet (2010) noted that an appropriately selected and placed furniture can draw people to outdoor spaces with the aim of making them feel welcome, relaxed, and involved. If street furniture is properly integrated in the design of a public space, it creates an identity and develops a sense of place around it (Transport & Regional Affairs Department of the Environment 2000). When desidig about furniture items for outdoor spaces Yücel (2013) noted that the items must be constructed of safe materials and designed to prevent injury, without sharp edges or exposed fasteners. More precisely, they should be attached to the ground with anchor bolts (for example, using surface mounting, i.e. attaching a bench to a concrete slab), or embedded in the ground. Also, according to Yücel (2013) furniture selection and design should take into account weather effects such as sunlight, expansion and contraction, wind stress, moisture, and in some cases, salt spray, frost, or ice. When taking into consideration which material to use for street/urban furniture Yücel (2013) moted that the most popular materials used are steel and wood, while other possibilities are stone, concrete, recycled plastic and various other materials. He also noted that the choice of materials depends on the context and limitations of the design; for example, whether the furniture should be resistant to vandalism, whether ventilation is needed for drying it during wet weather spells, what the weather conditions may be, how frequently the furniture is likely to be used and by whom, what the initial costs are, including mounting, the costs and ease of maintenance, and whether there is a possibility of using eco-friendly materials. In that context, wood is popular choice of material for street funriture, because it is a natural material that feels warmer in cold weather and cooler in hot weather, unlike metals. Wood may be inexpensive, but the type of wood selected should depend on the location and frequency use of the furniture. Paint or other finishing materials of furniture should be non-toxic and non-staining (Lovejoy 1997). In addition, the use of recycled materials in street furniture enables manufacturers to conserve natural resources and reduce their carbon footprints; it also educate the users of the furniture and the public, on the importance and mental and physical benefits of recycling (Yücel 2013). The location of the furnishings should be based on their functions (Crankshaw 2008) and coherent with the patterns and designs of the hard surfaces at the site (Yücel 2013).

2. MATERIAL AND METHODS

Based on research objectives a questionnaire was developed and was distributed in the respective languages of Slovakia and Croatia. The first part consisted questions regarding 'park users' demographic characteristics as gender, level of education (primary school, high school, and university), and age (according to six given categories). The second part of the questionnaire consisted questions regarding perception of wood furniture in the parks and statements about future possibilities of the parks that the respondents attend frequently.

Straightforward questions and Yes/no, items were used. Furthermore, multi choice item measure was used because according to Thorndike (1967) cited by Lewis-Beck *et al.* (2004) it can be a superior to a single, straightforward question. The first step in the research, a data collection was accomplished in Zagreb (Pirc Barčić *et al.,* 2017) and in 2018 the research was extend to Slovenian respondents in Ljubljana.

In Croatia, the survey was provide to 463 park users in the capital City of Croatia, Zagreb, but only 200 persons accepted to participate and complete the questionnaire. A personal, 'face-to-face' interview based on survey questions was the method used for surveying respondents for this study in Croatia.

On the other hand, in Slovenia an electronic form of the questionnaire was distributed to respondents via online version (open source application 1 KA) and social networks. University students were the "first movers" who started to share the questionnaire in Slovenia. The fact that students shared their contacts caused higher share of respondents holding academic degree in Slovenia. Out of 737 people who 'clicked' the survey, 145 people answered the questionnaire completely. At the beginning of personal interviewing the introducing statement by a researcher, justifying the research study, legitimize him, explaining the recipient's (respondent's) role and convincing that his participation in research is essential (Dillman *et al.* 1976) was presented to respondent. Additionally, in electronic version of questionnaire an introduction regarding the purpose of the research was noted to the respondents.

As described above, a multiple mode data collection – different samples and different modes was used. According to De Leeuw (2005) a typical fields of study using this approach include international and regional comparisons. The reasons for using this approach can vary. Different countries may have different survey traditions and/or different practical constraints. Martin (2011) also, concludes that in a cross-national survey, different countries may use different modes of data collection.

In Croatia, data collection was carried out during March, April and May 2017 and in Slovenia during February, March and April 2018.

The questionnaire consisted of 16 questions and Data were analyzed in MS Excel.

3. RESULTS AND DISCUSSION

3.1. Profile of 'park users' in Zagreb and Ljubljana

As seen in Table1, respondents were asked to indicate their age, education level and gander. Age was classified into five categories, while education was classified into three categories. As shown in Table 1, according to 200 respondents in Zagreb, 43 % of respondents were male and 57 % of total number of respondents were female, while Slovenia respondents were 37 % male and 67 % female. In Zagreb more than half, 61% are people between 19 and 35 years old, while in Slovenia this percentage reached almost 80 % of Slovenian respondents. In addition, 9 % of Croatian respondents were teenagers, between 14 and 18 years old. According to respondents in Zagreb, 60.5 % of them are high school graduate people, followed by respondents who have university education level (29.5 % of total number of respondents). In Ljubljana more than 50 % of total respondent are people having some university education (52 %). In Zagreb, 10 % of respondents have a primary school level of education, while in Ljubljana this was found to be care only between 1 % of respondents.

Table 1. Respondent profile of park users in Zagreb and Ljubljana

<table>
<tr><th colspan="2">Gender of respondents (%)</th><th colspan="2">Education level of respondents (%)</th><th colspan="2">Age groups of respondents (%)</th></tr>
<tr><td colspan="6">Zagreb (CRO) (n = 200)</td></tr>
<tr><td rowspan="4">Male</td><td rowspan="4">43</td><td rowspan="2">Primary school</td><td rowspan="2">10</td><td>14 – 18 years old</td><td>9</td></tr>
<tr><td>19 - 25 years old</td><td>32</td></tr>
<tr><td rowspan="2">High school</td><td rowspan="2">60.5</td><td>26 – 35 years old</td><td>29</td></tr>
<tr><td>36 – 50 years old</td><td>12</td></tr>
<tr><td rowspan="2">Female</td><td rowspan="2">57</td><td rowspan="2">University</td><td rowspan="2">29.5</td><td>51 – 60 years old</td><td>13</td></tr>
<tr><td>Older than 60</td><td>3</td></tr>
<tr><td colspan="6">Ljubljana (SLO) (n = 145)</td></tr>
<tr><td rowspan="4">Male</td><td rowspan="4">37</td><td rowspan="2">Primary school</td><td rowspan="2">0</td><td>14 – 18 years old</td><td>1</td></tr>
<tr><td>19 - 25 years old</td><td>55</td></tr>
<tr><td rowspan="2">High school</td><td rowspan="2">48</td><td>26 – 35 years old</td><td>23</td></tr>
<tr><td>36 – 50 years old</td><td>10</td></tr>
<tr><td rowspan="2">Female</td><td rowspan="2">63</td><td rowspan="2">University</td><td rowspan="2">52</td><td>51 – 60 years old</td><td>5.5</td></tr>
<tr><td>Older than 60</td><td>5.5</td></tr>
</table>

Croatian and Slovenian respondents were asked to note with whom they mostly spend time in some of parks in Zagreb and Ljubljana. Sixty five percent of 200 Croatian respondents noted that the time they spend in parks mostly with their friends, while 1 / 3 of the respondents noted that they spend it alone (35 %) or with their pets (38 %). Further more, 23 % noted that they often come to a park (big City parks or local neighborhood park) to spend with their children. In Ljubljana, also the biggest number of respondents spent time with friends (58 % of 145 respondents), what was expected given that the majority of respondents were young people. An interesting result an outcome that almost ½ of Slovenian respondents (47 %) spent time in park alone, and only 14 % of them with their pets. Between Croatian respondents, the situation was opposite (Figure 1).

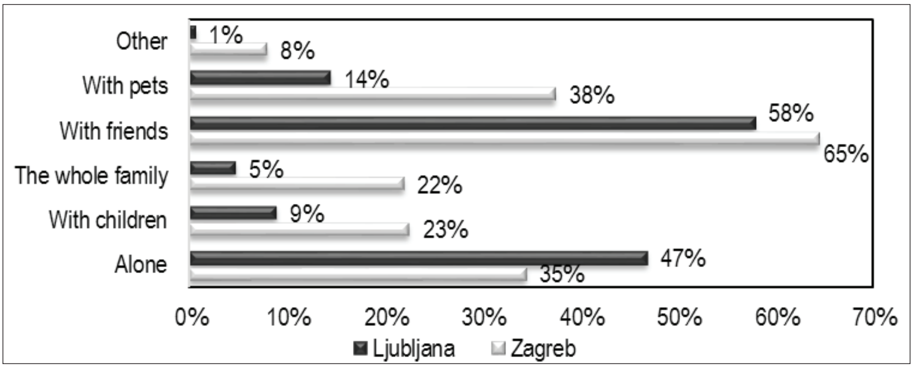

Figure 1. 'Company' for spending time in parks in Zagreb (n = 200) and Ljubljana (n = 145)

In addition, respondent were asked to indicate the purpose of spending time in the city and/or the neighborhood parks. As seen in figure 2, 22 % of Croatian respondents and only 9 % of Slovenian respondents noted that they are coming to parks to play with their children. Twenty-one percent of respondents in Zagreb visit parks to do some kind of physical activity e.g. body exercising or training, followed by spending a time in a picnic (19 %). In Ljubljana, 41 % of 145 respondents visit some of Ljubljana city parks to have some physical activity, but only 6 % of respondents would come to city parks to have some picnic. On the other hand, majority of respondents (81 % of Croatian respondents and 91 % of Slovenian respondents, respectively) noted that they are coming to parks to have some relaxing or resting time. Such a large difference in percentages for the use of parks can be attributed to the lack of urban park equipment itself, which can be read from the standpoint of urban park equipment itself.

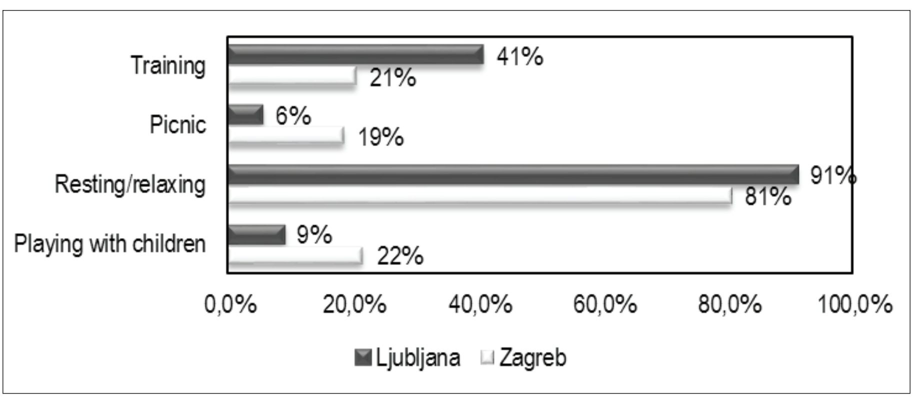

Figure 2. The purpose of spending time in Zagreb (n = 200) and Ljubljana (n = 145)

Evaluation of parks which they attend often was the next question that was presented to 'park users' in Zagreb and Ljubljana. As seen in figure 3.29 % of the Croatian respondents and 23 % of the Slovenian respondents noted that they are satisfied (evaluation mark 3). Additionally, 33.5 % of Croatians noted that they mostly satisfied (evaluation mark 4) with parks in Zagreb, while in Ljubljana more than half of the Slovenian respondents were mostly satisfied with their city parks in general. Fifteen percent of Croatian respondents and 21 % of Slovenian respondents noted that they are very satisfied with the city parks when looking for park facilities. On the other hand only 3% responded were totally unsatisfied with the Zagreb city parks in general. In Zagreb on average, the level of respondent's satisfaction with the city parks in general was 3.4 (Mean = 3,4; SD ± 1,05) and in Ljubljana was 3,9 (mean = 3,9; SD ± 0,69).

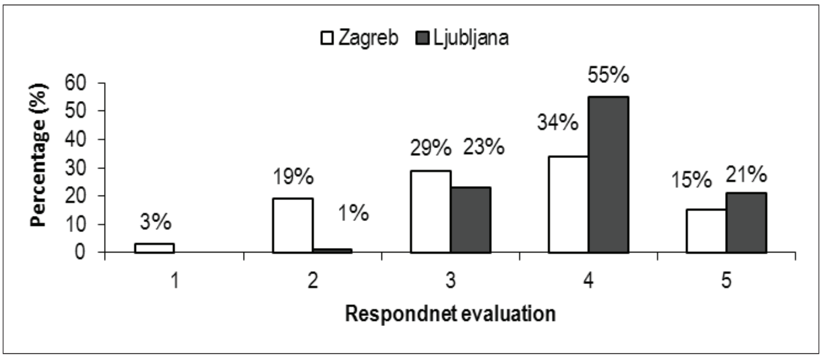

Figure 3. Respondents evaluation on Zagreb City parks (n = 200) and Ljubljana City parks (n = 145) in general

3.2. Perception of wood furniture in Zagreb and Ljubljana city parks

In order to get more information about wood furniture equipment placed in the parks, like benches, tables, and waste bins the 'park users' were asked to note their level of satisfaction with wood furniture equipment in general.

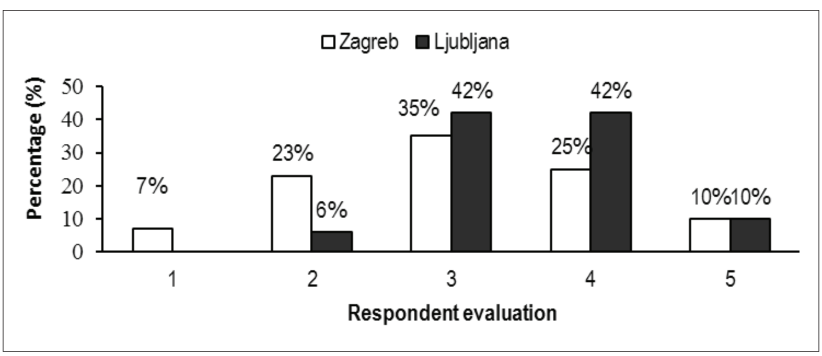

Figure 4. Respondents evaluation of wood furniture in Zagreb City (n=200) and Ljubljana city parks (n=145)

According to results shown in figure 4, more than 1/3 of the respondents (35 % of 200 Croatian respondents; 42 % of 145 Slovenian respondents) were satisfied with urban furniture in the parks. In Zagreb, twenty-five percent or respondetns noted that hey are very satisfied and in Ljubljana 42% of Slovenian respondents noted that they are very satisified with wood furniture euipment in Ljubljana cita parks. In Zagreb,only 7% of respondents noted that they are not satisfied with the urban furniture pleased in their parks. In general, the 'park users' are satisfied with the furniture paces placed in their city parks (for Croatian respondets a mean of responses was 3.07; SD±1,07; for Slovenian respondents a mean of responses was 3,54; SD±0,8).

In addition, to get a 'better picture' about the level of 'park users' satisfaction regarding a wood furniture in parks, respondents were asked to note the level of their satisfaction about certain furniture attributes, like design, functionality, commodity, and material which furniture was made of in Zagreb and Ljubljana. When deciding about attributes regarding benches, mean response: about design was 3.36 (Zagreb) and 3.43 (Ljubljana), about functionality was 3.42 (Zagreb) and 3.63 (Ljubljana), about commodity was 2.94 (Zagreb) and 3.12 (Ljubljana), and about martial used was 3.41 (Zagreb) and 3.70 (Ljubljana), respectively. Based on Croatian responses on the average, the mean response for all bench attributes was 3.21 and based on Slovenian responses was 3.47. For tables, mean responses for all attributes were as follows: design 3.08 (Zagreb) and 2.81 (Ljubljana); functionality 3.26 (Zagreb) and 3.00 (Ljubljana), and material used 3.10 (Zagreb) and 3.17 (Ljubljana). On the average, the mean response of all attributes was 3.14. and 2.99, respectively. Waste bin was the third wood 'street furniture' that was analyzed in this study. In Zagreb, according to the analyzed attributes, the highest mean response was noted for 'functionality' attribute (3.45), followed by 'material selection' attribute (3.12), and design' attribute (3.07). The same importance order of analyzed attributes was noted between Slovenian respondents – 'functionality' attribute (3.56), followed by 'material selection' attribute (3.31), and design' attribute (3.11). The mean response of all waste bin attributes on average was 3.21 (Zagreb) and 3.32 (Ljubljana).

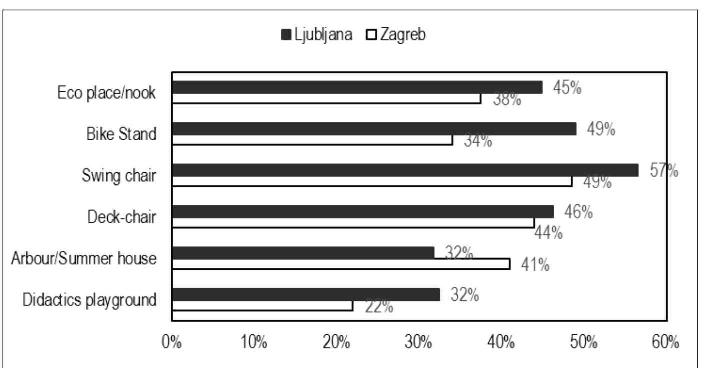

Figure 5. Wishes and need of 'park users' in the Zagreb (n=200) and Ljubljana (n=145); multiple response)

At the end of personal interviews ‘park users’ were offered to multiple choice options to choose an additional wood equipment accessories which they would prefer to use in the park, but which was not available at that time, like bike stands, deck-chairs, swing chairs, didactic playgrounds or eco nooks. In Zagreb, as shown in figure 5, respondents noted the lack of resting facilities - they would prefer swing-chairs (49 %), deck-chairs (44 %), and some kind of arbors/small summer houses (41 %). Also, eco place/nook was one of faculties that was found to be missing in the parks and ‘parks users’ would prefer to use it in the park. Bike stands (34%) and didactics playgrounds (22 %) was also one interesting park facility that would be very interesting to use between respondents. In Ljubljana, 57 % of respondents noted that they would prefer more swing chairs in the city parks; followed by bike stands (49 %), deck chairs (46 %) and Eco places (45 %).

3.3. Who is producing urban wood equipment in Croatia and Slovenia?

In Croatia and Slovenia there is a respectable number producers of urban wood equipment which can offer a quite interesting and well-designed produces (table 2).

Table 2. Urban wood equipment producers in Croatia and Slovenia

Country	Producer	Product	
Croatia	Euromodel		
Croatia	Kiton		
Croatia	Vojtek		
Croatia	Kova		

Slovenia	Eki Kranj		
Slovenia	Petrič		
Slovenia	Ziegler		
Slovenia	Cona plus		

4. CONCLUSIONS

For example, some parks serve people more for the purpose of short and occasional vacations while others are visiting for longer stays. This research showed that parks in Zagreb and Ljubljana do not have wood urban equipment for relaxation and relaxation, even though people use it. The existing urban (mostly) wood furniture is often a combination of wood and metal, which means that it should be maintained during the years of standing on external weather conditions. Given the size of parks and their position in the city, the parks have a fair amount of basic urban equipment, with thoughts on desks and waste bins. In the summer months when parks are visited more frequently, the lack of primarily seating and relaxation elements was noticed. In general, the 'park users' are satisfied with the furniture paces placed in their city parks, but there is always a possibility to make it better!

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EXPORT ACTIVITY OF THE POLISH WOODWORKING MARKET AGAINST THE EUROPEAN UNION - ECONOMIC DIMENSION

Grzegorzewska Emilia, Stasiak-Betlejewska Renata

ABSTRACT

Production of wood products in Poland compared to other European Union member states is significant, in particular, the production of wood-based panels. Polish trade timber industry exchange with the foreign once has also significant meaning. The competitiveness of native plants is mainly due to the high technological level of the available machine park and highly qualified staff, which has a direct impact on the quality of final products. Due to the fact that the timber industry provides semi-products for the Polish furniture industry, which plays a special role in the global market of furniture, its importance is even greater. Therefore, in the paper was the subject of the export activity of companies operating on the Polish timber market. Comparative analyzes were carried out against the background of EU member states. The primary source of research material were the reports of the Central Statistical Office Fri. “Statistical Yearbook of Industry” and “Statistical Yearbook of Foreign Trade”, as well as Eurostat and reports available in the International Trade Centre presenting trade European countries against the global market.

Key words: European Union, export, woodworking industry

1. INTRODUCTION

The woodworking industry is an important part of the world economy [Gejdoš and Potkany 2015, Šupine 2014, Grzegorzewska 2014]. Factors frequently cited as drivers of change with regard to long-term global demand for wood products are: economic development; demographics; scientific and technological developments; globalization; global climate change [European Forest Sector… 2005; State of the World’s… 2009; Aulisi, Sauer, Wellington 2008]. Globalization and economic growth are corroborating to increase international trade of wood and wood products and the flow of capitals into new investments in the forestry sector of emerging economies [Global wood… 2007].

Production of Polish woodworking industry compared to other EU Member States is significant, in particular, the production of wood-based panels. An important aspect in this area is also foreign trade.

Poland has the largest wood resources in Europe and the native forest cover of the country hovers around 30%. However, a good economic situation in the economy, and thus in the wood sector, and the competition for wood raw materials by the energy sector have led to shortages in recent years.

In Poland there are several large plants producing wood-based materials that provide semi-finished products for other industries such as the construction and the furniture industry. It should be noted that the Polish furniture industry has impressive production and export potential, which makes it one of the leading manufacturers and exporters, not only in Europe but also in the world [Grzegorzewska, Stasiak-Betlejewska 2014; Grzegorzewska, Więckowska 2016].

2. RESEARCH METHODOLOGY

The purpose of the research was to determine the activity of the Polish woodworking industry. Analyzes were performed for domestic market against the background of EU member states. In this article, authors attention has been focused on wood-based materials, which constitute an important intermediate product for the construction industry or the furniture industry. Furniture has unique export potential in the context of other industries of the Polish economy. The time range of the study was assumed for 2010-2015. The main source of research material was the statistical analysis conducted by the Interantional Trade Center.

A vertical analysis was used to show the dynamics of the annual export value from. The dynamics of the phenomenon was also presented throughout the five-year period covered by the analysis. In addition, in order to determine the role of individual countries in foreign trade of United Europe, their share in European export was calculated and it was a basis for elaborating a ranking. Countries are assigned items 1 to 28 according to the value of exported timber goods. This article presents the top ten of the elaborated ranking and in particular the importance of Poland in the analysed areas. Due to the fact that many categories of products belong to the woodworking industry, authors focused on selected wood-based materials, i.e. chipboard, fiberboard and plywood.

3. RESEARCH RESULTS

The research conducted by the Interantional Trade Center shows that in 2010 the export of THE wood and wood products exceeded EUR 80 billion. In this period the largest exporters of the woodworking industry included Germany, Austria and Sweden. Poland took fourth place in this ranking. The share of individual countries in EU exports was 20.5%, 10.5%, 9.5%, 6.8%, respectively. In turn, the least timber and wood products were exported from: Malta, Cyprus and Greece. In the years 2010-2015, the world's wood industry export has been increased by over 44% from 80.2 billion EUR to 113.3 billion EUR (Table 1).

Table 1. Export of the wood and wood products in selected EU countries on a global basis [thousands EUR].

Specification	2010	2011	2012	2013	2014	2015	2015/2010 [%]
World	80218112	86545271	92212518	99652023	106159808	113261000	141,2
EU 28	34175281	36627282	36577325	38897331	40656260	41743689	122,1
Germany	6664410	6724570	6410928	6598277	6883181	7087171	106,3
Austria	3609033	3872750	3660805	3729580	3678173	3809414	105,6
Sweden	3291863	3267232	3323187	3331055	3503483	3449364	104,8
Poland	2305029	2483023	2546225	2941899	3164638	3349762	145,3
Finland	1987625	2070327	2093003	2325746	2459013	2473074	124,4
France	2013748	2134625	2082523	2084995	2192929	2332957	115,9
Belgium	1889981	2073425	2000380	2142396	2103458	2254080	119,3
Romania	1174680	1403394	1609634	1881097	1870907	1801725	153,4
Latvia	1262548	1448142	1464387	1595989	1696746	1724203	136,6
Czech Republic	1394659	1513228	1526956	1630617	1693328	1703774	122,2

**Source: own elaboration based on data from the International Trade Center.*

Every year, this dynamics was at a similar level of 106-108%. At the same time exports of the wood and wood products in the European Union has been also increased significantly. Overall, this indicator has been increased by more than 22%. The dynamics of growth of the wood industry exports in the EU varied from 102% to 107%, only in 2012 it showed a slight decrease (0.1%). It is worth noting that the largest increase was recorded in export of the woodworking industry in Netherlands (197.6%), Croatia (181.5%), Lithuania (159.5%) and Romania (153.4%). On the other hand, among the countries that are at the top of the ranking in terms of export value of the woodworking industry, the highest increase was observed in Poland (45.3%). This contributed to increase the share of domestic market in the export of these products from 6.8% to 8%. Among the member countries of the European Union there were also such countries whose value of the wood and wood products export was decreased (Luxembourg, Greece, Cyprus and Malta). In the last year of the study, the leading countries in the ranking of the wood exporters did not change compared to 2010.

At the beginning of the analysed period, the value of the chipboard export in the world amounted 4.6 billion Euros, where more than 2/3 countries were from European Union countries (Table 2). Germany (604.6 million EUR), Austria (505.0 million EUR), France (329.2 million EUR), Belgium (278.3 million EUR) and the Czech Republic (20.1 million EUR) are the top countries in the list. The share of EU countries in EU chipboard export was 19.3%, 16.1%, 10.5%, 8.9%, 6.5%, respectively. In 2010, Poland ranks eighth position in this ranking (115.3 million EUR), which amounted 3.7% of EU export. In turn, the least the wood and woodworking products were exported from: Malta, Cyprus and Denmark.

Table 2. The chipboard export in selected European countries on a global basis [thousands EUR].

Specification	2010	2011	2012	2013	2014	2015	2015/2010 [%]
World	4644690	4950649	5611711	5972747	5924854	6175602	133,0
EU 28	3130545	3425858	3570813	3681611	3653044	3637401	116,2
Germany	604638	616135	597016	604973	585490	580296	96,0
Austria	505035	561794	572726	554186	554503	570392	112,9
France	329151	392543	392446	373565	397896	387914	117,9
Romania	159420	185536	291846	408400	398871	384207	241,0
Belgium	278288	309670	307407	320439	259214	278408	100,0
Czech Republic	203143	230200	236438	242085	260344	244675	120,4
Italy	104326	112552	122398	125830	140483	149395	143,2
Latvia	114788	122806	131794	146540	142434	142225	123,9
Spain	134252	154929	146816	131788	136015	140014	104,3
Poland	115310	135856	140891	155085	150629	138350	120,0

**Source: own elaboration based on data from the International Trade Center.*

In the analyzed period, global chipboard export has been increased by a third to nearly € 6.2 billion EUR. In the case of European countries the dynamics of this indicator was twice lower and it amounted to 116.2%. The growth rate of EU chipboard export was between 103% and 109%, only less than 1% in the years 2014-2015. The highest increase in the value of export of these wood-based materials was recorded by Denmark (299.6%), Romania (241.0%) and Portugal (228.2%). In 2015, the Polish market exported 20% more chipboard in the value than in the previous five years, but that it did not contribute significantly to its share of EU-28 export value. It still has not exceeded the 4% threshold.

On the other hand, the largest decrease in the value of chipboard export was recorded in Finland (65.3%), Greece (45.7%) and Slovenia (34.3%). In the last studied year, the top ranking of exporters of these products did not change compared to 2010. However, it is worth stressing Romania's promotion from sixth to fourth place and Spain from ninth to seventh place. In turn, Poland recorded a decrease from eighth to tenth place. Similar trends have been observed in Latvia and Italy.

In the analysed period, the global value of fibreboard export has been increased by 27.1%. For EU-28 Member States this increase was twice as low (14.0%). In 2015, the value of those products that went abroad was respectively 8.3 billion EUR for the global economy and 4.4 billion EUR for the EU-28 market. This means that the share of United Europe in global export was 52.9% and was 6.1p. Lower than the beginning of the analysed period. The research conducted by ITC shows that Germany is the undisputed leader in the ranking of fibreboard exporters. Their share over the period covered by the analysis exceeded 35% and in 2015 was 36.1%. The following places were: Poland (11.4%), Belgium (11.3%), Austria (7.4%) and France (6.4%). It is worth noting that the country has recorded the highest growth rate in the value of exports in this area taking into account the top of the ranking (140.5%). This contributed to Poland's advancement in the ranking of exporters of fibreboard from third to second position. In turn, the decrease in the exported value. In the case of Sweden, Luxembourg and Great Britain. The value of export has been decreased in these countries respectively: 40.3%, 31.5% and 25.1% respectively.

Table 3. Export of fibreboard in selected EU countries on the world [thousands EUR].

Specification	2010	2011	2012	2013	2014	2015	2015/2010 [%]
World	6560773	6948624	7534093	7466808	7769716	8337165	127,1
EU 28	3865490	3937825	4023001	4068014	4185356	4407546	114,0
Germany	1430011	1392468	1454012	1457514	1467332	1592793	111,4
Poland	356914	369527	381385	413786	466424	501457	140,5
Belgium	457024	476883	447499	455361	508345	500059	109,4
Austria	315633	317396	314159	335593	320149	327476	103,8
France	203926	219707	241676	240897	255216	281867	138,2
Spain	207063	218502	214606	226318	243475	274476	132,6
Ireland	117500	116077	119363	124698	133856	143244	121,9
Romania	93427	106179	114236	111558	109790	117188	125,4
Italy	120605	121171	147438	129395	123070	115015	95,4
Portugal	86916	99450	102318	101515	113454	107821	124,1

**Source: own elaboration based on data from the International Trade Center.*

The research conducted by the Interantional Trade Center shows that in 2010 export of the plywood exceeded 9 billion EUR (Table 4). In this period, the first place in the ranking of exporters was taken by Finland (405.1 million EUR), whose share in EU-28 exports was 21.4%. Germany (210.7 million EUR), Austria (186.3 million EUR), Belgium (166.0 million EUR) and Italy (151.4 million EUR) were on the next positions in the ranking. The share of these countries in EU plywood export was 11.9%, 9.8%, 8.8% and 8.0%, respectively. In turn, the least plywood were exported from: Luxembourg, Cyprus and Malta. Poland with export value of 76.3 million EUR took ninth position in the ranking. In 2010-2015 global plywood export has been increased by 9.3% from 9.0 billion Euro to 13.7 billion EUR. At the same time, the export dynamics of this product in the European Union (109.7%) was similar. The highest increase in the plywood exports in the EU of 13% occurred in 2011, and only in 2012 it was characterized by a decrease (5%). Slovenia (488.0%), Netherlands (266.9%), Bulgaria (212.3%) noted the most dynamic export. Nearly two times the value of plywood export has been also increased in Poland. This contributed to an increase in the share of the domestic market in the export of these products from 4.0% to 5.7%. Among the Member States of the European Union there are also countries that reduced the value of plywood destined for foreign markets (Malta, Ireland Portugal, Luxembourg or Sweden). In the analyzed period, the largest advancement in the ranking of exporters of this product was recorded in Slovakia (from 19th to 13th position) and Spain (from 8th to 3rd position).

Table 4. Export of plywood in selected EU countries on a global basis [thousands EUR].

Specification	2010	2011	2012	2013	2014	2015	2015/2010 [%]
World	9002036	10094763	11125252	11381928	12445491	13681885	109,3
EU 28	1894416	2143482	2054811	2154473	2362782	2524451	109,7
Finland	405071	445950	446926	479225	532888	534045	111,2
Germany	210726	241571	207604	205591	215642	229159	104,9
Spain	113052	139774	133351	147194	161635	197291	109,8
Austria	186269	215081	204664	208056	219142	192260	105,3
Latvia	115448	144287	152953	155853	166457	188478	106,8
Belgium	166008	165941	152606	165924	170773	181026	102,9
Italy	151427	156574	148307	138772	151447	166146	109,1
France	127583	132533	126185	125225	133970	159345	107,0
Poland	76323	93768	105428	117423	133008	144459	113,3
Czech Republic	53236	80073	66595	66643	76274	92552	114,5

**Source: own elaboration based on data from the International Trade Center.*

4. CONCLUSIONS

In the years 2010-2015, the world's wood industry export has been increased by over 44% from 80.2 billion Euro to 113.3 billion EUR. During this period, exports of the wood and wood products in the European Union (22%) has been also increased significantly. In turn, among the countries that are at the top of the ranking in terms of export value of the wood industry, the highest growth was observed in Poland (45%).

In the analysed period, global chipboard export has been increased by a third to nearly 6.2 billion EUR. For the EU Member States the dynamics of this indicator was twice lower and amounted to 116%. The largest increase in the value of export of these wood-based materials was recorded by Denmark, Romania and Portugal. In 2015, the Polish market sent abroad one fifth more chipboard in value than five years ago. However, it didn't contribute to a significant increase of the country's share of EU-28 exports - it still fluctuated at 3-4%. Due to favourable trends in other countries, Poland recorded a decrease from eighth to tenth position.

In the years 2010-2015 there was also noted an increase in the value of world fibreboard export by 27%. In turn, for EU-28 this increase was twice lower. In 2015 the value of those products that went abroad was respectively 8.3 billion EUR for the global economy and 4.4 billion EUR for the EU-28 market. Leader in the ranking of fibreboard exporters are Germany. Their share over the period covered by the analysis exceeded 35%. Another place was occupied by Poland, and the growth rate of fibreboard exports exceeded 140%. This has led to Poland's increase from the third to the second position.

The smallest increase in the value of the analysed wood products export was observed for the plywood. Both for the global economy and for the European economy it amounted 9%. Poland was ranked on the ninth position, but it is worth noting that in the analysed areas Poland was in the top 10 countries in terms of export value. It should be emphasized its special role in the foreign trade of fibreboard. Germany is the undisputed leader, which proves the country's unique importance for the European wood industry.

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SELECTED ECONOMIC AND MATERIAL ASPECTS BEHIND THE USE OF WOOD BY THE TIMBER INDUSTRY IN POLAND AND IN SELECTED EUROPEAN UNION COUNTRIES

Katarzyna Mydlarz, Marek Wieruszewski, Zbigniew Malinowski

ABSTRACT

The supply level of wood raw material in the European Union market is mainly driven by the forestry and timber policies of member states, whereas the elasticity of demand is determined by available raw material resources and the ownership structure of forests. In Poland, wood supply is shaped by the requirements of forest management and does not fully address the demand. Therefore, the purpose of this paper is to analyze the impact of a multifunctional forest management concept consistent with sustainable development principles on the harvesting of raw materials and on the price level, and to identify the relationship between forest ownership structure and wood supply in Poland and selected EU countries.

Keywords: wood material, forestry, economic aspects, wood industry, market

1. INTRODUCTION

Forest resources are the main source of wood supply for timber companies. In a sustainable economy, the structure of raw material supply and the volume of raw materials generated by forest areas are factors of essential importance in planning the production of timber and wood-based products, whereas a rational raw material policy coupled with technological progress enables the optimum use of materials from available forest resources.

National resources of wood raw material have a significant economic potential which is extended by importing additional volumes of wood from neighboring countries. According to data presented by the State Forests National Forest Holding (*Polskie Gospodarstwo Leśne Lasy Państwowe*, PGL LP), in 2017, ca. 40.5 million m^3 of wood was harvested in Poland which is ca. 1 million m^3 more than in 2016 and ca. 5 million m^3 more than in 2010 (www.e-drewno.pl, www.stat.gov.pl). Meanwhile, in 2016, 1,988,379 tons of wood raw material were imported, or ca. 2,658,834 tons (ca. 2.12 million m^3) if sawn and planed wood is taken into account (Leśnictwo 2017). The ever growing demand for wood and the fact that timber harvesting has increased over the years (and yet it fails to meet the demand of the industry) confirm that the demand for wood products is consistently growing. Also, this reflects the development and competitiveness of Polish timber companies.

Thanks to the European sustainable forest management, Poland keeps experiencing a dynamic growth of raw material resources, too. The ownership structure of forests is also changing. However, unlike in other European countries such as Germany, Finland or Sweden, the supply of various wood types continues to be largely dominated by state-owned operators. The importance of the private forestry and wood sector for the Polish economy is primarily noticeable in regions where it holds a large market share, i.e. in the eastern part of the country. But even there, the share of the private sector is considerably lower than in European Union countries.

Therefore, a research on the impact of multifunctional forest management principles consistent with the sustainable development concept could significantly contribute to a well-informed understanding of how to plan raw material harvesting from both state-owned and private forests.

2. RESEARCH METHODOLOGY

To meet the objective of this study, the characteristics of forest areas and the raw material potential available to the national timber economy were verified in selected European countries. Attention was paid to raw material harvesting in relation to current increment; the structure of forests; and the volatility of timber prices. Of the countries covered by the analysis, the following were selected: Poland, Germany (as the largest European economy), Finland (as the most wooded country in Europe) and UK (the least wooded country with the smallest forest area per capita in Europe). The basic sources of data for the indirect market analysis included reports from the Central Statistical Office in Poland, Forestry Commission, Forest Report, Food and Agriculture Organization (FAO), and Bundesministerium für Ernährung und Landwirtschaft. The analysis covered the timber harvest volumes as well as timber prices and their impact on the requirements of the timber processing sector in Poland and in selected European Union countries. The study relied on reports delivered by government bodies, specialized units and relevant organizations.

3. FOREST AREA AND TIMBER HARVEST VOLUMES IN SELECTED EUROPEAN UNION COUNTRIES

Land covered by forest management measures was taken into account, and standards used in international assessments were adopted. Currently in Poland, the area of forests is over 9,215,000 ha and represents ca. 29.5% of total land area (Central Statistical Office 2016). In European Union states, the average forest cover is ca. 35%. However, this ratio varies considerably from one country to another; for instance, forest cover is as much as 76% in Finland (the highest level in Europe); over 60% in Sweden and Slovenia; ca. 32% in Germany; 29.5% in Poland; and only 13% in the Netherlands and UK (Ragonnaud 2017, www.lasy.gov.pl).

A clearly higher forest cover is characteristic mainly of countries with a large share of land unfit for agriculture, including wetlands and mountain areas (Scandinavia, Austria).

Forest policies of European countries are the main determinant of the capacity to supply wood raw material to the markets. The supply of wood as a natural raw material, as it is the case in Poland, is largely determined by forest management requirements and meets the market demand to a certain degree. In Poland, the increased harvesting of raw materials is caused by various factors (including growing tree stands resources) and takes account of the 10-year forest arrangement plans approved by the minister of the environment (www.lasy.gov.pl).

According to the 2016 Large Inventory of the Forest, the average tree stands resources in Poland in 2011–2015 were 271 m^3/ha, compared to 191.4 m^3 of large timber per hectare recorded twenty years earlier (https://www.ibles.pl/documents/10180/63373/32-dowejko, www.ibles.pl). Within 20 years, standing timber stock increased by 41% which means a clear growth of tree stands resources accompanied by a consistent increase in timber harvesting (Fig. 1).

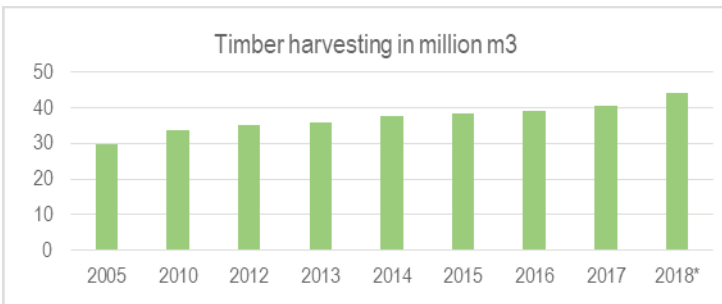

Fig. 1. Large timber harvesting in million m^3 (2018 figures are estimate data).
Source: own elaboration based on Leśnictwo 2017, www.lasy.gov.pl.

In Germany, the volume of harvested wood raw material also keeps increasing every year: in 2012, it was 52.3 million m^3; in 2013: 53.2 million m^3; in 2014: 54.4 million m^3; in 2015: 56.5 million m^3 (data retrieved from Destatis, the Federal Statistical Office of Germany, Holzkurier). In Finland, 62.3 million m^3 of timber was harvested in 2013; the current annual harvest volume is ca. 65 million m^3 (Statistical Yearbook of Forestry 2014, Finnish Forest Research Institute, www.smy.fi/en/forest-fi). In turn, in the UK the volume harvested in 2013 was 11.203 million m^3; in 2014: 11.69 million m^3; in 2015: 11.043 million m^3 (FAO 2005, 2010, 2013, 2015). The compilation of data suggests that the timber harvest volume varies from one country to another and depends on forest cover and on forest policy targets. Therefore, to address the growing needs of the timber industry and to maintain the proper forest policy, factors that need to be considered include (in addition to harvest volume) the ratio of harvest volume to the growth of resources in forest areas. This is a ratio that allows to determine the development targets for forest management and to find out whether non-economic functions of forests are taken into account .

For many years, Poland has experienced a steady growth of both timber harvesting and tree stands resources. The ratio of timber harvest to current increment has also been on the increase over the years. According to Figure 2 data, that ratio varies across the countries considered, from 28.5% in Ukraine to 101.8% in Sweden. The level recorded in Poland is 74.8% but as recently as in the 1995–2005 period, it was below 60% (www.ibles.pl) of current increment (of gross large timber) (2016 Report on the condition of Polish forests); according to other sources, it was even below 50% (www.forest-monitor.com.eu).

The ratio of harvest to annual increment is a widely used index of sustainable, durable development. It is impacted by various circumstances, including the age structure of forests, extreme weather conditions or biotic factors (pest damage); these are the determinants that periodically affect the increased volume of harvested raw material.

The level of wood raw material harvesting—which is moderate compared to the potential and requirements of the timber industry—is consistent with the implementation of the forest cover increase program ("National program for the growth of forest cover in Poland by 2050"), on the one hand, and considerably contributes to high price levels, on the other.

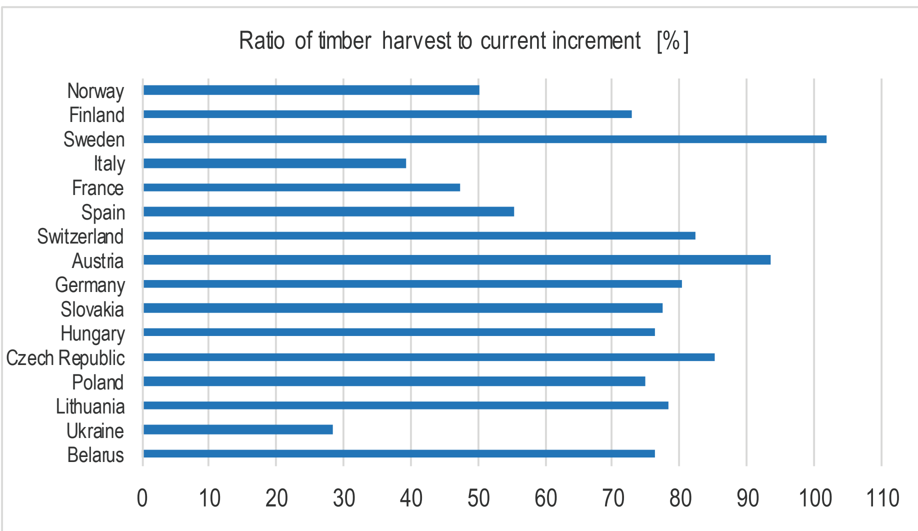

Fig. 2. Ratio of timber harvest to current increment.
Source: own elaboration based on the 2016 Report on the condition of Polish forests.

4. WOOD RAW MATERIAL PRICES IN POLAND AND IN EUROPEAN COUNTRIES

For timber companies, a major determinant of their development potential is the availability of the raw materials base and the price of raw materials. Where demand is growing, the supply has a direct impact on timber prices. Raw materials entering the Polish timber market are valued mainly by State Forests. Figure 3 shows a compilation of average timber prices in Poland within the last fifteen years. According to the diagram, some price drops were recorded only in 2009 and 2013 on a transitional basis. The greatest increase was reported for non-coniferous sawmill wood (mainly used in sawmilling). Since the last decrease recorded in 2013, timber prices have consistently grown by ca. 4% to 6% per year, depending on the assortment. For timber processing companies, this is a problematic situation which affects their financial stability. The prices grow year by year, causing an increase in material costs which have a high share in total production costs for many manufacturers (often ranging from 70% to 85% of costs, approximately, in the case of sawmills). Thus, raw material prices have a direct effect on production cost-efficiency while also affecting the competitiveness of finished products entering the market.

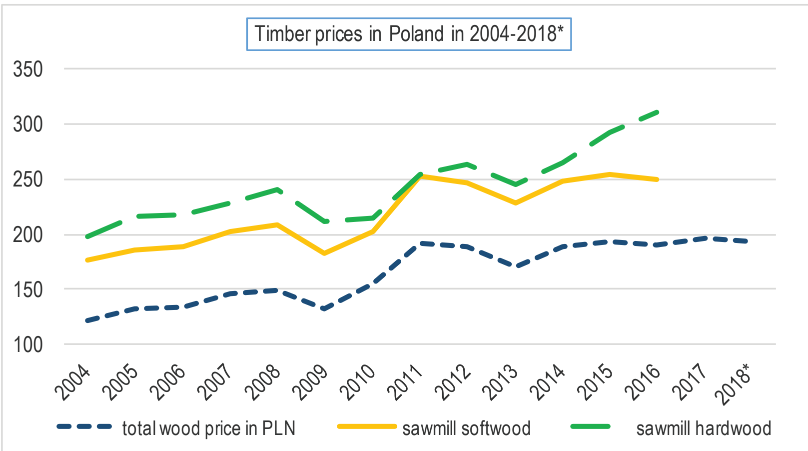

Fig. 3. Timber prices in Poland in 2004–2018 (data as of 1Q 2018)*
Source: own study based on data delivered by the State Forests National Forest Holding, www.e-drewno.pl

An increase in timber prices was also experienced in Germany. In 1H 2017, the prices of sawmill wood for the timber industry (harvested from German forests) reached 83.00–84.00 EUR/m³ (2a).

Next, Figure 4 presents a compilation of timber prices in Poland and selected European countries, i.e. Germany, Finland and UK (the prices are specified for coniferous sawmill wood). Prices in Figure 4 are specified in PLN; the average exchange rates delivered by the National Bank of Poland were used to convert the amounts expressed in EUR and GBP in the relevant periods. As shown in the diagram, a considerable difference in coniferous wood prices exists between Germany and Poland, Finland and UK. Note that Poland and Finland report a comparable level of wood raw material prices. Even though they differ in forest cover (ca. 29.5% in Poland vs. 76% in Finland), both countries have a comparable ratio of timber harvest to current increment (ca. 74.8% in Poland vs. ca. 73% in Finland) (Fig. 2). In Germany, the forest cover ratio is ca. 32% and the ratio of timber harvest to current increment is ca. 80.3%, a similar proportion to that recorded in Poland (2016 Report on the condition of Polish forests), whereas the average price level is ca. 50% higher than in Poland. Undoubtedly, the price level is impacted by the economic development level (measured with GDP) and the country's economic orientation. For instance, Germany's nominal GDP in 2017 was USD 3,684,816 million; Poland, Finland and the UK recorded a GDP of USD 524,886 million, USD 253,244 million and USD 2,624,529 million, respectively (www.wikipedia.pl, 2017 International Monetary Fund data). The GDP suggests that Germany is the most developed economy which may be a reason for the higher price level of raw materials. Furthermore, Germany is a production and export-oriented economy (the world's second largest exporter, after China) which means extremely high levels of both production and exports (www.wikipedia.pl).

Conversely, in the UK, the variation in timber prices (ca. 0.13%) is surprisingly low considering the country's forest cover ratio.

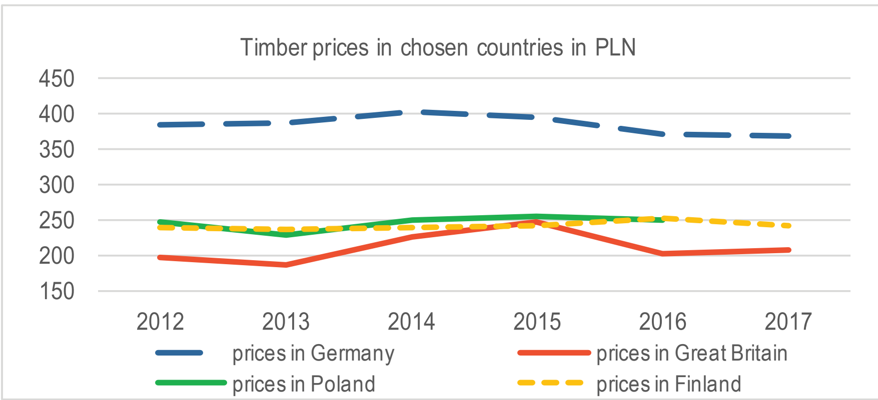

Figure 4. Timber prices in Poland, Germany, Finland and UK in 2012–2017.
Source: own study based on data delivered by the State Forests National Forest Holding, www.lasy.gov.pl, www.destatis.de., www.woodstat.se, www.forestry.gov.uk

Also contributing to the increase in timber prices is the growing demand for wood products in international markets. This results in a shortage of raw materials available for sale in European countries. As a consequence, the prices of round wood in the Polish market, though growing, become even more attractive to foreign entrepreneurs, especially German.

5. OWNERSHIP STRUCTURE OF FORESTS

Poland differs from many other European countries in terms of ownership structure of forests. State Forests (*Lasy Państwowe*, LP), the largest national supplier of wood raw materials, owns 80.8% of resources, including forests managed by PGL LP (77.0%), while the share of private forests is ca. 19.2% as of 2017 (www.lasy.gov.pl). LP delivers over 90% of raw materials to timber processing companies; the remaining 10% are imported our sourced from private forests (www.pb.pl).

As shown in Figure 5, in Europe, the largest share of private forests is characteristic of Scandinavian countries (Norway, Sweden, Finland) but also of France, Austria and Portugal. In these countries, ca. 80% of forests is held privately (or even 98% in Portugal). Although the share of public forests is not large in that group, forests can be accessed by the public without any stringent restrictions, except for specific local cases. At the other end of the scale, in the European part of Russia, Belarus and Georgia, all forest resources are managed by the state (www.forest-monitor.com).

In turn, the total forest area in Germany is ca. 11.4 million ha, including 48% of private forests, 4% of state-owned forests, 29% of forests managed by Länder, and 19% owned by social players (*www.lasy.gov.pl*). For more than 200 years, German forests have been managed in accordance with the sustainable development principle, as set forth in the Forest Act of specific Länder. The act prohibits harvesting more timber than the forest can grow back (www.ypef.eu, *www.bundeswaldinventur.de* , www.bmel.de).

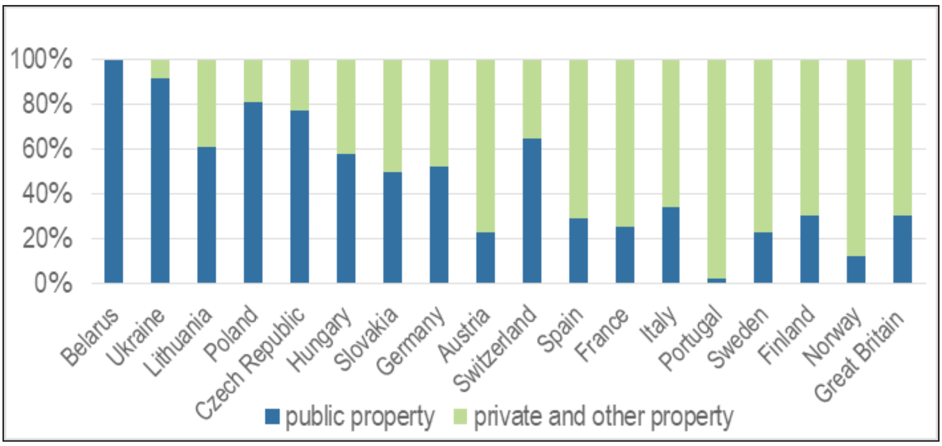

Fig. 5. Share of public forests in the total forest area in selected European countries. Source: own elaboration based on the 2016 Report on the condition of Polish forests.

In Finland, the country with the largest forest cover in Europe, forests extend to an area of over 26 million ha, including ca. 35% of state-managed forests, ca. 60% held by private persons and companies, and ca. 5% owned by local government units, churches and other operators (www.ypef.eu/floraifaunafin).

In the UK, in 2017, the forested area was ca. 3.08 million hectares, covering 13% of the national territory (Żaczek 2013). The economic development boosted the growth of British forests. In the UK, forests fall into two categories: woodland and certified woodland (44%) audited by the forestry authority. Certified woodland is managed and must comply with stringent norms set out by the Forestry Commission to which the British, Irish and Welsh forestry authorities (the Forestry Commission and Forest Service, respectively) are subject. The requirements are mainly determined by regulations concerning forest age and forest area management (including forest expansion, deforestation and accessibility to visitors).

The UK has a complex ownership structure of forests; 30% are owned by the state and the remaining part, in various configurations, is held by forest tenants or owners and is therefore referred to as forest areas not owned by Forestry Commission or forestry authorities.

As shown by relevant data, to the extent covered by this analysis, no direct relationship exists between timber prices and the ownership structure of forests. In Finland and UK, even though public forests are in a minority (with a share of ca. 30%), timber prices are comparable to those recorded in Poland where most forests (ca. 80%) are owned by the state, and are lower than in Germany where ca. 50% of forest areas are held privately. However, a relationship may be found between forest structure and raw material supply. For instance, in Poland nearly 75% of round wood raw material grown in State Forests enter the market within a year, whereas in Finland (where the state holds ca. 30% of forests) Metsähallitus (state institution in charge of raw material harvesting) harvests only around 10% of raw material available for harvesting on a countrywide basis (www.drewno.pl).

6. FINAL CONSIDERATIONS ANALYSIS

The volatile condition of the Central and Western European timber market is determined by growing consumer demand for highly processed products made with renewable raw materials. The ecological aspect of timber harvesting and processing drives the growing popularity of wood. In that context, both the technological level of the timber industry and the abundant resources of raw materials found in different European regions become increasingly important. As regards European countries addressed in this paper, the availability of timber resources largely contributes to the development of the timber industry. At the same time, the ownership structure of woods has a small impact on the volume and potential of timber harvesting. This largely results from the opening of the timber market to external supplies of raw materials, and is related to the forestry policy established by Western and Central European countries.

The price volatility of available timber types is related to the industrial development level and to the market position held by particular countries. Also, the changes in prices are considerably affected by national policies governing the access to forest resources. Countries who restrict the volume of timber harvested from national tree stands resources, considering their capacity to regrow (the increase in timber volume), demonstrate a higher increase in prices of round wood entering the market.

At the same time, this study may confirm that the ownership structure of forests affects the demand; countries with a much greater share of private ownership tend to use the growing raw material resources to a slightly greater degree. This results from the limited impact of monopolies who establish local conditions for the sale of timber in the European market. An open market policy, supported with sustainable development of the forestry and timber sectors, translates into stabilized trade in natural raw resources in European countries. The concept of a collaborative use of forestry resources by countries with different shares of private property may help streamlining the functioning of timber companies.

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PRODUCTS FROM FURNITURE PRODUCTION OF THE REPUBLIC OF MACEDONIA IN THE EXTERNAL - TRADE EXCHANGE

Živka Meloska, Mira Stankevik Šumanska, Angelina Meloska

ABSTRACT

Abstract: Exports and imports are the main components of the foreign trade, ie the growth imperative and the development of the economy in each country. Furniture production is one of the branches, which has a long tradition in the international market. Therefore, the paper presents the current situation with the structure of the export and import of furniture in the Republic of Macedonia in the period 2010-2017. The export and import of four groups of furniture were analyzed, according to SITC, as follows: wooden office furniture, wooden kitchen furniture, wooden bedroom furniture and other wooden furniture. In the past period the trend of export of bedrooms continues, and import of other wooden furniture. Also, the regional orientation of exports and imports continues to be realized with the countries from the immediate neighborhood (Serbia, Kosovo, Croatia, Slovenia), as well as Turkey, Germany, Italy, etc.

Key words: export, import, structure, furniture

1. INTRODUCTION

Foreign trade is one of the main goals of the macroeconomic policy of modern economies. It enables the development of competition and prevents monopoly affects the fall in prices and provides easy export of capital, which increases protection against risk. Industrialization, the liberalization of economic relations and globalization enable the development of foreign trade. The positive foreign trade stimulates the development of any economy.

Given that exports and imports are the main components of foreign trade their relationship is one of the key factors for the growth of gross domestic product, and therefore faster economic development. Export of products with high added value, unlike the export of raw materials and semi-products, brings profit to the economy, maintains competitiveness and higher employment.

Furniture production as part of the Macedonian wood industry is traditionally important both for satisfying the domestic market and also for export. The products from the Macedonian processing industry, and therefore the furniture industry are exposed to strong competition, which is especially expressed by the involvement of our country in the global processes, with the accession of the Republic of Macedonia to the World Trade Organization (WTO) and by signing the free trade between the Republic of Macedonia and the EU (CEFTA).

2. SUBJECT AND OBJECTIVE OF THE RESEARCH

The subject of paper research is the export and import of furniture products in the Republic of Macedonia. Also the trade balance in the separate product groups is analyzed, namely: wooden office furniture, wooden kitchen furniture, wooden bedroom furniture and other wooden furniture, as well as exporting and importing countries of furniture production.

Analyzes are based on data obtained from the Economic Chamber of Macedonia. Data on the movement of exports and imports of wood furniture are shown in US dollars for the period 2010-2017. The structure of exports and imports is analyzed according to SITC, through the four main groups of wood furniture, as follows: wooden office furniture, wooden kitchen furniture, wooden bedroom furniture and other wooden furniture. Exports and imports by countries of export and import are according to the classification of products according to SITC.

The objective of this research is to identify the trends in the trade of products from the production of wood furniture, and thus to establish competitiveness of this production on markets in the immediate environment and beyond.

3. FOREIGN TRADE OF WOODEN FURNITURE FROM THE REPUBLIC OF MACEDONIA

Before we show the situation with the export and import of wooden furniture from the Republic of Macedonia, we will present some more important data regarding the situation of the wood industry and furniture production in our country. According to the data from the State Statistical Office (SSO) of the Republic of Macedonia (2017), this industry accounts for less than 1% of the gross domestic product, or about 0,7%. The number of employees is steadily increasing, with about 1,3% of the total number of employees in the country.

According to data from the SSO of the Republic of Macedonia (2017), the share of the wood industry business entities in the total number of business entities in the processing industry of the Republic of Macedonia is about 14%. The share of the number of enterprises in the production of furniture in the total number of business entities in the wood industry is 57%. The average share of the number of employees in the wood industry in the total number of employees in the processing industry is about 6%, while the participation of the employees in the furniture production in the total number of employees in the wood industry is 64%.

For the volume of furniture production, it can be said that, according to all its holders, there is a tendency of increase according to the data from the SSO of the Republic of Macedonia (2017).

According to the same data in relation to the average share in the total export of wood industry products furniture production participate with 70%, while the import of furniture products is lower and it is 32%.

This chapter of the paper presents the foreign trade of wooden furniture in the period from 2010 to 2017, its structure, the trade balance, as well as the overview of the most important trade partners of furniture with the Republic of Macedonia.

3.1 Export - import of wooden furniture

Export of furniture production is given in Table 1. The total export, as well as the structure of export of the four more important groups of wooden furniture in the Republic of Macedonia is shown.

Table 1. Export of wooden furniture (in US dollars)

	Wooden office furniture	Wooden kitchen furniture	Wooden bedroom furniture	Other wooden furniture	Total
2010	208052	700775	2866196	2786450	6561473
2011	/	568936	3288241	3732170	7589347
2012	391069	578606	3471068	2909266	7350009
2013	409452	852156	4289378	2289687	7840673
2014	/	797116	4294056	2914229	8005401
2015	/	810712	3632699	2448211	6891622
2016	/	1037369	3553650	3246389	7837408
2017	398974	1344977	3475037	3511487	8730475
Average	**351887**	**836331**	**3608791**	**2979736**	**7600801**
AAR	**9,75**	**9,76**	**2,79**	**3,36**	**4,87**
Participation (in%)	**4,5**	**10,8**	**46,4**	**38,3**	**100,0**

According to the data in Table 1, for the period 2010 - 2017, the largest share in the export of furniture is the group wooden bedroom furniture with 46,4%. Then follows the group of other wooden furniture with 38,3%, and the rest of 15,0% belong to groups of kitchen furniture and office furniture from wood. In comparison with the period before 2010, most of the other wooden furniture was exported, followed by furniture for bedrooms, kitchen furniture and office furniture.

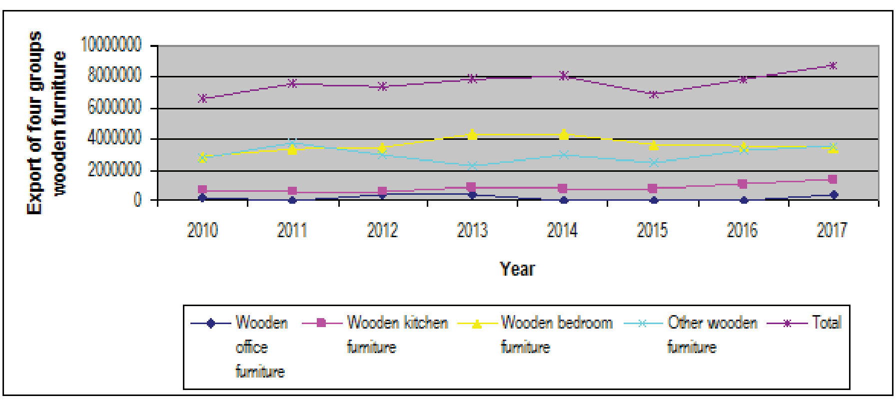

Figure 1. Dynamics of the export of wood furniture

From the data in Table 1 and Figure 1 it can be seen that the analyzed groups of furniture products show a tendency to increase from 2010 to 2017. The highest average growth rate has the wooden kitchen furniture with 9,76%, while the same for the export of bedrooms is the smallest and it is 2,79%. This trend of growth is followed by the total export of the four groups of furniture products with an average rate of 4,87% for the given period.

Import of wooden furniture for the period 2010 - 2017 is shown in Table 2. The total import, as well as the import of the four more important groups of furniture that are part of the furniture production in the Republic of Macedonia, are analyzed.

Table 2. Import of wooden furniture (in US dollars)

	Wooden office furniture	Wooden kitchen furniture	Wooden bedroom furniture	Other wooden furniture	Total
2010	294497	966034	4136859	5956309	11353699
2011	183644	930506	4069127	6683162	11866439
2012	1959007	1013126	2938095	7464923	13375151
2013	420658	874243	3073072	7640708	12008681
2014	660639	940022	3340455	8007105	12948221
2015	579167	743778	3021568	9233369	13577882
2016	433283	953498	3746982	8639937	13773700
2017	304714	903530	4174659	9243686	14626589
Average	**604451**	**915592**	**3562602**	**7858650**	**12941295**
AAR	**0,49**	**- 0,95**	**0,13**	**6,48**	**4,31**
Participation (in%)	**4,7**	**7,1**	**27,5**	**60,7**	**100,0**

From the data in Table 2 it can be seen that the largest share in the import of furniture has the group of other wooden furniture with 60,7%. Then follows the group of wooden bedroom furniture with 27,5%, and the rest of about 12,0% belongs to groups of kitchen furniture and office furniture from wood. In comparison with the period before 2010, also imported the most the group of other wooden furniture, followed by furniture for bedrooms, kitchen furniture and the smallest office furniture was imported.

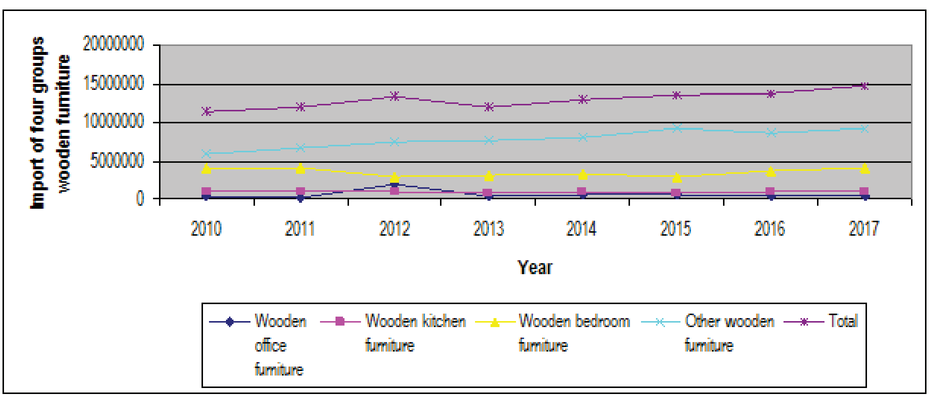

Figure 2. Dynamics of the import of wooden furniture

The data in Table 2 and Figure 2 show that all analyzed sets of furniture imports have tended to increase, except the kitchen wood furniture where it tends to decline for the period 2010-2017 year.

The highest average growth rate was recorded in the group of other wooden furniture, which is 6,48%, while the same for the import of office furniture is the smallest, accounting for 0,49%. The trend of import growth is followed by the total import of the four groups of furniture products with an average rate of 4,31% for the studied period.

3.2 Trade balance of wooden furniture

Based on the analyzed data on the export and import of the four main groups of furniture according to SITC, their balance for the period 2010 - 2017 was made. Also, the balance of the total export and import of the four groups of furniture for the same period is shown. They are given in Figure 3.

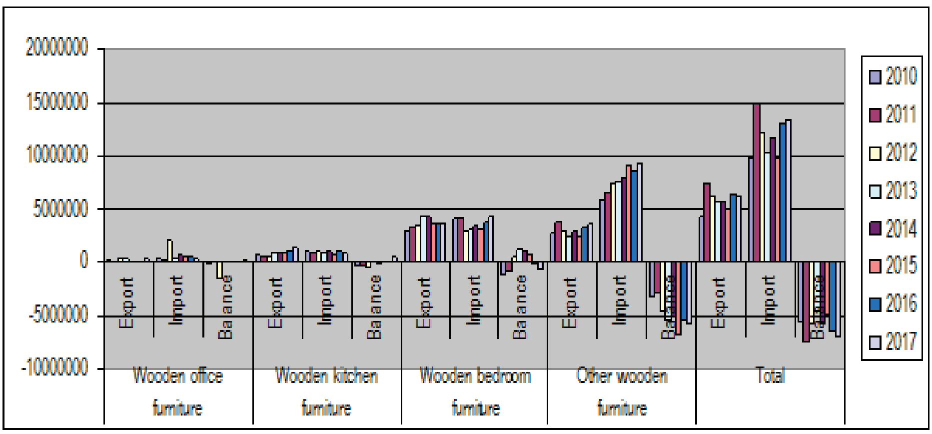

Figure 3. Trade balance of wooden furniture

The data in Figure 3 shows that the trade balance in the four groups of furniture has variable dynamics, with the exception of the group of other wooden furniture where the balance is negative in all years of the analyzed period (2010 - 2017). The trade balance in total for the four groups of furniture has a negative sign, which means that during the given period more were imported than exported these groups of products, that is, office, kitchen, furniture for bedrooms and other wooden furniture.

It should be pointed out that in the foreign trade in furniture in the Republic of Macedonia, the import is mostly used by the group of other wooden furniture, and in the export of the bedrooms from the wood and with the greater share has the group of other wooden furniture which includes furniture parts, and not garnish as in three other product groups.

3.3 Overview of the foreign trade of wooden furniture with the important partner countries of the Republic of Macedonia

According to data from the Chamber of Commerce of the Republic of Macedonia (2017), a review of the trade exchange of wooden furniture for the more important groups of furniture products which are distinguished by their presence are presented, like as the group of other wooden furniture and the group of bedrooms of wood.

Strategic markets for bedroom exports, which have the largest export in the analyzed period (2010 - 2017), are the immediate neighboring countries like Croatia 27%, Kosovo with 25%, Serbia with 12%, and the remaining 36% are from Montenegro, Slovenia etc. The products from the group of other wooden furniture are mostly exported to Montenegro 15%, further Slovenia 10%, the Netherlands 6%, while the rest belongs to Germany, Switzerland, Italy, the Czech Republic, etc. with a share of 69%. (Figure 4 and 5)

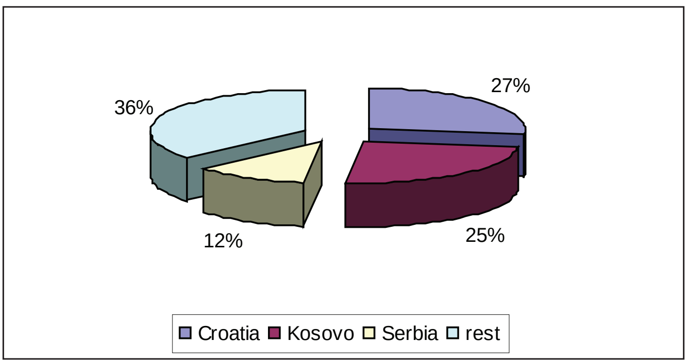

Figure 4. Export of wooden bedroom furniture

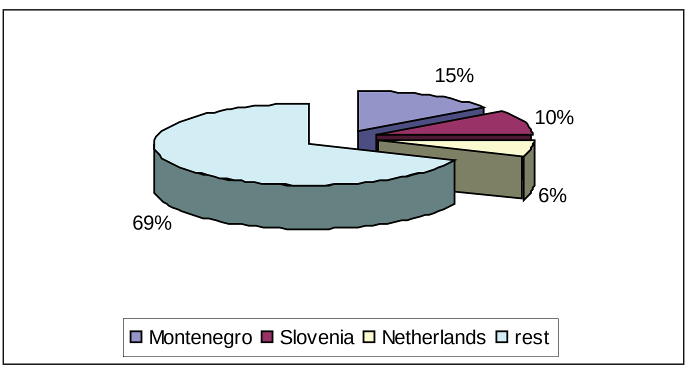

Figure 5. Export of other wooden furniture

Compared to 2010, export of bedrooms continues with the same trading partners in 2017, unlike the group of other wooden furniture where new export partners such as Montenegro and the Netherlands appear instead of Croatia and Greece.

On the other hand, the import of the same groups of furniture is mainly from Serbia with 39% and Turkey 25% in the bedrooms of the woods, while in the group of other wooden furniture in 2017 the most were imported from Serbia 32%, Turkey 24%, Croatia with 8%, and the rest of 36% share in imports Italy, Poland, Germany, China and others. (Figure 6 and 7)

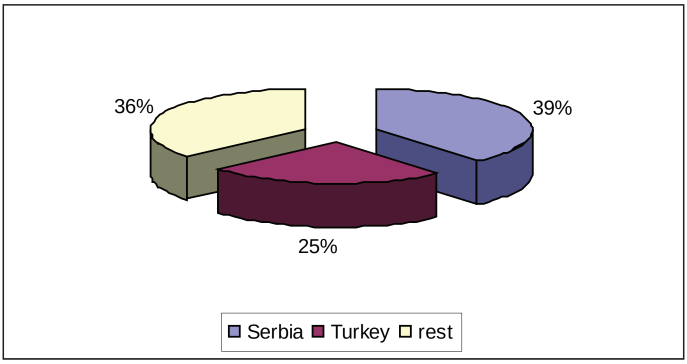

Figure 6. Import of wooden bedroom furniture

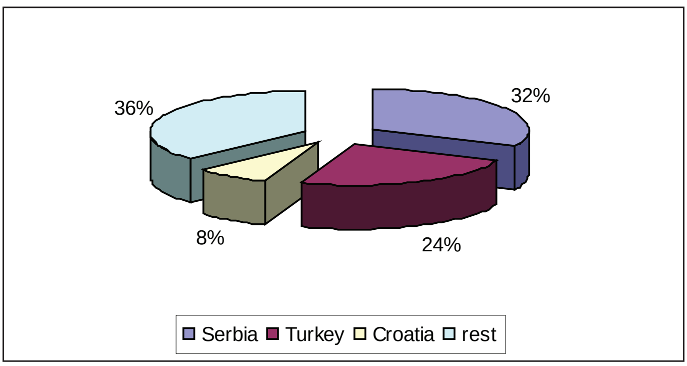

Figure 7. Import of the other wooden furniture

Compared to 2010, imports such as wooden bedrooms furniture, as well as other wooden furniture, are with trade partners from the same countries that continue to trade with Macedonian business entities in 2017 as well.

4. CONCLUSIONS

From the analysis of the foreign trade, ie the export and the import and the trade balance of the four groups of furniture, as follows: office furniture. kitchen furniture, bedroom furniture from wood and other wooden furniture in the Republic of Macedonia for the period 2010 - 2017, the following can be concluded:

The largest share in the exports has the wooden bedroom furniture, than follow the group of other wooden furniture, and the other groups of wood furniture. Imports are mostly imported with other wooden furniture, followed by furniture for bedrooms, kitchen and office furniture from wood.

According to the data for the period (2010-2017), the export of furniture is growing in all analyzed groups, the same happens with the import. Total for the export and import of furniture can be said to have a positive growth dynamics for the given period.

The trade balance in the four groups of furniture has variable dynamics, with the exception of the group of other wooden furniture where the balance is negative in all years of the analyzed period (2010 - 2017). The trade balance in total for the four groups of furniture has a negative sign, which means that during the given period more were imported than these groups of furniture were exported, ie we have a deficit of exports.

International trade in furniture from the Republic of Macedonia is not widespread in world markets. Almost the entire trade exchange for decades has been realized with neighboring countries. The reasons for such trade relations are due to the small transport costs, the good knowledge of the markets that is traditionally, and of course the already established interconnections dating back long ago. It can be said that this trend continues.

A small country such as the Republic of Macedonia must strengthen its exports in all sectors, as well as furniture exports in order to provide faster economic growth and development. Macedonian furniture manufacturers must undertake certain activities, which would promote and strengthen the market of the analyzed more important groups of furniture. The market offer should not be individual, but through appropriate and affirmed associations and groups with strong promotional activities.

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ENVIRONMENTAL LABELING: OBSTICLE OR ADVANTAGE IN RECOGNIZING WOOD PRODUCSTS IN INTERNATIONAL MARKETS

Andreja Pirc Barčić

ABSTRACT

Environmental labeling present an important segment in promotional activities related to an international sustainable production and consumption policies. Environmetal labels are voluntary environmental protection instruments by which manufacturers show their special interest for high environmental standards throughout the life cycle of their products. The aim of the paper is to show advantages and possible limitations of eco-labels usage in order to increase the usage of wood and wood products in international markets.

Keywords: environmental labeling, wood industry, sustainable consumption and production, eco-innovation

1. INTRODUCTION

The question of the importance of protecting the area we live in is one of the most important, if not the most important issue in today's modern time. This was emphasized in 1987 when the World Commission on Environment and Development (Brundtland Commission) presented a new concept of sustainable development as "a development that meets today's needs and does not jeopardize the needs of future generations". In a series of documents, the European Union presented a concept of sustainable development that introduces a systematic solution to environmental issues as a key political paradigm by promoting sustainable consumption and production, environmentally friendly management in an environmentally friendly manner, and public information on negative impacts and the production of environmentally friendly products. Wood processing and furniture manufacturing, together with their links to the forestry value chain industry, are an example of the circular economy as a new concept of the EU economy, as the economic growth of these activities is primarily based on forest maintenance, i.e. the use of raw material resources in accordance with sustainable development. The general goal defined in the Strategy for Wood Processing and Furniture Manufacturing of the Republic of Croatia, 2017-2020 with the Action Plan for Implementation 2017-2020 is a successful and profitable wood industry with balanced sustainable development in line with global environmental trends; information on the importance of using wood products from the standpoint of environmental protection; protection of the Croatian wood industry; better competitiveness of Croatian wood products and better positioning in export markets; and increasing employment in rural areas to reduce depopulation. Moreover, neither the producers of wood products (industry) nor end-users (consumers) know their roles and potentials to reduce the environmental impact on the environment.

2. SUSTAINABLE CONSUMPTION AND PRODUCTION

The term, Sustainable Consumption and Production, was developed at the Rio Summit of the United Nations Conference on Environment and Development in 1992. A policy document of the summit, Agenda 21, also included the objective to pursue more sustainable consumption and production (United Nations Sustainable Development 1992). The Organization for Economic Co-operation and Development (OECD) (2002) has defined sustainable consumption as the consumption of consumption of goods and services that meet basic needs and quality of life without jeopardizing the needs of future generations. Further more, sustainable consumption initiatives deal with raising awareness and changing consumption behavior, values, and motivations (Barber 2007). On the other hand, sustainable production sustainable production considers environmental, social and economic dimensions of firm's activities (Veleva 2001). De Giacomo et al. (2014) noted that initiatives for sustainable consumption and production aim to change particular production processes or products and can be considered a base for eco-innovation practices that paid attention to the environment impacts arising from these activities.

At European level, a key document related to promotion of issues regarding sustainable production and consumption is the Sustainable Consumption and Production and Sustainable Industrial Policy (SCP/SIM) Action Plan, referred to the year 2008 which address the environmental performance of products as also foster the demand for environmental-friendly products and production technologies. Another European document which contains issues regarding the sustainable consumption and production is the document Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions (COM) 2008 397 final. This document provides some measures to achieve a sustainable consumption and production that will determine a higher level of competitiveness of the European economy. The Action Plan has also the objective to reinforce the information towards consumers on eco-friendly products. The promotion of Sustainable Consumption and Production initiatives is crucial due to the fact that environmental pollution arising by industrial activities has been emphasized by many data and studies. Results conducted by Danish Technological Institute (2010) showed that SMEs are responsible for more than 60% of industrial pollution in Europe. The study, considered some case studies from 13 countries and an online survey covering EU 27 countries. Today, the movement to achieve sustainable production and consumption is one of the most important yet little known social movements of the new century (Barber 2007).

Within this context, green products defined as products striving to protect or enhance the natural environment (Ottman et al. 2006) can play can play a key role (Commission of the European Communities 2001).

3. ENVIRONMENTAL LABELS

Accoridnig to Dangelico and Pontrandolfo (2010) green products can be recognized in the market by third-party certified eco-labels, even though eco-labels are not available for all product categories. On the last 25 years there has been a huge appearance of eco-labels - about a dozen in 1990 and in 2018 463 eco-labels in 199 countries and 25 sectors! The increasing trend has been noted also regarding a green product innovation which is continuously growing (Dangelico, 2016), and being conducted both in developed countries and in emerging economies (Dangelico et al. 2017), even though research in emerging economies is still limited (Dangelico 2017). If companies want to reach a market of environmentally concerned customers it is crucial for companies to communicate their environmental performance and the environmental profile of their products to the customers. At the same time there is a demand from large consumer groups to know more about the environmental profiles of the products they are offered in the shops. These two needs are addressed by ecological labelling or eco-labels.

Environmental labels (Eco labels) are environmental protection instruments by which manufacturers and service providers demonstrate that they respect high standards of environmental protection throughout their product life cycle and service delivery. Eco-lables are important in promoting an international sustainable production and consumption policy aimed to reduce the negative impact of production and consumption on the environment, health, climate and natural resources, and fostering socially responsible business and sustainable life styles. Eco-labels can be obligatory and voluntary, and the company will decide if it wants to import a particular eco-label for their product, product program and / or service, and it is very important to point out that voluntary markers do not offer decision-making freedom but only give companies the choice whether they want to meet the requirements prescribed for obtaining an eco-label. From a business point of view, eco-labels are an environmental management tool that can inform customers of products' new green features in a visual way (Thøgersen et al., 2010). Manufacturers who want to get an eco-label must align their manufacturing processes with ecological standards.

International Organization for Standardization (ISO) defines three types of environmental labels and declarations and is getting together all three types is ISO 14020 (ISO 2000). It provides nine common guiding principles for the development and use of environmental labels and declarations (Minkov 2018). The first overarching principle of these standards is that environmental labels and declarations shall be accurate, verifiable, relevant and not misleading. According to the ISO 14020 standard, the overall goal of environmental labels and declarations is to encourage the demand and supply of sustainable products and services through communication of verifiable and accurate information on environmental aspects that is not misleading. Thereby the labels stimulate potential for market-driven continuous environmental improvement.

Based on different documents Minkov (2018) noted the most important differences regarding type I, type II and type III environmental labels, as follows:

Type I environmental labels are defined by ISO 14024 (1999) as voluntary, multi-criteria based third-party programs (managed by a respective eco-labeling body) that award licenses for the use of environmental labels on products. Type I eco-labels are based on the concept of eco-efficiency (Bjørn and Hauschild 2018), which proclaims that the development of new products or the improvement of existing products should be done with an intention to reduce their damage on the ecological systems (i.e., doing more with less). To achieve the certification, a product should fulfill certain product environmental criteria that are also based on life cycle considerations. “Product environmental criteria” is the official term as per ISO 14024. Type I eco-labels usually facilitate business-to-consumer (B2C) communication, and the awarded label indicates overall environmental preferences within a certain product category.

Type II labels are self-declared environmental claims that are either issued in the form of a claim, a stamp, a label, a declaration, or a more complex rating system. It is not mandatory for such claims to undergo third-party certification. Although ISO 14021 (2016) seeks to harmonize the basic principles and requirements of such self-declared claims, nowadays, their availability and variability on the market is large, making it almost impossible to categorize average properties and characteristics.

Type III environmental declarations (known also as environmental product declarations, or EPDs) present third-party verified and quantified environmental information on the life cycle of a product. They are governed by ISO 14025 (2006) and are based on an LCA study that was conducted according to specific product category rules (PCR). EPDs are intended for business-to-business (B2B) communication. Typical Type III programs (managedby a legal body called a program operator) include the Swedish International EPD® System and the German Institut Bauen und Umwelt e.V.

4. ECO LABELS IN WOOD INDUSTRY

Only Type I environmental labels can be included in the *Global Ecolabelling Network* (GEN), which currently includes 27 members. This type of eco-label is only awarded to the best. For example, in the Republic of Croatia, the Ministry of Environmental Protection and Energy, is responsible for two labels of type I eco-label: the national environmental protection label ‘Environmentally Friendly’ (Prijatelj okoliša) and the European Union environmental protection label (EU Ecolabel). The EU Ecolabel scheme is defined by Regulation (EC) No. 66/2010 of the European Parliament and of the Council of 25 November 2009 on the EU logo for the environment.

The European Commission, together with the Member States, develops benchmarks for certain product groups or for those with a significant market share. The measurements are specific to each product group and focus on the part of the environmental impact which is most significant and which can be affected, and the categories of products important for the wood products industry are: Furniture and Flooring based on wood, and bamboo (Wood-, cork- and bamboo-based floor coverings). Furthermore, for the area of certain wood-based products, the criteria for determining the environmental marking criteria for the EU logo for furniture (EU 2016/1332) have also been defined (since 31 December 2016 EU 2009/894 decision, which established ecological criteria for ‘wood furniture’ only, is not valid any more). Criteria for establishing the ecological criteria for the award of the EU logo for floor coverings based on wood, cork and bamboo is defined by the Commission Decision (EU 2017/176) (from 31.12.2016 the decision EU 2010/18, which established ecological criteria for 'wooden floor coverings' is only not valid any more). Currently, according to data from the EU Ecolabel database, only one product in the category 'wood furniture' has the EU Ecolabel mark, in Poland. In the category, wooden flooring has 478 products registered, of which 477 are from the Swedish manufacturer and 1 are in Italy. This was also one of the reasons, as outlined in the new criteria, to establish the environmental criteria for the award of the EU Ecolabel sign why the criterion was revised. Environmental Product declaration (EPD) can be assigned to different product categories, and the categories are defined by the Product Line Rules (PCR Porduct Category Rules). Overall, Ibáñez-Forés (2016) noted that communicating objective information and improvement of the corporate identity of the company have been identified as the main factors for adopting International EPD® Programme as environmental communication tool. On the contrary, the main weakness identified is the lack of knowledge about EPD programmes in general, by consumers. Based on the requirements defined in the rules for a particular set of products, a lifecycle assessment of products based solely on the application of LCA methodology (whose implementation is ISO 14040) is made. For wood-based products, it is important to highlight PCR for 'Wood and Wood Products for Use in Construction' (Wood and Wood Products for Use in Construction). Räty (2016) found out that an environmental performance is considered an important competitive factor for the Nordic wood product industry. Their results also indicated that insufficiently employed strategic possibilities embedded in the environmental performance of wood, despite the fact that the use of wood mitigates climate change by increasing carbon sequestration and substitutes building materials with higher carbon emissions. Also, they discussed that firms, especially SMEs, cannot turn this material advantage to a source of competitive advantage alone, but concerted actions throughout the whole value chain are needed.

5. OBSTICLES AND INCENTIVES

Despite potential advantages, however, eco-labels also present the opportunity for information overload which occurs when consumers with limited cognitive capacity are presented with too much information at any given time, resulting in poorer and less effective decision-making (Lee and Lee, 2004). This type of overload can result in consumer confusion, which may negatively affect emotions, trust, and satisfaction considered the most important marketing outcomes (Walsh and Mitchell, 2010). Although research indicates that consumers consider eco-labels in their consumption decisions, they do not always use this information to actually make decisions (Leire and Thidell, 2005). Certification and eco-labels, send a clear signal of 'environmental stewardship' to consumers who may be willing to pay a higher price in order to incentivize the joint production of sustainably-harvested commodities (Groom and Palmer, 2014). Contrary, common issues related to the adoption of eco-labels include high costs, excessive bureaucracy, a failure to achieve meaningful environmental stewardship, and an inability to address wider social issues (Gulbrandsen, 2010). Accoridng to Prieto-Sandoval et al. (2016) the ecolabeling innovation cycle starts when consumers express their environmental expectations and then, the most eco-innovative companies try to satisfy those expectations by improving their existing products, processes or suppliers. The also stated that the objective of these actions is to offer more value added to consumers than their competitors.

6. CONCLUSIONS

In order to face the challenges we are facing today, we need to change the way of production and consumption of products. We need to create greater value by using less resources, reducing costs, and impacting the environment. This is also good for business as business costs can also reduce dependence on raw materials. Ecological design and eco-innovation can mitigate the effects of production. They can help improve the overall performance of the product on the environment during their lifecycle and boost demand for better manufacturing technologies. Furthermore, eco-labels can help consumers make informed choices. Eco-labels offer a number of benefits to consumers: for example, government-sponsored and private eco-labeling can help consumers find products with the lowest environmental impact within any particular product group. Given the growing influence that eco-labeling has on environmental protection, the welfare of society, governmental and institutional strategies, eco-innovation, and company strategy, it is necessary to develop academic research that is focused on eco-labeling as an eco-innovation process and the future usefulness of eco-labeling for regions and economic sectors.

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THE PRICES AND UTILIZATION OF BIRCH AND BEECH RAW WOOD IN THE CZECH REPUBLIC – A BIOECONOMIC DIMENSION

Roman Dudík, Petra Palátová, Vlastimil Borůvka, Marcel Riedl

ABSTRACT

Forest management in the Czech Republic faces recently an unfavourable situation in the form of high share of salvage fellings in the spruce stands. These fellings are caused by synergy of effects of drought, honey fungus and bark beetle. This results in clear-cut areas of several hectares, that need to be afforested artificially. Solution of this situation will take place, among others, through the stands of pioneer species, including birch (Betula pendula Roth). But it is also available to grow the birch up to the felling age. In such a case a question about the utilization of birch raw wood in the Czech Republic occurs, because it has an impact on the prices of birch raw wood. The article deals with the analysis of possibilities of use of birch raw wood, prices of its assortments and a comparison with beech (Fagus sylvatica L.). On the one hand, there are no extensive capacities to process the birch raw wood into products with higher added value. On the other hand, the prices of birch raw wood are lower than in the case of beech, and because of that, for a range of products the processing of birch wood might be an interesting alternative in relation to beech.

Keywords: price, raw wood, birch, beech

1. INTRODUCTION

Czech forestry has been recently focused on the problem of declining spruce stands in lower and mid elevations, namely in the north of Moravia. The result is the increased volume of incidental felling. Relatively fast emerged clearings are spontaneously seeded by pioneer woody plants, very frequently by birch. Therefore, an opportunity offers itself to make use of the “creative force of nature” and to regulate the development of the self-seeded birch purposefully until its felling age. As to the costs of birch management, lower average costs can be expected as compared with the main commercial tree species in the Czech Republic (spruce, oak, beech, pine). As to the yields of birch management, a shorter rotation period should be taken into account and hence earlier yields. In addition to using the birch wood for energy where lower conversion into money can be expected, roundwood birch assortments can be used for example in the furniture industry (Dudík et al. 2018a).

The change in taking the birch not as a weed woody plant but rather as an alternative commercial tree species was analyzed within the project registered as *The evaluation of birch stands and their fulfilment of forest functions, birch management* *economics and proposed starting points for birch management in the Czech Republic* for the Grant Service of Lesy ČR (Forests of the Czech Republic, State Enterprise). This paper presents only a narrow part of the project concerning prices and utilization of birch raw timber. Moreover, a comparison is made with beech in the areas under review.

2. METHODS

Prices of birch and beech timber were taken over from data publicized by the Czech Statistical Office in 2010-2017 (CZSO 2018). Thus, the mentioned prices for the monitored period represent current prices for 1m^3 timber at the roadside and were not modified. Price respondents are forest owners and the prices are mean annual prices of timber assortments (roundwood assortments of quality grades II, IIIA/B, IIIC and IIID) distinguishable for beech and birch. The trend of development of the monitored timber prices is expressed by the relevant equation and by the R^2 determination index.

In the field of primarily used birch timber, an analysis was made of historic and current use in the Czech Republic. The utilization of beech wood is generally known in the Czech Republic and does not differ from the use of beech wood abroad.

3. RESULTS

The prices of some birch and beech timber assortments identified in the Czech Republic are shown in the below diagrams. The diagrams present also the development of prices in the period from 2010-2017 for the specific birch and beech timber assortments.

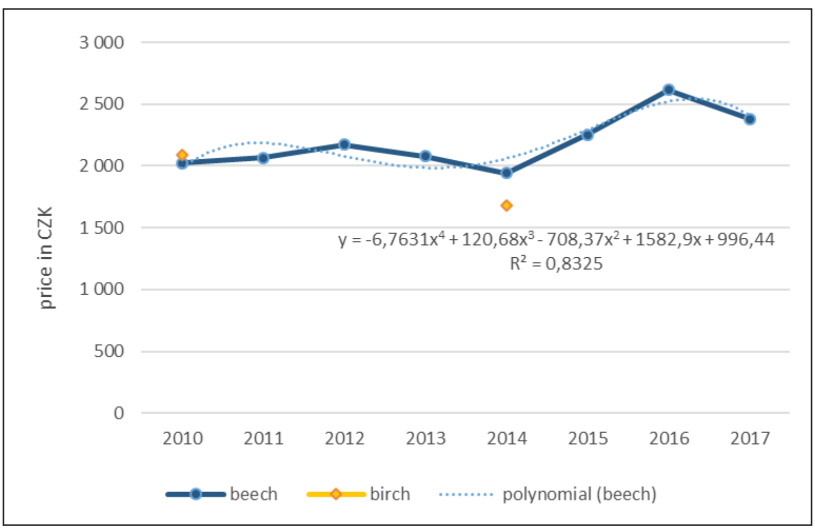

Figure 1. Development of prices of the quality grade II timber assortments in the Czech Republic in 2010-2017

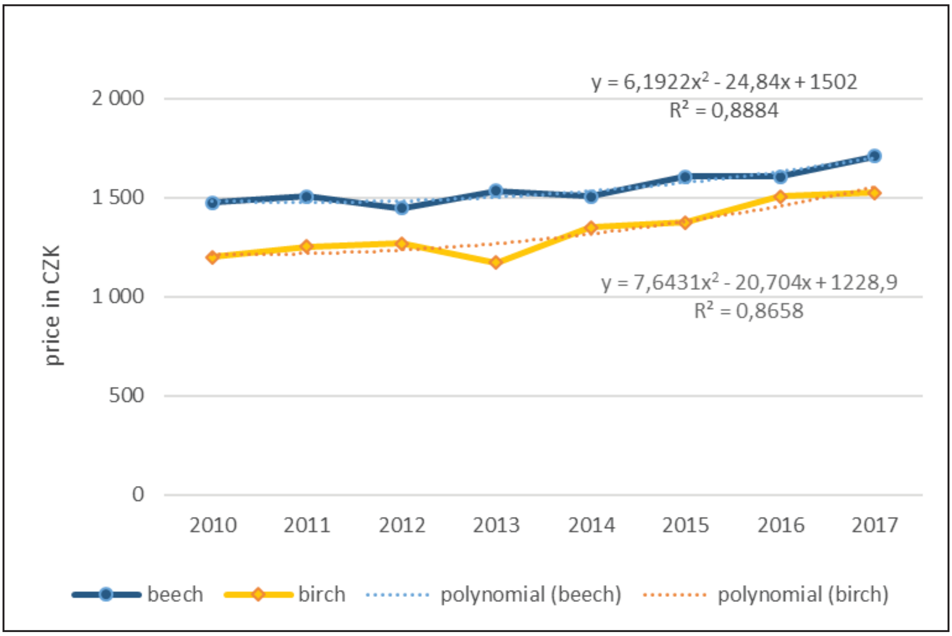

Figure 2. Development of prices of the quality grade IIIA/B timber assortments in the Czech Republic in 2010-2017

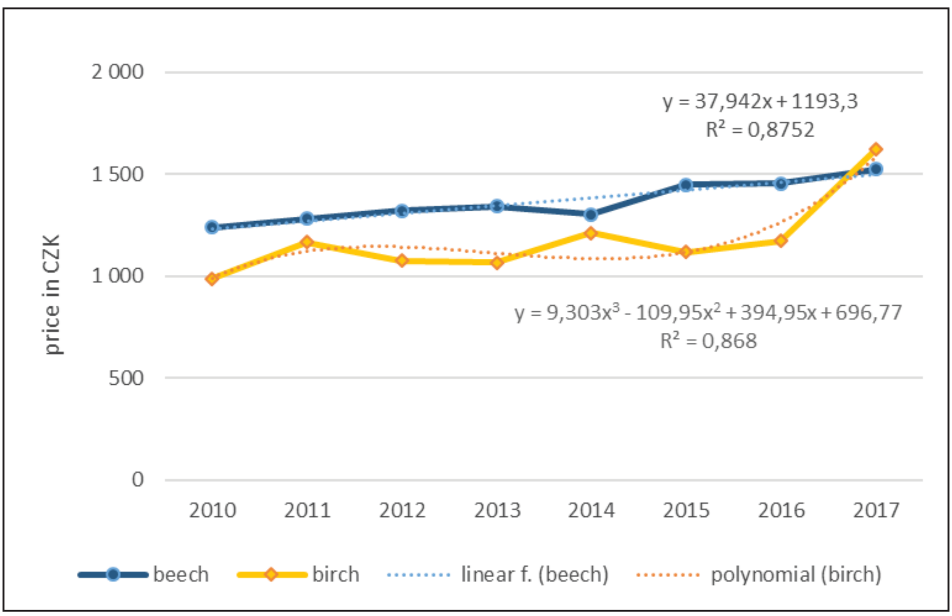

Figure 3. Development of prices of the quality grade IIIC timber assortments in the Czech Republic in 2010-2017

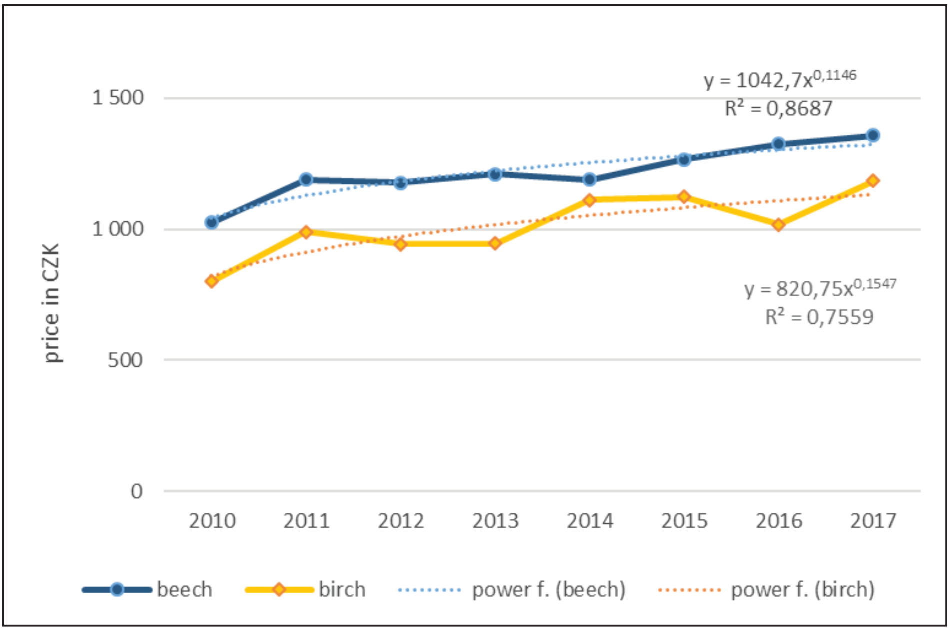

Figure 4. Development of prices of the quality grade IIID timber assortments in the Czech Republic in 2010-2017

The diagrams indicate that the long-term trend of the development of prices of listed birch and beech timber assortments is very similar. In the vast majority of cases, the prices of beech assortments are higher than the prices of birch for the given assortment. Only in two cases, the price of birch assortment was higher than the price of the same beech assortment. However, in the case of the IIIC timber assortment price of birch in 2017 it is possible to assume inaccuracy in CZSO data. Differences in the prices of birch and beech assortments in the period under review ranged in the interval from 98.00 CZK in favour of birch (assortment of IIIC quality grade in 2017) up to 363.00 CZK in favour of beech (assortment of IIIA/B quality grade in 2013).

The birch wood has a similar use as the beech wood. Birch timber assortments of quality grades I and II can be used for the production of sliced and peeled veneers. Peeled veneers can be used to produce plywood. Assortments of quality grade III can be used to make turned wood or for example toothpicks. Assortments of quality grades IV and V are used to produce particle boards or fibre boards. Quality grade V can be used also in the paper & cellulose industries. Assortments of quality grade VI can be used as fuel wood with the calorific value of birch timber being similar as that of other tree species. Possibilities for using the birch in the pharmaceutical or cosmetic industries are interesting, too. In conditions of the Czech Republic, there is no tradition of intentional cultivation of high-quality birch wood stands. However, we assume that the birch timber should not end as fuel wood but could find more extensive applications as high-quality material for the production of pulp and final products thereof.

4. DISCUSSION AND CONCLUSIONS

The identification of representative prices of broadleaved timber assortments is generally problematic in the Czech Republic due to the fact that broadleaves are less represented than conifers. This is also the reason why a smaller amount of the broadleaved timber is introduced to the market compared with the coniferous timber, which entails a potentially lower informative value in the prices of broadleaved timber assortments because these are obtained from a smaller amount of sold timber. As to the assortments of birch wood, the situation is even worse because data about the prices of birch assortments relate only to the tenth volume of beech timber sold, i.e. the prices of beech timber are identified from approximately ten times higher volume of timber sold.

This is also why the Czech Statistical Office publicized only two prices for the birch timber of quality grade II in the period under review. Relevant data for the publication of other prices in this assortment were lacking. Still, the prices of birch assortments publicized by the CZSO provide a starting point for comparing the timber prices of other tree species. The trend in the development of birch and beech timber prices is comparable, being slightly growing. The prices of beech wood are as a rule higher; however, by no more than 363.00 CZK. The difference in price is usually up to 300.00 CZK. Taking into account that the rotation period of birch stands is usually by a half shorter than in beech stands, we can see that the birch stands offer an interesting economic potential also to the forest owners (Dudík et al., 2018b). With its low price, the birch timber is interesting for the wood-processing industries.

Birch wood recovery and fibre quality are at the same level as in the other used broadleaved trees, see the available documents of Nordic companies METSÄ FIBRE (FIN) (METSÄ FIBRE 2017), UPM (FIN) (UPM 2016): e.g. fibre length 0.9 – 1.2 mm, fibre width 20 - 35 μm – although thinner-walled than beech, its tensile characteristics are comparable. Research findings presented by Fišerová and Gigac (2011) corroborate the justification of the above facts. The fibre strength and tensile index as well as the fibre length of sulphate pulp from the broadleaved timber range within the following sequence of pulps: robinia < oak < beech < poplar < birch < hornbeam. Similar results concerning the pulp of birch wood are included in papers (Koran 1995, Brodin, Theliander 2013), confirming its quality, comparable e.g. with the beech pulp and justification of its use. Another research (Borůvka et al. 2018) demonstrated that the impact of heat treatment on wood properties is less pronounced in birch than in beech, and that the birch is therefore more suitable for heat treatment. This simple and ecological method provides one of ways how to increase the use of birch wood in industries for products more valuable than fuel wood. In general, we can conclude that the birch can be an interesting alternative to beech in the conditions of the Czech Republic in a number of cases. The interdependence of causes and consequences leading to the idea of growing birch stands purposefully to their felling age at a larger extent is then on the interface between the traditional and social approach in bioeconomics.

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ACTUAL STATE AT THE EU-28 MARKET OF CLOTHES HANGERS OF WOOD

Slavica Petrović, Denis Jelačić, Margarita Bego

ABSTRACT

At the European Union market of clothes hangers of wood, in the period 2007-2017, important increase in trading volume was been achieved. Besides increase in external trade, internal trade increase was been achieved, too. The most important foreign trade partner of the Union was China, from which the import value of more than 100 million € was achieved during 2015. For market supply in the Union, the most important among the member countries were: Poland, the Netherlands, Germany and Spain, and since 2013 Romania. Increase in the use of clothes hangers of wood at EU-28 market is a clear indicator of changes in customer awareness, so instead of cheap plastic hangers, they decide to buy more expensive ones of wood. Continuous emphasis in the environmental properties of wood, as natural material, has contributed to this, which resulted in the increase of its use. Also, another important parameter which influences trading volume of these products at the European Union market, is that EUTR, which came into effect on March 1, 2013, does not apply to clothes hangers of wood.

Keywords: clothes hangers of wood, EU-28 market, trade volume, internal trade, external trade

1. INTRODUCTION

According to some historians, Thomas Jefferson, the third President of the United States of America invented the first clothes hanger. The public is more of the opinion that O.A. North of Connecticut in USA designed the first clothes hanger in 1869. The shape of clothes hanger has evolved over time, and in 1965, wooden component of the hanger construction got its modern design (Wernicke, M.).

According to the classification of UNECE and Eurostat, clothes hangers of wood are considered as secondary wood products (Oldenburger et al. 2014). In literature, there is no detailed research about international trade flows of this kind of wooden product, as well as the most important markets in the world for it. When we talk about quality requirements, which this product should fulfill, it can be concluded that they are not particularly specified. For international trade of clothes hangers of wood, sometimes PEFC or FSC certificate are required.

In certain European countries, such as Germany, ecofriendly symbol is used for this kind of product.[1] For awarding the eco symbol, content of chemical means used for

[1] For more information see the website of Germany producer of clothes hangers: URL: http://www.mawa-ecofriendly.de/english.html, accessed on 12.06.2018.

finishing of clothes hangers of wood is tested. That means clothes hangers of wood, which possess this symbol, do not contain heavy metal such as lead, mercury, cadmium, chromium VI substances, or other harmful substances like formaldehyde, primary aromatic amines, azo dyes, flame-retardants, polycyclic aromatic hydrocarbons.[2] In Poland, for clothes hangers of wood the certificate of health quality is issued.[3] Their contact with clothes is specially emphasized, because inappropriate chemical means can cause health problems to consumers. This is especially important for hangers of wood for children`s clothes. This fact has certainly contributed to the increase in the use of hangers from wood instead of plastic ones during the last years. Except for children, hangers can serve both female and male population. Next subdivision of wooden clothes hangers would be according to the kind of clothes they are intended for. Except plastic and wooden, metal clothes hangers are used, too.

One of the specific benefits which can influence increase in disposal of clothes hangers of wood to EU-28 market in the next period, and which has particular importance for Serbia, is the fact that EU Timber Regulation does not apply to them.

2. MATERIAL AND METHOD OF WORK

For the purpose of research, whose results are represented in this paper, appropriate methodological base was adopted, which consisted of general and specific scientific methods. In the paper, general scientific methods were used such as methods of content analysis, functional and comparative analysis, as well as methods of synthesis, induction and deduction. Method of content analysis was used for understanding appropriate regulations of the EU-28, which refer to clothes hangers of wood. Method of functional analysis was used first to determine the relationships among members of the EU-28, which are the most important suppliers of this market with clothes hangers of wood and the biggest importers of these products in the Union. The same method was used to determine the relationships among the biggest European importers of clothes hangers of wood and certain non-EU members. Method of comparative analysis was used for identifying the order of the most important suppliers of the EU-28 market with clothes hangers of wood. To draw conclusion about functioning of the clothes hangers of wood market in the EU-28, methods of induction and deduction were used. Method of syntheses was used in order to identify the main trade flows of clothes hangers of wood in the world, and especially at the EU-28 market.

By using specific scientific methods of regression and correlation analysis, the impact of wooden clothes hangers export from China to the USA and Russia on the EU-28 market supply of these products, was analyzed in the paper. For the purpose of market research in the EU-28 of clothes hangers of wood, data from Eurostat base were used.

[2] Content of test report see on the next website: URL: http://www.mawa-ecofriendly.de/TUEV-Rheinland.pdf, accessed on 12.06.2018.

[3] More about this certificate see on the website of Poland leader company for manufacturing of clothes hangers of wood: URL: http://forest.gorlice.pl/about-us/?lang=en#gallery-11, accessed on 12.06.2018.

Data about the export value of clothes hangers of wood from China to SAD and Russia were taken from Trade Map base. Timeline covering the period 2007-2017 was used for creating of econometric models. Data, which were used to create econometric models, are given in table 1. Econometric models were created by using software package “STATISTICA 7”. The choice of the single econometric model, which, in the best way represents correlation between analyzed phenomena, was done according to the highest value of the coefficient of determination. For the evaluation of the significance of the basic parameters obtained in the econometric models, *t*-statistic, the coefficient of correlation (R), the coefficient of determination (R^2), the adjusted coefficient of determination, *F*-statistic and *DW* test were used. For all tests statistical significance was α=0.05.

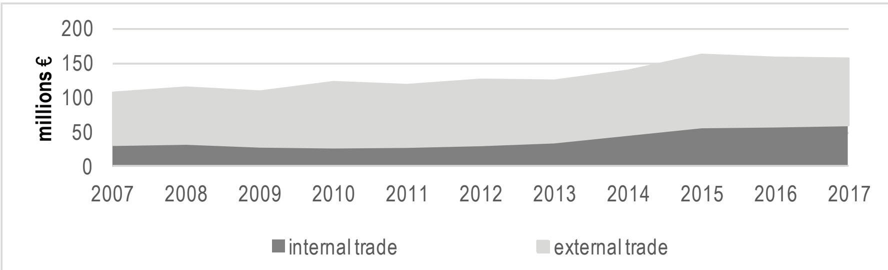
Table 1. Data used for creating the econometric models

Year	EU-28 import of clothes hangers of wood (y)	Export of clothes hangers of wood from China to USA (x_1)	Export of clothes hangers of wood from China to Russia (x_2)
	in units		
	pieces	000 €	000 €
2007	301528711	33342	3060
2008	297469789	23025	3795
2009	304672478	19166	2426
2010	324235248	22012	3801
2011	289375344	25999	4326
2012	271870980	24917	8098
2013	266613514	27806	5809
2014	294870965	29344	6805
2015	324150243	37779	6187
2016	300791871	29143	4445
2017	253401653	29956	5278

Sources: 1) EUROSTAT, 2018; URL: http://ec.europa.eu/eurostat, accessed on 12.07.2018.
2) TRADE MAP, 2018; URL: https://www.trademap.org/Index.aspx, accessed on 12.07.2018.

3. RESEARCH RESULTS AND DISCUSSION

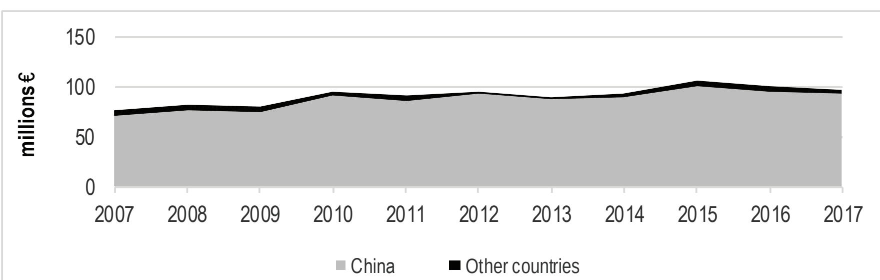
In order to meet the needs of the market in 2017, the Union countries imported clothes hanger of wood worth 158.1 million €, 61.7% of which represented the import value from non-EU countries, and 38.3% from the Union countries (graph 1) (Eurostat, 2018). Compared to 2007, total import value in 2017 was 45.9% higher, so that the import value from the non-EU countries increased by 27.3%, and from EU countries increased by 90.6%. Listed growth rates, clearly indicate a tendency of the EU countries to increase their own influence on supply of the Union market during the analyzed period. It was particularly present during the period 2014-2017, given that the import value from the EU countries in 2017 was 30.2% higher than 2014.[4]



Graph 1. Supply of EU-28 market with clothes hangers of wood (Eurostat, 2018)

3.1. Supply of the EU-28 market with clothes hangers of wood

China was the biggest supplier of the EU-28 market with clothes hangers of wood during the analyzed period. In the period 2007-2017, the import value of clothes hangers of wood from China to the EU-28 increased by 31.6% to 93.7 million € (graph 2) (Eurostat, 2018). In the Chinese market, the selling price for clothes hangers of wood could vary from 0.15$ up to several US$, depending on the quantity of wood in product, type of finishing and presence of metal parts on a hanger, such as metal clip hangers for skirts (Chinese producers of clothes hangers of wood). Of course, minimal order quantity of hangers influences the selling price, too. Depending on the producers, minimal order quantity of hangers ranges from 100 pieces up to 10,000 pieces. Selling price is mainly based on Incoterms FOB, whereas the port of delivery is Shenzhen. Delivery time depends on the producer, and it is approximately 35 days. Beech, maple and lotus wood are used for manufacturing of clothes hangers. Producers warrant that the wood moisture in hangers is less than 16%.



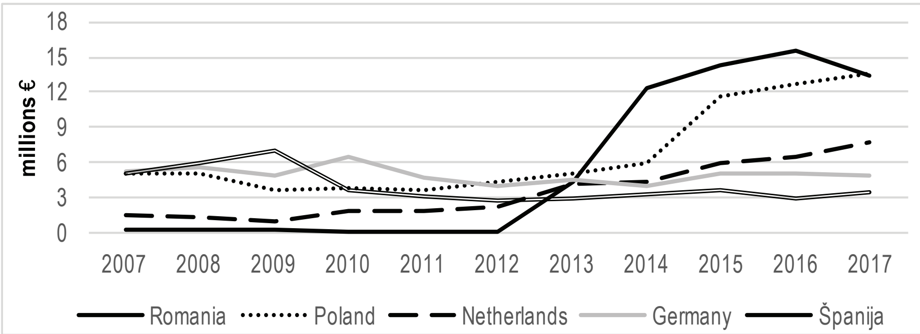
Graph 2. The import value of clothes hangers of wood of the EU-28 from China and the other non-EU countries in the period 2007-2017 (Eurostat, 2018)

[4] Research was done for clothes hangers of wood with HS code 44211000.

Except China, among the other non-EU countries, Hong Kong, Serbia, and Turkey had the most important significance for supply of the Union market, whereas the USA, India and Taiwan were less significant. The import value of the EU-28 from the first three countries listed, in 2017 represented 62%, and from all six countries, the value was 79.9%, of the total import value from the non-EU countries (excluding China). The growth of clothes hangers import from China to the EU-28 during the analyzed period had negative influence on the import of the same product from Hong Kong, USA, Taiwan and India. The EU-28 realized the biggest decrease in the import from Hong Kong, so that its value decreased by 77.3% during the period 2007-2017, to 484,167€ in 2017 (Eurostat, 2018). In the same period, Serbia and Turkey strengthened their roles in supply of the EU-28 market with clothes hangers of wood. During the period 2007-2017, the EU-28 increased the import value of hangers from Serbia by 118.8% to 1.2 million €, and from Turkey by 107.7% (Eurostat, 2018). In 2017, the EU-28 import value of hangers from Serbia was 41% higher compared to the import value from Turkey. During the period 2007-2017, except from Serbia, among the West Balkan countries, the EU-28 continuously imported hangers only from Bosnia and Herzegovina. The import value ranged from 400€ in 2013 up to 14,580€ in 2010 (Eurostat, 2018). Only in the period 2011-2016, the EU-28 imported hangers from Albania and the value of this import ranged from 652€ up to 18,834€ (Eurostat, 2018). The import of the Union countries from Montenegro and Former Republic of Macedonia was sporadic and with low values.

Among the EU-28 countries, for market supply with hangers of wood Romania and Poland had the greatest significance, then Netherlands, Germany and Spain (graph 3). During the analyzed period, significant changes occurred in the internal trade of clothes hangers of wood at the Union market. The most important of them were the following. The Union import of hangers from Romania had symbolic value up to 2012, but it increased by three times in the period 2013-2017. In the period 2007-2017, except from Romania, the EU increased the import value of hangers of wood from Poland by 2.7 times to 13.5 million € (Eurostat, 2018). The Netherlands was the third most important country for supply of the EU market. The import value of the Union from this country increased by 4.9 times to 7.7 million €, in the period 2007-2017 (Eurostat, 2018). Germany, which was the most important supplier of Union market in 2007, lost its role during the analyzed period. The import value of clothes hangers of wood in the EU countries from Germany in 2017 was lower by 9% compared to the value in 2007. Spain was in the similar situation. The other Union countries decreased import from this country, and its value in 2017 was lower by 32.3% compared to the value in 2007.

In 2017, the Union countries imported clothes hangers of wood worth of 42.9 million € from five biggest suppliers of the market, which represented 70.8% of the total import value of the Union from their members (Eurostat, 2018). Generally, it can be concluded that the countries that were the most important suppliers of EU market with clothes hangers of wood at the beginning of the analyzed period, namely 2007, lost their roles up to 2017. Their roles in supplying the Union market were taken over by Romania and Poland, mostly. In 2017, the import value of clothes hangers of wood of the other EU countries from these two countries represented 44.6% of the total internal trade of Union members.

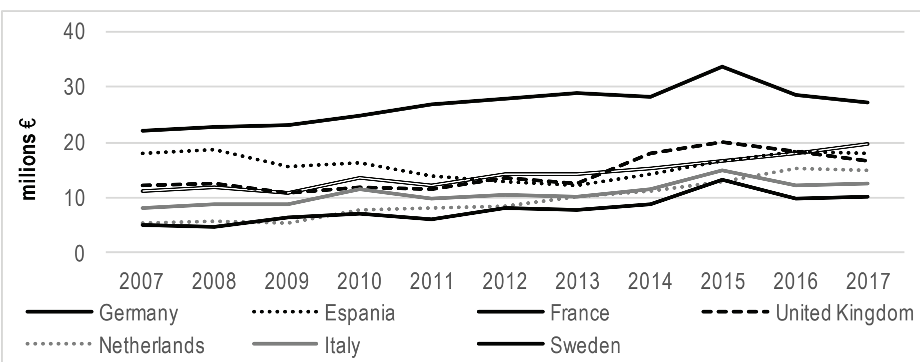


Graph 3. The most important members of the EU-28 for supply of its market with clothes hangers of wood in the period 2007-2017(Eurostat, 2018)

Croatia, as a West Balkan country and one of the EU members, didn't have a more important role in supply of the Union market with hangers of wood during the analyzed period. The other EU members realized the highest import value of hangers of wood from this country worth 15,752 € in 2014, and the lowest of 425€ in 2015 (Eurostat, 2018).

3.2. Biggest importers of clothes hangers of wood in the EU-28

The biggest importers of clothes hangers of wood in EU-28 were Germany, Spain, France, United Kingdom, Netherlands, Italy and Sweden (graph 4). In 2017, Germany realized the import value of 27.4 million €, Spain 18.1 million €, France 19.6 million €, United Kingdom 16.8 million €, Netherlands 15.1 million €, Italy 12.7 million €, and Sweden 10.1 million € (Eurostat, 2018). The import value of the seven listed countries in 2017 represented 75.8% of total import value of the Union (total import includes the import from EU countries and non-EU countries altogether).



Graph 4. Biggest importers of clothes hangers of wood in the EU-28 in the period 2007-2017 (Eurostat, 2018)

During the period 2007-2017, the Netherlands had the highest average annual growth rate of import value of 11%, which increased its own import value almost three times during the mentioned period, then Sweden with 7.1%, France 5.8%, Italy 4.7%, United Kingdom 3.2% and Germany 2.1%. In the same period, Spain, whose market needed a lot of time to recover after the recession, had the lowest average annual growth rate of import value of 0.1%. From 2007, when its import value of clothes hangers of wood was at the level of 18 million €, it decreased to 16.6 million € in 2017 (Eurostat, 2018).

China and Poland were the most important countries to supply Germany market with wooden hangers. In 2017, the value of Germany's imports from these countries represented 81.2% of total import value of these products (49.8% Germany, 31.4% Poland). Due to the continuous growth of the import of hangers from China to Germany, its value increased by 43.3% to 23.1 million € in the period 2007-2013 (Eurostat, 2018). After that, the import value significantly decreased, and in 2017 was the lowest for the period 2007-2017. It was lower by 40.9% compared to the value in 2013. Germany compensated for the decrease in the import from China, by increasing the import of hangers from Poland. This trend was typical for the period 2015-2017, when the import value of hangers increased from 6.4 million € to 8.6 million € (Eurostat, 2018). Besides the mentioned countries, Serbia was one of German's foreign trade partners during the period 2007-2017, too. In 2007, Germany imported the hangers from Serbia worth 305,998 €, but in the period up to 2017, the import value had a negative trend (Eurostat, 2018).

China and Poland were the biggest suppliers of the United Kingdom market with clothes hangers of wood in the analyzed period, too. The import value of hangers from China was increasing up to 2015, when it achieved the record of 15.9 million €, in order to decrease by 20.9% up to 2017 (Eurostat, 2018). Unlike China, in the period 2014-2017, the import value from Poland increased by 123.4% to 2.4 million € (Eurostat, 2018).

China, and from 2013 Romania, were the most important suppliers of market in Spain, France and Italy with clothes hangers of wood. In 2017, Spain's import value of hangers from China represented 82.2% of the total import value of these products. The Spain's import value from Romania first increased during the period 2013-2015 by 217.2%, and then up to 2017 it decreased by 86% in comparison to 2015.

France realized the lowest import value of hangers from China worth 3.2 million € in 2009, and record value of 9.8 million € in 2012 (Eurostat, 2018). During the period 2007-2017, it had an average annual growth rate of the import value of clothes hangers of wood from China of 7.9%. During the last years of the analyzed period, France increased the import of hangers from Romania, too. In the period 2013-2017, it increased by 367.8% to 4.4 million € in 2017 (Eurostat, 2018). Compared to the other biggest importers, Italy achieved the lowest import value of hangars from China. In 2017, it realized a little bit more than half, precisely 51.5%, of the total import value of hangers by import from China. Romania became very important for supplying this market, so that the import value of clothes hangers from this country increased from 0.9 million €, achieved in 2013, to 3.6 million € in 2017 (Eurostat, 2018). Serbia was one of the foreign trade partners of Italy for clothes hangers of wood during the period 2007-2017, when the import value increased by 3.3 times to 0.7 million € in 2017 (Eurostat, 2018).

China was the biggest supplier of markets in Sweden and the Netherlands with clothes hangers of wood during the analyzed period, too. In 2017, the import value of Sweden from China represented 92.4% of the total import value of these products, whereas the import value of the Netherlands from China represented 83.7% of total import value of the products. Sweden increased the import value of clothes hangers of wood from 4.5 million € in 2007, up to 9.3 million € in 2017, and in the same period the Netherlands increased from 2.8 million € up to 12.7 million € (Eurostat, 2018). During the period 2015-2017, Sweden imported clothes hangers of wood from Serbia, whereas the highest import value of 163,790 € was achieved in 2017 (Eurostat, 2018). In the period 2014-2017, the Netherlands imported clothes hangers of wood from Serbia, too. The highest import value of 263,956 € was achieved in 2017 (Eurostat, 2018).

3.3. Econometric modeling of the impact of selected factors on the supply of the EU-28 market with clothes hangers of wood

After the EU-28, which represents the most important foreign trade partner of China for clothes hangers of wood, the USA and Russia are the other two for disposing these products from China. Because of that, it was analyzed in the paper, to what extent the changes in export of clothes hangers of wood from China to these two countries may effect supply of the market in the EU-28 with these products. For this purpose, two single econometric models were created. The influence of the export of clothes hangers of wood from China to the USA, to supply the EU-28 with these products, best describes the linear econometric model (the highest value of R^2). An equation of this model has the following form:

$$y = 288{,}420{,}496 + 186 \cdot x$$

The basic parameters of this model are given in table 2.

Table 2. The basic parameters of the linear econometric model

Parameter		S	t	$\lvert t \rvert$	R	R^2	R^2_{cor}	$F_{(1,9)}$
A	288,420,496	39,147,776	7.367481	$> t_{0.5}$	0.0443088	0.001963	0.108930	0.0177
B	186	1400	0.133057	$< t_{0.5}$				

Calculated t-statistics, has showed the parameter *a* is statistically significant, and parameter *b* is statistically non-significant. Positive value of parameter b has showed that, if the export of clothes hangers of wood from China to the USA increases for 1000€, the EU-28 import of those products will increase by 186 pieces. Based on the previous conclusion, it can be said that the growth of the export of clothes hangers of wood from China to the USA market will not have negative influence on supply of the EU-28 market. However, low value of the coefficient of determination of this linear econometric model has showed that only 0.196% of variations in supply of the EU-28 market with hangers can be considered to result from changes in the export of those products from China to USA. Low value of the coefficient of correlation and its statistical non-significance have showed that marginal degree of correlation between the analyzed phenomena exists. Obtained value of Durbin Watson test (DW=1.27) has showed that existing of autocorrelation cannot be confidently asserted (Glavonjić et al., 2009).

The influence of the export of clothes hangers of wood from China to Russia, to supply EU-28 market with these products, best describes parabolic model (the highest value of R^2), with next equation:

$$y = 605,678,575.6 \cdot x^{-0.08611}$$

The basic parameters of this model are given in table 3.

Table 3. The basic parameters of econometric model

Parameter		S	t	|t|	R	R^2	R^2_{cor}	$F_{(1,9)}$
a	lna = 20.22186	0.554886	36.44327	$> t_{0.5}$	0.40050	0.16040	0.067112	1.7194
b	- 0.08611	0.065670	-1.31126	$< t_{0.5}$				

Calculated t-statistics, has showed that the parameter *a* is statistically significant, and parameter *b* is statistically non-significant. Negative value of parameter *b* shows that if the export of clothes hangers of wood from China to Russia increases by 1%, the EU-28 import of these products will decrease by 0.086%. Low value of the coefficient of determination of this econometric model has showed that only 16% of variations in supply of the EU-28 market with hangers can be explained with changes in the export of these products from China to Russia. The value of the coefficient of correlation and its statistical non-significance has showed that slight degree of correlation between the analyzed phenomena exists. Obtained value of Durbin Watson test (DW =1.58) has showed that existing model does not have autocorrelation (Glavonjić et al., 2009).

After two single econometric models, multiple econometric model was created. In this model analyzed the collective impact of the export of clothes hangers of wood from China to markets in the USA and Russia, to the EU-28 import of these products. Because of extremely low value of adjusted coefficient of determination, multiple econometric model has not analyzed in detail in this paper.

4. CONCLUSION

During the period 2007-2017, trade with clothes hangers of wood at the EU-28 market significantly increased. From 2007, when it was at the level of 76.6 million €, the import value of hangers of wood of EU countries increased to 97.6 million € up to 2017 (Eurostat, 2018). During the period 2007-2017, non-EU countries, firstly China, were the biggest suppliers of the EU-28 market with clothes hangers of wood. During this period, the EU-28 increased the import value of hangers from China by 31.6% to 93.7 million € in 2017 (Eurostat, 2018). In the same period, among the Union members, Romania and Poland were the most important countries to supply the EU market with hangers of wood. The import value of hangers from Romania into the Union was symbolic up to 2012, in order to increase by three times to the level of 13.4 million € (Eurostat, 2018) in the period 2013-2017. Unlike Romania, Poland was very important trade partner of the Union throughout the period 2007-2017. In the mentioned period, the import value of the Union from Poland increased by 2.7 times to 13.5 million € (Eurostat, 2018). Germany, Spain, France, United Kingdom, the Netherlands, Italy and Sweden were the biggest importers of clothes hangers of wood in the EU-28. In 2017, they imported hangers of wood worth 119.8 million € (Eurostat, 2018). China and Poland were the biggest suppliers of hangers of wood in the market of Germany and the United Kingdom. In the market of Spain, France and Italy it was China, and Romania from 2013, and in the market of Sweden and the Netherlands it was only China.

After the EU-28, USA and Russia were Chinese most important foreign trade partners for clothes hangers of wood during the period 2007-2017. Because of that, the paper analyzed the influence of the changes in export of those products from China to the mentioned markets on supply of the EU market. It proved that there is a weak correlation between the tested phenomena by creating two single econometric models. It also proved that changes in trade with hangers of wood between China and Russia have stronger influence on functioning of the EU-28 market then those between the China and USA. According to the above mentioned, further research of the EU-28 market of clothes hangers of wood should be continued by identifying the member countries which have important influence on functioning of the market.

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BALKANS TIMBER MARKET AMID CONDITIONS OF THE INCREASING CHINESE IMPACT

Branko Glavonjić, Aleksandra Lazarević

ABSTRACT

This paper presents the results of the research of the market for logs and sawnwood in the region of Balkans. The scope was to analyse the market situation and market movements amid conditions of the increasing Chinese impact in the last five years. The results show the clear trend of increase in the hardwood logs and the sawnwood export from all countries of the region, and especially from Serbia. In 2017 the region has become the 4th significant oak log supplier of China with the participation in the Chinese import of 7%. The leading country of the oak logs export to China is Serbia, followed by Romania, Slovenia and Bulgaria. Regarding the sawnwood export, the most presented is the beech sawnwood. Due to the constant demand of the Chinese timber merchants for this type of the sawnwood in the last five years, its prices have been constantly increasing. Since the logs export suddenly increased, some countries have imposed protection measures and temporarily banned their export.

Keywords: logs, sawnwood, market, export, price

1. INTRODUCTION

Wood and furniture industries in the Balkan[5] region are currently facing a number of problems and challenges in their development. However, the key factors which lead to their further development are the provision of necessary quantities of wood raw materials and materials, markets for the placement of wood products and professional staff. These three factors have also become an important segment of development in wood and furniture industries at the global level. This is the reason why companies from countries with leading wood and furniture industries in the world are present in almost all the regions with a large forest area for the purchase of wood raw materials. Given that the Balkans region is one of the European reagions with a large forest area, especially when it comes to hardwood species, timber traders from China, Japan, Israel and other countries are becoming increasingly present in this area for the sake of establishing new and strengthening the existing trade channels for supplying companies in their countries with the necessary quantities of wood raw materials. This particularly applies to the highest quality hardwood species, which are highly valued in the manufacture of furniture and other wood products with high added value.

[5] Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Montenegro, TFYR Macedonia, Romania, Serbia and Slovenia

On average, forests cover 40.5% of the Balkans region. Slovenia ranks first with 62 percent, followed by Montenegro (61.5%), Bosnia and Herzegovina (42.8%), Macedonia (39.6%), Bulgaria (35.2%) and Croatia (34.3). In the remaining countries forest area as a percentage of the total land area is below the above average value. Romania has the largest growing stock (1.9 billion m^3), while Albania has the smallest one (76 million m^3) (The Global Forest Resources Assessment 2015, FAO, 2016). The largest forested areas are in central Romania (Transilvania region), central and southern Bulgaria, eastern and south-western Serbia (South Kučaj) central Bosnia and Herzegovina (Kladanj, Romanija) and south-western Croatia (Gorski Kotar). According to Glavonjić et al. (2008) hardwood forests, and predominantly beech *(Fagus Silvatica, spp.)* and oak (*all oaks*), account for about 64 percent of forests in the region. The quality of oak differs from one country to another with the highest quality resources found in Romania, Croatia and the north-west region of Serbia. Quercus *(Quercus robur L)* is the most common high quality oak species, and it is also a species with a high demand in Western European markets (especially for flooring).

2. METHODS

An analytical and synthetic methodological approach was used for assessing the situation in the market of roundwood and sawnwood in the Balkan region and China. The main sources of production, export and import data on the selected wood products have been publications and databases from the official statistical offices and institutes of the selected countries, as well as international organisations (FAO, COMTRADE). In addition, published scientific papers from scientific institutions in the Balkan region and data from the Timber trade center of the University of Belgrade - Faculty of Forestry were used as secondary data sources. The first part of the paper presents the current state and the development of imports of logs and sawnwood of oak and beech in China over the past nine years, as well as the region's position in total Chinese imports of these products. The second part of the paper presents the results of the research of logs and sawn hardwood exports from the Balkans region to China, collectively at the regional level and individually by countreis. In addition, the paper gives a review of measures taken by individual countries in the Balkan region for the purpose of destimulating the exports of wood raw materials.

3. RESULTS AND DISSCUSION

It is widely known that in the last ten years, China has become the world's largest consumer of wood. The high growth rate of oak, beech and other hardwoods logs consumption for sawnwood and veneer has been achieved through their high imports, given that China's forest covers amounts to only 22.1%.

The expansion of the production and exports of furniture and other wood products in the last ten years has caused a sharp increase in import of logs and sawnwood. Figure 1 shows the trend of imports of oak logs to China over the last nine years. As shown, the import of oak logs has increased five times (from 165 thousand m^3 in 2009 to 825 thousand in 2017).

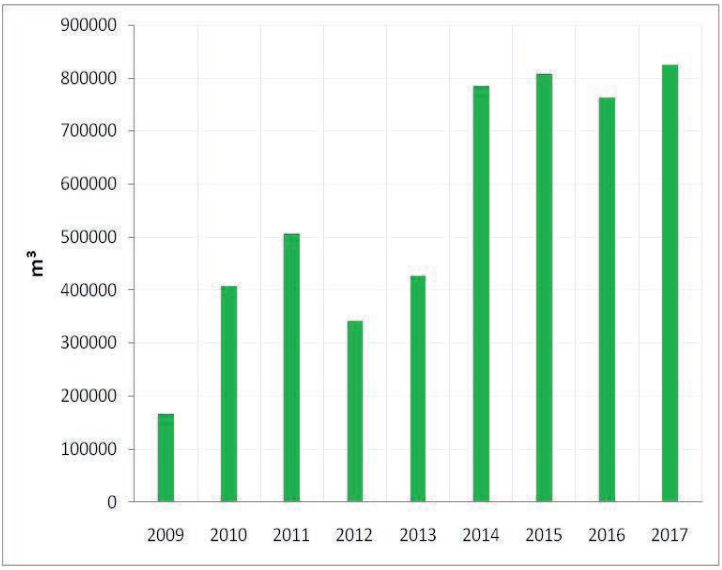

Figure 1. Import of oak logs in China

The most important countries from which China imported oak logs in 2017 were France (36%), USA (27%) and the Russian Federation (19%), while the Balkan region was in the fourth place with a 7% share. In 2017, China imported 61,788 m^3 of oak logs from the Balkan region, which is 5.4 times more than in 2016. Until 2013, China did not import oak logs from the Balkan region. However, in the 2013-2017 period, their imports to China "exploded" growing from 11 thousand m^3 to 61 thousand m^3 (Figure 2).

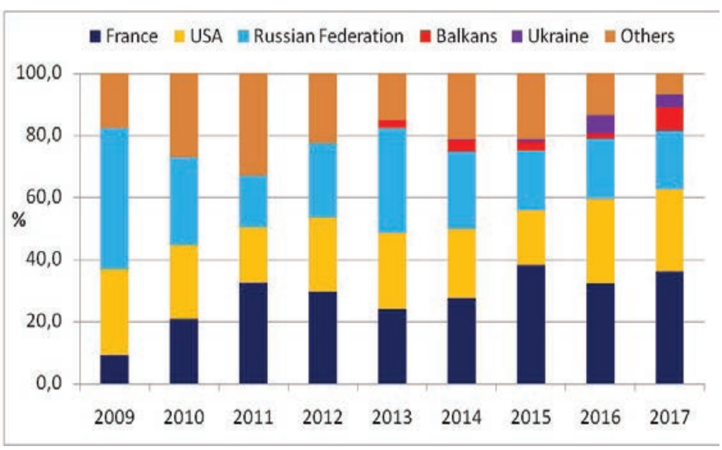

Figure 2. The five most important countries for importing oak logs in China

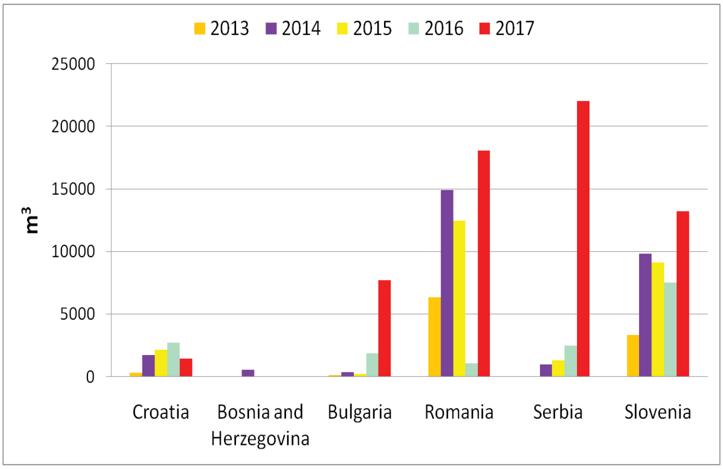

Figure 3. Export of oak logs from the Balkan region to China

The most significant countries of the Balkan region from which China imports oak logs are Serbia, Romania and Slovenia (figure 3). In 2017, the 85.5% share of total Chinese imports of oak logs from the Balkan region was from these three countries, of which 35.5% from Serbia. When it comes to Serbia, the Chinese market has become the most important market for oak logs exports with a 79% share in 2017. Romania is in the second place with a 6% share. However, all the quantities of oak logs exported from Serbia to Romania are re-exported to China together with oak logs from Romania via the Black Sea port. The same statement refers to the exports of oak logs to Slovenia, which are then re-exported to China along with logs from Slovenia via the Koper port. Bearing in mind the above, it can be concluded that about 90% of the total exports of oak logs from Serbia are exported to China, either directly or in the form of re-exports.

An analysis of the data on the exports of oak logs from Serbia and the production achieved in 2017 shows that nearly 2/3 of the total production was exported. This sudden increase in exports of oak logs has caused great problems in wood raw materials supply for the manufacturing of furniture and other wood products in Serbia. Therefore, the prices of oak sawnwood materials rose sharply, which additionally negatively influenced the competitiveness of domestic producers. For that reason, in early April 2018, Serbian producer associations sent an urgent request to the Government to issue a decree on a temporary log export ban. A similar measure has already been adopted in Bosnia and Herzegovina, Croatia and Montenegro in 2016. However, despite the ban on the export of wood raw materials in the form of logs, they are exported in the form of semi-finished products (as flitch).

In addition to oak logs, logs of other hardwoods, and especially beech, ash, maple, cherry and walnut, are exported from the region. In 2017, the total export of hardwoods from this region amounted to 726 thousand m^3, out of which 430 thousand m^3 or 59.2% from Slovenia. Slovenia is the leading country of the region in the export of beech logs (308 thousand m^3 in 2017).

Compared to the 2010 exports (1.15 million m^3), the exports in 2017 were significantly lower, but still high relative to the production achieved. The downward trend in total log exports is the result of measures taken by some countries in the context of banning exports or imposing taxes on log exports in order to destimulate their exports. In this respect, Bosnia and Herzegovina and Croatia have introduced measures to impose a ban on logs exports, and Montenegro applied taxes on their exports. Only Serbia did not introduce any protection measures for log exports, which caused its rapid growth, especially in 2017.

When it comes to timber and its imports to China from the Balkans, the results of the survey show a completely different picture compared to the import of logs. The imports of oak sawnwood to China increased by 72.6% in the last five years (figure 4) reaching the level of 1.64 million m^3 and the value of 992.5 million USD in 2017. The most important market for importing oak sawnwood in China is the USA. In 2017, China imported 1.25 million m^3 of oak sawnwood in the amount of USD 829.4 million, which was 76.2% of the total volume of imports, i.e. 83.6% of the total value. The other countries from which China imports oak sawnwood that stand out are the Russian Federation, France, Canada and Germany. The share of oak sawnwood from the Balkans in the total imports of oak sawnwood is minor both in terms of quantity and value. In 2017, only 8.912 m^3 of oak sawnwood was imported from the Balkan region. Bearing in mind the very high import of oak logs from this region, it is understandable that this is a low import of sawnwood.

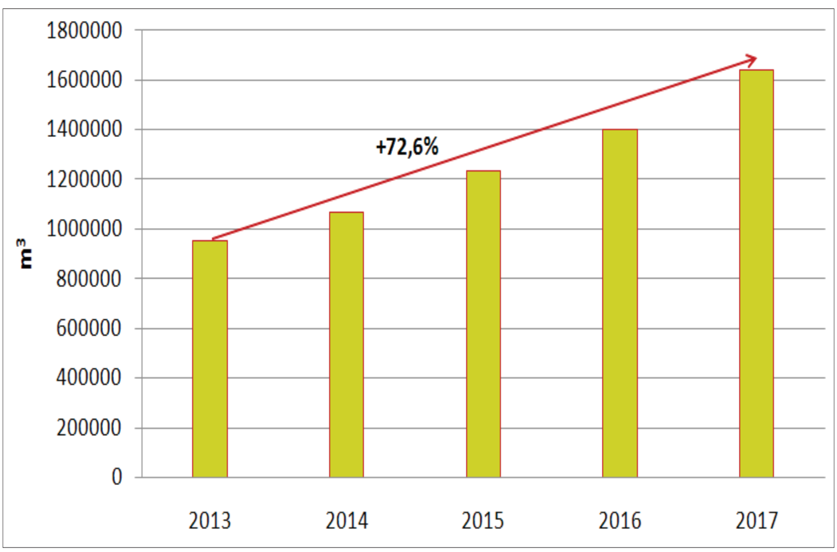

Figure 4. Import of oak sawnwood in China

However, the situation is completely different when it comes to importingcut beech sawnwood in China. As with oak sawnwood, imports of beech sawnwood had dynamic growth in the last five years (figure 5). Imports increased from 429 thousand m^3 (2013) to

738 thousand m^3 (2017) or 72.1%. The most important region from which China imports beech sawnwood is the Balkan region with a share of 59.7% in 2017. Data analysis shows that imports of beech sawnwood from the Balkan region have been steadily growing over the last five years, reaching the level of 440 thousand m^3 in 2017. Romania is the most important country from which China imports beech sawnwood (figure 6). In 2017, 207 thousand m^3 were imported from Romania, representing 37.5% of total imports. Therefore, Romania took the first position in the total imports of beech sawnwood in China. The second place was Germany with a share of 23.9%, followed by Croatia (8.7%), Bosnia and Herzegovina (8.0%) and Serbia (5.2%).

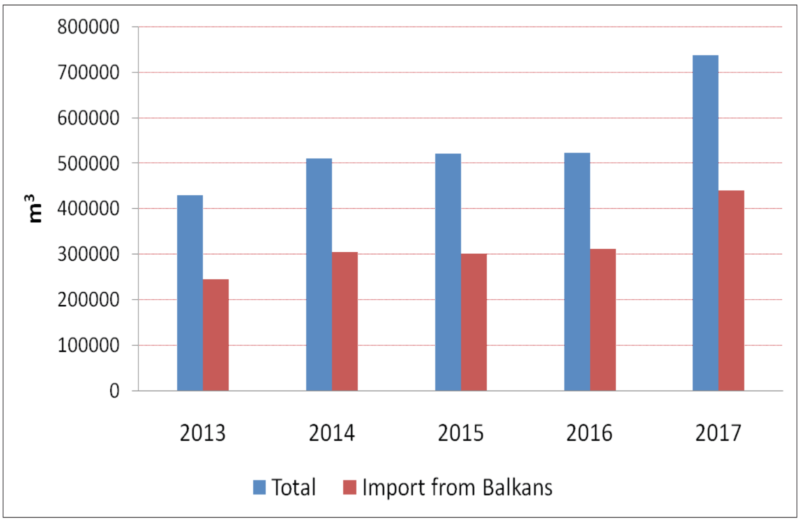

Figure 5. Import of beech sawnwood in China

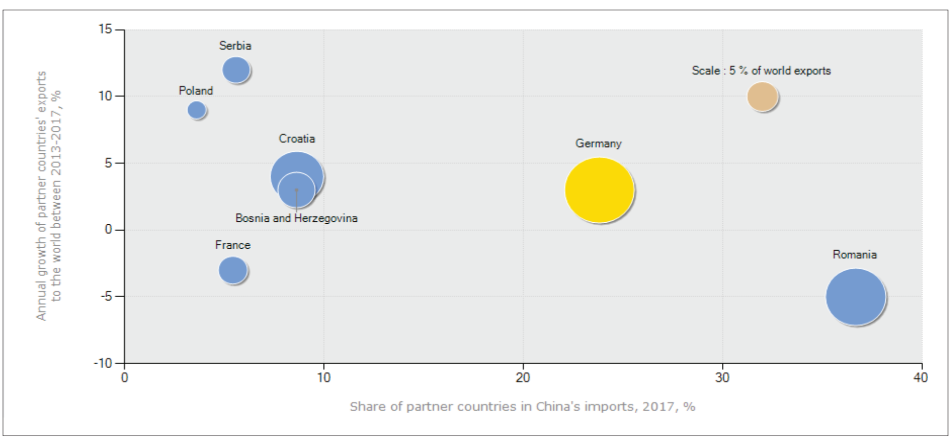

Figure 6. The share (%) of the most important countries in the total imports of beech sawnwood in China in 2017

The importance of the Balkan region for China when it comes to beech sawnwood supply is confirmed by the fact that four out of five most important countries from which this type of wood product is imported are from this region. Other countries from the region are present in the imports of beech sawnwoon in China, but to a significantly lower degree than the first four countries.

An analysis of the average prices of beech sawnwood exports to China from the Balkans and Germany shows that the prices are almost equal. In 2017, the average price of imported beech sawnwood in China from the Balkans amounted to 371.9 USD/m^3, and from Germany to 369 USD/m^3. Compared to 2013 (373.9 USD / m^3), average prices in 2017 were slightly lower when it comes to importing beech sawnwood from the Balkan region.

In China, beech sawnwood is mostly used for the production of furniture for sitting, but also for the manufacturing of kitchen and other types of furniture. Such use of beech sawnwood imposes a demand for appropriate quality of sawnwood that is required by the suppliers from the Balkans. The most common quality category in which chair elements are supplied are prime and prime/red heart beech with dimensions 50 × 50 × 300-1000 mm and 60 × 60 × 300-1000 mm. When it comes to lumber, most unedged lumber is exported in the length of 2.1 m or more. The steaming of lumber and elements is carried out at temperatures of 90-95°C for an effective duration of 3 hours to give the wood a suitable color.

In addition to logs and sawnwood, imports of other wood products from the Balkan region to China are minor. In 2017, the total import of wood and wood products from the Balkan region in China amounted to USD 209 million, out of which the share of sawnwood was 79.2% and of logs 15.5% (Figure 7).

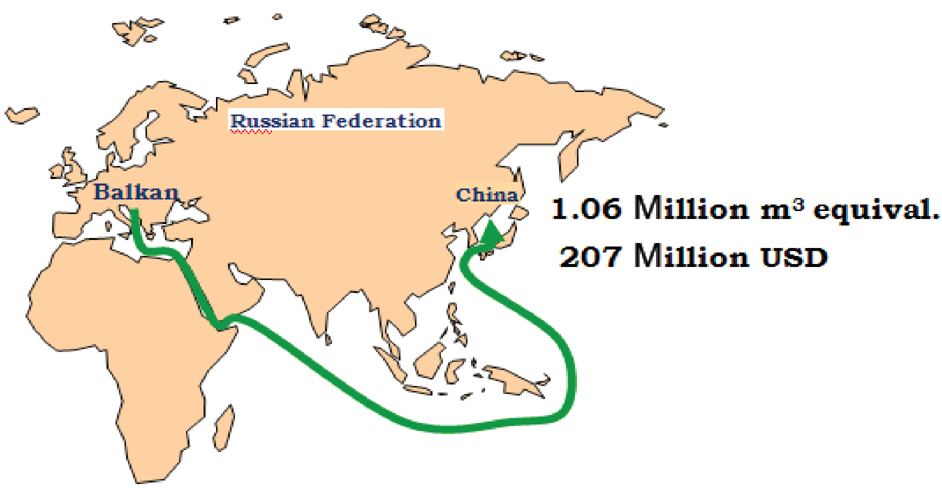

Figure 7. Trade balance of timber trade and products of wood: Balkan:China

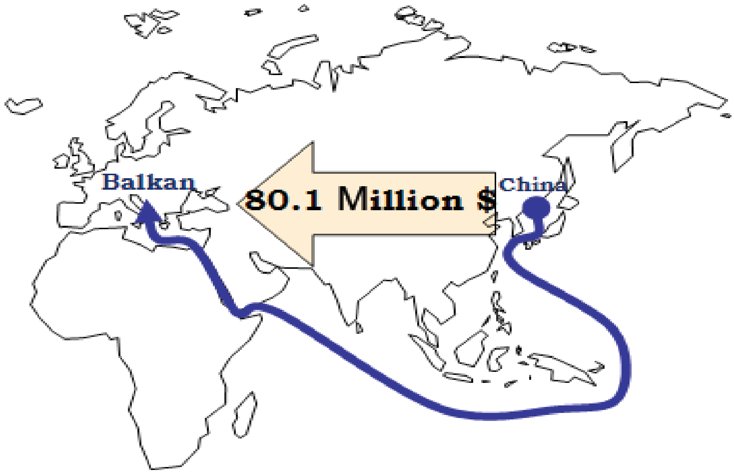

Figure 8. Trade balance of timber trade and products of wood: China:Balkan

On the other hand, when considering exports from China to the countries of the Balkans, it can be observed that the dominant categories of exported products are furniture and high-added value products. Some of these products are made from wood raw materials imported to China from the Balkans.

Some countries in Europe have a similar problems with the export of timber raw materials. According to Parobek et.al. (2014) the roundwood export in Slovakia is relatively high and significantly reduces the domestic availability of certain roundwood assortments.

4. CONCLUSIONS

Based on the results of the survey and analysis of the balance of timber and wood products trade, it can be concluded that low-added value products prevail in the structure of wood products exports from the Balkan region to China. Conversely, high-added value products are dominant in the structure of Chinese exports to the Balkan region. This structure of timber and wood products trade is unfavorable for the Balkan region and greatly influences the development dynamics of domestic wood and furniture industries. The extent to which such trends will continue depends on the government measures aimed at changing such a trade structure in the countries of this region

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WOOD INDUSTRY EMPLOYMENT TRENDS IN CROATIA SINCE 2010

Maja Moro

ABSTRACT

On the basis of established values of labour resources in the Croatia, specially in Wood processing and Furniture manufacturing for the period 2010 - 2017, this article presents an analysis of the current situation as well as anticipating employment trends in the woodworking sector to year 2022. According to Croatian Standard Classification of Occupations (NKD 2007), for sectors Croatian Wood processing (C16) and Furniture manufacturing (C31), the data of the number and composition of persons in paid employment in legal entities are gathered from Croatian Bureau of Statistics. Specially for the period 2015 – 2017 analysis include the share of women in the total number of employees for both of sectors. The dynamic economic analysis of time series data was performed and time series model for predicting the employment trend in Croatian wood sector was built. Because of turbulences in this market and the length of analyzed time series data, prediction is limited to year 2022.

Keywords: wood processing, furniture manufacturing, employment, trend, time series model

1. INTRODUCTION

In many European countries the sectors for Wood processing and Furniture manufacturing takes an important share in whole production sector, which is also reflected in the number of employees in the woodworking area. The European Union has committed to the principle of sustainable development as its policies and actions, based on balanced economic growth, price range of stability, strengthening the internal market, research and development, innovation, education, competitive social market economy and a high level of protection and improvement of environmental quality (Lučić, 2009). According to Samuelson and Nordhaus (2003), economic theories are dynamic by nature and now we are witnessing almost everydays changes that are caused by the penetration of IT and computer science revolution. In this new and dynamic conditions it is necessary to strive for a new standards using economic theory for the qualitative and quantitative analysis of markets.The key to survival and growth in the market is in organization's ability to adapt its strategy to the rapidly changing environment (Kotler, 2001). Interpreting economic data and forecasting the future economic values are under the influence of environment and government policies, starting from the basic economic theories that operate in the market (Fair and Case, 1989). Specific developments in some key macroeconomic variables, such as employment, production, imports, exports, the exchange rate of national currency, etc., characterize different turbulent periods of Croatian history (Lovrinčević, 2001). According to Motik (2010), knowledge of the market situation directly affects on all companies in the sector, their development, growth and business success in the future.

Intense competition, which comes as a result of globalization and the relatively recently entry of Croatia into the full membership of the European Union, leads us to the necessity of looking at the current market situation, in order to predict the situation in the future. It is known that future projections of development can not predict the detail movement of market indicators, such is the number of employees. They are only a rough indication of the future course, assuming that the macroeconomic policies won't change significanty (Hanke and Reitsch, 2001). According to Rozga and Grčić (2002), by using models we got a picture of what happened in the (near) past, what is the current situation, and planned and future course of events, i.e. the movement of an employment indicator in the near future.

This article offers a focus on the Croatian wood sector and position of Wood processing (C16) and Furniture manufacturing (C31) according to number of employees in comparison with total number of employees in Croatia, as well as comparison with the number of employees in Manufacturing sector. This paper also discuss a possibility to predict the number of employees in Croatian wood industry sectors, on the basis of established values in the period 2010 - 2017. The prediction is limited to the year 2022, because of turbulences in this market, and the length of analyzed time series data. Specially for the period 2015 – 2017 analysis include the distribution of employees by sex, and shares of woman and man employed in the total number of employees in woodworking sectors.

2. MATERIAL AND METHODS

The base of these reserch are data of the number and composition of persons in paid employment in legal entities according to Croatian Standard Classification of Occupations (NKD 2007) and they are gathered from Croatian Bureau of Statistics (DSZ). Database include the number of employees for period 2010-2017 in whole Croatia, manufacturing sector (C) and two main wood manufacturing sectors: Wood processing (C16 - official name of sector - Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials) and Furniture manufacturing (C31 - official name of sector - Manufacture of furniture). Specially for the period 2015 – 2017 analysis include number of persons according to NKD 2007. and by sexs, from JOPPD forms. Abbreviations for variable names are shown in legend in Table 1., and data gathered for these analysis are shown in Table 2. and Table 3.

Table 1. Legend for analyzed variables

Variable	Number of employees according to		
	NKD 2007.	NKD 2007. / JOPPD forms	
		women	men
CT	Total Croatia	CTw	CTm
MT	Manufacturing (sector C)	MTw	MTm
WP	Wood Processing (sector C16)	WPw	WPm
FM	Furniture Manufacturing (sector C31)	FMw	FMm

Table 2. Number of employees according to NKD 2017. (source DSZ)

Year	CT	MT	WP	FM
2010	1.168.179	219.976	11.050	9.676
2011	1.159.657	214.302	10.839	9.357
2012	1.153.497	207.298	11.072	8.887
2013	1.132.246	201.950	11.072	8.447
2014	1.120.507	198.069	11.521	8.443
2015	1.175.656	210.072	12.501	8.602
2016	1.177.004	208.375	12.858	8.944
2017	1.193.687	212.666	13.365	9.203

Table 3. Number of employees according to NKD 2017., and JOPPD forms (source DSZ)

Year	CTw	MTw	WPw	FMw
2015	562.206	75.707	3.224	2.500
2016	566.222	74.807	3.367	2.815
2017	573.464	76.089	3.663	2.925

For the purposes of forecasting the future trends in number of employees per year in the two main wooden sectors in Croatia, the dynamic economic analysis of time series data was performed.

3. RESULTS AND DISCUSSION

Position of Croatian wood sectors (WP and FM) according to number of employees is visible in comparison with total number of employees in Croatia (CT), as well as with a number of employees in Manufacturing sector (MT). The results of these analysis are given in Table 4.

From this table we can see that for the analyzed period 2010 - 2017 the average share of employees compared to the total number of employees in Croatia (CT) was 18% for Manufacturing sector (MT), 1,02% for Wood processing (WP) and 0,77% for Furniture manufacturing (FM). In the same time the average rate of change was negative for MT (-0,79%) and FM (-1,02%), positive for WP (2,44%).

Table 4. Shares of analyzed variables according to CT and MT

	Shares according to CT (%)			Shares according to MT (%)	
Year	MT/CT	WP/CT	FM/CT	WP/MT	FM/MT
2010	18,83	0,95	0,83	5,02	4,40
2011	18,48	0,93	0,81	5,06	4,37
2012	17,97	0,96	0,77	5,34	4,29
2013	17,84	0,98	0,75	5,48	4,18
2014	17,68	1,03	0,75	5,82	4,26
2015	17,87	1,06	0,73	5,95	4,09
2016	17,70	1,09	0,76	6,17	4,29
2017	17,82	1,12	0,77	6,28	4,33
Mean	18,02	1,02	0,77	5,64	4,28
Std.Dev.	0,41	0,07	0,03	0,49	0,10
Av.Rate	-0,79	2,44	-1,02	3,25	-0,23

The average share of employees compared to the number of employees in Manufacturing sector (MT) was 5,6% for Wood processing (WP) and 4,3% for Furniture manufacturing (FM). In the same time the average rate of change was positive for WP (3,25%) and negative for FM (-0,23%).

Comparison of the number of employees by sex (women vs. man) and the woodworking sector (WP vs. FM) for the period 2015 - 2017 is shown in Figure 1.

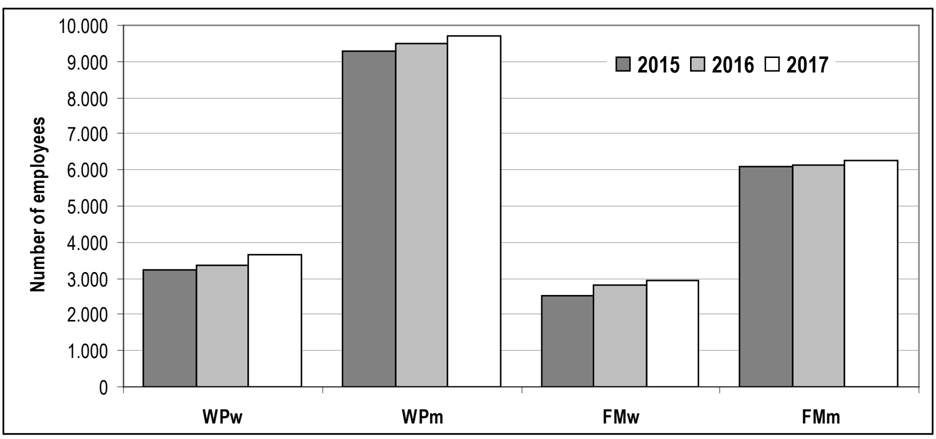

Figure 1. Comparison by sex in WP and FM

From this figure we can see that for the analyzed period 2015 – 2017 the number of employed women is considerably lower than the number of male employees. The share of women employed compared to the total number of employees in Wood processing (WP) is 26,5%, and compared to the total number of employees in Furniture manufacturing (FM) 30,8%, both with a positive rate of change.

Descriptive statistics were determined for the number of employees for all variables included in these analysis. The results are given in Table 5.

Table 5. Descriptive statistics for analyzed variables

Variable	Valid N	Mean	Std.Dev.	Conf.L. -95%	Conf.L. +95%	Minimum	Median	Maximum	Av.Rate
CT	8	1.160.054	24.226	1.139.801	1.180.308	1.120.507	1.163.918	1.193.687	0,309
MT	8	209.089	6.924	203.300	214.877	198.069	209.224	219.976	-0,482
WP	8	11.785	977	10.968	12.602	10.839	11.297	13.365	2,755
FM	8	8.945	446	8.572	9.318	8.443	8.916	9.676	-0,713
CTw	3	567.297	5.706	553.124	581.471	562.206	566.222	573.464	0,996
MTw	3	75.534	658	73.899	77.169	74.807	75.707	76.089	0,252
WPw	3	3.418	224	2.862	3.974	3.224	3.367	3.663	6,591
FMw	3	2.747	221	2.199	3.295	2.500	2.815	2.925	8,167
CTm	3	614.818	4.867	602.728	626.909	610.782	613.450	620.223	0,551
MTm	3	134.837	1.559	130.964	138.709	133.568	134.365	136.577	0,820
WPm	3	9.490	213	8.962	10.018	9.277	9.491	9.702	2,265
FMm	3	6.170	95	5.934	6.405	6.102	6.129	6.278	1,432

Columns 5 and 6 in the Table 5. represents the confidence intervals (*Conf.L. -95%, Conf.L.+-95%*) for the analyzed variables, and is calculated by the formula:

$$Conf.L.\mp 95\% = \mu \mp t_{\alpha/2}(k)\cdot\frac{s}{\sqrt{n}} \qquad (1)$$

$Conf.L.\mp 95\%$ – lower and upper limit of confidence interval
n – sample size
μ – mean
s – standard deviation

$t_{\alpha/2}(k)$ – critical values of Student’s t-distribution
k – degrees of freedom (k = n-1)
α – level of statistical significance

The confidence interval was calculated according to 5% significance level. Specifically, for these calculation, because of sample size, we used $t_{0,025}(7) = 2,365$ and $t_{0,025}(2) = 4,303$.

The last column in the Table 5. represents the average rate of change (*Av.Rate*) for the analyzed period, and is calculated by the formula:

$$\overline{S} = \left(\sqrt[n-1]{\frac{I_n}{I_1}} - 1\right)\cdot 100 \qquad (2)$$

$\overline{S}$ – average rate of change
n – sample size
I_1 – basic index in the first year of analiyzed period
I_2 – basic index in the last year of analiyzed period

The most interesting thing we can see from the table above is that for the analyzed period 2010 - 2017 the average number of employees was: 1,16 millions for Croatia (CT) with positive average rate of change (0,31%), 209 thousands for Manufacturing sector (MT) with negative average rate of change (-0,48%), almost 12 thousands for Wood processing (WP) with positive average rate of change (2,76%) and almost 9 thousands for Furniture manufacturing (FM) with negative average rate of change (-0,71%). It is also evident that in the last three years of the analyzed period only positive growth rates have been recorded, both in women and in men employed, in all analyzed sectors.

The basic indices for all variables are presented with a common reference year, currently year 2011 = index 100. For period 2010 -2017 the basic and chain indices are given in folowing Table 6., then follows Figure 2. that shows the comparison of the basic indices for all analyzed variables.

Table 6. Basic and chain indices for all variables

Year	Basic indices (b=2010)				Chain indices			
	CT	MT	WP	FM	CT	MT	WP	FM
2010	100,7	102,6	101,9	103,4	-	-	-	-
2011	100,0	100,0	100,0	100,0	99,3	97,4	98,1	96,7
2012	99,5	96,7	102,1	95,0	99,5	96,7	102,1	95,0
2013	97,6	94,2	102,1	90,3	98,2	97,4	100,0	95,0
2014	96,6	92,4	106,3	90,2	99,0	98,1	104,1	100,0
2015	101,4	98,0	115,3	91,9	104,9	106,1	108,5	101,9
2016	101,5	97,2	118,6	95,6	100,1	99,2	102,9	104,0
2017	102,9	99,2	123,3	98,4	101,4	102,1	103,9	102,9

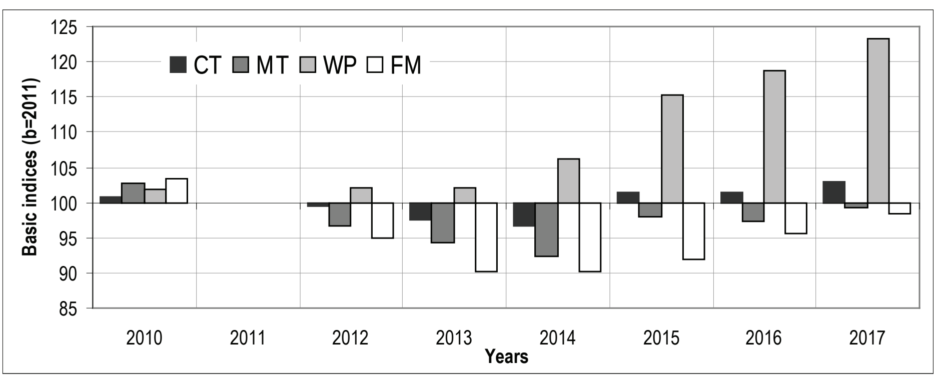

Figure 2. Comparison of the basic indices (b=2011) for all analyzed variables

Based on the average rates of change for Wood processing (WP) and Furniture manufacturing (FM) in the observed period, models A and B for prediction of future values of the number of employees in WP and FM were developed:

$$A_{WP}\,(t) = 1{,}0276^{t} \cdot 11050 \qquad (3)$$

$$B_{FM}\,(t) = 0{,}9929^{t} \cdot 9676 \qquad (4)$$

$A_{WP}\,(t)$ – model A for prediction of future values of the number of employees in WP

$B_{FM}\,(t)$ – model B for prediction of future values of the number of employees in FM
t – mark for the time, where *t=0* compared to year 2010, *t=1* compared to year 2011 etc.,

Existing and predicted values of the number of employees in WP and FM are graphically compared in Figure 3.

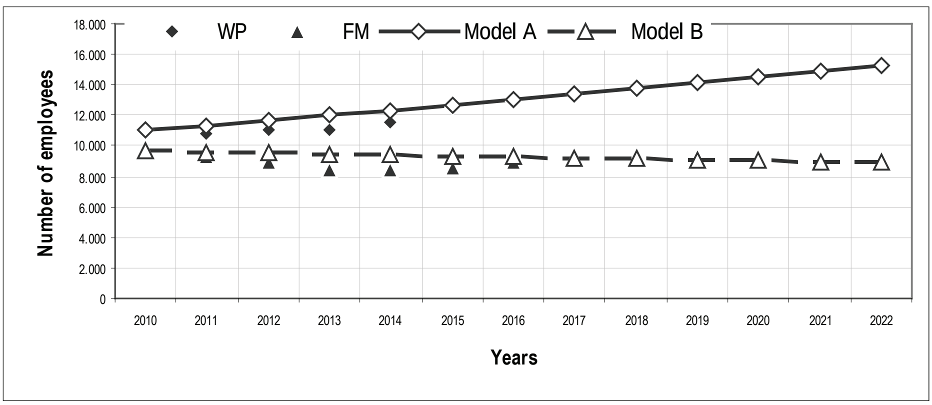

Figure 3. Comparison of existing and predicted values in WP and FM

4. CONCLUSION

According to model A, it is estimated that the number of employees in Wood processing (WP) will exceed 15 thousand by year 2022, while according to model B, the number of employees in Furniture manufacturing (FM) falls below 9 thousand.

Assuming that the macroeconomic policies will not be changed, and assuming that the constructed models A and B for predicting the number of employees satisfy all statistical and theoretical terms, the results of these research could become a great help for a future actions in woodworkong sector.

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VALUE CHAIN ANALYSES IN UPHOLSTERED CHAIR PRODUCTION: A CASE STUDY OF A SELECTED MANUFACTURER IN SERBIA

Aleksandra Lazarević, Branko Glavonjić

ABSTRACT

This paper presents the results of a research of value chain analyses in the production of wooden upholstered chairs based on the example of a selected manufacturer in Serbia. The aim of this research was to analyze the segment of value chain in relation to the process of finalizing sawn timber into high added value products. In this regard, the research was carried out on three chair models. The results of this research have shown that from 29 to 34 pieces of the selected models of chairs are produced from 1m^3 of sawn timber, and in that case the coefficient of valorization of sawn timber is increased from 4.1 to 5.7 times, according to the criterion of the sales price of chairs on parity EXW. If retail prices are taken into account, then the coefficient of valorization of the sawn material ranges from 6.5 to 8.9 times. This shows that the use of sawn timber for final products should be the tendency of all manufacturers in Serbia in order to achieve the highest value of production, exports and profits.

Key words: sawn timber, upholstered chairs, value chain, coefficient, valorization.

1. INTRODUCTION

A company acquires a concurrent advantage when it performs strategically significant activities cheaper or better than its competitors (Porter, 2007). This research paper presents analyses of a value chain in a domestic company for upholstered chair production. Through a dual approach this paper seeks to give a comprehensive description of the value chain in a particular case of domestic upholstered chair production. The value chain is characterized by a well-developed and strong logistics of supply with the necessary raw and other materials (diagram 1.). The manufacturers of furniture and other high added value products have a relatively well-developed chain of supply by domestic and international suppliers of the materials necessary for the production (Glavonjić, 2016). In Serbia, medium and small manufacturers of furniture as well as big manufactures of wood flooring and wood joinery have accepted and implemented the above mentioned concept of value chain. Some of the reasons for choosing such a concept are savings in the investments into the production capacities for primary wood processing, a faster turnover of capital and simplification of the supply chain. Well developed and organized suppliers are of utmost importance for the functioning of this model. The experiences of companies in Serbia that have accepted this model vary greatly. They range from extremely positive to rather negative experiences, due to the oscillations in the quantity, quality and prices of the necessary materials (Glavonjić, 2016). In recent years, analyses of the value chain in the production of furniture and wood products have been initiated in Serbia.

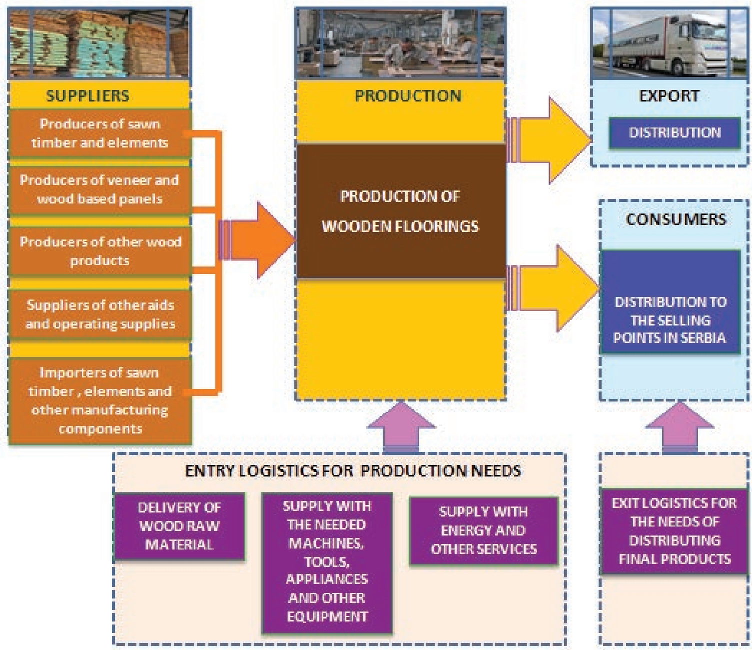

*Diagram 1: A value chain model in the manufacturing of furniture and other value added wood products with a developed logistics of supply of the necessary materials (*Source: Glavonjić, 2016)*

2. RESEARCH OBJECT AND GOALS

The object of this research is the value chain in the wood-technological processes of upholstered chair production.

The main goal of this research is the analysis of the value chain structure and the relationships among its components on the example of upholstered chair production in a chosen company in Serbia. Another additional goal of this research is to calculate the total costs that occur in the production of upholstered chairs and in the business activities of the chosen company, and their impact on the cost of some models of upholstered chairs and the company's profit. Hence, the coefficient of valorization was analyzed for 1m^3 of edged beech lumber finalized in three selected models of upholstered chairs.

3. METHODOLOGY

For the purpose of carrying out research in this paper, the following scientific research methods were used: analysis, induction, synthesis, generalization and the techniques of calculation and interview. The method of analysis was used to analyze the available production data and added value on the example upholstered chair production. In this study, the induction method was used to reach certain conclusions concerning the costs of their production and price. The method of synthesis was used in this paper to examine the process of upholstered chair production, as well as to analyze the overall costs that are created in the production of upholstered chairs and operations of the selected company in this process. The generalization method was used to draw conclusions about the added value in the production of upholstered chairs. All activities within the value chain create value. They are the basic elements by which organizations create a product or service that has value for the customer. At the same time, if they are properly defined, they are a source of competitive advantage or internal competence that makes the organization competitive in the market (Jaško et al., 2017). For calculating the costs of the selected models of upholstered chairs in a particular company and determining the coefficients of valorization of 1m^3 of sawn beech, the methods used were summarizing delineated cost calculations and the method for determining the sales price of the selected models of chairs. In addition to the aforementioned, another technique applied in the selected company was interviews with the staff engaged in upholstered chair production in Serbia.

4. RESULTS AND DISCUSION

The analyses of the value chain were performed for the entire production, and the coefficient of valorization was calculated only for three selected models of upholstered chairs.

According to Glavonjić (2016), the analysis and calculation of wood and wood product flows in Serbia for 2015 showed that only 48% of the total output of hardwood logs are processed into high added value products, and 52% are exported through low added value products: export logs (4%), sawn timber exports (41%) and the exports of other products with low added value. With such a small amount of raw material to be finalized, at this point Serbia can neither be a serious supplier of high added value products on the European nor on the global market.

Considering common social interest and efforts to raise the amount of finalized wood exported from Serbia, this paper shows the effects of finalization of 1m^3 of sawn beech wood for three selected chair models.

4.1. The coefficient of sawn beech wood valorization through the finalization of three selected upholstered chair models

The starting element for calculating the coefficient of valorization of sawn timber in the selected models of chairs was the purchase price at which the lumber was purchased.

Table 1. The average prices of sawn beech wood for the thicknesses of 25,38 and 50 mm

Types	Price (RSD/m^3)	Price (€/m^3)
Long edged lumber	42.500	348,4
Short edged lumber	32.000	262,3
Hyper short lumber	27.000	221,3

*Source: Data from the selected company; 1EUR=122 RSD[6]

[6] RSD: Serbian dinar

The second step in the valorization coefficient calculation was to calculate the amount of chairs of each model that can be produced from 1 m^3 of lumber (Table 2.)

Table 2. The amount of chairs of each model produced from 1m^3 of edged beech lumber, and their sales and retail prices

Chair model	No. of chairs produced from 1 m^3 of long edged lumber	No. of chairs produced from 1 m^3 of short edged lumber	No. of chairs produced from 1 m^3 of hyper short edged lumber	Sales prices (€/pcs), EXW	Retail prices (€/pcs)
Jana	34	32	30	42,4	66,1
Sara	34	32	30	42,4	66,1
Palermo	29	26	25	50,7	79,1

*Source: Data from a selected company; Note: Sales prices are prices without VAT and parity EXW.

The coefficient of valorization (k_v) of edged lumber through finalization for the three selected models of chairs is calculated as the relationship between the value of upholstered chairs produced from 1m^3 and the value of 1m^3 edged lumber.

$$k_v = \frac{\text{sales prices for chair } \left(\frac{€}{\text{kom}}\right) \times \text{amount of chairs produced from1m}^3 \text{ of edged timber}}{\text{purchase prices for1m}^3 \text{ of edged lumber}}$$

Table 3. The coefficients of valorization of 1m^3 of edged lumber through the finalization of wooden upholstered chairs of the selected producer in Serbia were calculated on the basis of the sales and retail prices of chairs in the selected company

Type of edged beech lumber	Purchase price for edged beech lumber (€/m^3)	Value of produced chairs from 1m^3 of edged lumber (prices are in €, based on sales prices EXW)			Coefficient of valorization		
		Jana	Sara	Palermo	Jana	Sara	Palermo
Long edged lumber	348,4	1441,6	1441,6	1470,3	4,1	4,1	4,2
Short edged lumber	262,3	1356,8	1356,8	1318,2	5,2	5,2	5,0
Hyper short edged lumber	221,3	1272,0	1272,0	1267,5	5,7	5,7	5,7

*Source: Calculations of the author; EXW-Franco fabrik

On the basis of the performed calculations and the obtained values of the coefficient of valorization, it can be concluded that these values range from 4,1 as the minimum value for the Jana chairs produced from long lumber to 5,7 as the maximum value for all three types of chairs produced from short lumber. The coefficients of valorization confirm the economic feasibility of the finalization of sawn lumber instead of its export. This particularly refers to the assortments of short and hyper-short structure, in which these coefficients have the highest value due to a significantly lower price at which these assortments are supplied compared to long lumber assortments.

When considering the retail price of the selected chairs in relation to the purchase price of 1 m^3 of individual assortments of sawn beech lumber, the coefficients of valorization are even higher (Table 4).

Table 4. The coefficients of valorization of 1m³ of sawn timber through finalization into the wooden upholstered chairs of the selected producer in Serbia are calculated on the basis of the purchase prices of sawn materials and retail prices of chairs

Type of edged beech lumber	Purchase price for edged beech lumber (€/m^3)	Value of produced chairs from 1m^3 of edged lumber (prices are in €, based on *retail prices*)			Coefficient of valorization		
		Jana	Sara	Palermo	Jana	Sara	Palermo
Long edged lumber	348,4	2247,4	2247,4	2293,9	6,5	6,5	6,6
Short edged lumber	262,3	2115,2	2115,2	2056,6	8,1	8,1	7,8
Hyper short edged lumber	221,3	1983,0	1983,0	1977,5	8,9	8,9	8,9

*Source: Calculations of the author

The value of the coefficient of valorization clearly justifies sawn timber finalization due to significantly higher financial effects.

In 2015, the total export of sawn beech timber from Serbia amounted to 107,331 m^3 with the value of 24,57 million EUR (Glavonjić, 2016). If this amount of sawn timber is turned into chairs and they are exported as final products, the financial effects would be several times higher. Assuming that the exported amount of sawn timber were processed into the Jana chair model, the financial effects of exports would be higher by about 5 times on average.

5. CONCLUSIONS

- Important elements that domestic producers particularly care about are product quality, development technology and reduced production costs. One way of increasing the production and export of upholstered chairs from Serbia is the improvement and optimization of value chains in enterprises that deal with their production. In the last two years in Serbia, the value chain has gained importance in both scientific and practical terms. A growing number of manufacturers are paying attention to the analyses and other segments of the value chain, and that is just the way to make the best out of it.

- Direct costs that are taken into account when calculating chair costs refer to raw material and material costs, the costs of earnings and amortization. The retail price information was obtained from the direct sales channel of the company.
- The analysis of the coefficient of valorization of 1m^3 of sawn timber as the starting form of wood raw material for the production of selected models of chairs has shown that its values range from 4.1 to 5.7 times in relation to the sales price of chairs on parity EXW (Franco factory, Incoterms 2010). If retail prices are taken into account, the coefficient of valorization of sawn timber ranges from 6.5 to 8.9 times. The value of the coefficient of valorization clearly justifies finalization of the structure due to significantly higher financial effects.
- If all sawn beech timber exported from Serbia were finalized into chairs and exported as final products, the financial effects would be several times higher. If the exported quantity of sawn timber from Serbia in 2015 had been converted into the Jana chair model, the financial effects of exports would have been about 5 times higher, and they would have reached the amount of about EUR 120 million.
- A deeper insight into the capacity utilization of production creates the possibility for these measures to be introduced in practice, while at the same time opening the path for new research in this field.

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FINANCING PREFERENCES AND PRACTICES OF SMES IN WOOD **PROCESSING AND FURNITURE INDUSTRY IN SLOVAKIA**

Zuzana Stroková, Josef Drábek

ABSTRACT

Access to finance is a key precondition for the existence, growth and development of SMEs. Bank funding is the most commonly used source of external finance for many SMEs, which are often heavily dependent on traditional financing to fulfill their strat-up, cash flow and investment needs. On the other side, alternative financing is available for newer, innovative and fast growing enterprises whose owners cannot get traditional financial resources. Both traditional and alternative financing represents one of the most significant challenges for new SMEs. The main purpose of this study is to identify the financing preferences and practices of a sample of SMEs in the wood processing and furniture industry in Slovakia.

Keywords: small and medium sized enterprises, traditional financing, alternative financing

1. INTRODUCTION

Small and medium sized enterprises (SMEs) are the driving force behind mature market economies. The importance of this segment lies not only in the functions but also in the position it holds in the national economy. They have an irreplaceable role not only in terms of job creation but also in terms of their share in value added. Dynamic development of SMEs is a key precondition for sound economic development.

Overall, in 2016 SMEs, in the EU-28 non-financial business sector accounted for (European Commission, 2016):

- almost all EU-28 non-financial business sector enterprises (99.8 %);
- two-thirds of total EU-28 employment (66.6 %); and
- slightly less than three-fifths (56.8 %) of the value added generated by the non-financial business sector.

According to the Slovak Business Agency (2018), almost all the main indicators characterizing the development of SMEs recorded positive developments. Compared to 2016, SMEs increased employment by 1.4%, value added by 8.9% and earnings by 7.5%. In the foreign trade area, SMEs have not been able to improve, with exports of SMEs almost unchanged and the share of SMEs in total exports even declined.

In 2017, from the total number of active business entities in Slovakia were 97.0% of micro enterprises (550 016), 2.5% of small enterprises (14 159) and 0.5% of medium enterprises (2 956). The share of large enterprises in the total number of active business entities was 0.1%, which in absolute terms means 662 subjects. The number of business entities in Slovakia represents the entire Slovak economy and the source of these data is the Register of Organizations of the Statistical Office of Slovak Republic. According to the above data, the SME in the Slovakia consists of **99.9% of the total number of entrepreneurs, the share of micro enterprises being 97.1%, that is 4.1 percentage points more than in EU countries**.

With regard to the SME industry, **more than one quarter (25.2%; 142 906) of active SMEs performed its main activity in the area of business services in 2017**. A slightly lower share of 21.2% (120 178) was achieved by the representation of SMEs in the trade. The construction sector (16.7%, 94 694) and the industrial sector, with a total of 75 670 SMEs (13.3%), are more markedly divergent. The deployment of other sectors in the SME category did not exceed 10%.

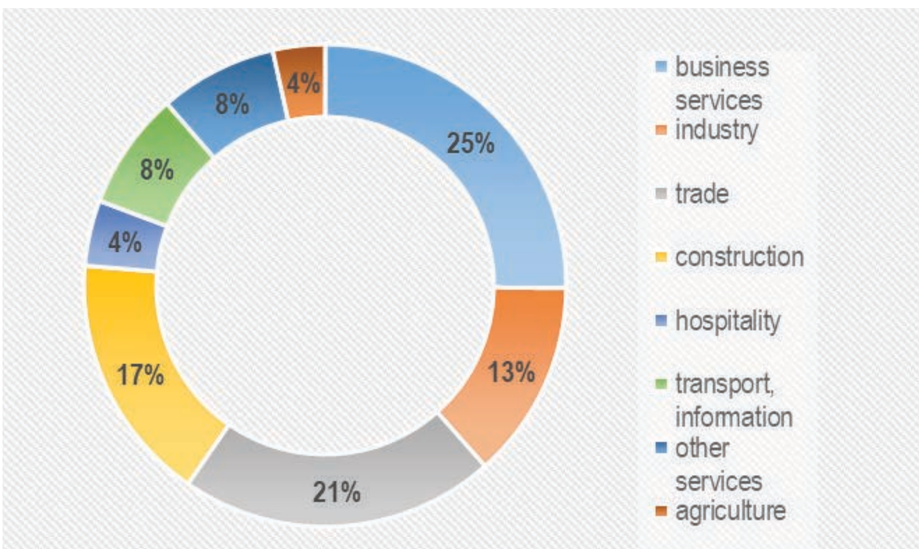

Figure 1. Sectoral structure of SMEs in 2017

The above situation shows that in 2017 more than three quarters (76.3%) of SMEs were established in four sectors: business services, trade, construction and industry.

In terms of structure of SMEs according to legal forms in 2017, **natural persons – entrepreneurs** accounted for **61.4%** and **SME - legal persons** accounted for **38.6%.**

Despite their indisputable benefits and advantages, SMEs face obstacles arising from the very nature of SMEs and from specific business conditions in Slovakia. According to Fetisovová, Vlachynský and Sirotka (2004), Sobeková Majková (2011) and Grubišić Šeba (2016) the first group of disadvantages includes mainly limited access to external financial resources, mainly due to the high risk of SMEs. Problems arising from specific business conditions include high tax wedge, legislation, legal uncertainty and a malfunctioning capital market.

Belanová (2015) adds that a situation where a significant proportion of SMEs can not meet their financial needs - can not obtain financial resources through the banking sector, capital markets, other suppliers of financial resources, is referred to as the SME **Financing Gap**.

As the causes of its origin, the OECD (2006) states that providers of external financial resources have difficulty assessing the financial situation of the company and the owners as well as the less intensive relationship between SMEs and financial markets (SMEs often receive financial resources from informal sources). An important aspect of stimulating financial gap is asymmetric information. In SMEs, the information asymmetry is higher, which reduces their chances of obtaining financial resources compared to large enterprises. An important factor that greatly affects the intensity and nature of the financial gap is the country in which the SME operates (its macroeconomic environment, the institutional and legal framework, the financial system, etc.).

Rupeika-Apoga (2014) stresses **alternative financing** – venture capital, business angels and different government support programs can become the solution for funding attraction, especially for new SMEs in the all over the world. Obiora and Csordás (2017) add although alternative financing is gradually rising and becoming more prominent in the financing scene, **traditional financing** still greatly outweighs it in terms of popularity as a source of funds.

The EU wood processing industries include the production of sawn wood, wood-based panels, and wooden construction materials and products. About 70% of the wood in the EU is used in construction and furnishings. The furniture industry is a labour-intensive and dynamic sector dominated by SMEs and micro enterprises. EU furniture manufacturers have a good reputation worldwide thanks to their creative capacity for new designs and responsiveness to new demands. The industry is able to combine new technologies and innovation with cultural heritage and style, and provides jobs for highly skilled workers.

Data in table 1 shows, in 2016 the total revenues of wood processing industry in Slovakia increased from 1 407 million EUR to 1 651 million EUR, and the total costs increased from 1 408 million EUR to 1 610 million EUR. In 2016, the wood processing industry reached the gross economic result for the first time of 41 thousand EUR compared to the previous two years. Employment in Slovak wood processing industry has been steadily increasing over the period under review.

Table 1. Selected economic indicators of wood processing (WP) and furniture industry (FI) in Slovakia. Source: Green report 2017

Indicator	Industry	Million €			
		2013	2014	2015	2016
Revenue	WP	443	613	590	687
	FI	596	771	817	964
	Total	1 039	1 384	1 407	1 651
Costs	WP	441	597	573	660
	FI	572	805	835	950
	Total	1 013	1 402	1 408	1 610
Gross **economic result**	WP	2	16	17	27
	FI	24	- 34	-1 8	14
	Total	26	- 18	- 1	41
Employment	WP	3 535	5 005	4 875	4 954
	FI	8 133	10 583	11 102	11 287
	Total	11 668	15 588	15 977	16 241

2. MATERIAL AND METHODS

The aim of the survey was to evaluate the use of standard and alternative forms of SME financing in the wood processing and furniture industry in Slovakia. The survey was conducted in questionnaire form. The questionnaire was distributed among 2,500 subjects, and 214 respondents have participated in the research, which represents a return rate of 8.56%. The data obtained in the questionnaire survey were evaluated by the description, numerical and graphic methods.

Most of the companies involved in the survey were from Bratislava region (26.17%), Trnava region (13.55%), Banská Bystrica region (12.15%) and Žilina region (11.21%). Representation of enterprises from other regions was relatively even: Nitra region (9.81%), Košice region (9.35%), Prešov region (8.88%) and Trenčín region (8.88%).

In terms of sectoral structure, industrial and construction enterprises with the same share (25.70%) were the most representative in the sample. The second largest group was wholesalers, retailers, repairers and motorcycles (17.29%). The third largest group in the group was agriculture, forestry and fisheries (12.62%).

In terms of size criteria, small enterprises (43.93%) and micro enterprises (38.32%) had the greatest level of representation in the research. Medium sized enterprises had the smallest representation in the sample (17.76%).

The aim of the paper was to identify preferences and practices in the use of standard and alternative forms of SME funding in wood processing and furniture industry in Slovakia. In the following section, the results are only for the sample of SMEs in wood processing and furniture industry (25,70 %; 54 SMEs). Sectors analyzed in the article are categorized according statistical classification of economic activities (NACE Rev.2). We select following industries of wood processing:

- NACE 16: Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials.
- NACE 31: Manufacture of furniture.

3. RESULTS AND DISCUSSION

The following table presents an overview of the structure of research sample in terms of its legal forms, size categorization, number of employees and regional breakdown. The overview is complemented by the structure of enterprises in terms of their life cycle and the lenght of enterprise´s existence.

Table 2. Selected characteristics of research sample. Source: own

		Natural person (%)	**SME – legal person** (%)	**SMEs as a whole** (%)
Type of business		1.9	98.1	100.0
Number of employees	0 – 9	100.0	18.9	20.4
	10 – 49	0.0	52.8	51.9
	50 – 249	0.0	28.3	27.7
Legal form of business	Self employed	100.0	0.0	1.9
	Limited liability company	0.0	86.8	85.2
	Joint stock company	0.0	7.5	7.4
	Other	0.0	5.7	5.5
Region	Bratislava region	0.0	22.7	22.2
	Trnava region	0.0	15.2	14.8
	Trenčín region	0.0	11.3	11.1
	Nitra region	0.0	11.3	11.1
	Žilina region	0.0	9.4	9.3
	Banská Bystrica region	100.0	11.3	13.0
	Prešov region	0.0	9.4	9.3
	Košice region	0.0	9.4	9.3
Phase of the life cycle	Expansion phase	0.0	26.4	25.9
	Maturity phase	0.0	67.9	66.7
	Crisis phase	100.0	5.7	7.4
Lenght of **existence**	Less than 3 years	0.0	1.9	1.9
	From 3 to 10 years	0.0	30.2	29.6
	10 years and over	100.0	67.9	68.5

The research sample consisted of 98.1% of the representatives of SMEs and one natural person - entrepreneur. In total, 52% of entrepreneurs with a staff of between 10 and 49, 28% of entrepreneurs with 50 - 249 employees and 20% of entrepreneurs with less than 9 employees were surveyed. Among the SMEs, the vast majority of companies with a guarantee limited (87%), and another 8% were joint-stock companies. Altogether, 85% of limited liability companies were surveyed. The largest part of the companies surveyed was based in the Bratislava region (22%). Other regions are represented at 10% with a maximum deviation of +/- 2%. In terms of lifecycle, most entrepreneurs were mature (67%) and expanded (26%). From the point of view of the length of enterprise´s existence, long-term entrepreneurial companies prevailed - 67% took entrepreneurship for more than 10 years, followed by a further 3 - 10 years by another 30% of entrepreneurs.

The survey showed that almost half of the adressed entrepreneurs (46%) declared that they had not used any form of external financing during the previous 12 months. More than half of respondents (66%) said they had used **bank loans** as a source of external financing during the previous 12 months, and 69% of entrepreneurs declared the use of **leasing**. The least used resources were: **public sector support** (14%) and **external equity financing** – venture capital, business angels (7 %).

Table 3. Financial preferences of research sample. Source: own

Financial source	**1**	**2**	3	4	5	Weighted **average**
Bank overdraft	22,7%	36,4%	18,2%	13,6%	9,1%	2,5
Bank loan	19,0%	14,3%	57,1%	4,8%	4,8%	**2,6**
Other loans (business partners, family friends and relatives)	52,9%	29,4%	5,9%	5,9%	5,9%	1,8
Leasing	20,0%	30,0%	40,0%	10,0%	0,0%	2,4
Factoring	81,3%	12,5%	0,0%	6,3%	0,0%	1,3
Forfaiting	93,3%	6,7%	0,0%	0,0%	0,0%	1,1
Supplier credit	50,0%	5,6%	22,2%	5,6%	16,7%	2,3
Trade credit	81,3%	0,0%	6,3%	6,3%	6,3%	1,6
Notes	87,5%	6,3%	0,0%	6,3%	0,0%	1,3
Advances from customers	56,3%	31,3%	12,5%	0,0%	0,0%	1,6

This table presents the percentage of responding Slovak SMEs expressing a preference for selected financial resources where 1 = very low preference, 2 = low preference, 3 = neither low nor high preference, 4 = high preference and 5 = very high preference. As table 3 shows, respondents express the strongest preference for **bank loan** and **bank ovedraft** as indicated by their means 2,6 and 2,5, respectively. In the case of leasing and supplier credit, SMEs show slightly weaker preference compared to bank loan and bank overdraft as indicated by their means 2,4 and 2,3.

The last section of research focused on the purpose of using a bank loans by SMEs. More than half of respondents (58 %) used bank loan for working capital over the previous 12 months. The rest of respondents (42 %) used bank loan for purchase of property, means of transport and machinery. None of enterprises made use bank loan for research and development activities, for company promotion or for the development of the activities on international market.

In terms of leasing use, financial leasing was predominant among SMEs (77%) and operating leasing reached 23%.

Research has also emerged that 95% of SMEs did not have experience with applying for EU funds. One of the respondents used this option but was not successful. The reason for the rejection was lack of information, strict conditions for obtaining and administrative burden. The same share of SMEs would not use EU funding to meet strict conditions (35%) and administrative burdens (35%). 15% of SMEs have highlighted, among other reasons, the high financial costs associated with the application process, corruption and non-compliance with the business plan, and current topics.

A positive signal is that nearly 63% of SMEs would use this form of funding in the future.

4. CONCLUSION

The results of our research confirmed that the prevailing external source of SME financing is bank credit, followed by overdraft and leasing. Banking financing among SMEs in Slovakia prevails and changes are not expected in the future. This is supported by the results of the SBA survey (2017), which focused on the use of external financing for SMEs (n = 1000). The survey shows that 64% of SMEs expect to use bank loans, 32% leasing and 24% state support over the two-year horizon.

The interest of SMEs in alternative forms of financing is significantly lower. SMEs in our survey have experience with state aid and financial support from EU funds.

Availability of financial funding strongly depends on company development level, the bigger and familiar companies are the broader choices they have.

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THE EFFECT OF THE INITIAL PUBLIC OFFERINGS OF WOOD-BASED INDUSTRY AND AGRIBUSINESS COMPANIES **IN POLAND - A COMPARATIVE ANALYSIS**

Leszek Wanat, Leszek Majchrzak, Łukasz Sarniak, Elżbieta Mikołajczak

ABSTRACT

The study verifies whether there is a relationship between the companies activity on the capital market in search of new financing sources and their level of development. Representatives of two dynamically developing sectors of the Polish economy were selected for the study as follows: the wood-based sector and the agricultural sector (agribusiness), listed on the Warsaw Stock Exchange. The TOPSIS method: Technique for Order Preference by Similarity to an Ideal Solution was used to assess the level of enterprises development. Based on the results of the comparative, statistical and descriptive analysis of the stock data in wood-based industry and agribusiness sectors, the main recommendations were formulated.

Keywords: wood-based sector, agribusiness, initial public offering, capital market, Poland

1. INTRODUCTION

One of the sources of raising capital for further development of the company is the initial public offering. This process consists of issuing new shares and offering them to stock exchange investors. In most cases, the public offering in Poland can attract from several to several hundred million zlotys (PLN). These funds are most often used for the development of the company. Since relatively large amounts can be obtained this way compared to the company's assets, they have a significant impact on the investment activity of enterprises.

The effect of initial public offerings is understood as a state reflecting the level of development of the company, resulting from investments financed with funds coming from the issue of shares [Boot and Thakor, 1997; Chudobiecki *et al.*, 2009; Levine, 2012; Jin *et al.*, 2017; Sarniak, 2018]. The aim of the study was to analyze this phenomenon and to determine its impact on the development of enterprises - case study of the selected companies from the wood and agricultural sectors [Jonsson, 2012; Pawlak, 2013; Wanat *et al.*, 2013; Klus and Wanat, 2015; Kaputa *et al*., 2016; Mikołajczak *et al.*, 2017; O'Brien and Bringezu, 2018]. In particular, a research hypothesis was verified which assumed that wood processing companies had made greater use of the initial public offering and had a higher level of development than agricultural companies. The study covered companies from the wood and agricultural sectors listed on the Warsaw Stock Exchange, which conducted a public offering in the years 2005-2017, and excluded from the analysis those entities which were withdrawn from the stock exchange quotation in the period under review as a result of bankruptcy or takeover by another company.

In order to verify the hypothesis, an ex ante and ex post analyses of the companies' financial situation from both analyzed sectors were carried out in the ex ante and ex post perspectives, i.e. before and after the public offering. In order to assess the level of the enterprises development, the method of linear ordering of objects was used, taking into account multi-criteria relations (TOPSIS). Determination of the enterprises development measure (a synthetic variable) was suggested, followed by typology of the individual companies development.

2. METHODS

In economic research, exemplary methods are sought, which constitute an adequate tool for identification of the level of enterprises' development. In this group, TOPSIS (Technique for Order Preference by Similarity to an Ideal Solution) is one of the most frequently used methods by which various objects can be sorted and then compared according to strictly defined features [Hwang, Yoon 1981]. This method consists of determining the Euclidean distances between individual objects and a pre-determined pattern and anti-pattern. On this basis, a synthetic measure of development can be determined and the types of companies' development can be identified (depending on the identified level of development of enterprises).

The research scenario using the TOPSIS method assumes the implementation of at least the following stages [Wysocki, 2010]:

1) The selection of characteristics describing a given phenomenon may be prepared on the basis of substantive analysis and preliminary statistical analysis.

2) Standardisation of the characteristics values - this can be done using the following formula (1):

$$z_{ik} = \frac{x_{ik}}{\sqrt{\sum_{i=1}^{N} x_{ik}^2}} \tag{1}$$

Description:
z_{ik} - normalized value of the k-th characteristic for the i-th object;
x_{ik} - value of the k-th attribute for the i-th object.

3) Determining the weights for each characteristic according to the formula (2):

$$v_{ik} = w_k z_{ik} \tag{2}$$

- this can be done by means of an expert survey.

Description:
v_{ik} - value of the k-th characteristic for the i-th object after taking into account the weight.
w_k - the weight of the k-quota;
z_{ik} - normalised value of the k-th characteristic for the i-th object.

4) Determination of pattern and anti-pattern.

a. For the stimulant: $A^+ = \{\max_i(v_{i1}), \max_i(v_{i2}), \max_i(v_{i3}), \dots \max_i(v_{ik})\}$
b. For the destimulant: $A^- = \{\min_i(v_{i1}), \min_i(v_{i2}), \min_i(v_{i3}), \dots \min_i(v_{ik})\}$

Description:
A^+ - standard pattern
A^- - anti-pattern
v_{ik} - value of the k-th characteristic for the i-th object after taking into account the weight.

5) Calculation of the Euclidean distances from the standard pattern and anti pattern:

a. For the stimulant: $d_i^+ = \sqrt{\sum_{k-1}^{K}(v_{ik} - \max_i v_{ik})^2}$

b. For the destimulant: $d_i^- = \sqrt{\sum_{k-1}^{K}(v_{ik} - \min_i v_{ik})^2}$

Description:
d_i^+ - euclidean distance from the standard pattern
d_i^- - euclidean distance from the anti-pattern
v_{ik} - value of the kth characteristic for the i-th object after taking into account the weight

6) Application of the value of the synthetic characteristic using the formula (3):

$$S_i = \frac{d_i}{d_i^+ + d_i^-} \quad 3)$$

Description:

S_i-value of synthetic characteristics.

Being aware of the values of the synthetic variable (development measure), it is possible to identify the types (level) of the enterprises' development [Wysocki, 2010]. One way to divide the analyzed objects into classes is to delimit them using basic statistical measures: an arithmetic mean and a standard deviation of a synthetic characteristic. This results in a basic typology, which is reflected in the division into 4 classes:

Class 1 - very high level of development: $S_i \geq \bar{S} + SD$
Class 2 - Moderate level of development: $\bar{S} \leq S_i < \bar{S} + SD$
Class 3 - Sub-average level of development: $\bar{S} - SD \leq S_i < \bar{S}$
Class 4 - Low level of development: $S_i < \bar{S} - SD$

Description:
S_i - value of synthetic feature for the i-th object;
$\bar{S}$ - average value of the synthetic characteristic;
SD - standard deviation of synthetic characteristic (from the sample).

3. THE OBJECT AND THE SCOPE OF RESEARCH

The development of enterprises is influenced by many economic, social, legal and institutional factors. They operate with different forces and frequencies. They vary depending on the size of the company and the industry, influencing the shaping of the individual capital structure of the company, as one of the key factors determining the development of enterprises is capital. Most often it comes from owner's payments or bank loan. However, traditional forms of raising capital are limited and sometimes difficult for entrepreneurs to access. Therefore, opportunities are being sought to strengthen the company's financial structure on the capital market. An alternative form of raising funds is to conduct an initial public offering and introduce shares to stock exchange trading. The biggest advantage of such process is the possibility of obtaining a significant amount of financial resources for investments necessary for the development of the enterprise.

In this perspective, an attempt was made to analyze the impact of funds raised on the capital market by the selected companies from the wood and agricultural sectors for the purposes of the present study. In order to examine the effect of the initial public offerings, i.e. the impact of the share issue capital raised on the development of the surveyed enterprises, a synthetic measure was built (as an aggregate measure of development). The TOPSIS method was used for this purpose. The objects of the research were individual enterprises from the wood and agricultural sectors (personal scope). On the other hand, the factors determining the level of development of particular companies (material scope) were the features. For the purpose of the analysis, only the amounts as set out in the companies' accounts (reflecting the financial situation of the company) were selected. Limiting the source of analyzed factors to measurable values, determining the financial situation of the company, was aimed at ensuring comparability of data for individual companies.

In order to measure the level of development of enterprises from the surveyed wood and agricultural industries, the following characteristics were distinguished:

- **Indicator 1 -** The amount of funds raised to the balance sheet total (the index informs about the percentage of the company's assets that could be allocated in investments after the public offering).
- **Indicator 2 -** Amount of investment outlays to balance sheet total (this index shows how much has been invested after the public offering).

- **Indicator 3 -** Percentage change in sales revenues (this index shows whether the investments made had a real impact on the increase in sales revenues).
- **Indicator 4 -** Real change in the profit on sales (this index shows whether the investments made had an impact on the improvement of the financial result).

In the designed research scenario it was assumed that all the features described with the use of selected indicators (1-4) are stimulants (between which there is a direct proportional dependency: the higher the value of the index, the higher the level of development). Assuming that the development of a company depends on the size of the company and the strength (value) of the funds obtained within the public offering, it is necessary to maintain comparability of data (provided in standardized values, absolute values or as a percentage).

In order to determine the characteristics assessing the level of development, an ex ante and ex post analyses were carried out, based on the data obtained from the financial statements. The ex ante analysis used data from the last annual financial report of the audited company before the Initial Public Offering. Similarly, in the ex post analysis, the financial statements prepared for the audited company one year after the stock exchange debut (initial public offering) were used.

The time period of the study was therefore from one up to two years. On average, this period has passed since the issue of shares and the raising of financial resources until the moment when the level of development of enterprises was examined. The exact measurement depends on the date when the initial public offering was made. This choice of test period seems to be optimal (Figure 1). If the problem is treated more broadly, it would be necessary to examine the medium-term development measures, as it will take time to implement innovative technologies stimulating the development of the company.

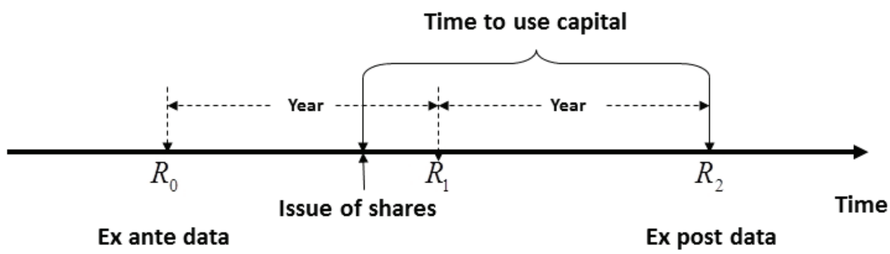

Figure 1. Time period of research
Source: authors' own elaboration

3. RESULTS

On the basis of the collected secondary data, calculations were made and the obtained results were statistically verified and tabulated (Table 1).

Table 1. Indicators for the assessment of the agricultural and wood industry enterprises level of development that conducted their initial public offering on the Warsaw Stock Exchange

Company	**Industry**	**Company profile**	Index **1**	Index **2**	Index 3	Index 4
Agroton	Agri-cultural	Agricultural production company (cereal seed, livestock farming and livestock sales, food production)	0,85	0,20	0,60	-7 189
Arctic Paper	Wood-based	Manufacture of premium graphic paper	0,13	0,01	785,42	117 349
Astarta Holding	Agri-cultural	Sugar production and sale	0,10	0,20	0,77	13 976
Barlinek	Wood-based	Floorboard manufacturer	0,35	0,25	0,40	-36 750
BSC Drukarnia Opakowań	Wood-based	Manufacturer of paper and board packaging	0,27	0,31	0,48	2 730
Drewex	Wood-based	Manufacturer of children's wooden furniture	0,19	0,17	-0,08	-1 687
KSG Agro	Agri-cultural	Agriculture and processing (all segments)	0,53	0,30	-0,71	-51 230
Milkiland	Agri-cultural	Dairy product manufacturer	0,64	0,05	0,41	5 881
Ovostar Union	Agri-cultural	Poultry farming and egg production	0,78	0,46	0,87	13 725
Stelmet	Wood-based	A manufacturer of wooden garden architecture	0,07	0,06	-0,02	11 427

**Source: authors' own elaboration*

Table 1 summarizes the standardized values for the indicators proposed in the research scenario, reflecting the criteria used to assess the level of development for the agricultural and wood industry enterprises surveyed. These companies have conducted an initial public offering and are listed on the Warsaw Stock Exchange.

On the basis of the TOPSIS method, a synthetic variable was determined, assessing the development level of the surveyed enterprises. Weightings are the same for all variables. The enterprises were ordered in a descending order according to the values of the determined synthetic variable. Following calculation included the average value and standard deviation of each determined index. As a result, development types were identified and the obtained typology of the surveyed companies development level is presented in Table 2.

Five types were determined, which measure (strength) the level of development of enterprises as follows: very strong, strong, medium, weak and very weak. If it is to ignore the outlier observations [Okupniak *et al.*, 2017], it can be seen that the surveyed companies have an average or low level of development.

Table 2: Typology of the development level of agricultural and wood companies based on synthetic values of the development measure

Company	Industry	The value of the synthetic development measure	Development type identification
Arctic Paper	**Wood-based**	0,68	Very Strong (I)
Ovostar Union	Agricultural	0,42	String (II)
Agroton	Agricultural	0,32	Medium (average) III
BSC Drukarnia Opakowań	**Wood-based**	0,30	Medium (average) III
Milkiland	Agricultural	0,29	Medium (average) III
Astarta Holding	Agricultural	0,28	Medium (average) III
Stelmet	**Wood-based**	0,24	Weak (IV)
KSG Agro	Agricultural	0,23	Weak (IV)
Drewex	**Wood-based**	0,23	Weak (IV)
Barlinek	**Wood-based**	0,19	Very weak (V)

**Source: own elaboration*

However, there are no strong indications that companies from any of the surveyed industries perform better in the area of acquiring and using funds from the initial public offering.

5. CONCLUSIONS

The paper tries to verify whether companies representing two dynamically developing sectors in the Polish economy as follows: agricultural business (agribusiness) and wood-based industry use capital market tools for the development of their enterprises and gaining a competitive advantage. However, this specific and so far underutilized model of shaping the capital structure has not proved to be a tool influencing the development of the surveyed companies in a significant way.

In particular, the research hypothesis, which assumes that wood processing companies have made greater use of funds from the initial public offering and have a higher level of development than agribusiness companies, could not be verified positively.

However, the following conclusions and recommendations can be formulated on the basis of the conducted research:

1) A relatively small number of companies in the wood and agribusiness sector choose to use the capital market as a potential source of development finance. Therefore, this area and capital market resources remain largely unused, at the same time being a potential opportunity to seek competitive advantages.

2) The majority of the surveyed companies, in terms of the typology of their development level, oscillate at an average level. This means that the funds raised from the

capital market under the initial public offering are not fully utilized by the companies. Above all, however, the funds are not used for the development of companies, probably serving other purposes (e.g. consumption, refinancing or indirect financing of other projects).

3) Possible change of the identified situation is viable, as the potential of the capital market, including the one present on the Warsaw Stock Exchange, remains unused. Therefore, the area for capital investments of new companies is open and this activity may determine further development and increase in competitiveness of both the analyzed industries based on wood and agribusiness.

In this context, it is also not possible to seek links between the level of development and the symptoms of the IPO effect (initial public offering) in the case of wood and agricultural companies.

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BUSINESS INNOVATION IN CROATIAN WOOD PRODUCTS INDUSTRY COMPANIES

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ABSTRACT

The purpose of the business innovation process is to create value for the organization. That value can come from creating new revenue opportunities or driving more revenue through existing channels; from creating efficiencies that save time, money or both; or from improvements to productivity or performance. Companies belonging to low-tech industries where also wood products industry belonging to, are able to develop and realize innovation at an equal level as companies belonging to industries with moderate or highly developed technologies. The aim of this study was to analyze, some business innovations (e.g. enterprise resource planning, quality and environmental activities, e-commerce) in selected wood products industry companies in Croatia.

Keywords: business innovation, wood products industry, e-business, certification, quality marks, EU funding

1. INTRODUCTION

The rapid development of technology and flow of information have prompted many organizations to create innovation, *i.e.*, actively seeking new methods, ideas, and creative solutions to improve and/or develop new products, production processes, and business activities (Tan and Nasurdin, 2011). There is a common misconception that the development of innovation is only possible in high-technology industries; however, innovations in low and/or moderately-low technology industries have been developed, which include the wood product sector industries (Maskell 1998; Mendonça 2009). According to Kirner et al. (2009), companies belonging to low-technology industries are able to develop and realize innovation at an equal level as companies belonging to industries with moderate or highly developed technologies. In addition, importance of wood products industry lies in the fact that it has enormus potential to contribute low-carbon economy (Basarac Sertić et al., 2018).

For an example, ISO 9001 certification is one of indicators of innovativeness that was noted by Terziovski and Guerrero (2014). In their research they confirmed that ISO 9001 has a positive effect on ecological efficiency of new products; that it has a positive effect on process innovation performance and acts as a “catalyst for change” to create flatter structures. They also confirmed that ISO 9001 promotes the internal customer concept. Besides reflecting on business innovativeness ISO 9001 certification has many organizational impacts, for example it has positive effect on production performance, moreover implementation of ISO 9001 has a positive and significant effect on production, purchasing, human resources and marketing performance (Prates and Caraschi, 2014). In the last decades environmental issues have become very important and also play important role in the wood products industry. While some environmental issues are controlled by mandatory regulations, such as air pollutant emissions, the other such as environment management systems (EMS) certification, chain of custody certification etc., are voluntary. These voluntary environmental approaches showed to be useful supplements to traditional mandatory command (Ziegler and Nogareda, 2009). In addition, they confirmed by econometric analysis a significantly positive effect of environmental process innovations on certified EMS. The most widespread standard for environmental management is ISO 14001 and it is developed by International Organization for Standardization. The econometric analysis developed by Rehfeld (2007) shows that the certification of EMS by ISO 14001 or European Environmental Management and Audit Scheme has a significantly positive effect on environmental product innovation. An integrated approach to quality management and environmental management certification has positive effect to organization and according to Hernandez-Vivanco et al. (2016) the level of integrated management systems positively influences process and product innovation capabilities. The need for innovation and creativity within the forest products is a necessity for sustainable forest products industry throughout the world (Ratnasingam et al., 2013). Sustainability in forest products industry is mostly reflected through the forest certification schemes. The most widespread forest certification schemes are Forest Stewardship Council® (FSC) and Programme for the Endorsement Forest Certification Schemes (PEFC) (Klarić, et al., 2016a). According to Klarić et. al. (2016b) comparison of financial performance indicators between FSC certificate holders and companies from wood industry sector in total showed higher ratios of almost all indicators.

The purpose of the business innovation process is to create value for the organization. That value can come from creating new revenue opportunities or driving more revenue through existing channels; from creating efficiencies that save time, money or both; or from improvements to productivity or performance. Research done by Perić et al. (2017) show that improvements in information systems, souch as implemementatiom of implementation of ERP within the business and production system within Croatian wood processing companies have a positive effect on organizational effectiveness overall productivity. Sawhney et al. (2006) define business innovation as the creation of substantial new value for customers and the firm by creatively changing one or more dimensions of the business system. In actuality, business innovation is far broader in scope than product or technological innovation. Ratnasingam (2004) views the value of furniture as a matter of perception, as it is sold based on a perceived value, rather than on an actual value. This suggests that the creation of value-added furniture is not about using high quality materials or state-of-the-art technologies, but rather it is about expressing a lifestyle in a creative and innovative manner. Innovation is relevant only if it creates value for customers, and therefore for the firm (Sawhney, 2006; Golob, 2009). Study results conducted by Pirc Barčić et al. (2016) suggest that relationships between innovation elements and business practices may help Croatian furniture manufacturing companies to better understand the importance of management activities in developing and/or improving innovations. However, in some EU regions, especially in new member countries like Croatia, the design and development of innovation measures is still a relatively novel concept.

In that context this study presents the first investigation that attempt to explore how some selected business innovation (like, e.g quality and environmental activities, e-commerce) have an impact on business success of wood industry companies in Croatia.

2. METHODOLOGY OF RESEARCH

The framework of present study included all active companies in the Republic of Croatia with more than 5 employees, and according to their core business activities, were classified in the field as C 16 - wood processing and C 31 - furniture manufacturing, based on National Classification of Activities (2007). The main objective of our research was to analyze business innovation activities within wood products industry companies. Therefore, only those with the best performance indicator - credit rating mark “A” were selected (the best 10 % of each group) from regional credit rating service Boniteti.hr, for latest financial year 2016. Profile analysis of company’s performance included financial indicators of companies. The main source of information about financial indicators of business activities is the financial statements of a company; basing on which the evaluation of the company’s business activities and financial status is performed.

In this paper financial indicators chosen and used for the analysis of selected companies were as follows: EBIT (Earnings Before Interest and Tax), ETQ (Efficiency of Total Equity), ROA (Return on Assets), ROS (Return on Sales) and ROE (Return on Equity).

Extensive research of e-business innovativeness indicators was conducted on websites of sourced companies from furniture manufacturing and wood processing. The following e-business indicators were researched: having company’s website; using e-mails; having web sales, having social network profiles - Facebook; Twitter; Instagram; LinkedIn and YouTube.

Data about FSC CoC and PEFC CoC certification were gathered from official FSC database (FSC, 2018) and PEFC database (PEFC, 2018). Database of Croatian quality management and environmental management certificate holders for obtaining data about ISO 9001 and ISO 14001 was used (Kvaliteta.net, 2018). Croatian quality marks innovativeness indicators from Croatian Chamber of Economy are obtained. Croatian Chamber of Economy issues the marks of “Croatian quality” and “Croatian Creation” that can be acquired by the products and services with the quality above average, if they are manufactured in the Republic of Croatia or they are the result of Croatian tradition, research and development or innovations and inventions. Additionally, as one of innovativeness indicators company’s EU funding was used and data was collected from official Croatian webpage about EU funding in Croatia (https://strukturnifondovi.hr/). Descriptive and inferential statistics was used to analyze data.

3. RESULTS

According to the results obtained, totally 47 companies were analyzed, precisely 32 of them from furniture manufacturing sector (C 31) and 15 from wood processing sector (C 16). Comparing the companies from both sectors by number of employees, in furniture manufacturing manly had 11 to 50 employees (50 %) and from 51 to 250 employees (43.8 %). In wood processing sector were employed manly from 51 to 250 employees (60 %), and in same proportion (20 %) from 11 to 50 and more than 250 employees. If we are looking the classifying a company according to its size by Commission Recommendation 2003/361/EC, C 31 sector was represented by small and medium sized companies, while C 16 medium, small and large companies.

As already mentioned, the evaluation of companies' business performance and financial status have a significant role in making financial managerial decisions. For this research 5 business performance indicators were selected, table 1. Results show that company's profitability (average values), like EBIT and financial performance profitability ratios ROS have greater value in wood processing companies than in furniture production companies. Other indicators Return on Assets, Return on Equity have higher value for furniture production companies. The average Efficiency of total equity coefficient was also analyzed, and was approximately the same for both sectors (1.11 and 1.10).

Table 1. Performance Indicators of the Companies (average values)

Indicator	Furniture Production N = 32	Wood processing N = 15
EBIT	4 775 839 HRK	7 836 260 HRK
ETQ	1.11	1.10
ROA	11,49%	8.83%
ROS	7.72%	8.02%
ROE	22.26%	14.74%

To assess E-business Innovation Indicators activities (EBII) within selected companies eight indicators were chosen. It can be seen from the descriptive statistical results (table 2.) that the most companies in both presented sectors have official website (C 31 - 93.75%, C 16 - 100%), available e-mail (C 31 - 96.88%, C 16 - 100%). In online sales, furniture manufacturing sector showed the slightly better results, 15.63% of them have that option (table 3.), comparing to the wood processing companies where just 13.33% of them have online sales. But these results are not surprising, because the product that furniture manufacturers produce represents a "final product", and as such is ready for sell. On other side, wood processing companies mainly produce "semi-final products" which are in subsequent stages of the manufacturing process ready for sale. This research showed that social networks, such as Facebook, are mostly used by both sectors, more precisely 84.38% of selected companies from C 31 sector have an active account, and 66.67% form C 16 sector. Other social media Instagram, LinkedIn and You Tube are also used, but less than Facebook (form 6.7% to 33.55%).

Table 2. E-business innovativeness indicators (EBII)

Innovativeness Indicator	Production of furniture N=32	Wood processing N=15
Website	93.75 %	100.00%
Online Sales	15.63 %	13,33%
E-mail	96.88 %	100.00%
Facebook	84.38 %	66.67%
Twitter	21.88 %	6.67%
Instagram	21.88 %	20.00%
LinkedIn	28.13 %	13.33%
YouTube	25.00 %	33.33%

Analyzing the EU funding innovativeness indicators (EUFI) totally 14 (43.75%) companies from furniture production sector were beneficiaries of EU funds and 5 (33.33%) from wood processing sector. And average funding for companies that belong to sector C 31 was 5 423 149 HRK and for C 61 companies was 15 497 203 HRK.

Further, obtained results regarding Certification Innovativeness Indicators (CII) (table 3.) have shown that wood processing companies had mainly implemented FSC CoC certification (86.67%), then ISO 9001 (40.00%), and ISO 14001 (26.67%). Just 6.67% of them had PEFC CoC. On the other hand, for C 31 sector results of CII had lower levels, totally 25% of furniture production companies had FSC CoC, while 28.13 % had ISO 9001 and 9.38% ISO 14001 certificate.

Table 3. Certification innovativeness indicators (CII)

Innovativeness Indicator	Furniture Production N=32	Wood processing N=15
FSC CoC	25.00 %	86.67%
PEFC CoC	0.00%	6.67%
ISO 9001	28.13%	40.00%
ISO 14001	9.38%	26.67%

Regarding the results of Croatian Quality Marks Innovativeness Indicators (CQMII), evaluated by having of quality mark within selected Croatian wood product industry companies, 3.31% from C 31 and 6.67% from C 31 had Croatian Quality mark. No one from these sectors had Croatian Creation mark.

To explore how some selected business innovation activities have the impact on business success of wood industry companies in Croatia several statistical tests were done for each sector and in total. Mann-Whitney U test showed that companies from both sectors who have website achieved better performance profitability ratios ROS and ROE ($U = 2.00$; $n1 = 2$; $n1 = 45$; $p = 0.007$; $p = 0.17$ two-tailed). Also, companies who have implemented FSC CoC certification have better profitability indicator EBIT, instead of those who don't have FSC CoC (U = 127 000; n1 = 26; n1 = 21; p = 0.002).

Analyzing the sector C 31 separately, results showed that implementation of ISO 14001, ISO 9001 and FSC CoC has a small and positive and effect on performance profitability ratios ROS and EBIT ($r = 0.238$; $r = 0.290$; $r = 0.211$; $p<0.05$). E - business innovation activities (like having a website, Instagram profile) have small but positive effect on company profitability ($r = 0.295$; $p<0.05$). This research has also confirmed positive and small effect on profitability ratios ROS and using EU funds ($r = 0.212$; $p<0.05$).

Moderate significant effect have implementation of FSC CoC and PEFC CoC on company's profitability indicator EBIT within the companies from C 16 sector ($r = 0.409$; $r = 0.433$; $p<0.05$). Also in same sector the results showed that Croatian quality mark has small but positive effect on company's profitability ($r = 0.247$; $p<0.05$). Correlation matrix showed moderate effect on performance profitability ratios ROA and EBIT within wood processing companies that have LinkedIn, Facebook and Twitter profile ($r = 0.545$; $r = 0.433$; $r = 0.433$; $p<0.05$). Small effect was found between profitability ratios ROS, profitability indicator ETQ and EU fundings ($r = 0.212$; $r = 0.630$; $p < 0.05$). Correlation analysis of business innovativeness indicators and efficiency of total equity and financial performance profitability ratios have been done also for furniture manufacturing. For C 31 sector, there was a small significant correlation between Croatian quality marks innovativeness indicators and EBIT ($r = 0.326$; $p<0,05$).

4. CONCLUSION

Selected companies from each sector represent the 10 % of total population with the best performance indicator - credit rating mark "A". Therefore, reasonable assumption was: are selected companies been able to develop and realize innovation activities "to some extent" as companies belonging to industries with moderate or highly developed technologies? In this study, mostly participated small and medium sized companies. The study shows that researched companies mainly have implemented different kinds of innovative segments in their production processes and in business activities. Well known fact is that using social media is a powerful tool for reaching progress and customer's desires. The results have shown that majority of researched companies have implemented e-business activities, with the slightly better results in furniture manufacturing than in wood processing. Regarding certification innovativeness indicators, FSC CoC certification found to be mostly implemented in wood processing, and ISO 9001 certification in furniture manufacturing. To explore how some business innovation activities effect on overall business performance of wood processing companies' several statistical tests have been done. This research has confirmed that E-business innovativeness indicators like: having a website, Facebook, LinkedIn and Twitter company profile have positive impact on business success of wood industry companies in Croatia. Further, research also confirmed that implementation of ISO 9001, ISO 14001, FSC CoC certification and Croatian quality marks in Croatian wood industry companies have a positive effect on companies' business success.

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SELECTED ECONOMIC INDICATORS OF SAWMILLING AND PAPER PRODUCTION INDUSTRY IN THE CZECH REPUBLIC

Petra Palátová, Roman Dudík

ABSTRACT

Wood is an important renewable raw material and the store of (mostly) coniferous wood in the Czech Republic is sufficient. The primary wood processing has a long tradition in the Czech Republic and can potentially offer enough sources for further manufacturing. But the level of domestic wood-processing including the level of value added is not favourable and also connected with high share of exports of raw wood. Selected economic variables were chosen to assess the situation in the sawmilling and paper industry, namely the CZ NACE 16.1 and CZ NACE 17.1 according to the classification of economic activities including the comparison of these industries. Primary source of the data were taken from the publications annually published by the Czech Ministry Of Industry and Trade. The data source covers the time period from 2012 to 2016. The article contains also some suggestions for improving the situation regarding the value added.

Keywords: Wood, manufacturing of wood, paper industry, added value, NACE classification

1. INTRODUCTION

The stock of raw wood in the Czech Republic is sufficient for further manufacturing processes in the following wood and paper industries. Both of them belong to traditional fields in the Czech Republic. According to the classification of economic activities (NACE classification), wood processing and paper industry pertain to CZ NACE 16 and CZ NACE 17, where 16.1 - Sawmilling and wood impregnation and 17.1 - Pulp, paper and cardboard production are the matter of this article.

Primary source of the data are the annually published documents by Ministry of Industry and Trade – so-called Panoramas of manufacturing industries. Both above mentioned subdivisions, 16.1 and 17.1, are evaluated according to selected economic indicators, namely number of companies, number of employees and value added. Because value added in the absolute number is not a comparable criterion, there is also a calculated value added per 1 employee. Simple arithmetic mean and variation range were used too. They are calculated as follows:

$$\text{Arithmetic mean: } \sum_{i=1}^{n} X_{i} \cdot \frac{1}{n}$$

$$\text{Variation range: } R = X_{max} - X_{min}$$

Wood processing industry in terms of competitiveness is evaluated, for example, by Sujová et al. (2015 a) and Sujová et al. (2015 b). Technical efficiency in Czech sawmilling is evaluated by Šedivka (2009). The whole forestry sector is a matter of evaluation by FAO (2014 b), where also the sub-sectors, wood processing and pulp and paper industry are assessed.

2. DIVISIONS CZ NACE 16 AND CZ NACE 17

The whole division 16 is divided into 2 sub-divisions – 16.1 – Sawmilling and wood impregnation and 16.2 - Manufacture of wood, cork, straw and plaiting materials except furniture, which is further divided into 5 categories. CZ NACE 17 deals with production of paper and paper products. There are also 2 subdivisions - 17.1, namely Pulp, paper and cardboard production (further divided into 2 categories) and 17.2, which is Manufacture of paper and cardboard products (further 5 categories).

2.1. Selected indicators of CZ NACE 16.1 17.1 – number of companies, number of employees

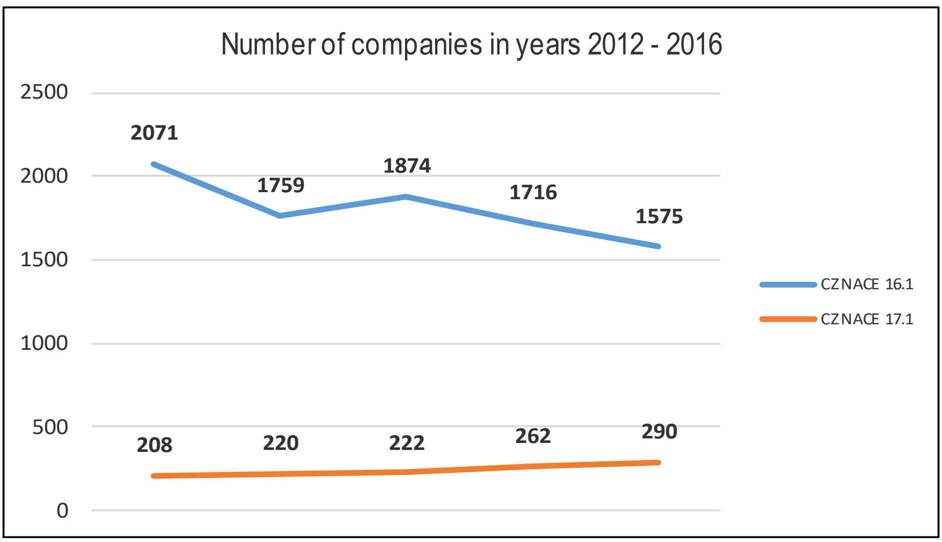

Figure 1: Number of companies in CZ NACE 16.1 and CZ NACE 17.1
Source: Panoramas of the Manufacturing Industries of the Czech Republic (2012-2016)

While the situation in CZ NACE 16.1 shows that there is a decline in number of companies, the opposite situation occured in CZ NACE 17.1, where the number of companies is growing recently. However, the number of companies in each category reach very different values. For comparison – in CZ NACE 16, the majority of companies belong under 16.2 and 16.1 reach less than 10 % of overall number of companies. Companies´ share in CZ NACE 17.1 reach around 1/3 of all companies in division 17.

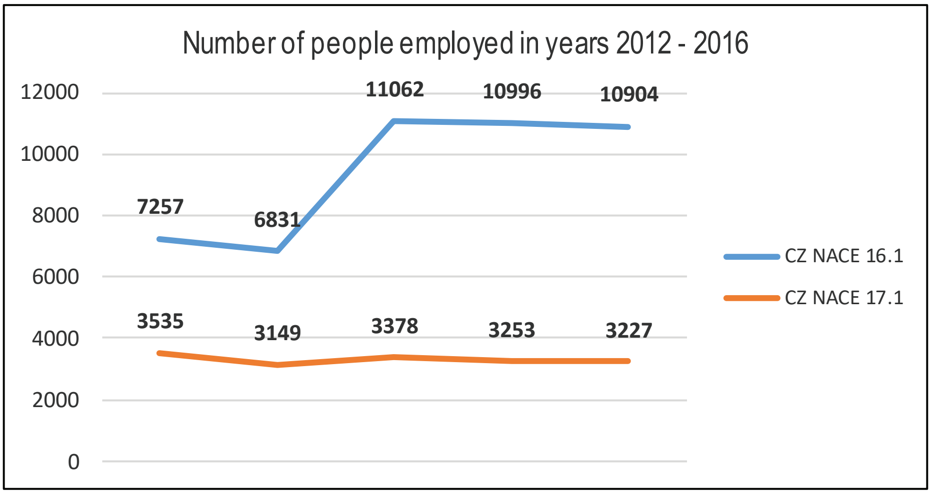

Figure 2: Number of employees in CZ NACE 16.1 and CZ NACE 17.1
Source: Panoramas of the Manufacturing Industries of the Czech Republic (2012-2016)

There is a significant change considering the years 2012 and 2016 in sawmilling and wood impregnation, where in 2016 the number represents around 150 % of the situation in 2012. In fact, there is nearly no change in the number of employees in the production of pulp and paper. Values in tables below are presented (also the calculated values) in entire units and converted from Czech crowns into Euros. The exchange rate used is 25,50 CZK/ 1EUR according to the state in May 2017 (Selected foreign exchange rates, 2018).

2.2 Selected indicators of CZ NACE 16.1 and 17.1 – value added and value added per 1 employee

Table 3: Value added and value added per 1 employee (in EUR) – CZ NACE 16.1

Year	2012	2013	2014	2015	2016	Variation range	Arithmetic mean
Value added (VA)	131 273	158 549	180 389	172 983	201 690	70 417	168 977
VA per 1 employee	18 088	23 727	28 063	27 112	31 752	13 664	25 748

Source: Panoramas of The Manufacturing Industries of the Czech Republic, 2012-2016, own calculations

Table 4: Value added and value added per 1 employee (in EUR) – CZ NACE 17.1

Year	2012	2013	2014	2015	2016	Variation range	Arithmetic mean
Value added (VA)	157 418	157 010	200 568	227 663	241 179	84 169	196 767
VA per 1 employee	44 532	48 213	65 931	72 011	77 326	32 794	61 603

Source: Panoramas of The Manufacturing Industries of the Czech Republic, 2012-2016, own calculations

Value added in the absolute value has increased during the observed period from 2012 to 2016 in both CZ NACE sub-divisions. Value added per 1 employee is a better, comparable criterion. We can see a positive trend in the increase in this indicator, again in both sub-divisions. Nevertheless, the value added per 1 employee is much higher in pulp and paper production (CZ NACE 17.1) than in sawmilling and wood impregnation (CZ NACE 16.1).

3. DISCUSSION

Value added is an often-used economic variable. Relative version of this indicator (per 1 person or employee) enables us to compare different fields of economy.

The long-term situation in value added in the whole forestry sector including a detailed look at individual areas (forestry, pulp and paper, wood-processing) is brought by FAO (2014 b), where the situation from 1990 to 2011 is described. There are no big fluctuations in the value added in the individual sectors. Definitely the highest creation of value added is in pulp and paper industry (in percentage). What might be considered as a problem is an increase in production, not followed by an increase in the value added per employee.

The value added can be increased by shifting the prices of the final products up, by decreasing the input costs or by increasing the amount of sold quantities (FAO, 2014 b). The other fact is whether this can be reached in conditions of wood industry, where a strong correlation between prices can occur (e.g. the prices of roundwood in the Czech Republic has a strong correlation with prices in Germany and Austria and thus the price determination might not be straightforward) and where the demand for wood is a „driven" demand depending on the demand in other industries (e.g. furniture industry, construction industry). In addition to that, an increase in value added should be considered in a broader context of the development of the whole industry.

In the Czech Republic, the low creation of value added is often discussed (Panorama of the Manufacturing Industry, 2013, 2014, 2016). It is mainly a situation in wood-processing, where the raw wood and roundwood is exported abroad, although it can be processed to a higher value products on the domestic market. Alarming is the situation described by FAO (2014 a), where the Czech Republic is stated among five biggest exporters of roundwood worldwide (with Russia, New Zealand, USA and Canada). More than 1/3 of domestic production of roundwood is exported abroad (FAO, 2014 a). In other words, too much of low value added products are exported abroad and in addition to that, there is a low domestic demand for wood and products, which do not help to increase the value added. What might help is a quality marketing support for the consumption of wood and products made from wood.

4. CONCLUSIONS

Wood-processing and paper industries are those of quite good potential for future in the Czech Republic, profiting from the stock of raw wood available. While the number of companies in sawmilling and wood impregnation is declining year-on-year, number of companies in pulp and paper industry is increasing moderately. Number of people employed in CZ NACE 16.1 has an increasing trend, the situation in CZ NACE 17.1 is relatively stable. Value added is higher in CZ NACE 17.1, both in absolute and relative (per 1 person) expression. The usual way how to improve value added is by decreasing the input costs, increase the prices of final products on the market or increase the amount of sold quantities. This seems like an simple solution, but the practical application is definitely not easy.

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THE FUTURE PERSPECTIVES OF SPRUCE AND FIR WOOD USE IN SELECTED COUNTRIES OF THE CENTRAL EUROPE FOR WOODEN CONSTRUCTIONS

Miloš Gejdoš, Martin Lieskovský, Marek Potkány, Ladislav Nozdrovický

ABSTRACT

The paper is focused on analysis of the potential for the Spruce and Fir raw wood in Slovakia, Austria and the Czech Republic. Evaluated is the supply assortment structure of these wood species in selected countries over the past five years, with the forecast of its development in the future. Also the analysis for prices development of reliabile assortments was made for wooden constructions purposes in selected countries. The basic factors, which this development influence was identified, with the prognosis for the future. Determined was the basic frames for the available volume of this tree species use in wooden constructions segment. We are also focused on economic parameters for this raw-wood use in wooden constructions area, in which dominated the coniferous tree species. Particularly in Slovakia will increase the abundance of beech and the abundance of spruce will decrease, thus will need to look for other alternatives substitution with another wood species.

Keywords: raw-wood assortments, wood prices, wooden constructions, market with wood

1. INTRODUCTION

Demand for coniferous saw logs has in recent years increased significantly. This is true for the European and the global markets. This growth is due to several trends in the timber market. Coniferous sawnwood is generally considered as the basic raw material for constructions and some types of wood constructions (Gejdoš, Potkány, 2017; Štefko et al., 2015). It is not only due to its physical-mechanical properties but also to the relatively low demands on the processing technology. However, in the furniture industry and design industries is also used. This is largely influenced by furniture giants and the Asian market, where demand for beech timber products stagnates.

However, the rise in prices for coniferous sawlogs is not only rising demand. Global climate change causes increased intensity of extreme weather phenomena, and thus increases the frequency and intensity of accidental fellings. Most coniferous stands in Central Europe have unsuitable species, spatial and age composition. These extreme phenomena thus gradually eradicate such ecologically weakened forest stands. The initial spruce representation in Slovakia was in the past 4.9%. Currently, it's 23.1 % (Green Report, 2017). In the Czech Republic, spruce representation has decreased by almost 4%

since 2000 (Report on Forestry and Forestry of the Czech Republic). There are still some specific conditions in Slovakia: a non-transparent market environment, an inappropriate structure of the processing industry, weak control of the state, variability and setting of technical conditions for qualitative sorting of wood.

On the basis of this, it can be assumed that the volume of available coniferous sawlogs will generally decrease in the future. The aim of the article is to evaluate and point out the development trends in the timber market, which confirm the decreasing deliveries trend of coniferous sawlogs volume and present the potential possibilities of spruce wood use in the sector of wooden constructions.

2. MATERIAL AND METHODS

Information about supplies of spruce and fir saw-logs in Slovakia, Czech republic, Austria and Germany were assumed from Information bank of Forestry national center of Slovakia, Czech statistical office, Federal ministry of Food and Agriculture (Germany) and Federal Ministry of Agriculture, Forestry, Environment and Water Management (Austria).

Assessment of price developments was focused on sawlogs assortments from spruce and fir trees in selected provinces of Austria, Czech Republic and Slovakia. The analysed period represents the period from 2000 to April 2018. In the case of the Czech Republic the prices were calculated with using the exchange rate of the National Bank of the Czech Republic. The assortments prices for Austria are in the trade parity on forest roads or forest warehouse. Prices in Slovakia and Czech Republic are placed on parity FCO (ex-warehouse vendor, respectively FCA (loaded truck purchaser). In order to provide absolutely correct comparison, it is necessary to add the transport costs to the Austrian prices (eventually parity DAF or CIF). Information on price developments have been drawn from the magazine Holzkurier, the Czech Statistical Office and the Forestry market information system.

3. HARVESTING AND DELIVERY

The volume of timber harvesting in the last two decades in the countries of Slovakia, Austria, Germany and the Czech Republic predominantly increased. The increase was mainly due to the high share of accidental fellings (several wind calamities and insects calamities), but also a higher proportion of forests in older age classes. It is therefore objectively apparent that, due to sustainable management in forests, the volume of planned timber felling will be diminished prospectively.

Growth of the felling volume was also reflected in the volume of sawlogs supplied. The partially decreasing linear trend in deliveries of this assortment was recorded only in Germany (Figure 1). In all other countries, the volume of supply of this assortment has grown slightly since 2000 on the linear trend.

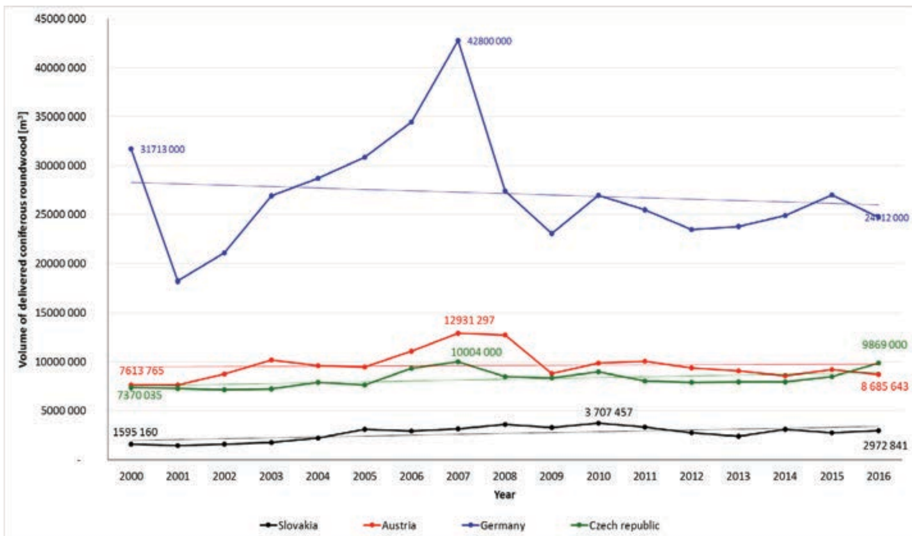

Figure 1. Volume of delivered coniferous Roundwood in selected countries of central Europe for years 2000-2016 [m^3]

More interesting is the view on development of the percentage share of coniferous sawlogs supply in the overall assortment structure according to countries (Figure 2). This development shows that wood recovery and rising the share of higher-quality raw-wood assortments were in the Czech Republic and Slovakia. On the contrary, the share of deliveries of this range fell in the Germany and Austria. This development also affects the harvested volume. In real, the characteristics of the regional timber market also affect it. In fact, Austria and Germany import relatively large volumes of this assortment from the Czech Republic and Slovakia (with regard to the production volumes in these countries). The decreasing share in Germany and Austria also partly reflects the emergence of new trends in bioenergy and renewable energy. In connection with the announced reduction in the share of nuclear energy in Germany, the imbalance between supply and demand for timber by 2020 would be approximately 40 million. m^3 (Wendisch, 2010). This reflects the gradual pressure of energy producers, who are already beginning to grow in demand for coniferous wood, which is the main raw material in Germany and Austria. This is mainly due to the wood species composition of forests in these countries. Only Slovakia, which has a significantly higher share of non-coniferous trees, differs significantly from the woody composition of Czech Republic, Austria and Germany. In combination with the inappropriate structure of the processing industry, which is mostly focused on processing of coniferous logs, this further exacerbates demand-side pressures and consequently increase the price of this assortment.

Figure 2. Percentage share of coniferous Roundwood in delivered assortments structure of selected countries in years 2000-2016

4. WOOD PRICES

In Fig. 3 is the development of prices of spruce and fir saw-logs in Slovakia, Czech Republic and Austria for the period 2000 to April 2018. The price development (beyond the crisis period) over the past decade confirms the increasing trend of the prices of this assortment. Price development is just a confirmation of what we said in the previous chapter. In recent years, both demand and felling volume have grown. As demand continues to grow, disposable harvesting volume are becoming increasingly limited, and so is the assumption of further price growth in the future. In Slovakia and in the Czech Republic since the period of the global economic crisis, the price of qualitative classes III.A and III.A / B (by 21 and 26 € .m^{-3} respectively) has increased. In Slovakia, even the price of quality class III.B is higher than III.A to 4.5 € .m^{-3}. This is mainly influenced by the setting of technical conditions and better availability of assortment III.B. Even though the price parity and the quality setting of individual quality classes vary from country to country, the same development trend is visible in price development (Fig. 3). Thus, price developments are almost copied across countries, despite different market and economic conditions. This is another unmistakable sign that the coniferous sawlog branch market is globally interconnected. Major factors such as the global economic crisis or big calamities can thus influence price developments at least on all European markets. It should be noted, however, that the cost of inputs to wood harvesting technology has grown more dynamically than wood prices during this period, suggesting that the price levels of these assortments were still partly underestimated. The development of wood prices will be in the future influenced in particular by the foreseeable reduction in the harvesting volume, the possible introduction of payments for forest ecosystem services, and the sector of renewable energy sources based on wood will also play an important role. If the trend continues, by 2020, the lack of wood on the market will deepen significantly, which will fundamentally affect the price of raw wood assortments.

The assortment of coniferous saw-logs, which is the basic assortment for the production of building timber and construction segments for wooden constructions, is already deficient in the wood market today. They rarely exceed the prices of this assortment level over 100 € from 1 m^3. In the future, however, it can not be expected that the price of this assortment will drop more significantly unless the global recession of the economy and the economic sector again occurs.

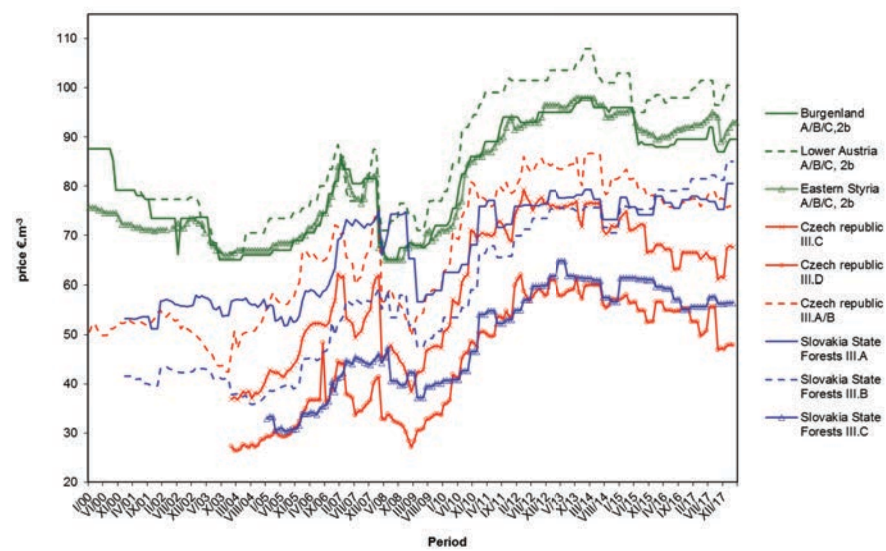

Figure 3. Development of spruce and fir sawlogs prices (in €.m^{-3}) in selected countries of central Europe

5. FUTURE OF CONIFEROUS IN WOODEN CONSTRUCTIONS

The wooden constructions segment has become a very popular and dynamic sector in the last decade. Wood products are produced in a low-energy production system with minimal emissions compared to other materials (steel, metals, plastics, concrete, fossil fuels), whose production emits much more CO2, i. e. leaving a bigger carbon mark. A "cascade use of wood" is promoted, based on multiple uses of biomass before the end of its life cycle. These circumstances only support the fact that raw-wood material should be used primarily in construction, furniture manufacture, or other long life cycle products (long-term fixation of CO2). Energy should be primarily generated from wood waste, residues, or recycled products (Moravčík et al., 2018). Table 1 shows the volume of seizures and CO2 emissions (In Gg CO2 eq.).

This balance shows that in Slovakia, in the year 2016, 3,11 mil. tons of CO2 in wood products were fixed, but at the same time in the same year, 2,051 mil. tons of CO2 from consumed wood products after their lifetime in the atmosphere were liberated. The overall balance is favorable, because the volume of CO2 fixed in wood products increased by 1,059 million. tons of CO2. It is also clear from the table, that the greatest contribution to this balance had coniferous wood and wood panels, which are the most used elements of wooden constructions today.

Table 1. Volume of seizures and emissions of CO_2 (in Gg CO_2 eq.) [source: Moravčík et al. 2018]

Year	CO_2 Balance	Together	Coniferous sawnwood	Non-coniferous sawnwood	Wooden panels	paper
2016	Seizures	-3110,37	-959,20	-349,34	-950,23	-851,60
	Emissions	2051,23	540,65	325,07	412,16	773,35
	Difference	-1059,14	-418,55	-24,27	-538,07	-78,25

The latest trends in wooden constructions leading to the use of laminated veneer wood (LVL). It is a material similar to plywood, but the veneers are oriented in one direction and thanks to the longitudinal joining of the veneer on swath (in the middle of abut) they reach larger dimensions (length up to 24.5 m). In Europe, LVL is produced mainly from spruce, in USA mainly from douglas fir and yellow pine, especially for a favorable strength / weight ratio. Laminated veneer wood can be applied as beams, boards, wands of lattice works, etc. It is also used in new buildings and in the reconstruction of beams, ladder belts, floor of transport vehicles, scaffolding boards, assembled houses, etc. LVL is not only used for construction purposes, but also for furniture and construction joinery for windows, stairs and doors. In North America, Australia and Asia, LVL's production has steadily increased over the past decade (Zubková, 2010).

Growth in production glued laminated wood (LLD) was also recorded, which is especially preferred in Japan. The LLD is produced by gluing multiple lamellas, the fibers of which are parallel. Boards from coniferous wood, predominantly from spruce, forming individual cross sections, are categorized according to strength. In accordance with STN 73 1701, the sawn timber used for the production of glued lamellar elements is classified into four classes: SA (high strength sawnwood), SB (normal strength), SC (reduced strength) and SD (Low Strength). The SB class is most often used, for economical reasons, different classes are present in one cross-section, and a lower grade is placed close to the neutral axis. We can only distinguish between two classes of SI - normal strength and SII

- low strength sawnwood (Zubková, 2010, Hrčka, 1987). LVL is made from secondary raw material qualitatively lower than it is in the production of massive parts or glued laminated wood. Even the consumption of wood is much lower. Timber consumption for 1 m^3 LVL is 12% lower (2.60 m^3) than for 1 m^3 LLD (2.94 m^3) (Kairi, 2005). It is clear, with suitable choice of structural elements it is possible to achieve relatively interesting savings of input raw material. Naturally, it depends on the user's preferences and on the conditions in which it is to be implemented. In wooden constructions segment is the new trend the recycled material use (Gergeľ et al. 2017; Igaz et al. 2017).

6. CONCLUSION

With the gradual decrease in intent fellings due to accidental felling in previous years and decades, while optimizing the forest wood species composition under new ecological conditions, the representation of the most popular wood species - spruce will be decrease. In particular, transformation and innovation of the wood processing industry will be necessary in Slovakia. The structure of supplies and assortments will gradually change, and the timber and timber products market will have to adapt. In the segment of wooden constructions, the share of large-scale materials from other wood species will grow, respectively, they will be upgraded so, that the input raw material requirements will be minimized.

The aim is to propose solutions aimed at exploiting the potential of the wooden constructions sector in Slovakia from the point of view production, added value creation and market share, which is still not sufficiently exploited. The solution could be state aid directed to the producers who use the domestic raw materials.

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THE IMPACT OF MOTIVATION ON CORPORATE CULTURE IN SMALL AND MEDIUM-SIZED WOOD-PROCESSING ENTERPRISES IN SLOVAKIA

Miloš Hitka, Silvia Lorincová, Milota Vetráková, Zdenka Musová

ABSTRACT

Employee motivation and corporate culture represent an essential part of human resources management. A higher effort is invested into achieving organizational goals by employees, who are motivated. Employees do not need to leave the company, if they are identified with a corporate culture, in terms of remuneration and the work environment. The aim of the article was to define the impact of employee motivation on the level of corporate culture. Using descriptive statistics, the level of motivation was defined in a medium-sized enterprise operating in Slovakia in the wood-processing industry in the area of furniture production. Motivational-oriented groups of employees were identified using cluster analysis. In the following step, the dependence between the identified groups and the level of the corporate culture was tested. Based on the research results, at the significance level of a = 0.05, we can conclude that statistically significant differences in employee motivation do not have the impact on of corporate culture.

Keywords: employee motivation, corporate culture, CLUA, t-test

1. INTRODUCTION

The effective business activity in a competitive environment is the driving force of each company. The aim is to achieve success and maximize the prosperity of the company. The company's success depends on the ability of an employee to perform as best as possible. The performance is influenced by a number of factors, such as a form of remuneration, a positive atmosphere at the workplace, communication between the supervisor and his / her subordinate, employee satisfaction, self-actualization, opportunity to apply one's own ability, access to information and other factors.

According to Weihrich and Koontz (1993) motivation represents a chain where a sense of need is placed in the first place. Subsequently, it creates the desire to create activities directed towards the fulfillment of the desired wishes. It is a psychological force in determining the direction of employee behavior and the level of effort (Nabi et al., 2017). In recent research, motivation was investigated in various areas (Sánchez-Sellero et al., 2018; Selvarajan et al., 2018; Schaltegger, Burritt, 2018; Ďuračík et al., 2017; Kucharcikova, Miciak, 2017; Ližbetinová, 2017; Vlacsekova, Mura, 2017; Aung et al., 2016; Kucharčíková et al., 2016; Poliacikova, Vaclavikova, 2016; Sheldon et al., 2016; Starchon et al., 2016;

Weberová, Ližbetinová, 2016; Caleon et al., 2015; Durisova et al., 2015; Minarova et al., 2015; Sanchez-Sellero et al., 2015; Stacho, Stachová, 2015; Pinnock, Hazell, 2014; Kubovský, 2012). Kropivšek et al. (2011) examined motivating employees of Slovenian and Croatian wood-industry companies in times of economic downturn. Hersey et al. (2013) focused on the impact of motivation on work performance. The result of the research is that from 20% to 30% of employee skills and knowledge are used by employees to maintain their jobs. On the other hand, if employees are motivated, their skills are used to 80-90%. The importance of positive motivation of employees in the enterprise was confirmed by Kozjek, and Ovsenik (2017). The research results have shown that employee motivation can influence 46.7% of the employee performance.

Nowadays, corporate culture is a concept that should be part of the company vision. Each company has its own unique culture (Brooks, 2003). Nevertheless, the corporate culture is still underestimated by some Slovak enterprises. Previous research (Hu et al., 2018; Chan et al., 2018; Obrad, Gherhes, 2018; Cetin, Guney, 2017; Grenčíková, Vojtovič, 2017; Kučerka et al., 2017; Marková et al., 2017; Moran, 2017; Tromblay, 2017; Hajdúchová et al., 2016; Almubark et al., 2015; Fejfrova, Urbancova, 2015; Gejdoš, Potkány, 2015; Hiadlovský et al., 2016; Khlif et al., 2015; Mura, Sleziak, 2015; Stachová et al., 2015; Fonseca et al., 2013; Patel et al., 2009) examined the corporate culture in different field. In general, the concept of corporate culture can be defined as a set of values, standards affecting the behavior of employees and their creative work (Armstrong, 2014). It is a reflection of human dispositions of thought, and behavior. It affects human consciousness and awareness. Corporate culture strengthens a person‘s relationship to work, regulates relationships between employees, and influences employee activity significantly.

2. MATERIAL AND METHODS

A questionnaire was used to determine the level of motivation and to analyze the motivation factors of the company at the current time. It consisted of 30 closed questions (Hitka, 2009). The questionnaire was divided into two parts. Socio-demographic and qualification characteristics of employees were examined in the first part. Basic data about age, gender, seniority, completed education and job position were obtained through this section. The second part of the questionnaire was made up of individual motivation factors. It was possible to find information on the characteristics of the working environment, on the working conditions, on the system of assessment and remuneration in the company, on the personal work in the company, on the social care system, on the employee benefits, on the satisfaction or dissatisfaction of the employee, his / her value orientation, relationship to work, colleagues and the enterprise as a whole. The motivation factors were arranged in alphabetical order to avoid influencing the respondents. Employees could assign each motivation factor to one of the five grades of importance from the Likert scale.

Software STATISTICS 12 (Dell, Oklahoma City, Oklahoma) was used in evaluating the questionnaires. Descriptive statistic was used to characterize the sampling unit. Consequently, similarly, motivational-oriented groups of employees were identified using cluster analysis, Ward's method, Euclidean distance (Mason, Lind, 1990; Triola, 1989). One of the possibilities of using the information contained in multidimensional observation is to sort the plurality of objects into several relatively homogeneous clusters. Applying CLUA leads to positive results, especially where the study file actually breaks into classes and where objects tend to be grouped into natural clusters. It is possible to reveal the structure of the studied set of objects and classify individual objects using suitable algorithms. Consequently, it is necessary to find a suitable interpretation for the described decomposition. It reduces the size of the task radically. The number of variables considered will be represented by a single variable expressing belonging to the class or type thus defined. The aim is to achieve a state where objects within the clusters are as similar as possible and objects from different clusters are similar to the least. In the next part, the clusters were shaped and characterized. Subsequently, a t-test was used to compare the identified groups. The t-test can be used in small samples if the assumption of normal distribution in both groups is maintained and variance is not significantly different. The P-value calculated by the t-test expresses the probability of an error that may arise by accepting the hypothesis of the existence of the difference between the examined groups. The difference between groups can be seen as the dependence of these two variables. Subsequently, working hypotheses were defined:

WH1: We suppose that there are significant differences between identified groups of employees in the motivation.

WH2: We suppose that the level of motivation requirements has an impact on the level of corporate culture.

3. RESULTS

Total of 87 white-collar workers from a furniture company located in the south of Slovakia participated in the research. Respondents were of different sexes, ages, and seniority. Based on the obtained answers, two groups of similarly motivational-oriented employees were created using CLUA (Figure 1). The average values of the preferred level of motivation are shown in Figure 2. Then, using the t-test, the preferred level of motivation was compared among similarly motivational-oriented groups of employees (Table 1). Based on the research results, we can conclude that there are statistically significant differences in the motivation requirements between identified groups of employees in almost all motivation factors at the level = 0.05, except motivation factor physical effort at work and prestige. Following the results, WH1 is confirmed.

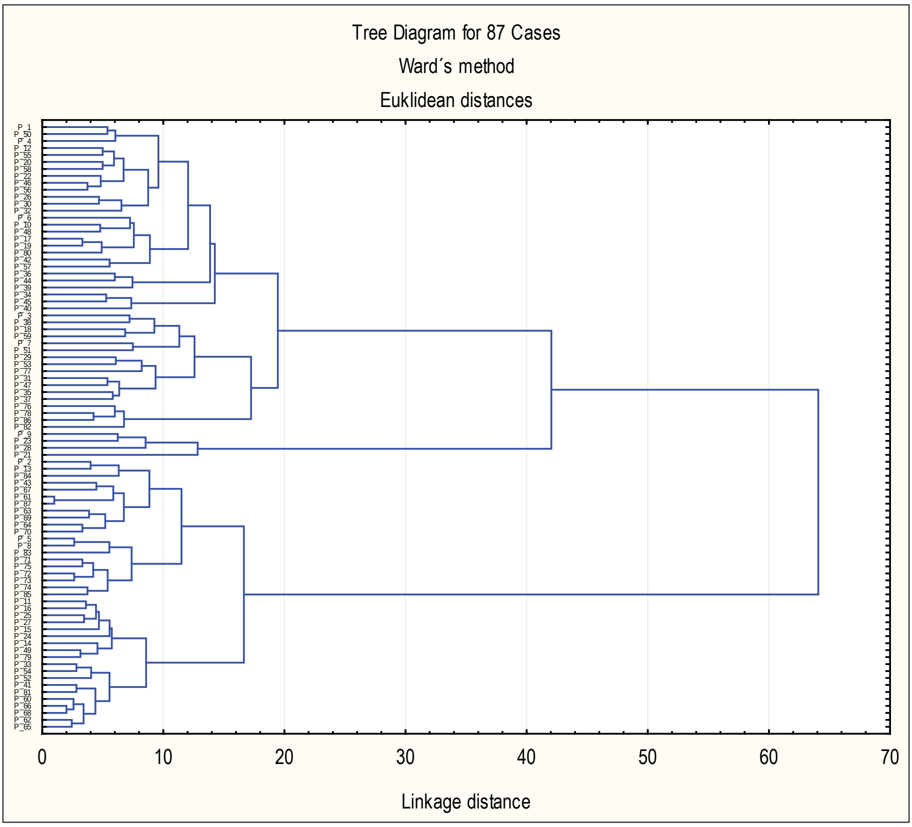

Figure 1. Hierarchical cluster analysis of motivational profiles of 87 workers

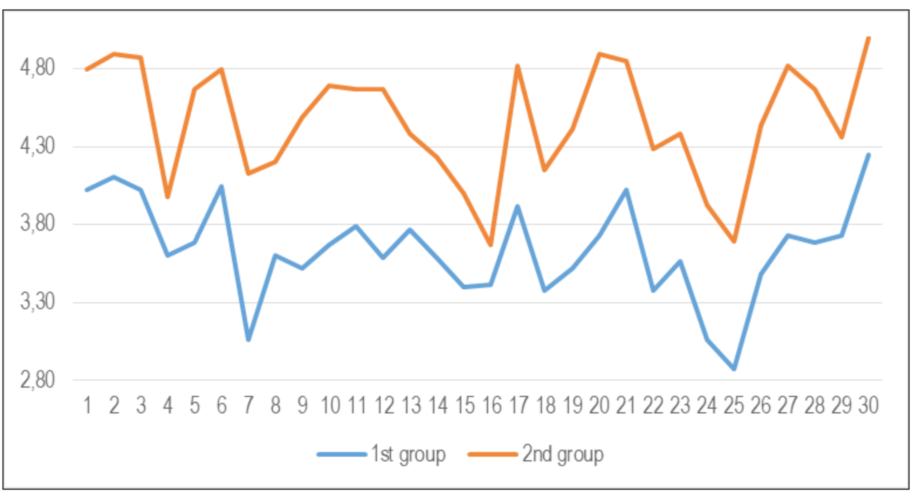

Figure 2. Average values of the preferred level of motivation for identified groups of employees

Table 1. Comparison of similarly motivational-oriented groups of employees by t-test

Motivation factor / Indicator	Frequency		Average		Standard deviation		t-test	Degree of freedom	p-level
	1st group	2nd group	1st group	2nd group	1st group	2nd group			
Atmosphere in the workplace	48	39	4.02	4.79	1.000	0.409	-4.533	85	**0.000**
Good work team	48	39	4.10	4.90	0.994	0.307	-4.794	85	**0.000**
Fringe benefits	48	39	4.02	4.87	1.280	0.339	-4.035	85	**0.000**
Physical effort at work	48	39	3.60	3.97	1.005	0.778	-1.886	85	0.063
Job security	48	39	3.69	4.67	1.170	0.577	-4.773	85	**0.000**
Communication in the workplace	48	39	4.04	4.79	0.922	0.469	-4.636	85	**0.000**
Name of the company	48	39	3.06	4.13	1.174	0.951	-4.577	85	**0.000**
Opportunity to apply one's own ability	48	39	3.60	4.21	1.125	0.767	-2.841	85	**0.006**
Workload and type of work	48	39	3.52	4.49	1.052	0.601	-5.098	85	**0.000**
Information about performance result	48	39	3.67	4.69	1.191	0.521	-4.999	85	**0.000**
Working hours	48	39	3.79	4.67	1.184	0.577	-4.221	85	**0.000**
Work environment	48	39	3.58	4.67	1.069	0.530	-5.776	85	**0.000**
Job performance	48	39	3.77	4.38	0.951	0.633	-3.455	85	**0.001**
Career advancement	48	39	3.58	4.23	1.048	0.742	-3.250	85	**0.002**
Competences	48	39	3.40	4.00	1.233	0.973	-2.492	85	**0.015**
Prestige	48	39	3.42	3.67	1.069	0.869	-1.178	85	0.242
Supervisor's approach	48	39	3.92	4.82	1.145	0.389	-4.708	85	**0.000**
Individual decision-making	48	39	3.38	4.15	1.084	0.779	-3.764	85	**0.000**
Self-actualization	48	39	3.52	4.41	1.185	0.677	-4.165	85	**0.000**
Social benefits	48	39	3.73	4.90	1.047	0.307	-6.733	85	**0.000**
Fair appraisal system	48	39	4.02	4.85	1.176	0.432	-4.158	85	**0.000**
Stress	48	39	3.38	4.28	1.282	0.759	-3.896	85	**0.000**
Mental effort	48	39	3.56	4.38	1.090	0.747	-4.006	85	**0.000**
Mission of the company	48	39	3.06	3.92	1.099	0.807	-4.075	85	**0.000**
Region's development	48	39	2.88	3.69	1.196	0.977	-3.435	85	**0.001**
Personal growth	48	39	3.48	4.44	1.271	0.754	-4.142	85	**0.000**
Relation to the environment	48	39	3.73	4.82	1.364	0.451	-4.783	85	**0.000**
Free time	48	39	3.69	4.67	1.274	0.478	-4.543	85	**0.000**
Recognition	48	39	3.73	4.36	1.300	0.628	-2.771	85	**0.007**
Base salary	48	39	4.25	5.00	1.120	0.000	-4.176	85	**0.000**

Note – statistically significant differences are highlighted in bold.

In the following step, the dependence between motivation and corporate culture was identified. The results from the analysis of corporate culture were divided according to identified groups of the employee. Using the t-test, both groups were compared. From the result (Table 2), we can conclude that the identified groups are very similar in the area of corporate culture. Following the results, WH2 is rejected.

Table 2. Testing of the importance of the identified groups of employees in the corporate culture

Indicator	Frequency		Average		Standard deviation		t-test	Degree of freedom	p-level
	1st group	2nd group	1st group	2nd group	1st group	2nd group			
Corporate culture	48	39	36.02	35.34	14.447	12.662	0.230	85	0.818

4. CONCLUSION

Simple prescription how to motivate all employees generally do not exist. Managers assume that employees are motivated by financial motivation factors. They are often surprised to see that there are other motivation factors that can even be more motivating in some circumstances. However, employee motivation can work effectively only if it is based on a proper knowledge and understanding of motivational factors and their differentiation in relation to certain types of employees. Clustering will help us answer the question of whether there are some motivation types of employees in the enterprise, or groups of people with similar motivation profiles. Based on the clusters created, it is possible to use the resemblance of motivation requirements of respondents when putting motivators into motivation programs for a similarly motivational-oriented group of employees. In our research, it was confirmed that there exist significant differences between identified groups of employees in motivation. Consequently, it was tested whether identified groups of employees have different requirements for the direction of corporate culture. However, the hypothesis was not confirmed. It means that the level of motivation is not dependent on the level of corporate culture in the company analyzed.

Our findings cannot be generalized yet in all areas of the wood-processing industry in Slovakia and not at all in all fields of industry. Further analyses and examinations of the gender, education, seniority and job position need to be carried out.

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COMPARISON OF MATERIALS FOR BUILDING CONSTRUCTION AND THEIR INNOVATIONS IN TERMS OF SUSTAINABLE GROWTH

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ABSTRACT

Sustainable development became a discussed issue and its main idea is to find out how to satisfy the needs of the present without compromising the capacity of future generations, guaranteeing the balance between economic growth, care for the environment and social well-being. It is a key topic in achieving the acceptance of bioeconomy in society in general. One of the industries trying to fulfill the consumer demands connected with environmental and health requirements is the building industry that is the topic of this paper. It deals with the importance of innovation in the building construction materials for sustainable growth focusing on assembled wood-framed houses. The paper presents a comparison of the conventional building materials and innovated alternate materials used in the building construction, especially the advantages of these materials based on selected indicators. The role of innovations in this effort is also the subject of our interest and their role will be explained in this paper.

Key words: innovation, innovated building materials, sustainable growth.

1. INTRODUCTION

The issue of sustainable development deals with the economic growth regarding the requirements of the society by creating the welfare conditions in short term, medium term as well as in long term period. Economic and demographic development naturally increases demand for natural resources. Sustainable development supports optimizing resource using, information flows, and communication in the chain, coordination and cooperation, as well as education of individual stakeholders in the sector. The approaches to the corporate social responsibility that are constantly innovated encourage the continual commitment to participate in the sustainable development. It allows the company to be competitive on the global market due to innovations of individual key components adjusted to customers and trends in world markets when applying the principles of sustainable development and environmental protection (Loučanová et al., 2015; Šterbová et al., 2016, Parobek et al. 2015).

The European Union has accepted the Strategy of sustainable development to enforce the sustainable development principles in various sectors. This strategy is based on the assumption of how to meet current needs so as not to endanger the possibilities of continued growth for the next generation. The main objective is to ensure a high level of environmental protection, economic prosperity and social equality. The strategy is also based on the requirement to change the society in different spheres (e.g. more responsible consumption, smart natural resources use, detection of new and sustainable forms, economic growth strengthening, new alternative sources of energy, more effective transport and global society). This implies the involvement of all participants of social life. Each principle moves to national level and to each society subjects (Šupín, 2004; Šupín, 2013; Loučanová et al., 2014; Maťová et al., 2017).

Sustainable construction is a chance how the building industry can contribute toward sustainable development. This idea lies in transforming the demand for sustainable development into an opportunity, creating and breaking into new markets, and innovating responses that satisfy traditional demands in the industry and the new societal demands for sustainable development (Bourdeau, 1999). According to data in the European Union (EU) the building sector contributes to 42 % of final energy consumption, 35 % of total GHG emissions, 50 % of the utilization of extracted materials, and 30 % of water consumption (European Commission, 2011). Following the mentioned figures we can state that construction and housing play a fundamental role when aiming at enhancing societal goals for sustainable development. By developing the construction and utilization of buildings in the EU, it is claimed that the total final energy consumption could be decreased by approximately 40 %, total greenhouse gas (GHG) emissions by 35 %, and the use of building materials by 50 % (Herczeg et al., 2014; Olšiaková et al., 2017).

The environmental requirements for innovative product management in relation to corporate social responsibility (CSR) based on the principles of sustainable development are implemented by the environmentally oriented management program (Kollár, Brokeš, 2005). Through environmentally oriented management of product portfolio, it is necessary to apply activities that allow overcoming the conflicts among market, society and environment. This is the reason why the companies try to improve the environmental performance of their products. The company regards also social and economic aspects when it considers environmental behaviour to ensure safer product using by customers during creating the added value of the product. The connection of innovation management and corporate social responsibility when applying environment protection forms the system of environment management which stands on three pillars: environmental product performance, innovation quality from the point of view of a customer and the product´s added value (Kalamárová et al., 2014; Olšiaková et al., 2016; Parobek et al., 2016; Paluš et al., 2018; Häkkinen, 2007).

The impact changes that are caused by the buildings construction and utilization can be influenced by choice and transport of raw materials and products in construction projects with the utilization of renewable energy when the buildings are used in order to maintain the intended indoor climate and air quality (Häkkinen, 2007). The positive expectations for increasing wood usage in multistore constructions have to deal with impacts on environment and the long carbon storage in wood, as it is proved by various studies about its life cycle focusing on carbon footprints (Cabeza et al., 2014; Gustavsson et al., 2010; Upton et al., 2008).

The most commonly quoted sustainability criteria for selection of building materials is that the material should score well in most of the following areas: renewable, low energy, low CO_2 emissions, sourced locally, reusable and recyclable, minimum waste, non-polluting (Kaputa, Kalamárová, 2014).

Sustainable development is a development strategy based on using the sustainable sources with the increasing importance of socio-economic approach. It is also connected with environmental issues taking into account social conditions and society development. It allows creating the complex system which supports environmental sustainability as well as socio-economic development.

Although the consumer can perceive and understand the environmental advantages of wooden products, the practical significance of wood environmental attributes can be unintelligible for most consumers (Toivonen, 2012).

This paper is aimed at explaining the role of innovation in relation to materials for building construction comparison in terms of sustainable growth.

2. METHODOLOGY

We used the analytical-synthetic method to evaluate the importance of building materials innovations for sustainable development focusing on wooden buildings. The analysis was realized with regard to heat transfer coefficient (U) and thermal resistance (R) of analysed materials for building construction. The following step was the comparison of obtained data that allowed us to determine the innovations significance for sustainable growth at the level of all three pillars supporting the integration of environmental policy and economic policy (Loučanová et al., 2017).

3. RESULT AND DISCUSSION

The comparison of material characteristics was used to demonstrate the innovation significance for sustainable growth from the perspective of the buildings construction materials.

Based on the results shown in Table 1, the most appropriate construction materials are innovated construction material YTONG and assembled building structure, which have obtained better values in the monitored indicators compared to the traditionally used materials (e.g. ferro-concrete, full or perforated brick). Traditionally used materials have high heat transfer coefficient and therefore they are not as economical as innovated materials. There is also a difference between full brick and innovated material (difference -2.72 W/(m2K) or between perforated brick and innovated material - 2 W/(m2K) (see Figure 1).

Table 1. Compared characteristics of building construction materials

Buildings	**Thermal Resistance - R m2K/W**	**Heat transfer coefficient - U W/(m2K)**
Masonry buildings - Ferro-concrete	0.31	3.23
Masonry buildings - Brick - full	0.35	2.86
Masonry buildings - Brick -perforated	0.47	2.14
Masonry buildings - Innovated material YTONG – insulated	7.42	0.14
Masonry buildings - Innovated material YTONG – non-insulated	3.45	0
Wooden buildings - Wood	2.67	0.37
Wooden buildings - Assembled building structure	7.45	0.14

*Source: Loučanová et al., 2017

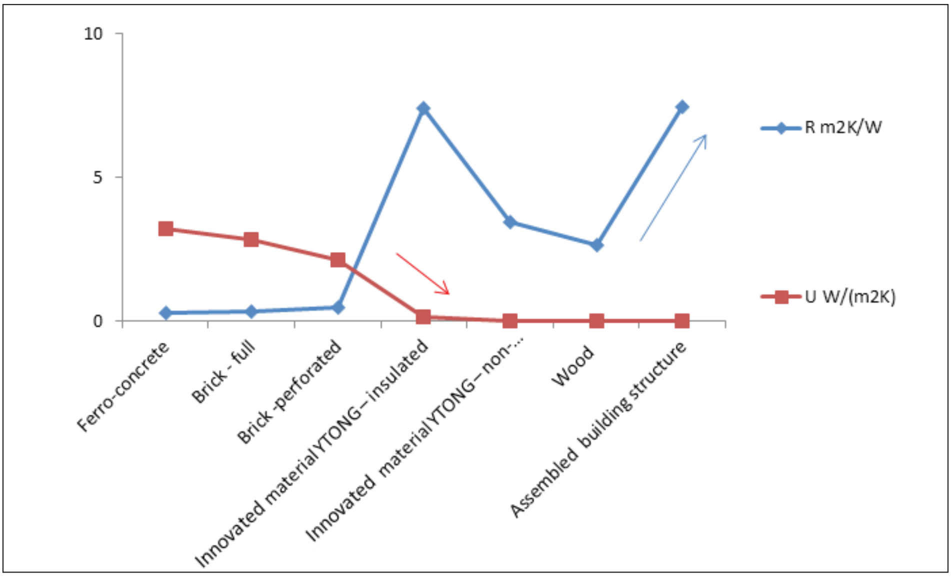

Figure 1. Heat transfer coefficient (U) and thermal resistance (R) comparison according to the type building

Wood as a construction material achieves considerably better values compared to original materials normally used in building constructions. Relative to the innovated material, YTONG is connected with minimal, but positive differences. Based on the comparison we can state that building materials innovations are of great importance for sustainable growth because they are economical, as it is proven by the savings of the heat coefficients of the innovated materials against the traditionally used materials. These innovations also fulfil the ecological function by saving energy for heating the buildings where innovated materials are used, due to lower heat transfer coefficient and thermal resistance. Additionally, wooden assembled buildings, in contrary to innovated material YTONG, are constructed from a heterogeneous natural material, which is more consistent with nature. Moreover, less energy will be used to produce these innovated materials than to produce original materials used for building construction, what is making these innovated materials more environmentally friendly. Owners of buildings from innovated materials can use savings connected with the nature of these buildings for other purposes. Because of shorter construction time, the social aspect of sustainable growth is fulfilled. Innovations of building materials are of great importance for sustainable growth and wooden assembled buildings that underline even more (Loučanová et al., 2016, 2017).

Sustainable development is an elementary issue in achieving the acceptance of bioeconomy in society in general. On the other hand, there is quite limited understanding on the interconnection between environmental sustainability and building regulations as driving forces for the future wood use in the multistore construction business, which is a core for development sustainable forest bioeconomy due to its long-standing role of building as carbon storage. As environmental attitudes in society tend to develop through increased knowledge and even experienced discomfort and harm from environmental problems, it is also anticipated that in the future a greater proportion of consumers will be likely to seek more environmentally friendly alternatives to housing. Regarding all these aspects, wood material in modern urban construction has some definitive advantages, which has become visible especially among younger consumer segments (Høibo et al., 2015; Kaputa, Paluš, 2014).

Toivonen (2011, 2012) states that consumers as well as construction material companies attribute a high value to the environmental quality of wood. Toppinen et al. (2013) in their study present that elements related to the environmental sustainability of wooden products in housing, the products´ social acceptability, and the esthetic characteristics of wood can be connected with a different consumer lifestyle. These differences consist of a complex interaction among consumer background, values, and behavior.

Toivonen and Hansen (2003) say that wood compared to many other materials is more attractive material. However, environmental quality is not the main quality attribute for consumers or organizations in their selection of construction materials. From the perspective of professional literature, only a few studies have directly linked the future of WMC (wooden multistory construction) to its key factor, i.e. changing values in the society toward sustainable development. The future perceptions of WMC value chain actors have scarcely been searched (Hurmekoski et al., 2015, 2016; Wang et al., 2014).

4. CONCLUSION

Innovations together with sustainable growth have a substantial place in a market economy. Sustainable growth is a persistently developing and essential factor in a globalized world which is constructed on three pillars - economic, social and environmental. Regarding the mentioned results we can state that buildings made of innovated materials are more affordable and they fulfil the economic aspect of sustainable growth. Moreover, a number of positive aspects can be mentioned with innovated materials, e. g. a considerable saving of time compared to the construction of buildings from the traditionally used materials, significant thermal resistance of the walls, almost half the thickness compared to the classical wall, which increases the useful area, the energy saving, fulfilling the social aspect. Because the innovated building materials are supposed to be health-promoting and environmentally friendly, also environmental aspect of sustainable growth is fulfilled. We can conclude that innovations are of great importance for sustainable growth in terms of building materials.

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THE APPLICATION OF MODERN METHODS OF CHANGE **MANAGEMENT TO OPTIMIZE PROCESSES**

Simanová Ľubica

ABSTRACT

Changes in the business and their management are now an important tool for competitiveness. They are also one of the decisive factors for the performance and stable economic growth of the enterprise. The aim of the article is to illustrate the application of methods of change management for process optimization in a particular company wood industry. Optimization is focused on spatial layout of workplaces, material flows and material handling.

Key words: process, change, change management, optimization, material flow

1. INTRODUCTION

In today's changing environment, it is important for businesses to react quickly and effectively to the changes brought by the market. Key factors for successful business can be the ability to stay on the market for a long time, to make a profit, and to secure a good name for the business. These attributes are primarily performed by enterprises with a sophisticated internal business philosophy based on each process article, with a positive approach to changing and using new methods, tools and trends in process management. Most businesses in Slovakia are engaged in manufacturing activities, and the production process itself consists of a large number of complicated operations. In manufacturing processes often there are bottlenecks that need to be eliminated by optimizing production processes, in many cases focusing on spatial layout of workplaces, material flows and material handling.

2. MATERIAL AND METHOD

2.1. Process, Process Management and Change Management

Hammer and Champym (2000), Šmída (2007), Luděk (2005) coincide in the definition of the process as a set of interrelated activities with one or more types of inputs and form an output which has a certain value for the customer and represents a characteristic variable of process control.

Process management is focused on the causes of arising discrepancies, not on the final outputs. This type of management control is based on the idea that the cause of company's bad results is inefficient running of company processes where it is necessary to make them rationale and more effective, which will result in higher added value for the customer (Marcineková - Sujová, 2015).

Drdla a Rais (2001) state that the change can not only happen, but can also be planned and managed. If it is in the interest of management to build a successful business, it is obvious that he will be primarily interested in a controlled change. Change management in today's environment is becoming a major management discipline. Changing means a qualitative conversion of certain characteristic parameters that describe the status of an object or already.

Authors Vodáček - Vodáčková (2001), Koter (2000), Palán (2002) define change management as a set of approaches to economically efficient reduction of change with negative consequences for the organization and how to continuously improve the position of the organization on the market through never ending care of business development processes. The company's goal is to turn the organization into an innovative and adaptable market-oriented system.

The change process is very complex, but there are models to make the change (Rosenau, 2000). Business Change Management according to Majtán (2002) can be seen as a project in which it is necessary to follow the following steps: Define the target and the partial objectives, identify the persons, their roles and responsibilities, determine the forms and scope of communication, develop a timetable.

According to Drucker (1992), senior managers should prevent changes in the business environment, and their organizations are still ready to change.

Koter (2000) defines change management as continuously improving the organization's position on the market through never-ending care for business development and its processes.

Palan (2002) describes the management of organizational change as a complex, internally structured process of transforming an organization into a competitive economic entity while respecting proprietary, managerial and social values. The company's goal is to turn the organization into an innovative and adaptable market-oriented system.

Successful change requires adaptation of methods, techniques, strategies and implementation tactics to specific history, culture, and people in the organization.

According to Dupaľ and Brezina (2006), it is just newer logistic concepts that allow to achieve a higher functional and quality level of produced products, shorten the production times, increase productivity, and efficiently solve the logistics chain. They also optimally align and synchronize individual transport, storage, production or assembly processes. Among the most used methods and concepts of production management are the authors Rašner and Rajnoha (2006), Kavan (2002), Gregor et al. (2000), Dupaľ and Brezina (2006): JUST IN TIME, KANBAN, OPT, KAIZEN.

2.2. Methods of material and spatial organization of the production process

Keřkovský and Valsa (2012) argue that in connection with the spatial and organizational organization of the production process is necessary to solve the following two interrelated aspects of production management: material flows, the decisive criteria of which are the speed, distance and fluidity of the transport and layout of fixed position positions, process layout, cell layout, and product layout.

Šebej (2003) states that the material flow represents the spatial arrangement of the production process. The flow of workpieces is the most important part of the material flow. Material flow is understood as an organized movement of work items (raw materials, semi-finished products), finished products, waste, and packaging, tools in production and in circulation.

Optimizing material flow means searching for its ideal level, continuous material movement at minimal cost, time, energy, means, workers, but also other factors such as length of transport distance, volume of transport per unit time, capacity (transport unit load) the use of the loading space, but also the duration of transport operations (Rosová - Balog, 2013).

In practice, several methods of material flow analysis are applied, the difference of methods is given by the relationship between the input data, the type and quantity of the material. The diagram is made up of graphic symbols linked to the string. The symbols show the succession of the individual work activities of the production process. The string shows the physical flow of material, and the scheme also includes information expressing the material flow quantification as activity order, intensity between activities, and place of origin.

Authors such as Gregor (2005), Rosová - Balog (2013), and Rašner (2017) agree that the graphical representation of the material flow is a graphical representation of the material flows between the workplaces and generates a general idea of the material flow movement, including manipulation and transport. They also recommend a graphical representation of the material linkages between the different work paths of the transport paths and the course of the material, and the Sankey diagram, which is considered to be the most used in expressing the material flow. The starting point for building a diagram is knowledge of workspace layout. The distance of the material flows is represented by the length, the thickness and the direction of the route is shown by the arrow joining the individual workplaces (activities). Flow lines are color-coded for greater resolution in the diagram.

3. RESULTS AND DISCUSSIONS

Figure 1 shows a process for effecting a change in the process for producing the shuttering boards. The various steps of the process have their justification, succession and time horizon.

Figure 1. Model of change management in the process of production of shuttering boards
Source: personal processing

The first step was to analyze the material flow of the production of the shuttering boards from the dry storehouse to production until the finished products are stored. The graphical representation of the optimal material flow is shown in Figure 2.

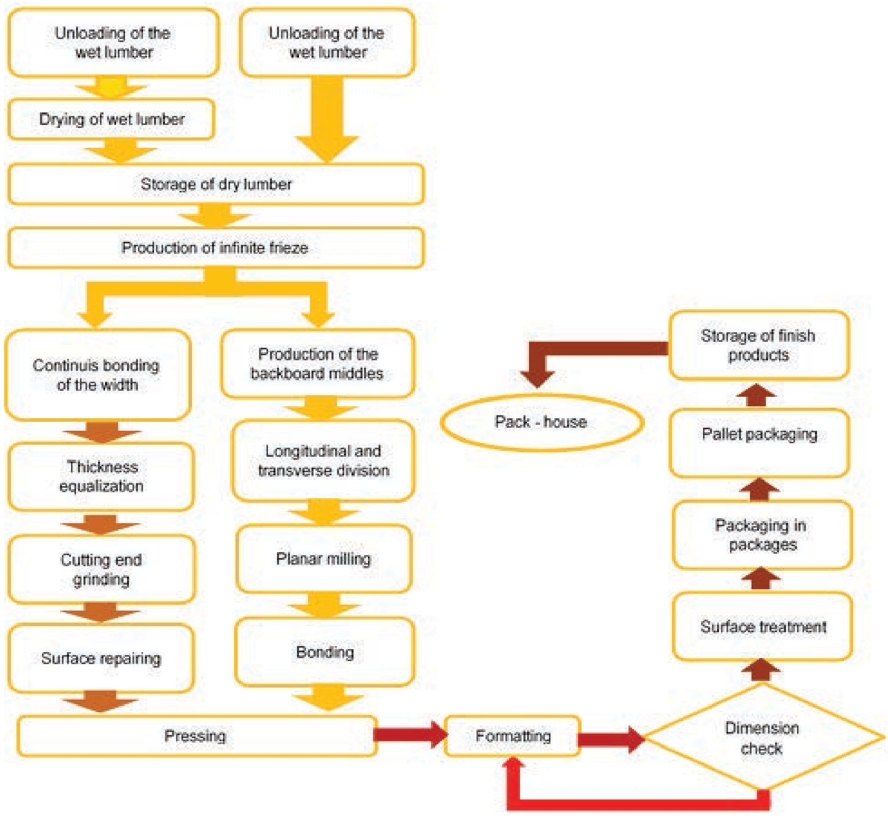

Figure 2. Optimizing the spatial layout of production by material flow
Source: personal processing

Figure 3 shows a layout arrangement of workplaces in the enterprise for shuttering boards. The main reason for the change was the reduction of the handling paths when moving the defective components to manually and mechanically removing the errors, and consequently reducing the cost of material transfer.

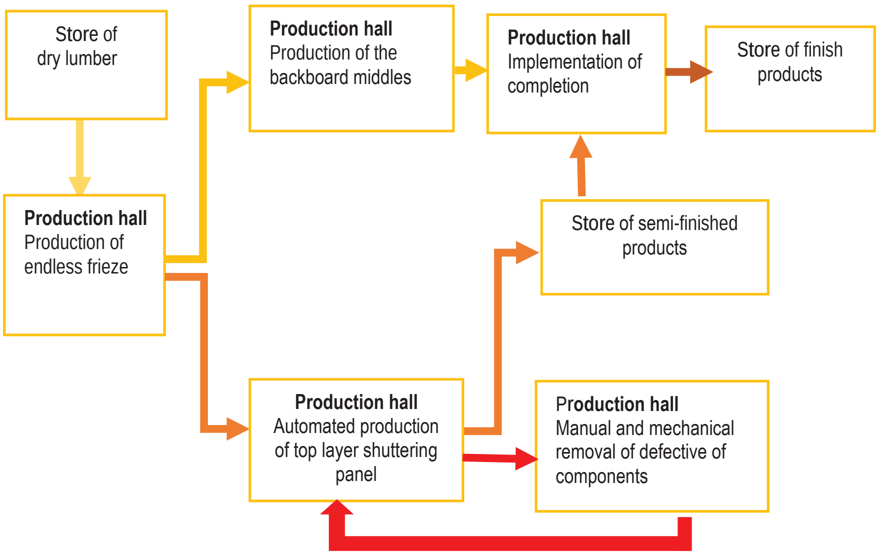

Figure 3. Layout of workplaces in the process of making the shuttering boards before the change / Source: personal processing

The main idea of the change was to change the location of the assembled production hall to manually and mechanically repair the defective components. This hall was transformed into a flowing hall and located opposite the production hall with an automated layer shuttering panel. At the same time, a smooth flow of material was ensured. The design of the new layout of workplaces after the change can be seen in Figure 4.

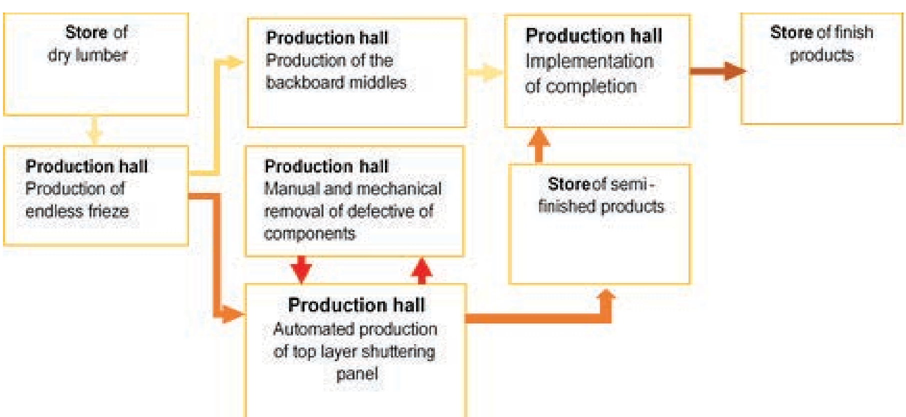

Figure 4. Design layout of workplaces in the process of making the shuttering boards after a change / Source: personal processing

Manufacturing companies are increasingly feeling the need to produce their products well, at a low cost and at a low cost. Change management, rationalization measures, excellent co-operation, fluidity and material flow organization together with the optimal layout of workplaces contribute to cost reduction.

Changes in the process of making the shuttering boards were carried out according to the steps of the change management model and the following analyses, methods and tools were used: material flow analysis in the production process, selection of suitable indicators for process evaluation and data acquisition from the measurement of the runways, analysis of fuel consumption, analysis of wage costs and total cost of labour of transporting material, survey of the total costs of moving the assembled hall with the relevant engineering networks.

The proposed solution has resulted in the company shortening transport routes, saving time for transportation, saving fuel and employee, optimizing material flow and optimizing layout of workplaces.

The transport route has been reduced by 268 m compared to the original layout solution, 1 employee has been saved, and the component transport time has been reduced by 12 minutes per 1 transport batch. When deciding about the layout of the workplaces, the possibility of relocating the assembled hall together with the engineering networks at relatively low costs, creating entrance entrances to the hall, which had an impact on the shortening of the distance, were considered. Total annual savings amounted to € 12,658.00.

Decision-making and management changes have been employed methods such as process analysis, characteristic calculations for material flow analysis, graphical methods to view the material flow and the layout of workplaces in the production halls, the small scale method of intuition, as well as experience in managing processes of change management processes, from making spatial layout designs for workplaces with regard to the flow of material flows.

4. CONCLUSION

Various methods and tools can be used to manage material flow changes. Material flow fulfils certain goals in the production process, requires certain inputs and results in a particular product. Material flow includes a sequence of processes that take place in a particular environment, it is part of handling equipment, and is specific to certain methods. It represents a system that needs to be directed, modified, managed and analysed in detail on the basis of certain characteristic parameters such as journey times and time, speed of movement of means of manipulation, use of employees' working time, etc. The above-mentioned characteristics can be further applied within the process analysis used for detailed graphical material flow analysis. This article is part of the research project VEGA 1/0286/16 - Management of Changes Based on a Process Approach. The research, which was carried out in 2017, addressed 508 enterprises from different sectors of the economy of the Slovak Republic. Research was focused on identifying ways to use methods and tools to improve the quality and performance of business processes. The partial result of the project was that in the wood-processing industry, approximately 15% of the interviewed enterprises used process maps and about 4% flow charts focused on process analysis and optimization. Compared, for example, with the automotive industry, this is 10% less when using a process map.

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THE IMPACT OF THE SELECTION OF THE PERIMETER WALL OF A FAMILY HOUSE ON THE ASSESSMENT OF THE LIFE CYCLE AND ITS COSTS

Debnár Marek, Jochim Stanislav, Štefko Jozef, Potkány Marek

ABSTRACT

The paper is aimed at assessing the reference building of a family house with two types of perimeter walls: timber frame house and brick house. The reference building was designed according to the realized questionnaire survey and represents the ideas of potential customers of the construction of a family house. The goal was to evaluate the lifecycle of the house according to the design of two types of perimeter walls. Other parameters of the building were considered constant for both house solutions. We used the Envimat, software tool to evaluate the life cycle impact assessment with using available methods and input materials databases like an Ecoinvent. Both versions were also evaluated in terms of life cycle cost.

Keywords: life cycle costing, life cycle assessment, wooden house, perimeter wall

1. INTRODUCTION

Mortgage loans for own housing are currently most affordable in the era of independence of the Slovak Republic (NBS, 2017). Many people choose to invest in housing solutions in the form of a family house, because housing prices are relatively high, which has also resulted in a boom in mortgage lending. A potential investor asks how to secure their own housing. Alternative is a classic form of silicate construction or wood-based construction. Market share of timber constructions in Slovakia has increased from 2% to 10% in the last 15 years (Šuštiaková, 2016). It clearly shows the rising trend of interest in this type of construction. In the evaluation of the objective decision which type of family house to choose to enter into considerably economic aspects. According to (Pelzeter, 2007), Life Cycle Cost Analysis (LCC) can provide real information on the preference of individual building technologies for the construction of family houses exclusively from an economic point of view throughout their life cycle. The ecological side is also very important. To what extent is it necessary to deal with the construction of a house in terms of environmental impact, the ISO 14 040 and 14 044 standards describes in detail the methodological approach to use the Life Cycle Assessment (LCA) to assess the environmental impacts of the family life cycle building. An important aspect of the life cycle assessment of a building is therefore the economic and environmental aspects that need to be assessed in their synergies. The aim of the paper is to assess the reference building of the family house with two types of perimeter walls: timber frame house and brick house. The reference building was designed according to the questionnaire survey and represents the ideas of potential customers of the construction of the family house (Debnár and Potkány, 2016). The assessment of the life cycle of the house is solved partly due to the selected element of the building in two designs of the types of perimeter walls. Other parameters of the building were considered constant for both house solutions. We used the LCA, Envimat software tool with ecoinvent database to evaluate the life cycle impact assessment using available methods and input materials databases. Both versions were also evaluated in terms of lifecycle costs.

2. MATERIALS AND METHODS

The reference house (tab.1) and its parameters were determined on the basis of a survey which was processed in the form of a questionnaire. The questionnaire was implemented in 2017 and answered by 621 respondents. The reference building design (RB) took into account the preferences of the respondents. We have designed the reference building of the house using two different building systems. One is wood as the main building material. In this case, it is a wood building. In the latter case, the main building material is brick, which is a silicate structure. In both constructions (wood and brickwork porotherm), the constant elements of the house are considered, which were considered identical and therefore not included in the analysis. These are: base plate, windows and entry door, 1st floor structure and roof construction type. The calculation of the timber construction was carried out by the company Drevodom Zvolen and the calculation of the brick construction by ABC building company.

Table 1. General information on the houses

	Wooden house	**Brick house**	**Source**
Base plate area (m^2)	92 (11.5 x 8)	92 (11.5 x 8)	Disposition of RB
Usable floor area (m^2)	157	147	Questionnaire survey (QS)
Household size (no. of people)	4-5	4-5	QS
Number of bedrooms	4	4	Disposition of RB (QS)
Number of floors	2	2	Disposition of RB (QS)
Construction type	Timber frame construction	Porotherm – clay bricks	QS
Type of roof	saddle roof	saddle roof	Disposition of RB (QS)
Heat transfer coefficient for external wall U[W/m^2K]	0.15	0.15	Fragment 5.0 software

2.1. Life cycle costing and life cycle assessment

The LCC analysis methodology is used to interpret the comparison of two different building alternatives. It takes into account the time factor and also the total life cycle costs. This methodology, known as Life Cycle Costing, is basically a summary of all expenditure and costs associated with the building that are determined by standard economic calculations at the present value (Aguacil et al., 2017 and Becchio et al., 2015). The determination of lifecycle length is rather complex (Mortensen, 2013, Nerotsa, 2016 and Niemila, 2017). The standard specifies the basic procedures, but when determining the life cycle of a complex product such as family house construction, where elements with different lifespan and moral wear occur, it must be sensitively approached so that the results are not distorted. How far we analysed the life cycle costs presented (Figure 1).

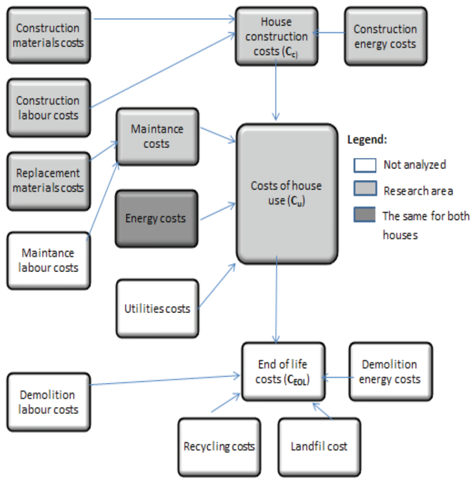


Figure 1. System boundaries and the costs in the life cycle of the houses (Bull,2015)

The total life cycle costs of a house comprise the costs of construction, use and end-of life waste management and are calculated as follows (Bull, 2015):

$$\mathbf{LCC = C_C} + C_U + C_{EOL}$$

Where:

LCC – total life cycle costs of a house
C_C – costs of house construction
C_U – costs in the use stage of the house
C_{EOL} – costs of end-of-life of the house

The construction costs C_C comprise the costs of the production and transport of construction materials as well as the labour and energy costs for the construction of the house and of course producer’s profits. The costs incurred in the use stage comprise the costs of energy for space and water heating, lighting, cooking and domestic appliances as well as the costs for water and waste water treatment. Maintenance costs during its service life are also considered and include cost of labour, materials, energy and transport associated with the replacement of windows, doors and floor covering. In addition to the costs, there will be some revenue from selling the construction waste for reuse or recycling for which the system should be credited. However, due to a lack of data, this is excluded from the study. All the costs represent overnight costs, i.e. as if incurred at present time for all the life cycle stages so that no discounting is applied. This is for two reasons. First, the economic performance of the houses is expressed in cost rather than financial-value terms. Second, one of the aims of this chapter is to identify cost hot spots in the life cycle of houses and related improvements, which would be applicable and carried out in the present time rather than in the future. However, the influence of more volatile costs such as energy on the total LCC is analysed as part of the sensitivity analysis as suggested by ISO 15686-5.

The environmental aspect will be evaluated for environmental impacts by the methodology of ISO 14 040 and 14 044 Life cycle assessment of reference building analysis. LCA is an (Wu, 2017 and Yi, 2016) approach that examines environmental aspects and the impacts of the product throughout its life cycle, from the acquisition of raw materials, through the production, realization and disposal of production waste to the environment (Fig. 2). The observed impacts will be compared for the alternative of the wood-based and silicate construction in the range of the perimeter walls. We used the software Envimat to make use of the available input methods and databases to evaluate the life cycle impact assessment. For the assessment of building materials LCA calculations we need information that is in the catalogues of environmental profiles of building materials and structures. This information differs for each country or region, the nearest Czech EnviMat catalogue is updated in 2015. The analyses needed to identify the necessary properties according to ISO 14 040 and are summarized in the Environmental Product Declaration (ISO 14 025), which is a condition certification and classification of the material or product in the EnviMat catalogue or similar database (Pifko, 2013).

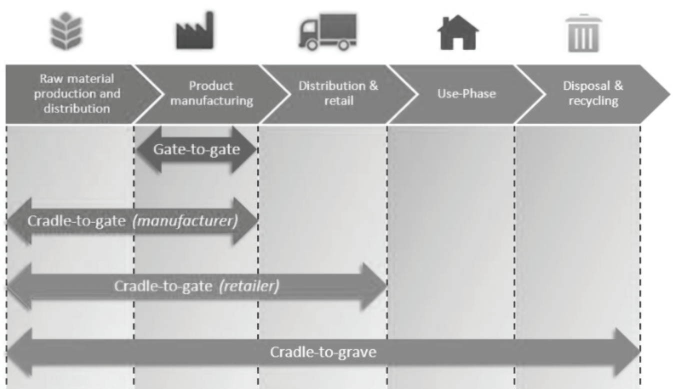


Figure 2. System boundaries of LCA, source: lcaboundaries.com

Based on the available manufacturer databases that mostly declare the impact only on a certain life cycle stage, we have chosen the LCA cradle-to-gate system boundary for simplicity. By linking the results of both analyses, we evaluate the economic and environmental benefits of both alternatives.

2.1.1. Specification wall of brick house

In the case of silicate construction, the majority of respondents stated that the main supporting element of the building of the family house will be brick. Thus, a brick with a thickness of 300 mm was used in the perimeter wall (Figure 3). The building is insulated with a 100 mm mineral wool contact system. A façade acrylic coating resistant to cold, rain, and also sunlight is applied to the insulation. From the interior, a structured plaster is applied to the lime-based interior to a thickness of 12 mm. The specification of the properties of the materials used is described in Table 2.

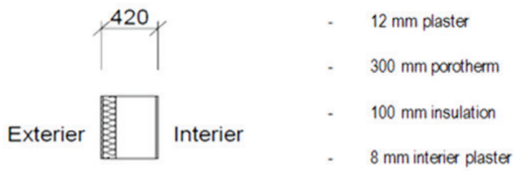


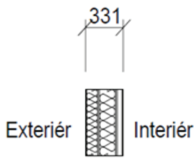
Figure 3. External wall of brick house

Table 2. Specification of external wall of brick house

	Material	Density ρ_d [kg/m^3]	Thermal conductivity [W/(m.K)] Declarated by producer	Heat Capacity c [J/(kg·K)]	Diffuse resistance factor μ [1]	Source
1.	Baumit GranoporTop acrylate plaster	0,0018	0,7	1020	110	Technical inforrmation Baumit
2.	ISOVER CLIMA 034 – Rockwool insulation	148	0,034	1030	1	STN EN 12667
3.	Brick Porotherm 30 Profi	800	0,155	1000	5	Technical inforrmation Porotherm
4.	Baumit KlimaDekor-interier plaster	0,0017	0,7	1020	5	Technical inforrmation Baumit

2.1.2. Specification wall of timber frame house

For wooden house, we chose the timber frame type of construction (Figure 4), namely the panel construction system. The main supporting element is the 60/140 mm wooden pillars axially spaced 625 mm. In the perimeter walls from exterior side is the HDF board has a thickness of 15 mm, which meets the parameters of diffusely opened moisture-resistant fibreboard. A 100 mm thick mineral wool thermal insulation system is installed on the HDF board where the façade acrylic plaster is resistant to adverse climatic conditions. Inside the interior is a pillar structure covered with a 15 mm OSB 3 board, which is joined by a perforating. OSB 3 boards are also suitable for wet environments. Before the OSB 3 board are a 40/60 mm internal battens that serves to guide the electrical installation. The space between internal battens is not filled with mineral wool. From the interior is 12.5 mm thick plasterboard. In a room with increased humidity, plasterboard is more resistant to moisture from the interior. More detailed specifications of the materials used are described in Table 3.



- 12.5 mm plasterboard - gypsum
- 40 mm air gap
- 15 mm OSB 3
- 140 mm mineral wool in construction
- 15 mm HDF
- 100 mm mineral wool Isover clima – external
- 8 mm exterier plaster

Figure 4. External wall of timber frame house

Table 3. Specification of external wall of timber frame house

	Material	Density ρ_d [kg/m^3]	**Thermal conductivity [W/(m.K)] Declarated by producer**	**Heat Capacity** c **[J/(kg·K)]**	**Diffuse resistance factor** μ **[1]**	**Source**
1.	Plasterboard - gypsum RBI 12,5 mm	680	0,21	960	6-10	Technical inforrmation - Rigips
2.	Service cavity	420	-	-	-	-
3.	Rockwool insulation	148	0,034	1030	1	STN EN 12667
4.	OSB3 Oriented Strand board	600	0,13	1700	200/150	Technical inforrmation - Egger
5	Timber frame construction	420	-	-	-	-
6.	Rockwool insulation in construction	148	0,034	1030	1	STN EN 12667
7.	HDF, 15 mm High Density Fiberboard	625	0,1	1700	11	Technical inforrmation - Egger
8.	Thermal insulation (outer)- ISOVER CLIMA 034	148	0,034	1030	1	STN EN 12667
9.	Baumit GranoporTop acrylate plaster	0,0018	0,7	1020	110	Technical inforrmation Baumit

3. RESULTS AND DISCUSSION

From the comparison of the impact of the perimeter walls of the family house in the selected wall structure we can state that the analysed life cycle costs are 7% lower in favour of the brick house in 30 years horizon (fig.5). With the same thermal and technical properties, the wall thickness of the wooden house is 90 mm thinner, which increases the useful area of the house by almost 10 m^2. Therefore, costs were also calculated on 1 m^2 of floor space. The environmental impact of the perimeter walls is expressed on m^2 of the perimeter wall area. We can conclude that in all the criteria being compared, the impact on the environment was lower of the wood-based perimeter wall, as shown (Table 4).

Table 4. Results of environmental impact of perimeter wall for both alternatives, source: envimat

Criteria / Envimat	Outside Wall of Timber frame house	Outside Wall of Brick house	Unit
Primary energy input for production (PEI)	635.027	882.635	[MJ·m^{-2}]
Global Warming Potential (GWP)	37.52	78.6855	[kg CO_2 eq. m^{-2}]
Acidification Potential (AP)	142.06	194.682	[g SO_2 eq. m^{-2}]
Eutrophication Potential (EP)	53.266	54.868	[g $(PO_4)^{3-}$ eq. m^{-2}]
Ozone Depletion Potential (ODP)	0.00244738	0.00517956	[g R-11 eq. m^{-2}]
Photochemical Ozone Creation Potential (POCP)	13.7867	18.9339	[g C_2H_4 eq. m^{-2}]
Density (p)	199.892	664.762	[kg·m^{-3}]
Basic weight	64.06	279.20	[kg·m^{-2}]

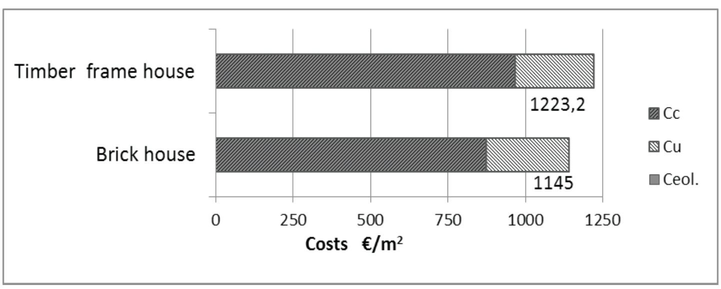


Figure 5. Results of partial LCC analysis for both alternatives

4. CONCLUSION

The analysis was performed partially and does not show the overall impact of the construction from a lifecycle perspective. The results of the paper show that the life cycle costs are 7 % higher for the wood-based construction, but the environmental impact of the perimeter walls is lower. This fact in favor of silicate construction could be mitigated in the future by a forthcoming legislation that would favor this type of construction by subsidy.

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DEVELOPMENT OF MULTI-STOREY TIMBER BUILDINGS IN EUROPE AND US

Manja K. Kuzman[1], Eva Haviarova[2]

ABSTRACT

Extensive research has shown that material-neutral buildings are on the rise. For over a decade, function-based regulations have been common in many European countries and this contributed to an increase of multi-storey timber buildings. This paper gives an overview of some characteristic modern timber buildings in the Europe and the USA, as well as the different construction techniques being used. Successful initiatives supporting the use of timber for building construction are also presented. The opportunities for the further development of sustainable timber constructions lie in new production methods, high prefabrication, energy-efficient and climate-effective architecture and economic feasibility. Strong partnerships, increased responsibilities for planning, improved and systematic feedback of experience, team cooperation, and knowledge of user's preferences, are also important components of successful building project. There is a great market potential for the use of wood in all types of buildings, employing a combination of digital design as flexible planning and design tools in combination with CNC processing, to design and build extraordinary projects.

Key words: Architecture, timber construction, digital design, wood processing

1. INTRODUCTION- WOOD STRUCTURES THROUGH HISTORY

Up to the 19th century, wood was irreplaceable as the most important fuel and raw material for all types of construction. However, due to large city fires in Europe, fire protection measures including legislative measures were introduced in several European countries during the late 19th century to discourage or restricted the use of timber frames for the construction of multi-story buildings. Multi-story constructions of wood are not a new invention. In Japan, there is the more than 1400 year old Buddhist temple complex Hōryū-ji, including a five-story pagoda, with a height of 32 meters and approximately 20 x 20 meters in the basal area. Dendrochronological analysis helped to estimate that the wood used in the central pillar of the pagoda have been felled in 594, so this should be one of the oldest wooden buildings in the world (Figure 1).

The construction of multi-story wood-framed buildings was re-introduced in the early 1990s in several western European countries. Many countries refrained from using flammable materials because of uncertainty about fire risks in the buildings. This helped the concrete industry to dominate the building market in Europe, particularly in Central

Europe with a market share of 70-80% (Winter, 1995). In the early 21st century, less than 10% of one- and two-family houses in Germany, France or the Netherlands were built with wood, but more than 85% of such houses in Nordic countries (Eliasson et al., 2015). However, extensive research has shown that material-neutral building regulations are preferable and, for over a decade, function-based regulations have been common in many European countries. This has resulted in a considerable increase in wooden multi-storys buildings (Markströom, 2018).

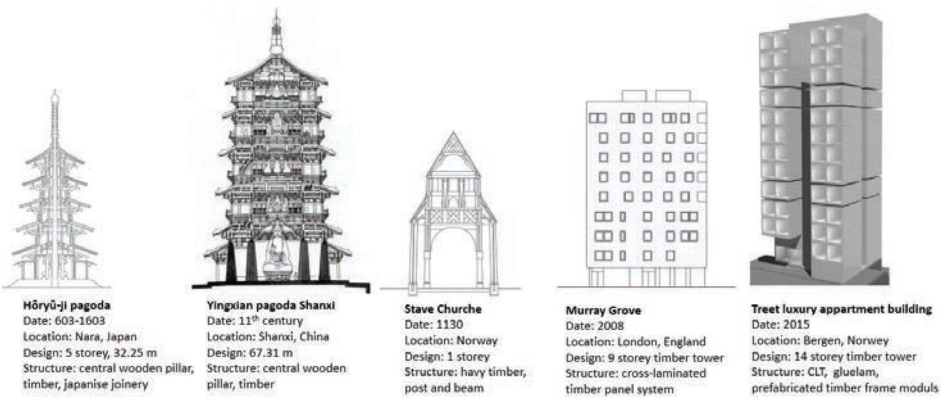

Figure 1: Examples of wooden structures throughout the history

In the USA, use of light timber frame construction is very common, mainly in residential buildings. Only recently, era of wooded multi-story buildings is gaining momentum with fast development and use of engineering materials, such as cross-laminated timber (CLT) and nail-laminated timber (NLT).

1.1. Development of modern multi-story buildings–wooden “skyscrapers

In the late 1980s, a construction product directive from the European Commission stipulated functional based requirements for the use of products in building construction with the aim to remove technical barriers to trade in construction products between member states in the European Union (Schickhofer, 2013). This means that any material, wood, concrete or steel, that fulfils the functional requirements as specified in the national building regulations can be used for the construction of multi-family buildings. It has been nearly three decades since this European Commission construction product directive was issued, but the use of wood frames in the construction of multi-story buildings is still low, even in the Nordic countries where it is about 10% of new multi-story buildings.

Modern building regulations have however contributed to an increase in the construction of multi-story timber buildings of up to eight storys (Kitek Kuzman et al., 2018) (Table 1, Figure 2).

Table 1.Present stage and future suggestions for multi-story buildings–wooden "skyscrapers".

1995 - 2005	3-5 story buildings
2008	8-storey tenant-owned apartments, *Växjö*, Sweden
2009	9-storey tenant-owned apartments, L*ondon, UK*
2011	7-storey multi-family house, Berlin, Germany
2012	8-storey tenant-owned apartments, Bad Aibing, Germany
2013	9-storey apartment building, Milan, Italy
2013	10-storey building in Melbourne, Australia
2014	14-storey apartment building, Bergen, Norway
2018	24-storey building HoHo, Vienna, Austria
2020?	30-storey building, Canada
2025?	34-storey building, Stockholm, Sweden
?	80-storey building, London, UK

The increase can be attributed to several important factors such as a lower cost of building compared with wood than with other materials, and advantages of using wood in industrial building, together with a growing environmental awareness, where the choice is motivated by the fact that wood is a renewable material and that its use reduces CO_2 emissions, provided that the timber is harvested in forests where sustainable forestry, with replanting and management plans, is practiced.

Although the development and implementation of timber constructions in multi-story buildings is on different levels in different European countries and in North America, the trend towards an increasing use of wood is clear. The main reasons are that wood used for building is renewable and locally available; it is beautiful, sensuous and has superb technical characteristics. Timber construction leads the way in terms of energy-efficient building. Many responsible contractors, architects and businesses now choose a timber construction because of its efficient use of both resources and money (Figure 2).

1 2 3

Figure 2. 1: Treet 14-storey apartment building, Bergen, Norway, 2: 24-storey building HoHo, Vienna, Austria, 3: 30-storey UBC building Vancouver, Canada

In the USA, a 12-story mixed-use project in Portland, Oregon, is in the process of construction and will be the tallest all mass timber high-rise building in North America. This project is intended to demonstrate that timber buildings of this scale are feasible. There are few more positive attributes of this building: first high-rise building with wood from ground floor, as the load-bearing construction; first high rise building with exposed wood; first project carrying out fire tests on exposed glulam connections, CLT and glulam beam-floor assembly. Seven story high T3 office building in Minneapolis is another exemplary large mass-timber structure. Structures like these are positively disrupting traditional construction. They are considered because of high labor cost, labor scarcity, high foundation cost, construction scheduling, and availability of sustainable material (Figure 3).

Figure 3: Multi-story building in the process of construction in Portland, Oregon, USA and T3 office building, Minneapolis, USA

2. CHALLENGES FOR FURTHER DEVELOPMENT MULTI-STOREY BUILDINGS – WOODEN "SKYSCRAPERS"

Although the trend is clear, there are still several technical problems to be solved before timber is again the major construction material in multi-story constructions. The main areas for further development are:

Fire protection: It has taken a long time to solve fire requirements in the initial projects. The impression is that the authorities involved were not used to interpret legislation as it applies to higher timber-framed residential buildings.

Sound proofing: Insulation against noise transmission in timber buildings is another issue which requires further research to ensure a high-quality living environment.

Prefabrication of elements: Construction time most be reduced and quality improved through off-site prefabrication.

Installations: Installations should be integrated into the framework to a greater extent than today. A greater extent of prefabrication has been requested to avoid extensive subsequent installation work at the construction site.

Weather protection during the construction period should be specified at the planning stage and quality assured with flexible protection. Experience shows that protection by tents with overhead travelling cranes is a great benefit not only for a dry structure, but also for the work environment. The speed and ease with which the height can be increased is extremely important (Kitek Kuzman and Sandberg, 2018).

Exterior façade maintenance: The cost of façade maintenance throughout the life cycle in relation to the cost of investment requires further monitoring. There is a risk that short-term decisions will create additional costs in the long term.

2.1. A Combination of visible wood, digital design and advanced processing as future trends

The development potential and obstacles in multi-story building is employing a combination of digital design and computer numerical control (CNC) processing. The construction engineers know-how to make use of the digital tools; they have geometric imagination capabilities and construction know-how while the architects have ambitious ideas for building extraordinary projects.

Digital design and production using CAE (computer-aided engineering), CAD (computer-aided design) and CAM (computer-aided manufacturing) have allowed timber construction to evolve into new design dimensions. Innovative connections, modern wood-based materials and cutting-edge CNC milling offer entirely new possibilities to shape wood into almost any conceivable form. Nowadays, there are flexible planning-design tools and CNC processes that allow us to design and build extraordinary architectural structures (Figure 4).

Figure 4. 1: The wooden Wave as a free Form, Kristiansand, Norway,
2: Tamedia office building in Zürich, Switzerland, 3: The Yeoju golf clubhouse, Koreya,
4: Aspen Art Museum, USA

Advanced timber structures save money at the construction site because they allow exact planning and quick assembly as a result of prefabrication. This is also an economic benefit for builders when the time between new construction and rental is short. For investors, it is important that advanced financing and the marketing of the property take less time and are accompanied by assured on-time completion. One of the main advantages of a modern production concept, in-factory rather than on-site, for timber structures is that the construction method is primarily dry, and there is a reduced risk of damage to the structure as a result of moisture.

3. CONCLUSION

A transition from traditional building practices to multi-story timber buildings depends on several factors. Many different players such as architects, consultant engineers, constructors, contractors, subcontractors, and suppliers are involved in the processes of design, engineering, construction, material supply, and activity coordination. The action of these actors, their beliefs and perceptions, knowledge and skills, and above all the institutional setup influence the development of construction systems.

Timber multi-story building in recent years has gathered momentum in European countries and gaining importance in other parts of the worls. Construction of the first experimental buildings was completed and today the trust in new multy-story timber buildings is growing. The number of projects, quality and importance, as well as the rising interest from different groups and customers show this trend. The reasons are two: economy and ecology. European timber multi-story building is progressing with regard to building performance, construction methods and building costs. It is becoming increasingly widespread in Europe, and the number, quality and types of timber buildings indicate the progress towards their becoming a common construction practice in the middle-rise buildings. However, the use of wood for multi-story building construction varies widely among the European countries.

In the USA, emergence of tall wood buildings increases the anticipation of architectural transformation. Technologies such as cross-laminated timber (CLT) and nail-laminated timber (NLT) have enabled high-rise buildings to be built with positive environmental record but for many practical reasons this transformation will take some time. In general, positive aspects of wood as a structural material include its strength, environment-friendliness, simple handling and appropriateness for industrial use, but knowledge gaps in wood application have led to a reduction of its use by structural engineers and architects.

We see opportunities for further development and future trends in high prefabrication, partnership and increased responsibilities for planning and construction, the improved systematic feedback of experience and team cooperation. Demonstration projects are vital to show the various actors, e.g. the wood industry, architects and designers, builders, and housing associations, as well as technical and business potential of wood as a multi-purpose building material that should be used sensibly.

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INVESTMENT DECISION-MAKING USING CORRECTION METHODS OF RISK ANALYSIS IN BIOMASS

Martina Kánová, Josef Drábek

ABSTRACT

Paper is interested in investment decision-making in the production process related to biomass. Analysis and valuation was focused on construction of storage areas for storage of fuel wood and energy chips. Methodologically, indicators based on discounted cash flow for investment effectiveness valuation were used. We applied certainty coefficients at the level of correction of revenues. The discount rate was based on actual reports on average interest rates on loans in commercial banks. Results of the investment effectiveness analysis present that the project is effective and viable. Investment criteria and required capital appreciation are fulfilled. The project also has a good risk maneuver level, which in terms of project lifetime creates space for effective investment. Overall investment efficiency has been reduced by application of certainty coefficients, but the project also declares the required capital appreciation.

Keywords: Investments, Investment Effectiveness Valuation, Risk Analysis, Biomass, Slovakia

INTRODUCTION

Investment decision-makings should be regarded in each business entity as the crucial factor for its long-term prosperity. Acquired decision affects the performance of the company as well as its competitiveness in long time. If a competent investor has an interest to make qualified investment decision, it means that he must in decision respect primarily a time and risk factor. In the capital-intensive investment projects needs to pay attention to the risks that the preparation, realization and use of investment brings.

Potential for cost reduction represents the key to increasing the efficiency and economy of the business in each manufacturing enterprise. One way to reduce the energy costs of an enterprise is to use alternative renewable sources. Efficient use of available resources is also biomass, which is available in individual regions of Slovakia. Biomass is a major renewable energy source to replace fossil fuels to a great extent.

The paper aims to formulate a certain systematic approach to the handling of the risk associated with investing and investment decision-making with using of correction methods of risk analysis.

1. LITERATURE REVIEW

Within the investment and financial decision-making process, every business entity is interested in making the price of the wood chip as optimal as possible. The analysis of the production of the chips shows that the production of wood chips in its own direction, so in the undertaking concerned is economically the most advantageous. The production of wood chips, in its own right, eliminates a number of risks associated with the process of its production with suppliers, transport and storage. Of course, it is important to note that for each business, value added, profit, as well as the generation of a cash flow for the return of capital resources, rate of recovery of the capital invested.

Evaluation of projects - feasibility study, the present study differs from the preliminary study particularly with deep processing as well as financial and time demands. Basic filling of technical and economic study described for example Drábek and Polách (2008), Valach (2006), Scholleová (2009), Veber (2009) and others.

Based on practical experience, knowledge from projects implementation it can be concluded that the role of pre-investment phase is primarily to ensure precision and maximum completeness of the basic economic parameters of the project, which crucially affects the efficiency of investment. After completion of the decision-making process about the implementation of the project or the most suitable variant of the project, implementation phase occurs. Investment decisions (how much, to what, when, where and how to invest) belong among fundamental decisions, which greatly affect the future development of the company and its efficiency (Sujová, Hlaváčková and Šafařík, 2015).

Wood processing industry in Slovakia is influenced by the economic crisis causing stagnation in the construction industry and decrease in the customer demand for construction, woodwork and furniture products. Many companies are looking for different forms of cost savings (Vetráková, Potkány, Hitka, 2013).

Companies that provide production of energy from forest biomass basically address several issues:

a) ensuring raw material resources from the region (the gravitational area) for efficient energy production,

b) transport of raw materials,

c) efficient production of wood chips,

d) storage of wood chips,

e) an optimal energy production process,

f) optimization of capital expenditures for investment activity,

g) effective financing of the above-mentioned processes.

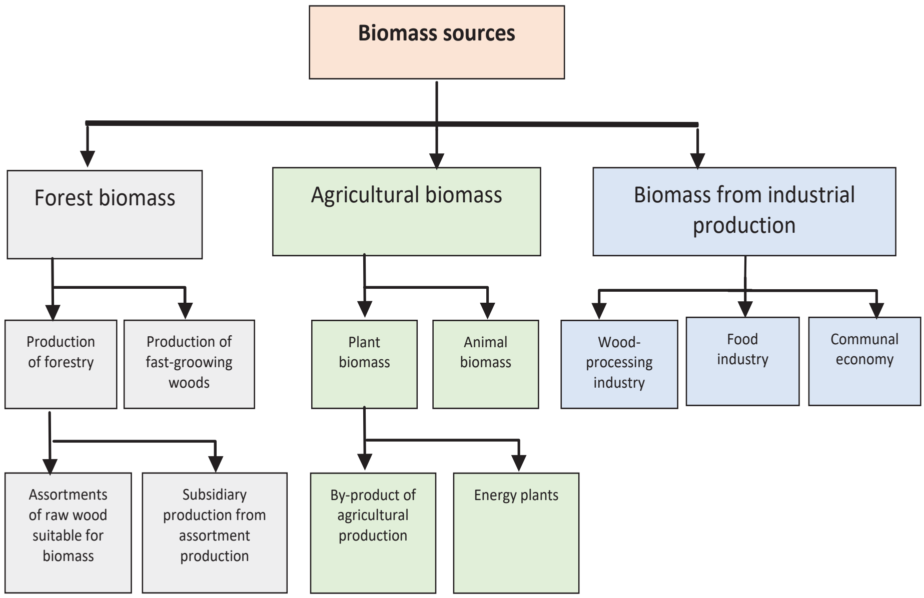

Figure 1. Sources of biomass from economics. Source: own

This process, resp. the stages of biomass energy production can be expanded, narrowed, depending on the availability of resources (raw materials, spatial, human, financial). However, the most important factor is the financial resources, as the process of producing wood chips and producing individual types of energy is financially the most demanding, in this process, there are the most types of risk factors that need to be fully accepted, respectively projected into the process of economic evaluation.

Two key issues at the enterprise level are:

- effective production of wood chips,
- optimization of capital expenditures on own energy production (investment intensity of technology).

More important than how much enterprises invested is income expected from those investments (Drábek, Jelačić and Merková, 2014). Insufficient development focused on competitiveness of wood-processing production and efficiency increasing, no solutions of the availability of financial resources for implementing of innovative plans could cause decreasing of competitiveness and long-term recession. The main reason for the negative status of the WPI is long-lasting unsolved problems.

As described Sujová et al. (2015), current policies of national governments prefer to provide for a high level of finalization of wood processing in the State of raw wood production. Just lack of investment is often the reason of low level of finalization and thus low added value creation in companies.

FDI may become the basis for the modernization of production facilities, the transfer of new technologies, know-how, creating healthy competition and more efficient to integrate our economy into the international division of labour, decreasing unemployment, growth of GDP (Merková and Drábek, 2010).

The terms of risk and uncertainty clearly defined and distinguished Frank H. Knight (*1921*). Both words refer to the indefinite future, but in a different way. At risk, we are able to describe the current situation and, on that basis, determine the probability of certain future events. With uncertainty the lack of information prevents us describe the current state and quantify the possible outcomes of our future decisions (*Baláž, 2009*).

Information about ambient positions and consequences of the decision alternatives is a fundamental classification aspect of decision-making processes. From this perspective are distinguished these types of decisions: under certainty, risk, uncertainty and indefinite conditions (*Varcholová and Dubovická, 2008*).

Risk is an integral component of business. Doing business is associated with prospects for particularly good economic performance on the one side, while on the other side it carries a threat of a failure bringing about losses, which may sometimes be so extensive that they substantially disturb the firm's financial stability and may even drive it to bankruptcy (*Merková, Drábek and Jelačić, 2013*).

In observations of economic effects, the concept of *risk* is interrelated with that of *uncertainty*. In certain conditions when nothing can be said with certainty about future situations and their occurrence because people have not encountered them so far, such situations are intuitively referred to as risky. Risk arises in situations when the result is uncertain, though the likelihoods of the different possible results are known or can be estimated. Uncertainty arises when an unknown result cannot be anticipated even with a certain likelihood; i.e. it refers to unforeseeable circumstances against which there is no protection in terms of known insurance principles.

2. MATERIAL AND METHODS

Individual approaches of economical effectiveness evaluation, their abilities, dynamic abilities and estimation on capital expenses and investment project income in whole, such as evaluation of influence of project realization on enterprise management and development could be used (more in Drábek, Jelačić, Merková, 2014). Appropriate **indicators were processed** and calculated, we decided to apply methods in the article presented in Tab. 1.

Table 1. Methods for investment effectiveness valuation used in the article. Source: own

Net present value (NPV):	NPV = CVCF – IC where: CVCF - current value of cash-flow IC - invested capital	(1)
	$CVCF = \frac{CF_1}{(1+k)^1} + \frac{CF_2}{(1+k)^2} + \frac{CF_3}{(1+k)^3} + ... + \frac{CF_n}{(1+k)^n}$ or $CVCF = \sum_{i=1}^{n} \left[CF_i / (1+k)^i \right]$ where: CFi - annual investment income during the project time of economic life cycle (estimated CF) k - discount ratio (measure) n - time of project life cycle	(2)
	$NPV_I = \sum_{t=1}^{n} \frac{CFi.I_k}{(1+r_f)^n} - IC.C_{CE}$ where: NPV1 - NPV reflecting the certainty equivalent coefficient Ck - certainty equivalent coefficient of each year's cash income rf - risk-free interest rate CCE - certainty equivalent coefficient of capital income CFi - expected revenues (cash flow) for the project's economic life IC - one-off capital investment (capital expenditure) t - project's life, t = 1, 2 ... k, ... n	(3)
Internal rate of return (IRR):	$IRR = d_1 + \frac{NPV_1}{NPV_1 - NPV_2}(d_2 - d_1)$ where: d1 - discount rate where NPV > 0 d2 - discount rate where NPV < 0 NPV1 - positive NPV, at discount rate d1 NPV2 - negative NPV, at discount rate d2	(4)
Profitability index (PI):	PI = CVCF / IC where: CVCF- current value of cash-flow IC - invested capital	(5)
Discounted payback period (DPP):	$DPP : \sum_{i=1}^{DDS} \frac{CF_i}{(1+k)^i} = IM$ where: CFi - annual investment income during the project time of economic life cycle (estimated CF) k - discount ratio (measure)	(6)

The determination of the discount rate with a risk margin can be expressed mathematically as follows: When the updating rate "i" (time premium) is a risk-free rate and the risk rate "k" is a rate comprising the updating rate and the risk (i+r), the risk coefficient (α) will be given as:

$$\alpha = \frac{(1 + i/100)^t}{(1 + k/100)^t} \quad (7)$$

The certainty coefficients were applied into the basic variant of net cash flow analysis by correction of revenues, at the level of 0.98-0.86 during whole lifecycle of the investment project.

The interest (discount) rate was based on the official statistics of the National Bank of Slovakia (NBS): Based on the reports on average interest rates on loans in commercial banks denominated in euro, data as of January 31, 2018, category of new business (the period January 01 – 31, 2018, taken into account non-financial corporations), initial interest rate fixation for the category of other loans over 5 years: 3.67%.

Corporate income tax rate in Slovakia at the level of 21% and funding 5% for the most often used legal form – Ltd. company was used.

For calculation, numerical and graphical presentation of the results we used the program MS Office Excel and software Statistica12 from StatSoft, Inc.

3. RESULTS AND DISCUSSION

Results are interested in presenting a possible way of securing the needs of the production process related to biomass, wood chips and wood chipping machine.

We applied correction methods, certainty coefficients as well as discounted cash flow methods for investment effectiveness valuation described in methodology.

Characteristics of planned investment **- construction of storage areas for storage of fuel wood and energy chips** are following:

- Fuel storage volume per year: 150 000 m3
- Storage capacity of the energy chips per year: 50 000 m3
- Covered storage capacity: fuel wood: 9 000 m3
- Capacity of sheltered warehouse: 1 400 m3
- Capital expenditure: € 390 000, D&A linear, 20 years (lifetime for the building)
- Expected lifetime of the investment project: 15 years
- Project financing from Equity: € 150 000,
- Project financing from Debt.: € 240 000, payback period 8 years, interest rate = 3.67%
- Estimated annual revenues: € 164 000
- Expected annual costs without D&A and Interests: € 91 500

Table 2. Evaluation of storage economic efficiency – Var.1. (Base). Source: own

Indicator (€) / Year	**1**	**2**	3	4	5	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Revenues	**164 000**	**164 000**	**164 000**	**164 000**	**164 000**	**164 000**	**164 000**	**164 000**	**164 000**	**164 000**	**164 000**	**164 000**	**164 000**	**164 000**	**164 000**
Costs	91 500	91 500	91 500	91 500	91 500	91 500	91 500	91 500	91 500	91 500	91 500	91 500	91 500	91 500	91 500
D&A	19 500	19 500	19 500	19 500	19 500	19 500	19 500	19 500	19 500	19 500	19 500	19 500	19 500	19 500	19 500
Interest of Debt.	8 808	7 707	6 606	5 505	4 404	3 303	2 202	1 101	0	0	0	0	0	0	0
Earnings before tax (EBT)	**44 192**	**45 293**	**46 394**	**47 495**	**48 596**	**49 697**	**50 798**	**51 899**	**53 000**	**53 000**	**53 000**	**53 000**	**53 000**	**53 000**	**53 000**
Income tax (21%)	9 280	9 512	9 743	9 974	10 205	10 436	10 668	10 899	11 130	11 130	11 130	11 130	11 130	11 130	11 130
Earnings after tax (EAT)	**34 912**	**35 781**	**36 651**	**37 521**	**38 391**	**39 261**	**40 130**	**41 000**	**41 870**	**41 870**	**41 870**	**41 870**	**41 870**	**41 870**	**41 870**
Funding (5%)	1 746	1 789	1 833	1 876	1 920	1 963	2 007	2 050	2 094	2 094	2 094	2 094	2 094	2 094	2 094
Disposable profit	33 166	33 992	34 819	35 645	36 471	37 298	38 124	38 950	39 777	39 777	39 777	39 777	39 777	39 777	39 777
D&A	19 500	19 500	19 500	19 500	19 500	19 500	19 500	19 500	19 500	19 500	19 500	19 500	19 500	19 500	19 500
CASH FLOW	**52 666**	**53 492**	**54 319**	**55 145**	**55 971**	**56 798**	**57 624**	**58 450**	**59 277**	**59 277**	**59 277**	**59 277**	**59 277**	**59 277**	**59 277**
Loan payment	30 000	30 000	30 000	30 000	30 000	30 000	30 000	30 000	0	0	0	0	0	0	0
NETT CASH FLOW	22 666	23 492	24 319	25 145	25 971	26 798	27 624	28 450	59 277	59 277	59 277	59 277	59 277	59 277	59 277
Discount rate (3,67%)	**0.96460**	**0.93045**	**0.89751**	**0.86574**	**0.83509**	**0.80553**	**0.77701**	**0.74951**	**0.72297**	**0.69738**	**0.67269**	**0.64888**	**0.62591**	**0.60375**	**0.58238**
Present value of Cash Flow	**50 802**	**49 772**	**48 752**	**47 741**	**46 741**	**45 752**	**44 775**	**43 809**	**42 855**	**41 338**	**39 875**	**38 463**	**37 102**	**35 788**	**34 521**
Present value of Cash Flow Total	**648 086**														
Net Present Value (€)	**258 086**														
Profitability Index	**1.66**														
Internal Rate of Return (%)	**11.67**														
Payback period (years)	**8.28**														

Table 3. Evaluation of storage economic efficiency – Var.2 (Certainty coefficients). Source: own

Indicator (€) / Year	**1**	**2**	3	4	5	**6**	**7**	**8**	**9**	**10**	11	12	13	14	15
Revenues	**164 000**	**164 000**	**164 000**	**164 000**	**164 000**	**164 000**	**164 000**	**164 000**	**164 000**	**164 000**	**164 000**	**164 000**	**164 000**	**164 000**	**164 000**
Certainty coefficient	**0.98**	**0.98**	**0.98**	**0.95**	**0.95**	**0.95**	**0.92**	**0.92**	**0.92**	**0.89**	**0.89**	**0.89**	**0.86**	**0.86**	**0.86**
Adjusted Revenues	**160 720**	**160 720**	**160 720**	**155 800**	**155 800**	**155 800**	**150 880**	**150 880**	**150 880**	**145 960**	**145 960**	**145 960**	**141 040**	**141 040**	**141 040**
Costs	91 500	91 500	91 500	91 500	91 500	91 500	91 500	91 500	91 500	91 500	91 500	91 500	91 500	91 500	91 500
D&A	19 500	19 500	19 500	19 500	19 500	19 500	19 500	19 500	19 500	19 500	19 500	19 500	19 500	19 500	19 500
Interest of Debt.	8 808	7 707	6 606	5 505	4 404	3 303	2 202	1 101	0	0	0	0	0	0	0
Earnings before tax (EBT)	**40 912**	**42 013**	**43 114**	**39 295**	**40 396**	**41 497**	**37 678**	**38 779**	**39 880**	**34 960**	**34 960**	**34 960**	**30 040**	**30 040**	**30 040**
Income tax (21%)	8 592	8 823	9 054	8 252	8 483	8 714	7 912	8 144	8 375	7 342	7 342	7 342	6 308	6 308	6 308
Earnings after tax (EAT)	**32 320**	**33 190**	**34 060**	**31 043**	**31 913**	**32 783**	**29 766**	**30 635**	**31 505**	**27 618**	**27 618**	**27 618**	**23 732**	**23 732**	**23 732**
Funding (5%)	1 616	1 660	1 703	1 552	1 596	1 639	1 488	1 532	1 575	1 381	1 381	1 381	1 187	1 187	1 187
Disposable profit	30 704	31 531	32 357	29 491	30 317	31 143	28 277	29 104	29 930	26 237	26 237	26 237	22 545	22 545	22 545
D&A	19 500	19 500	19 500	19 500	19 500	19 500	19 500	19 500	19 500	19 500	19 500	19 500	19 500	19 500	19 500
CASH FLOW	**50 204**	**51 031**	**51 857**	**48 991**	**49 817**	**50 643**	**47 777**	**48 604**	**49 430**	**45 737**	**45 737**	**45 737**	**42 045**	**42 045**	**42 045**
Loan payment	30 000	30 000	30 000	30 000	30 000	30 000	30 000	30 000	0	0	0	0	0	0	0
NETT CASH FLOW	20 204	21 031	21 857	18 991	19 817	20 643	17 777	18 604	49 430	45 737	45 737	45 737	42 045	42 045	42 045
Discount rate (3,67%)	**0.96460**	**0.93045**	**0.89751**	**0.86574**	**0.83509**	**0.80553**	**0.77701**	**0.74951**	**0.72297**	**0.69738**	**0.67269**	**0.64888**	**0.62591**	**0.60375**	**0.58238**
Present value of Cash Flow	**48 427**	**47 482**	**46 542**	**42 413**	**41 602**	**40 795**	**37 124**	**36 429**	**35 737**	**31 896**	**30 767**	**29 678**	**26 316**	**25 385**	**24 486**
Present value of Cash Flow Total	**545 079**														
Net Present Value (€)	**155 079**														
Profitability Index	**1.40**														
Internal Rate of Return (%)	**9.18**														
Payback period (years)	**9.42**														

Based on the presented data and processed analysis performed in Tab. 2 and 3, we can state the following conclusions:

- Results of the investment project effectiveness analysis by the indicators of net cash flow present that the project is effective and viable.
- Evaluation of the project by the NPV, PI, IRR and DPP methods declares that the investment criteria are fulfilled and therefore the required capital appreciation at the level of 8 %.
- The project also has a good risk maneuver level, which in terms of project lifetime creates space for effective investment (IRR 11.67 %).
- The application of certainty coefficients shows that the overall investment efficiency has been reduced (IRR 9.18 %), but the project also declares the required capital appreciation.
- We recommend applying of the certainty coefficients, especially in order to reduce the overall risk of the project and thereby ensure the overall stability of the company.

CONCLUSION

The enterprise's investing activity affects all factors of the production process and extends over long periods of time. This is why investing inevitably involves the handling of risk. The paper aimed to formulate a certain systematic approach to the handling of the risk associated with investing. We have done a risk analysis to clarify the relevance of the factors and acceptability of risk, and identified options to reduce the risk to an acceptable level. Every business entity should take due regard the risk involved in investing and ensure that the risk is reflected in the investment efficiency evaluation in order to improve the investment decision-making process.

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AN OVERVIEW OF CROSS-LAMINATED TIMBER IN NORTH AMERICA

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ABSTRACT

Mass timber products, wood-based engineered construction materials, are becoming widely prevalent in the design and construction sector. Being a cost-effective, carbon efficient, durable, and sustainable building option, mass timber construction has already had a profound impact in residential and non-residential applications in Europe, and it has been reaching new heights in Canada, and recently gaining momentum in the United States. All architects, builders, designers, and forestry communities including the forest product industry, landowners, rural communities, and environmentalists have reason to be excited about these promising new timber products. Mass timber products are envisioned as substitutes for traditional building materials like concrete, masonry, and steel. The most widespread mass timber product is cross-laminated timber (CLT), which was first introduced in the early 1990s in Austria and Germany. It is currently on a rapid upward trajectory in North America. The main purpose of this article is to provide a brief overview of CLT and its market status and future prospects in North America.

Keywords: Cross Laminated Timber, Market, Mass Timber Products

1. INTRODUCTION

CLT is an innovative secondary wood product which has already proven to be a remarkable alternative to traditional building materials such as concrete and steel. The CLT concept is similar to plywood, except for the absence of veneer layers. CLT panels consist of odd number of layers (typically three to nine) of dimensional lumber stacked perpendicular to the adjacent layers and then glued together to form structural panels (Figure 1). With this orthogonal configuration, adjacent layers act as reinforcement of the entire panel, adding to dimensional stability, exceptional strength, and rigidity in both directions. CLT panels consist of only two materials; lumber and adhesive. While locally produced softwood lumber is primarily being used in the CLT panel manufacturing, some initiatives has recently explored a possibility of using underutilized hardwood in CLT manufacturing in the U.S. (JOC, 2017).

Over the last 30 years, CLT has been used for a wide range of applications in Europe and Australia, including single and multi-family residential buildings, schools, and office buildings. CLT panels are ready-to-use with lengths up to 60 feet and widths up to 10 feet (Crampton 2016), used in structural walls, ceilings and roofs. CLT panels are typically prefabricated with pre-cut designs for doors, windows, and stairs. As its strength is equivalent to concrete and steel to replace in multistory buildings, CLT has been used as both a standalone system in construction as well as hybrid applications with steel and concrete.

Figure 1. CLT Panel Layup and Finished Panel

1.1. Other Mass Timber Products

While CLT is the most common and widely accepted product globally, several types of mass timber products are available for architects, designers, and builders used in residential and non-residential construction. The various types of mass timber products include (Think Wood 2017; StructureCraft 2017) (Figure 2):

- Nail Laminated Timber (NLT): Similar to CLT, NLT panels are created from dimension lumber stacked on edge, but instead of glue, it is fastened with nails or screws to create a larger structural panel. Due to its variety of textured appearances, as a substitute for concrete slabs and steel decking, NLT is used in flooring, decking, roofing and walls, and even in elevator and stair shafts in mid-rise wood-frame buildings.
- Glue Laminated Timber (GLT or Glulam): Glulam is comprised of individual dimension lumber stacked parallel layers and then bonded together with durable, moisture-resistant adhesives. With its excellent strength and stiffness properties, GLT is typically used for beams and columns in residential and commercial construction.
- Dowel Laminated Timber (DLT): DLT panels are produced from softwood lumber and utilizing wooden dowels, instead of glues resins, nails or metal fasteners to form beams and panels. DLT is particularly best suited for horizontal spans in flooring and roofing applications due to its unidirectional grains structure.
- Mass Plywood Panel (MPP): MPP is similar to CLT, but it is constructed from large-scale plywood panels. It uses engineered veneer and custom plywood layups as a base material rather than lumber in other mass timber products. Freres Lumber Company in Lyons, Oregon manufactures MPP in the Northwest U.S.

Figure 2. Various Mass Timber Products

a. Nail-Laminated Lumber (NLT)

b. Glue Laminated Timber (GLT or Glulam)

c. Dowel-Laminated Lumber (DLL)

d. Mass Plywood Panels (MPP)

2. ADVANTANGES OF CLT

Wood is a material of choice for an ecologically and economically conscience design, the central theme of modern construction. No material serves better the needs and demands of green building. As presented in Table 1, mass timber products including CLT come with a series of environmental and economic benefits for construction and well-being.

The ability to sequester carbon from atmosphere is one of the major environmental advantages of using CLT over concrete and steel. While some carbon is released into the atmosphere during processing, wood stores and preserves carbon over the period of a lifetime, creating a significantly lower carbon-footprint than other building materials. In addition, lower greenhouse gas emissions and lower energy input required for the CLT panels manufacturing are other key benefits (Laguarda-Mallo & Espinoza, 2015). Furthermore, byproducts of CLT production, i.e. sawdust, can be converted to energy, further reducing the energy consumption.

Wood is generally perceived as an ideal material to create a healthy environment and to improve the wellbeing of occupants. In a recent study, Burnard and Kutnar (2015) described the restorative environmental design as a central aspect of wood construction to connect inhabitants to our natural environment. The opportunity to strategically expose the wood of CLT building elements helps create a more welcoming and healthy built environment. In many cases main raw material for CLT panels, wood can be sourced from underutilized forests locally. CLT usually presents the opportunity for utilizing lower-value wood resources, as its structural performance does not depend on the mechanical property of individual layers. With the creation of additional production sites, the environmental impacts of transportation can be further reduced. At the same time, the economic benefits can be kept in the local region with a broader prospect of economic development in terms of manufacturing jobs and new markets for forest landowners in rural timber regions.

Table 1. Benefits of mass timber products

Environmental	Low-carbon alternative to steel and concrete	Carbon sequestration	Renewable source with promising end of life prospective
Economic	Potential of local economic benefits	Reduced construction time and financing cost	Reduced labor requirements
Construction	Suitable for modular design concepts	High compatibility with traditional and innovative construction systems	High degree of pre-manufacturing for on-site assembly
Well-being	Wood is perceived to be healthy	Appealing and innovative	Compliance with emission goals

CLT is manufactured as a large panel, increasing the degree of prefabrication and reducing the construction time and installation costs, which eventually makes it a cost effective building material. Setup of pre-manufactured CLT elements is relatively simple and reduces the demands for machine, tools and labor at the job site. Steps to finish the exterior and interior of the structure can immediately proceed after installation of the panels. Additionally, CLT is lighter in weight than conventional steel and concrete construction, reducing the requirements and cost for appropriate foundations.

Other notable benefits of CLT include its performance against natural disasters like fire and earthquakes. With its effective lateral load resisting system, recent research studies reported that CLT perform exceptionally well with no residual deformation and ductility (Pei et al 2012). Similarly, CLT is found to act more like concrete and other non-combustible construction, and have the potential to provide excellent fire resistance. In some aspects, CLT has a better inherent fire resistance potential than a steel structure (Laguarda-Mallo and Espinoza 2015).

The design of modern construction never relies on a single material. Complementing, and in some cases reinforcing, a wooden structure with steel and concrete elements can help achieve higher degrees of functionality and stability. Deliberate utilization of concrete, combined with mass timber elements, can offset efforts and cost to regulate the temperature and relative humidity of indoor environments. Wood, and in particular CLT, helps to holistically address the challenge of balancing economic and environmental needs to create a truly sustainable environment with prosperity in the local scale.

3. CURRENT MARKET STATUS AND FUTURE PROSPECTS

Over the past 5 years, several on-going and completed construction projects have created a dynamic movement around mass timber products, in particular CLT. Descriptors such as sustainable, durable, and eco-friendly building material have positively influenced the markets for CLT and other mass timber products globally.

North America currently has seven active manufactures of CLT (Table 2). In Canada, Nordic and StructurLam are early CLT manufacture pioneers while Element5 and LEAF engineered Wood products have recently made inroads into the market. The other Canadian firm Structure craft produces Nail Laminated Timber (NLT) and Dowel Laminated Timber (DLT) and receives CLT from other sources and should be included as a player in the N.A. mass timber manufacturing market.

Table 2. Current and new entrants to Mass timber manufacturing in North America

Company Name	Year Established or CLT Certification	APA Certification	Mass Timber Products	Plant Location
Nordic Structures	2010	Yes	CLT, GLT	Chibougamau, Quebec
Structurlam	2012	Yes	CLT, GLT	Pentiction, British Columbia
Structurecraft		Yes	NLT, DLT	Abbatsford, British Columbia
Element5	2015	No	CLT, GLT	Ripon, Quebec
LEAF Engineerd Wood Products	2017	Yes	CLT, GLT	Delvin, Ontario
DR Johnson	2016	Yes	CLT, GLT	Riddle, Oregon
SmartLam	2016	Yes	CLT	Columbia Falls, Montana
Sterling Lumber		No	Industrial Matting	Phoenix, Illinois
International Beam	In progress			Dothan, Alabama
Katerra	In progress			Spokane, Washington
Vaagen Timbers	In progress			Colville, Washington
LignaCLT	Proposed			Maine
Smartlam	Proposed			Maine

The first certified CLT produced in the U.S. was supplied by DR Johnson Lumber Co., in Riddle, Oregon USA. In 2016, Smartlam in Columbia Falls, Montana, also started manufacturing structural CLT. Several new initiatives have been announced to add CLT capacity in the U.S. Katerra, a technology and construction firm is currently establishing CLT production in Spokane Valley, Washington. Production is planned to launch in 2018-2019. Also in the region is Vaagen Timbers who are building a facility in Colveille, Washington. International Beams, a manufacturer of I-Joists, is currently in the process of developing CLT production in their Dothan, Alabama facility; the first to use Southern Yellow Pine. It is expected to be ready for production in 2019-2020. Rather than using CLT as a building material, Sterling Lumber in Phoenix, Illinois, advertises CLT as a matting product. Other notable plans for increases in production are LignaCLT and SmartLam, which have publicly proposed to build facilities in Maine USA.

Due to the premature nature of the industry and sensitive business data available, production information regarding the CLT manufactures in North America is limited. In 2015 estimated N.A. Production capacity is 110 thousand cubic meters (m3) (Espinoza et all, 2015), and while recently the most through estimated global production of CLT is at 1 Million m3 (Muszynski et all 2017) Global CLT production in 2015 exceeded 620,000 m3, and it is expected to double by 2020 (Gatterer, 2017). The global CLT market is projected to be valued at $2.07 billion by 2025. Demand for CLT in North America was valued at $119 million in 2016, but is likely to become the second largest market in the world. Consumers are likely to prefer wood-based construction over concrete in the future, continuing to drive market growth. With the creation of numerous examples for commercial and residential projects, multi- and single story buildings, mass timber will occupy a significant space in the construction industry.

4. CLT STANDARDS

Over the last 10 years the product standard level, material design standard and building code acceptance have evolved along with the familiarity CLT and Mass timber products (Mohammad 2012). Starting in 2010 a Joint standard development process was initiated between Canada's FPinnovations and the U.S. APA- the Engineered Wood Association to develop a bi-national CLT standard for north America (Borjen 2012) Following this the official consensus based CLT certification for the North American, the ANSI/ APA PRG 320 was developed. This futher ensurs that the product maintains dimensions, tolerance, performance requirements, test menhods, and quality assurance and trademarkeing for CLT Panels (ANSI/ APA PRG 320-2018).

ANSI/ APA PRG 320 is reconized in the 2015 international building code (IBC), and international residential code (IRC) as well is required in the national design specifications for wood construction (NDS). Concurently in candada the standard is reconized by the 2015 national building code of canada (NBCC) and the Enginneering desing in wood (CSA O86-14) (APA 2016, Podesto 2016). Other references for product standards and perfomance ratings have been established and are growing quickly these resources include FPinovations, American Wood Council, CLT Handbook, Product Design guides, Think wood, WoodWorks and APA publications. A full list of product offerings and APA PRG 320 types can be found on their website (APA 2018). While major advances in product certifaction and quality improvmenets in manufacturing exsist, Standardizing CLT product sizes and dimentions still is a barieer and Architects and developers must refer to each manufacture's design guide specifications.

Local, state, national and international buidling codes for the acceptance of Mass timber is complex and broad in it's practice and application. In the pacific NW States specifically, Washington and Oregon have changed quickly while other states in the east are slower to adapt to these changes. Special state and local permitting acceptations are designed and accepted as a result of this and so projects have been accepted and built on a project by project basis. However, this takes a huge amount of time and effort to involve the whole project team and engineers to pass the permitting process (Oregons BEST 2017, Muszinzki et all. 2017)

Buidling codes and standards have responded quickly at a local and state level streamlined into architects, developers and engerneers minds to use the product more regulariliy. FPinnovations, American Wood Council, Thinkwood, Woodworks and Forest Products Labratory along with many Universities have been instramental in laying the foundation for resaerch and testing the applicability of CLT in the North American building codes. These groups offer tremendous amount of support for anyone interested in building with mass timber. As this product matures and becomes streamlined into urban development, 8 20 story buildings will need to become standardized building type recognized in the IBC and NBCC (Pei et all. 2016). In response to this In April 2018 votes to change the 2021 IBC code for the acceptance of mass time have been approved. This includes 14 Tall mass timber code changes, more importantly changes to break up Type IV building into separate categories (Type IVA, IVB, IVC and IVHT) based around fire performance, concealed spaces, structural components and loading. (AWC 2018).

5. KEY CHALLENGES TO CLT MARKET DEVELOPMENT

In recent years, research has solved many issues around CLT. Still today, there are some noticeable barriers in the establishment and expansion of the CLT market in the U.S. (Laguarda-Mallo and Espinoza 2015). While CLT currently meets building code requirements internationally for residential, commercial, institutional, and industrial facilities, they must be adopted by state and local building codes in the U.S. to become a standard building material. CLT is incorporated in North American building codes since 2015 as a heavy timber element. Similarly, although CLT has proven performance ratings against earthquake and fire, many consumers and construction professionals still question the risks associated with CLT buildings against seismic and fire hazards.

Even though early research and some pilot tests have clarified some questions on CLT's performance, current awareness and attitude of market participants toward CLT, building codes and permitting processes, seismic and fire testing needs, gaps in industry knowledge, product availability, and labor force are the noticeable barriers in the establishment and expansion of the CLT market in the U.S. (Espinoza et al. 2016; Oregon BEST 2017). The greatest barrier for CLT is reported to be its lack of availability in the marketplace (Mallo and Espinoza 2015). Similarly, lack of experienced and well-trained architects, builders, and designers keeps from extending its demand in the CLT market.

The construction industry has interest in using CLT, but existing wood-products manufacturers are still in the middle of a learning process to create additional production capacities. Pei et al. (2016) pointed out the necessity of a systematic educational infrastructure and timber design curriculum for modern timber engineering in the U.S. higher institutions.

While CLT currently meets building code requirements internationally for residential, commercial, institutional, and industrial facilities, they must be adopted by local building codes in the U.S. first, to become a standard building material. CLT is incorporated in the North American building codes since 2015 as a heavy timber element. Similarly, though some of the safety tests have nullified the myths about CLT's performance against earthquake and fire, many consumers and construction professionals still fear that CLT buildings are riskier to seismic and fire hazards.

It appears that most of these barriers are basically due to gaps in knowledge among all market participants (Schwarzmann, 2017; Oregon BEST 2017). Education covering the entire supply chain, including both, supply-side (CLT manufacturers) and demand-side (architects, builders) is needed to correct some of the outdated misinformation and myths about mass timber products. Creating skilled labor, particularly training architects, engineers, and developers, is quite crucial because only architects and engineers can design buildings efficiently and sustainably (Schwarzmann, 2017). More research and outreach activities are required to highlight the benefits of using sustainable building materials to reduce our carbon footprint and greenhouse emissions, and in the meantime to promote local forest product markets. More strategic activities including design and adoption education, workforce training, and marketing should be implemented to address these barriers to getting product to the market (Oregon BEST 2017).

6. CONCLUSIONS

The mass timber products industry, primarily led by CLT, is an emerging sector of the forest product industry in North America. It comes with a tremendous upside potential in both residential and non-residential construction in the U.S. Having several environmental as well as economic advantages over traditional building materials such as concrete and steel, it has gained momentum in both demand and supply in the U.S. While the southern timber markets are currently depressed, primarily triggered by over-supply of raw materials, this new forest product industry has bright future prospects particularly from a perspective of raw material availability in the U.S. South. While the North American CLT industry is gaining momentum mostly supported by grants and pilot projects, a lack of well-established market and insufficient trained architects, builders and designers are the main hindrances to its market development in the construction sector. Effective educational and outreach programs covering the entire supply chain of the mass timber industry are necessary to better inform all forestry stakeholders and market participants about these eco-friendly building materials.

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PROCES MANAGEMENT AS A TOOL FOR THE REALIZATION OF CHANGES AND IMPROVEMENTS IN WOODPROCESSING ENTERPRISES IN SLOVAKIA

Pavol Gejdoš

ABSTRACT

The article deals with the issue of process management as a tool for implementing changes in wood processing enterprises in the Slovak Republic. It presents the results of the research carried out in 2017 on more than 500 enterprises. It presents how businesses perceive the nature of the changes they make to what types of changes are important to them due to their economic results and business goals. The last part presents the results of interdependencies of selected surveyed factors.

Keywords: process, changes, management, improvement, quality

1. INTRODUCTION

The success of a market organization in the long run depends primarily on the quality of its products and services compared to competitors in competition where quality is not only seen as a factor in the image of an organization but is a determinant of its survival. By applying quality management in organizations, we can meet the expectations of our customers, improve our performance by improving and streamlining processes. Process management and change management as part of quality management is a means to minimize the risk of not meeting customer requirements and achieving performance parameters that guarantee not only the successful survival of an organization in a competitive struggle but also its performance growth and development. In every area of business, there are business processes that are critical to achieving strategic goals where business improvement itself depends on our ability to detect strengths and weaknesses and opportunities for further progress because only significant improvement in quality can ensure the organization's efficiency and competitiveness.

2. MATERIAL AND METHODS

Šmída (2007) defines the process as an organized group of interrelated activities, passing through one or more departments within or outside of the company, in which inputs are consumed and outputs produced that have value for the customer. Change is a manifestation of the development process and currently, there is a great pressure on the need for change.

Luděk (2005) says that process is a sequence of partial operations with clearly defined output at the end as a characteristic variable of process management.

Process is a term that is used in various meanings. In the real world, there are several types of processes, such as chemical process, manufacturing process, biological process, technological process, or for example process as a run of application (Coulson,1994).

According to Veber et al. (2006), the concept of quality is characterized as a degree of compliance with the requirements by the set of inherent characteristics. Whilst the requirement is defined as the need or expectation that is determined, they are generally assumed or binding, inherent is interpreted as existing in something, especially as a mark and the term character (characteristics) as a distinguishing feature.

Owen and Maidment (1996) define quality as a sum of features and characteristics of the product (production line), or a service related to its ability to meet the desired need.

Process represents integrated activities that generally require participation of several activities. Processes must be purposeful and efficient, they should serve customers, not the company (Kassay, 2013).

Hammer and Champy (2000) define process as a set of activities that require one or several types of inputs and creates outputs that have a certain value for the customer.

Process management is focused on the causes of arising discrepancies, not on the final outputs. This type of management control is based on the idea that the cause of company's bad results is inefficient running of company processes where it is necessary to make them rationale and more effective, which will result in higher added value for the customer (Marcineková - Sujová, 2015).

The process approach focuses on objectives and outputs of the process regardless of which departments of the company the process passes through. Company departments are in the relationship of a supplier and a customer; the owners of the processes provide services to each other within the enterprise. Process approach allows the identification of critical points in the creation of value for the customer faster than in the case of functional management.

Comparing the main ideas of the authors Janać, J., Mamatkulov, O., Rentková, K. (2013) and Zavadský (2006) the classification and structure of methods, tools and techniques for managing and changing processes can be diverse. A classic breakdown of these methods used to ensure quality in all phases of the production cycle is the breakdown of methods into seven traditional and seven new tools of the quality management.

The basis of the change, according to Vodáček and Vodáčková (2001), is in the conversion from the state at the start to the state at the finish for the purpose of the improvement of the company position at the market. There must be constant care about the development of the company and its processes.

Change management in the enterprise by Majtán, M. (2002) can be seen as a project for which it is necessary to observe the following steps: defining targets and milestones, identify the person, their roles and responsibilities, determine the form and extent of communication, establishing a timetable.

Successful change requires adaptation of methods, techniques, strategies and implementation tactics to specific history, culture, and people in the organization. The change process is very complex, but there are models to make the change Rosenau, M. D. (2000).

Authors Palán, J. et al. (2002) argues that the management of changes is a core set of knowledge and skills that are essential to ensure the required quality solutions to the problems of organizational changes. Change means a qualitative transformation of certain characteristic parameters that describe the state of the object or event.

3. RESULTS AND DISCUSSION

In the next part will be presented the results of the research, which was realized in year 2017 to more than 500 companies in the Slovak republic. The results in the first part present the basic breakdown of the sample of enterprises by size - number of employees (table 1), according to their main activity (table 2) and according to the structure of the capital to which they are funded (table 3).

Table 1. The number of employees in wood processing companies in Slovak republic

Number of employees in %				
0 - 10	11 - 20	21 - 50	51 - 250	Over 250
42,12	25,61	14,63	7,30	7,30

Table 2. The main subject of the activity in wood processing companies in Slovak republic

The main subject of the activity in %			
Production	Business	Service	Distribution and transportation
86.59	9.76	2.44	1.22

Table 3. The ownership of the company in wood processing companies in Slovak republic

The ownership of the company in %			
Net domestic capital	Prevailing domestic capital	Prevailing foreign capital	Net foreign capital
79.27	14.63	1.22	4.88

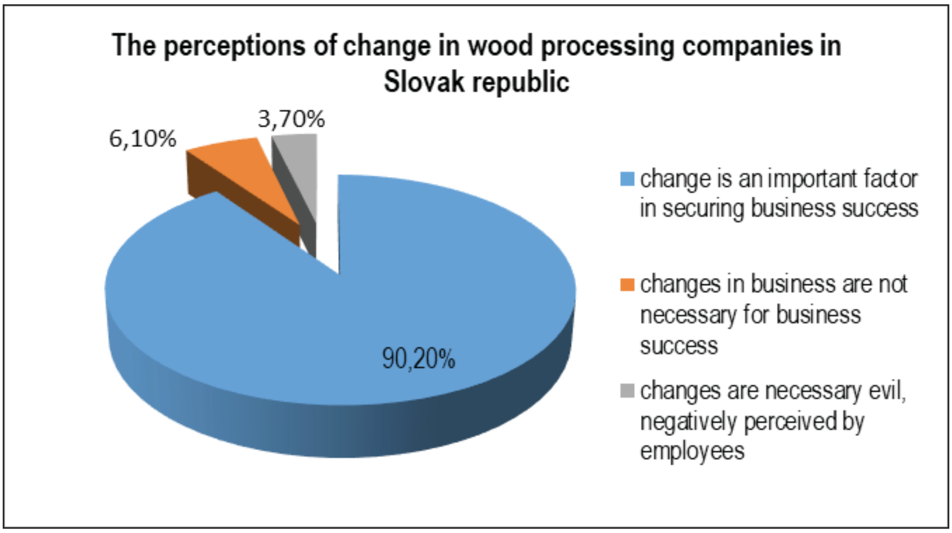

Figure 1. The perceptions of change in wood processing companies in Slovak republic

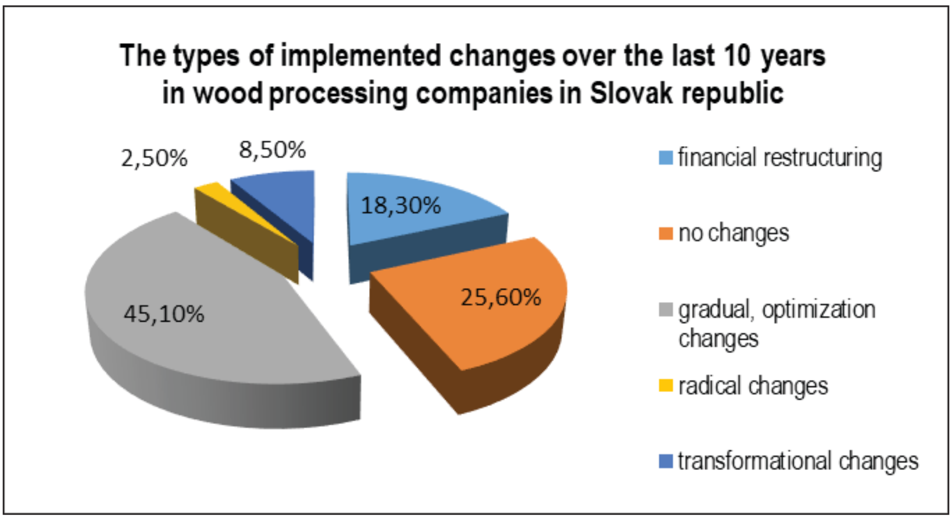

Figure 2. The types of implemented changes over the last 10 years in wood processing companies in Slovak republic

Figure 1 shows that wood processing companies perceive changes in their businesses, as more than 90 percent of businesses see change as an important factor in successful business. Figure 2 shows the types of changes made by wood processing companies over the last 10 years. The most common are gradual, optimization changes, financial restructuring or no changes.

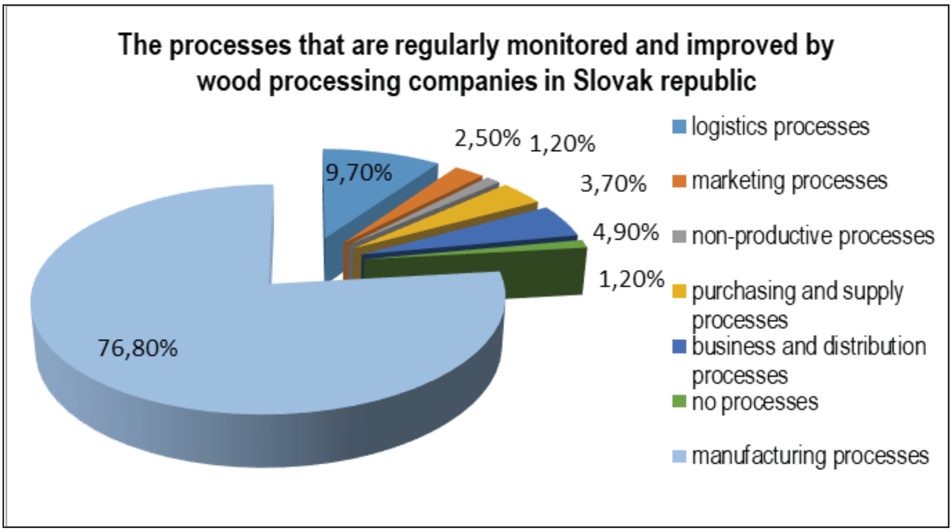

Figure 3. The processes that are regularly monitored and improved by wood processing companies in Slovak republic

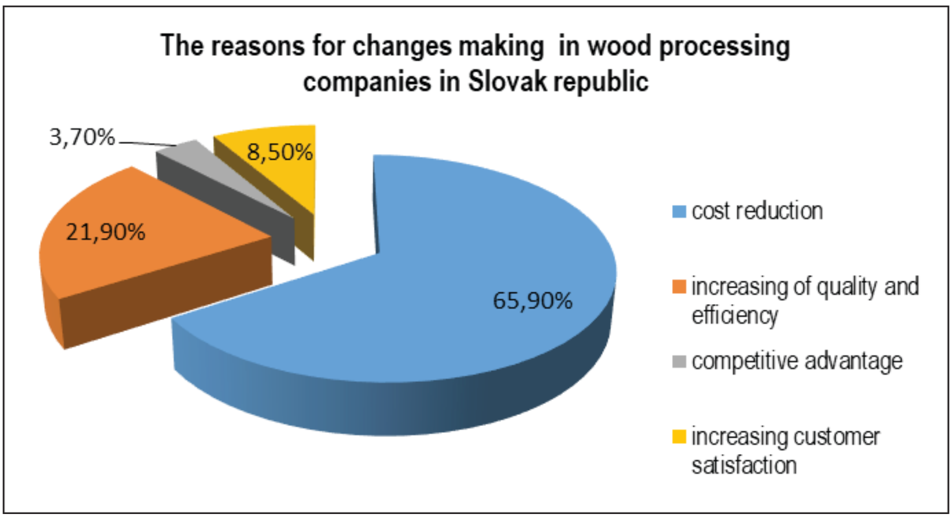

Figure 4. The reasons for making changes in wood processing companies in Slovak republic

Figure 3 shows that over 76% of wood processing companies in Slovakia regularly monitored manufacturing processes and nearly 10% of logistics processes, which is logical since up to 86% of enterprises are manufacturing enterprises. This is clearly followed by the economy of the enterprise, where almost 66% of wood processing companies as a reasos for changes have reported cost reduction and consequently increasing quality and efficiency (Figure 4).

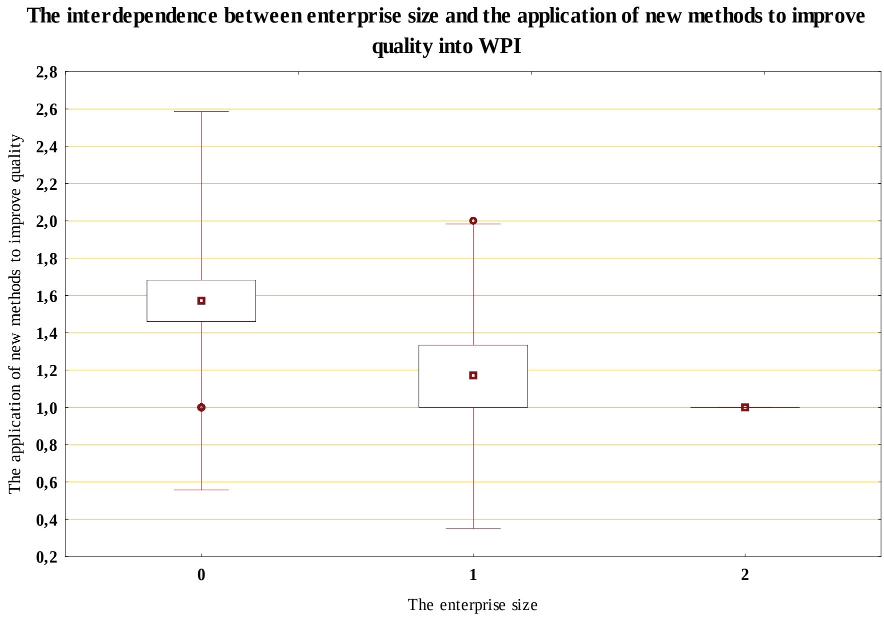

Figure 5. The independence between enterprise size and the application of new methods to improve quality into WPI

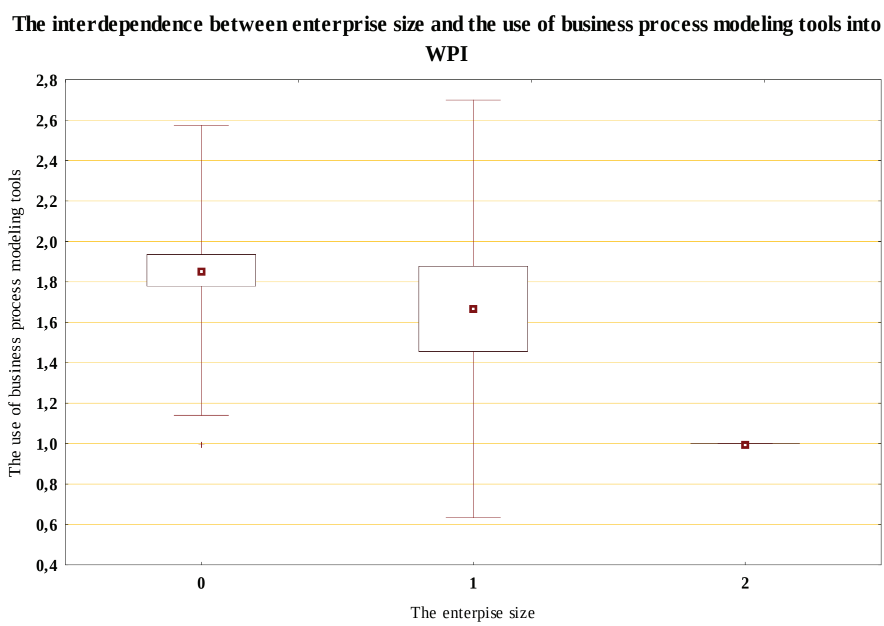

Figure 6. The independence between enterprise size and the use of business process modeling tools into WPI

In order to better interpret the results, we have undergone analyzes by means of statistical methods and the one-factor scattering analysis where we investigated or there is some correlation between the investigated factors. From Figure 5, there is a correlation between enterprise size and the application of new quality improvement methods. Large enterprises use the methods listed, all medium enterprises almost all. The worst situation is for small businesses up to 50 employees, there is a variance of responses is relatively small and is inclined to the view that small businesses in most cases, new methods used. When we analyzing the use of business modeling tools in WPI (Figure 6), we can say that large businesses use business modeling tools all, by medium-sized businesses there is a very large scatter of responses, which shows that there are companies that use the tools, but many of them are not, and the worst situation is for small businesses where most of them do not use these tools.

4. CONCLUSION

In general, there is a realistic assumption that even more significant changes in the organization's economic efficiency will be noticed by the introduction of process-based change management based on value creation and process efficiency. This is evidenced by the fact that the quality of the processes by which these corporate achievements are created is a significant factor influencing the quality of the products and services provided. At the moment, the efforts of enterprises are directed to the field of detection of the causes of emerging disasters already in the initial process and not the resulting product without the possibility of redress. Business entities operating in all sectors of the economy are thus aware of the fact that the quality of processes is the result of stable conditions ensuring regular compliance with predefined quality criteria.

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RISKS AND POTENTIAL OF THE STATE SUPPORT FOR WOODEN HOUSES IN SLOVAKIA

Potkány Marek, Debnár Marek

ABSTRACT

The paper is aimed at evaluating of the conditions of the decree of the state support for financing of wooden houses, prepared by the Ministry of Agriculture and Rural Development of the Slovak Republic in the framework of providing support for the development of forestry and the recovery of raw wood in the Slovak Republic. The questionnaire survey was addressed to the potential producers of wooden houses in Slovakia. The aim was to identify and analyse the potential of interest in use in providing of state support for a low-energy family-made wooden houses and the possibility of specific criteria for meeting the required conditions (purchase price, usable area and qualitative criteria).

Keywords: wooden house, state support, subsidy, forestry, woodworking industry

1. INTRODUCTION

Forestry is a branch of the slovak sational economy whose main objective is the planned and sustainable management of the slovakian forests and their development. Forests are at the same time environment, a renewable natural resource, a raw material producer and other tradable forest products and services, but also a provider of a whole range of non production services. Further development of forestry is now directly dependent on the assessment of the benefits that forests provide and the forms of existing support. The woodworking industry of the Slovak Republic is a sector in which the forestry sector and its development are directly dependent. This sector has an impact on the economy and employment. According to the Forest Management Report of the Slovak Republic for the year 2016, 2 449 000 m³ of raw wood was exported. Exports of coniferous assortments were dominated by saw logs I and III. quality class (42% of total exports, ie 1 028 000 m³ of wood). If it is known that 30% of this volume of wood consisted of assortments III. classes of quality – saw logs, then exported in this quality approximately 700,000 m³. This is the volume of wood, part of which could be processed and recovered on the domestic market. In Slovakia, a high degree of wood export has been maintained for many years, and in relation to the possibilities of its production, a low rate of recovery, especially as a construction material in the construction sector. Each year 2,5 to 3,5 mil. m³ of raw wood of different quality is exported (Gejdoš, Potkány, 2017). Part of this raw material can be used, for example, to produce components of wooden houses. These are glued wood, large-area structural and insulating board materials and other wood products. The condition is greater demand for this wood raw material and the existence of enough processing companies that are able, for example, to produce wooden home construction products or components. According to Slovak Association of Wood Producers of Slovak Republic it is assumed that if this wood remained in Slovakia, another 6,500 people could be employed in the wood industry.

Ministry of Agriculture and Rural Development of the Slovak Rebuplic, as a tool for adding value to the processing of domestic raw material is considering some form of state support. It is support for the development of forestry and evaluation of raw wood in the Slovak Republic. Support should be related to a wooden family house with low energy or near zero energy consumption needs. The aim of the forthcoming decree is to increase domestic demand for timber products, increase domestic processing and use of raw wood and also increasing of employment in this sector. The secondary effect is to support the housing of citizens in particular in the countryside and to reduce the energy consumtion of buildings. The aim of the draft decree is therefore not only to contribute to the development of the forest-wood complex and to the better use of domestic renewable resources, but also to meet the objectives of the Paris Climate Agreement of 2015. Accepting the targets of 20/20/20 of the Europe 2020 strategy we obliged to cut down gradually energy consumption, CO2 production and to increase the ratio of renewable energy sources. As 40% of energy is consumed by buildings, there is a significant change in requirements of energy efficiency. The construction of low energy houses as for masonry or timber constructions using renewable sources of energy for heating and water heating are becoming the favoured solution (Štefko, Potkány, Debnár, 2017), (Čulková, et al., 2017) and (Brege, Stehn, Nord, 2014). The potential of raw material processing in Slovakia, in particular, in the sector of wooden houses construction exists. The market share of wooden houses in Slovakia is rather difficult to predict, as the Statistical Office does not have this type of statistics, so using a variety of sources, whether or magazine publications we will try to estimate this value. According to relevant source, which is in our opinion the Slovak Association of Wood Producers, it can be stated that before 10-12 years ago, the share of wooden houses minimum of 2% and at present this value is closer to 10%. The trend should be sustainable and market share growth should support and raising awareness only grow, and could reach 20% already in 2020 (Debnár, Potkány, 2016). The main goal of paper is to present the result of survey about the potential of interest in use in providing of state support for a low-energy family-made wooden houses and the possibility of specific criteria for meeting the required conditions.

2. MATERIALS AND METHODS

In order to present the current working version of the decree and conditions for drawing subsidies for the support of wooden constructions, we used the document published on the legal and information portal of the Slovak Republic, located on the website: https://www.slov-lex.sk/legislativne-procesy/SK/LP/2017/602. The current version of the state support decree considers the following selected conditions (shortened version):

Support will be provided to a house that meets these conditions:

a) built-up area of the house will be at least 75 m²,
b) the house will have at least three living rooms,
c) the house will be approved and its purchase price for the construction of a house without base plate under the building contract will be at least 65,000 EUR without VAT
d) the house will be made to the finalization as a complete house,
e) the house will be classified into the energy class of the global primary energy indicator A1 or A0,[7])
f) the house will not be an establishment for business purposes.

Support will be provided in amount

a) EUR 6,000 per house in energy class A0 outside the capital of the Slovak Republic,
b) EUR 5,000 per house in energy class A1 outside the capital of the Slovak Republic,
c) EUR 4,000 per house in energy class A0 on the territory of the capital of the Slovak Republic,
d) EUR 3,000 per house in energy class A1 on the territory of the capital of the Slovak Republic

Support will increase by EUR 2 000, if the house is in the village in less developed district.[8]

Support will increase by EUR 2 000, if the applicant proves by the declaration of the contractor that at least 50% of the wooden construction products from which the house is constructed are made of wood coming from forests of the Slovak Republic.

Support will increase by EUR 2 000, if the applicant proves by a declaration of the contractor that at least 70% of the wooden construction products from which the house is made is made of wood that comes from sustainably managed forests for which a PEFC or FSC certificate has been issued.

Through the questionnaire, we approached 117 companies within the Slovak Republic dealing with the construction of wooden houses. The objective of the questionnaire was to identify and analyze the potential of interest in the use of state support by Ministry of Agriculture and Rural Development of the Slovak Rebuplic Support to a wooden family house with low energy or near zero energy consumption needs. The question was distributed by e-mail contacts in April-May 2018. To our questionnaire survey involved 43 companies which is 36.75% of all surveyed companies. We consider the sample of respondents to be sufficient because we were able to get answers from representatives of companies that, based on previous survey results, account for up to 80% market share in

[7] Annex no. 3 Table F. of Decree No. 364/2012 Ministry of Transport, Construction and Regional Development of the Slovak Republic implementing Act no. 555/2005 on the energy performance of buildings. The upper limit of the energy class "A0" for the global primary energy indicator is ≤54 kWh / (m2.a) and for the energy class "A1" = 55-108 kWh / (m² .a) for family houses.

[8] Act no. 336/2015 on the support of the least-developed districts. District in which the registered unemployment rate, calculated from the available number of job seekers, was at least nine calendar quarters from 1 April 2015 to 31 March 2018 higher than 1,5 times the average registered unemployment rate in the Slovak Republic over the same period.

the given segment. Responses we received from representatives of the following companies: Atrium Ltd., BAU Holding Ltd. Drevstav Slovakia Ltd., Drevodom Orava Ltd., ForDom Ltd., JK Slovakia Ltd., HAAS FERTIGBAU, Ltd., MHouse Ltd., Ecostav Ltd., IQ-ecodom Ltd., Montistav Ltd., Scandi Haus SK Ltd., Raj bývania Ltd.

3. RESULTS AND DISCUSSION

Table 1 presents basic data on the number of research, the interest in the state subsidy, as well as the preferred type of construction and the overall finalization of the wooden house works contract.

Table 1. General information of the survey

	The number of surveyed companies	**Responded**	**Not responded**
	117	43 (36,75%)	74 (63,25%)
	Interest in state subsidy	**Lack of interest in state subsidy**	**Without opinion**
	42	0	1
	Preferred type of construction of wooden house		
Timber frame construction	24 (55,81%)		
Panel system construction	16 (37,21%)		
Solid wood construction	1 (2,33%)		
Combined construction	1 (2,33%)		
Traditional log construction	5 (11,63%)		
	The most common type of finalization of the contract		
House with walls and roof construction	4 (9,52%)		
House without fixture	19 (44,19%)		
Complete house	19 (44,19%)		

An interesting finding from Table 1 is the fact that the preferred construction systems of wooden houses are timber frame construction (55,81% of respondents) and panel system construction (37,21% of respondents), which predominate over other types. For traditional log construction (11,63%) it is necessary to consider that such a type is not an ideal solution to the family form of living, but rather as a recreational option or a house for business purposes. If we compare the given facts with the current version of the state support decree so prepared there is the preferred type of traditional log construction, solid wood construction and combinated wood construction, which is in conflict with the most preferred types of contructions in practice.Within the most common type of finalization of the contract dominated alternatives of complete house or house without fixture (44,19%).

The current version of the state support decree is only envisaged with the support of finalization of the complete house, which may disadvantage more than half of potential applicants. Opinions on the idea of subsidy amount present figure 1. Assuming that any future support for the construction of wooden houses considered the minimum purchase price without base plate at the level EUR 65 000 without VAT. It is possible to state from our findings that this condition should be met in practice. Up to 69% of contractors declarate that average purchase price of the complete house without a base plate is at level 65 000 – 90 000 EUR without VAT (figure 2).

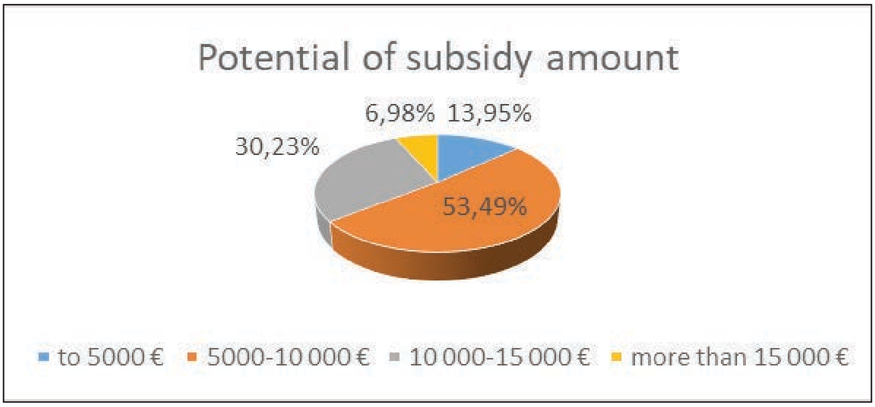

Figure 1. Potential of subsidy amount

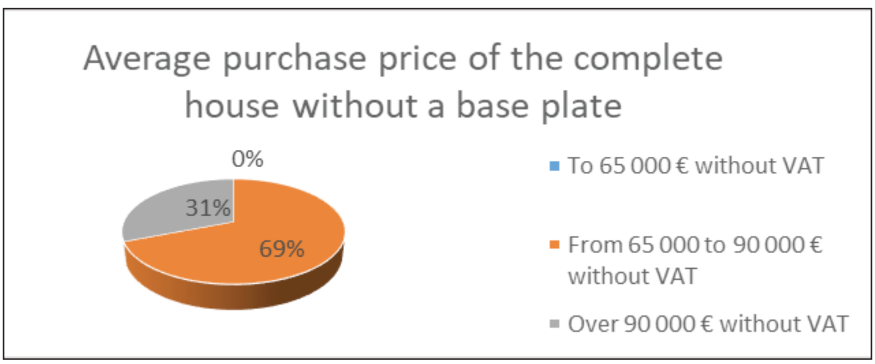

Figure 2. Average purchase price of the complete house

Figure 3 presents the result of energy certificates of already completed houses. Basically, all companies with one exception, can ensure the performance of the contract in the required energy class A1 (the global primary energy indicator is = 55-108 kWh/(m².a) and up to 28% of the company is building a house in the tightest energy class A0, where the global primary energy indicator is ≤ 54 kWh/(m².a). These requirements are enforceable under Act no. 555/2005 on Building Energy Efficiency, valid from 1st january 2021.

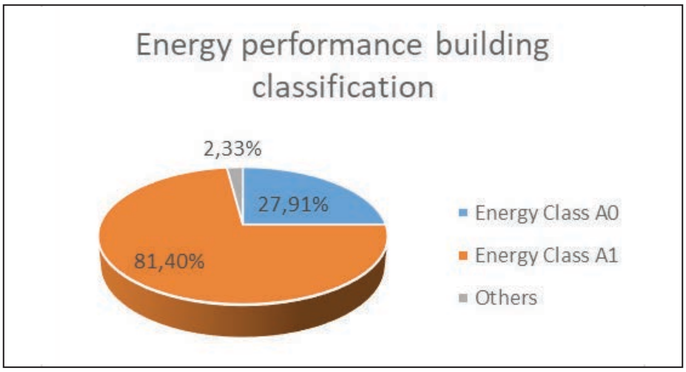

Figure 3. Energy performance building classification

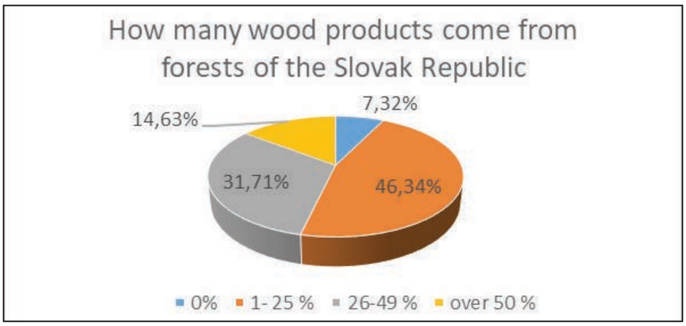

Figure 4. Share of the wooden building products made from wood of Slovak forests

State support may be increased by EUR 2 000 if the applicant proves by the declaration of the contractor that at least 50% of the wooden construction products from which the house is constructed are made of wood coming from forests of the Slovak Republic. However, only 14.63% of enterprises reported such a share in our survey (Figure 4). Here is the fact that Slovak companies import most of the components for the construction of a wooden house from abroad and there is no use and appreciation of domestic wood raw material. We state our opinion as a problematic point in the forthcoming decree.

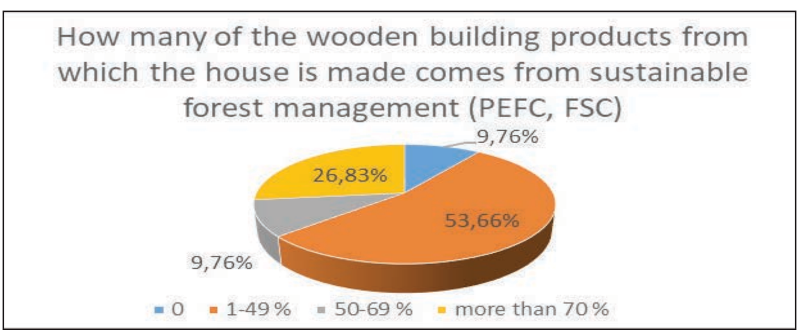

Figure 5. Share of the wooden building products with certificate marks PEFC or FSC

One of the conditions for drawing a government subsidy for the construction of a wooden house, which can increase its value by EUR 2,000 is the declaration of the contractor that at least 70% of the wooden construction products from which the house is made, is made of wood that comes from sustainably managed forests for which a PEFC or FSC certificate has been issued. However, this level exceeded only 26.83% of respondents (Figure 5). Most companies have reported a lower to minimum value for the origin of wood from sustainably managed forests for which a PEFC or FSC certificate has been issued. In this case, we also state our view of a certain risk of raising the subsidy.

4. CONCLUSION

Ministry of Agriculture and Rural Development of the Slovak Republic, plans to support the development of forestry and the recovery of raw wood in the Slovak Republic. Support should be related to state subsidy. Support should be related to a wooden family houses with low energy or near zero energy consumption needs. This should have a positive impact on the management of supported households. The proposal is supposed to support 100 to 200 wooden family houses, respectively. households with an average subsidy per household of between EUR 5,000 and EUR 10,000. The total amount of state support is planned at 1 mil. EUR. Its aim is to increase domestic demand for wood products, increase domestic processing and use of raw wood and thus employment in the sector. The secondary effect is to support the housing of citizens in particular in the countryside and to reduce the energy performance of building. The aim of the draft decree is therefore not only to contribute to the development of the forest-wood complex and to the better use of domestic renewable resources, but also to meet the objectives of the Paris Climate Agreement of 2015. The potential for the use of the support is large and public interest is considerable. However, the process of preparing legislative and commenting documents is very time-consuming. The whole process takes more than one year of ever-changing conditions. we used the document published on the Legal and Information Portal of the Slovak Republic, located on the website: https://www.slov-lex.sk/legislativne-procesy/SK/LP/2017/602.

From our point of view, the basic amount of the support of 5000 or 6000 EUR can only be reached for a limited number of applicants. We consider the major problem of this support only to the type of complete house implementation and also the preference for less-used construction systems to those in practice commonly usable as timber frame and panel construction systems. This condition automatically eliminates more than half of potential applicants for state support. Subsidy is only relatively difficult to increase by another value. This is particularly true of funded developed districts, but in particular the conditions of the wooden building products made from wood of Slovak forests, which should be more than 50%. This condition is met by only 15% of enterprises. Another risk is also the conditions about the share of the wooden building products from which the house is made and comes from sustainable forest management with certificate marks

PEFC or FSC. The required stake is more than 70%, with only just over 25% of the companies building wooden houses declare this level. Therefore, we propose to simplify the process and give a chance to draw support for multiple customers and future users of wooden houses. Only then can state support meet its declared objectives.

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DIGITALISATION OF HIGHER EDUCATION AS PART **OF THE IMPLEMENTATION OF INDUSTRY 4.0 IN THE WOOD SECTOR IN SLOVENIA**

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ABSTRACT

The development of Information and Communication Technologies (ICT) has induced large structural changes in societies, whose success is now associated with gaining and distributing knowledge. The concept of lifelong education has become one of the main principles of educational institutions around the world. The traditional ways of gaining and distributing knowledge have become insufficient and rigid, and in some cases of poor quality. This is particularly true for the special as well as highly interdisciplinary knowledge and competences needed for interdisciplinary studies, such as Wood Science and Technology. Digitalisation of the educational process, the use of modern ICT and introduction via e-learning are some of the possible solutions to these problems. Additionally, they are all part of the concept of Industry 4.0, the implementation of which is the key to the development of the wood sector in Slovenia. New technologies and learning methods will stimulate the development of business models (e.g. virtualisation technologies in the sales/marketing process) in the wood industry, which will have a positive impact on the development of the whole wood sector and consequently increase demand for wood products. The goal of the research is to examine the best practices and technologies for digitalisation of education and to analyze the use of e-learning approaches and technologies in the higher education context of wood science in Slovenia.

Keywords: Industry 4.0, e-learning, higher education, ICT, wood industry, Slovenia

1. INTRODUCTION

The development of the Information and Communication Technologies (ICT) has induced large structural changes in societies. So-called knowledge or digital societies are thus emerging (Keidanren, 2016), which bring many opportunities for progress as well as many challenges. Due to the large amount of data and information that is accessible through (digital) media, the potential level of knowledge that people can gain has increased, although in practice this progress is not always sufficient. The main problem is in quality of the information and knowledge, and their steady dispersion. Thus the main drivers of economic growth are activities connected to acquiring and distributing knowledge and/or competences. The biggest problems arise in digital literacy, as around half of all Europeans still do not have the basic digital skills needed to thrive in this context (see "The Digital Economy and Society Index (DESI)", European Commission, 2018c). As such, the concept of continuous, lifelong education has become more popular, which is also one of the key orientations for the development of the European Union and its member states (European Commission, 2018a). The idea here is that the labour market is constantly evolving, and most of the skills, competences, and qualifications that people need change over time. To deal with these changes people need to be equipped with a variety of basic skills, including literacy, numeracy, foreign languages, science and digital skills. At the EU level there are some programmes and initiatives for developing such skills: e.g. the Erasmus+ Programme, the Rethinking Education initiative, lifelong learning strategies, the Grand Coalition for Digital Jobs, ESCO (Classification of European Skills, Competences, Qualifications and Occupations), and so on. All this has a significant impact on national strategies in the field of education and development of competences, as reflected in numerous projects (e.g. Competence Centres) and at all levels of formal education. As already noted, modern ICT is of great importance when developing the framework and content of educational processes. It is important from two regards: (1) the new industrial revolution (Industry 4.0) concerns all aspects of life and society, and requires new skills, knowledge and competences; (2) it also changes various educational processes, the results of which are the competences mentioned above. We thus need new knowledge and competences, which can be obtained in a different ways.

Industry 4.0 was initially introduced in 2011 in Germany, and symbolises the beginning of the so-called Fourth Industrial Revolution (Lasi et al., 2014). Industry 4.0 represents the current trend of automation technologies in the manufacturing industry, and it mainly includes enabling technologies such as cyberphysical systems (CPS), the Internet of Things (IoT) and cloud computing (Xu et al., 2018). Implementation of this concept has primarily taken place at the level of production companies, but has been moving into all aspects of the society in recent years. One of the umbrella strategies within the EU is that of smart specialisation (S3) (European Commission, 2017b). Slovenia, as an EU member state, has adopted this concept as an important part of the country's economic policy, which is also reflected in the strategy of smart specialisation, or S4. S4 is a platform for concentrating development investment on areas where Slovenia has the critical mass of knowledge, capacities and competences to succeed, and where there is innovation potential for placing the country within global markets and enhancing its recognisability (Republic of Slovenia…, 2018).

The educational process, the results of which are new era competences, has to be adapted to meet modern requirements. UNESCO (2008) has thus designed the ICT competency standards for teachers to help educational policy-makers and curriculum designers. The standards consist of three parts: (1) a policy framework explaining the rationale, structure and approach underlying the project; (2) a competency standards modules' structure, which combines the components of educational reform with various policy approaches to generate a matrix of skill sets for teachers; and (3) implementation guidelines providing a detailed syllabus of the specific skills to be acquired by teachers within each skill set or module. It is therefore important for educational institutions to follow these guidelines in order to be effective and successful in their work and mission. According to *Forbes* (Laurinavicius, 2017), the e-learning market was valued at over $165 billion in 2015, and is likely to grow by over 5% from 2016 to 2023, exceeding $240 billion. The first step to success in this context is to create something valuable people are willing to pay for, and then self-publish it by using an appropriate platform to host courses.

Digitalisation of the educational process and the use of modern ICT in its implementation is one way to achieve this, thus applying a direct implementation of the concept of Industry 4.0 in the educational process. This also includes the establishment of an e-classroom, and thus the basic infrastructure for implementing other state-of-the-art approaches and technologies to support education. The scope and depth of digitalisation of education should be adjusted to the specific areas of the field being studied, and often the introduction of various elements is conditioned by economic, organisational and system requirements. Especially important here are the professional and pedagogical competences of pedagogical workers, among which digital competences are very important (European Commission, 2018b).

In recent years, a lot more researchers have examined the development of the wood sector. One project found that the challenges faced by companies now require a high level of skill to overcome, and so a lot has been done to improve the competences of employees in the wood sector (Humar et al., 2012). Two such projects were carried out in recent years: (1) KOCles between 2012 and 2015, and (2) KOCles 2.0 between 2016 and 2018, the aim of which was improving the competences for various different employees in the wood sector. In 2013 a “Model of Competences for the Wood Sector” was designed (Kropivšek et al., 2013), on the basis of which a number of trainings were carried out (Kropivšek and Zupančič, 2016). Among the 91 competences listed in the model, 15 of them are related to digital literacy, and many related training projects have since been carried out. In the wood sector, as in many other sectors, some changes have already been made to prepare for the introduction of Industry 4.0 concepts, and these will, in addition to their technological effects, stimulate the development of new business models in companies (e.g. virtualisation in the sales/marketing process). The wood sector is preparing for the transition to a digital society, so it is important to adapt the educational system to follow these guidelines. This is especially true for formal education of young professionals in the wood sector as well as for transferring the results of the latest research into practice through educational modules for employees in wood industry companies.

The main goal of the current research is thus to examine the best practices and technologies for digitalisation of education and to analyse the use of e-learning approaches and technologies in terms of wood science higher education in Slovenia.

2. MATERIALS AND METHODS

2.1. Survey

An online survey was conducted to check the digital literacy and the attitudes of pedagogical workers and students towards the use of ICT in the study process, with emphasis on e-classrooms. An open source application was used for creating, conducting and analysing the online survey. The survey was sent to 41 pedagogical workers who collaborate with the Department of Wood Science and Technology of Biotechnical Faculty of University of Ljubljana. It was accessible online between May 10 and 21 2018. A total of 27 people completed the questionnaire. Another survey was sent to all 156 active students at the Department of Wood Science and Technology, and this was accessible online between April 23 and May 14 2018, with 116 completed responses. A similar survey was conducted at the Department of Wood Science and Technology in 2011, when 20 pedagogical workers and 106 active students answered the questionnaire.

The survey for students consisted of 14 questions, while for the pedagogical workers there were 10 questions. The survey in both cases consisted of closed type questions with one possible answer, and in most cases a four-point Likert scale was used.

Data were further analysed in Microsoft Excel 2016 on the basis of a frequency distribution, which is a tabular summary of data showing the number (frequency) of observations in each of several non-overlapping categories or classes (Anderson et al., 2015; Košmelj, 2007). The frequency of a class *j* is marked as $f_{j.}$ For comparison of frequencies of different classes, a relative frequency is used. This means that the frequency of a class equals the fraction or proportion of observations belonging to a class. It is normally presented by percentage frequency distribution, $f_{j.}\%$:

$$f_j\% = \frac{f_j}{N} * 100$$

Where is: f_j is the frequency of a class *j*, and *N* is the number of observations.

Some results of the survey were compared with the results of the survey conducted within the University of Ljubljana (UL) project “Digital UL – with the innovative use of ICT to excellence”, the aim of which is developing innovative learning environments and introducing methods and pedagogical practices by integrating new technologies (Digitalna UL, 2018).

2.2. Log analysis in the e-classroom

In order to check the actual use of the e-classroom (in this case, the Moodle platform) by users, the logs of all activities were analysed for the recent academic year (between June 11 2017 and June 11 2018). The sample consisted of 260 students and 24 pedagogical workers, who all together generated 93,328 events (clicks). Special attention was paid to group data in comparable groups of activities and frequency calculations (see above), as well as the proportion (relative frequencies – see above) in order to compare these data with each other.

3. RESULTS AND DISCUSSION

3.1. Best practices and platforms for digitisation of education

In November 2017 the European Union adopted the Fact Sheet on the Digital Education Action Plan with regard to the skills challenges linked to digitalisation, cybersecurity, media literacy and artificial intelligence. According to this, digitalisation is transforming the nature of work and poses new challenges, with 90% of future jobs requiring digital skills, which 44% of Europeans currently lack. The priorities in this case are: (1) making better use of digital technology for teaching and learning, (1) developing relevant digital skills and competences for digital transformation (also “teach the teachers” programs), and (3) improving education systems through better data analysis and foresight (through the launch of artificial intelligence and learning analytics pilots) (European Commission, 2017a).

Education at all levels in the EU is incompatible with the developmental excpectations of a digital society. The educational process has to ensure the growth of the digital competences of students, the development and availability of freely accesible learning resources (e.g. MOOC, or massive open online courses), the changing role of ICT tools to increase the efficiency and quality of the learning process, and the integration of educational institutions with the economy and other users (European Commission, 2014). The field of accesible learning resources, such as MOOC, has seen great progress in recent years. Shah (2018) found out that the total number of MOOC learners worldwide is now 81 million (with around 23 million new learners added in the last year). The top MOOC providers by registered users are: Coursera (30 million users), edX (14 million), XuetangX (9.3 million), and Udacity (8 million). The pace at which new courses are being added is also increasing, and to date over 800 universities around the world have launched at least one MOOC. The number of announced MOOC courses now stands at 9,400, up from 6,850 last year, with many leading universities taking part world (e.g. Harvard and MIT) (Shah, 2018).

The technology behind such online courses is called a Learning Management System (LMS). Different web pages have made lists of the “best” online learning platforms (Laurinavicius, 2017; Couture, 2017; Martinez, 2018; Capterra, 2018), and there is a huge number of LMS that can be used. One of the most popular is Moodle (Capterra, 2018), which is also the platform used by the Department of Wood Science and Technology.

3.2. Use of ICT in the study process

Up-to-date ICT is available at the Department of Wood Science and Technology for use in the study process (Figure 1). A total 74% of the pedagogical workers surveyed in this study agree with this statement, compared to UL as a whole, where only 48% of the pedagogical workers agree with it (Digitalna UL, 2018). A total of 70% of the pedagogical workers state that they often include ICT in their pedagogical process, and are fairly confident when using it, although only 44% believe they can organise the study process by including ICT in an appropriate way, which indicates a lack of competence in this regard. In terms of grading students, only 37% of pedagogical workers use ICT for ongoing grading and a little less than half for final evaluation of students’ knowledge. The survey results also indicate low levels of encouragement for students to use ICT for study purposes.

Nearly half (49%) of the pedagogical workers believe that it is possible to use ICT for almost any kind of study topic. Interestingly 85% consider that the use of ICT makes the study process more interesting, and 75% that students can better follow lectures this way. Moreover, 75% of pedagogical workers agree that the use of ICT improves the efficiency of the study process. However, one third of the pedagogical workers believe that students are less likely to follow the lectures when ICT is included. The key to maintaining a high level of ICT use in this context is thus the provision of sufficient technical support, for both pedagogical workers and students.

Similar results were observed within the project "»Digital UL" (Digitalna UL, 2018). These showed that pedagogical workers and students from the Biotechnical Faculty are no better with regard to the knowledge and competences needed to use ICT in the pedagogical process compared to whole of the University of Ljubljana. The attitude towards ICT is mixed. People often give up because of the time needed in the initial implementation phase of integrating ICT into the study process. Material resources are available at the Biotechnical Faculty, and the existing equipment is well used and has sufficient technical support. With regard to using ICT in the pedagogical and study process, it turns out that pedagogical workers at the Biotechnical Faculty rarely use such tools for grading students compared to pedagogical workers from whole of University of Ljubljana.

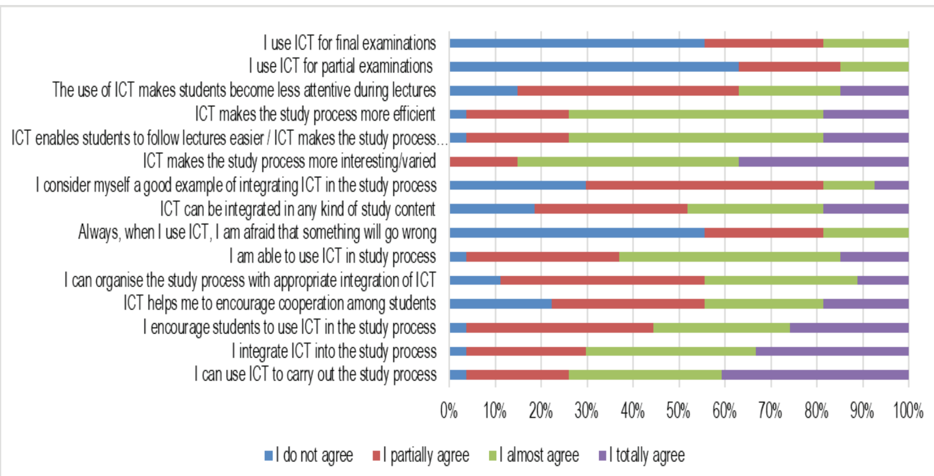

Figure 1: The use and attitudes towards ICT in the pedagogical process

Nearly 90% of the surveyed pedagogical workers use communication tools such as email when implementing the pedagogical process, while most of them do not use social media for this, and this was also supported by most of the student respondents. A total of 74% of the pedagogical workers often use digital presentations form, which is significantly more than seen with the whole of the UL. Only 19% of the pedagogical workers use recorded lectures/video lectures, although as many as 60% of students regularly use video materials while studying. There is thus a big gap between what is offered by pedagogical workers and what students expect and are used to. Specific tools such as those for visualisation, stimulation and modelling are restricted to specific study fields, so they are regularly used only by 30% of the pedagogical workers. Social media are almost never included in the pedagogical process. Here we find an opportunity for improvement of the study process in future applications, since over 70% of students believe that online communities have a positive influence on cooperation, maintenance of contacts, belonging to the group, and exchange of opinions, as well as on their regular study habits. This is also true for cloud computing tools used to enable groups, file storage, and so on, which are now used in less than 50% of cases by both pedagogical workers and students.

3.3. E-classroom (Moodle)

The Department of Wood Science and Technology has been using the online platform Moodle since 2010 as a unified learning environment and support for traditional study approaches. Since 2018 it has also been the official study platform for whole of the Biotechnical Faculty. Based on the results of this study, we conclude that the satisfaction of both pedagogical workers and students with regard to using the Moodle platform has increased significantly compared to 2011. They are particularly satisfied with the functions, the ease of editing and the graphic of the e-classroom (for all three statements more than 90% of the respondents state they are satisfied or very satisfied, whereas only 50% were satisfied with these aspects in 2011).

Furthermore, the use of individual e-learning modules has increased considerably, while their structure has remained similar. The most common uses of e-classrooms are to publish study materials (more than 60% of respondents use this function several times a week), communicate with students (via forums and direct messages) and publish grades (with regard to both of these functions, 40% of respondents use them several times a week). This fully corresponds with the analysis of log records of all activities in the e-classroom. For both pedagogical workers and students the system provides a very useful calendar of events, the ability to grade seminars, and to a lesser extent the possibility of online evaluation. Moreover, 80% of the students are satisfied with the pedagogical workers regarding their response time.

By comparing the results of our survey and those from the one in 2011with regard to the usefulness of various tools in the e-classroom, we found the following (Figure 2): (1) knowledge of such tools and thus digital literacy increased significantly, (2) all tools (except chat rooms) were recognised as very useful, among which tools for plagiarism checking and for interactive study materials were seen as especially useful. Beside this, a total of 64% of the students believe they would benefit from more video tutorials and interactive materials, while 74% would like to use quizzes for self-assessment as preparation for lectures and exams, and 55% would like to try online examinations.

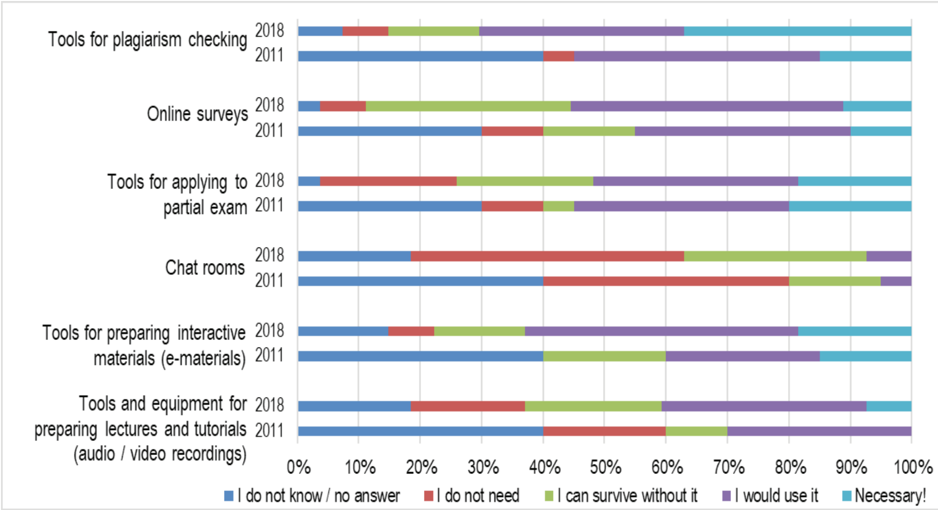

Figure 2: The usability of tools in the e-classroom in 2011 and 2018

4. DISCUSSION AND CONCLUSION

As we mentioned in the introduction, some preparations have been already made to introduce the Industry 4.0 concept into wood and other sectors in Slovenia, as evidenced by many projects (e.g. that for smart specialisation S4). New technologies and concepts will encourage the development of new business models in the wood sector and the wider economy. A lot has been done to improve the related competences in the wood sector in recent years, which is now preparing for the transition to a digital society, so it is important to adapt the education system to follow these guidelines. This is especially true for formal education of young professionals in the wood sector, as well as for transferring the results of the latest research into practice through educational modules for employees in companies. It is thus vital to change and adapt the content of various study programs and the way they are implemented. One of the challenges for the future is permanent education of pedagogical workers in the use of ICT, as well as the continuous introduction of new ICT into pedagogical practice. Only in this way can students be prepared for the labour market and challenges brought by Industry 4.0.

Digitalisation of the study process in higher education is a comprehensive project that needs to be carried out on many levels. The most important is implementation at the university / faculty level. Digitalisation of the study process is primarily an organisational project with strategical goals on the field of digitalisation, which mainly include determining the level of the didactic use of ICT in the study process (according to the SAMR model; adopted from Puentedura, 2006, and Anderson, 2013). The next phase is the process design of these goals in the study process, including both didactic and content-based. According to Crina et al. (2015), improving the quality and the use of digital technology in the study process is closely interwoven with the educational model used (based on strategic guidelines). Two aspects in particular are important for implementation: (1) the technology (ICT), and (2) the performers. ICT needs to be properly designed and available, along with the appropriate technical support. In order to use ICT, pedagogical workers, as the most important performers in the study process, need to be qualified to use ICT in didactic way and be educated about security in a digital context. Therefore generic, didactic and professional orientated digital competences are expected from pedagogical workers, and these should be developed (Ottestad et al., 2014).

In this work we examined the best practices and technologies for digitalisation of education and analysed the use of e-learning approaches and technologies in the context of higher education in wood science in Slovenia**.** We can conclude that the available ICT and technical support, as well as digital literacy of both pedagogical workers and students at the Department of Wood Science and Technology, are satisfactory. The biggest gap between the current guidelines for the implementation of the study process (European Commission, 2017a) and actual practice is in the use of online grading tools, video lectures, social media and cloud tools. This is related to the use and development of online educational content (such as MOOC), which is still in the initial phase. We can conclude that the attitude towards the use of ICT is mixed among both students and pedagogical workers, although all the necessary technology is available and all the participants have at least the basic knowledge needed and a desire to use ICT. However, a lack of time is the main reason why ICT is not implemented in the study process to the extent that it could be, although in some cases the strategic direction of the institution is another reason for the lack of implementation.

The direct implementation and use of ICT in the pedagogical process is quite successful in case of the Moodle e-classroom system, which has been used at the Department of Wood Science and Technology since 2010 to support traditional study approaches. The information and digital literacy of both students and pedagogical workers has increased over this time, which is probably the reason for the better user experience found with the current survey. There have also been quite a few intern workshops carried out over the years, and the use of individual modules has increased significantly, while their structure remains similar. The Moodle platform is most commonly used for publication of study materials and direct messaging, but this could change in future. This is because we found out that users consider the plagiarism tools and tools for preparation of interactive study materials as especially interesting. The first one is already available with new the installation of Moodle, and has been used by some pedagogical workers, while the second remains part of the developmental plan for online educational content (i.e., an MOOC), the implementation of which will be necessary in the future, according to Shah (2018).

Digitalisation of the study process is not only a technological challenge, but also an organisational project that includes strategic goals, which should be implemented into the study process by pedagogical workers who need to be motivated and able to use ICT both didactically and technically. The introduction and development of such a learning environment may be one of the first concrete objectives on the way to achieving the larger (digital) goals.

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EXPERIMENTAL DEVELOPMENT OF WOOD PRODUCTS

Milan Šimek

ABSTRACT

The article describes and explains current tendencies of product development in the field of wood products. Firstly, CNC technologies within the furniture industry and other areas are presented. The CNC technology offers many advantages and can bring manufacturers of all sizes a global competitiveness. Later on CNC background is given, next, wood and furniture design innovation “CNC manufacturing design” as a new alternative direction for wood and furniture design is described. A combination of CNC technology, ready-to-assemble (RTA) furniture concept and new wood composite materials, besides others, brings a contemporary advanced manufacturing concept. To create a design for CNC manufacturing, a complex knowledge of creation, including the innovation techniques, virtual modeling, rapid prototyping, manufacturing, wood jointing is required. Specific examples of the new type of CNC designs are presented and explained on successful projects.

Keywords: experimental development, CNC, wood, design

1. INTRODUCTION

The history of industrial competitiveness is often related to innovation and new techlologies. The most important innovation of the 19th century in the furniture industry was the industrial wood bending, which is mailny associated with the name of Michael Thonet. This cabinet maker and inventor also came up with the idea of saving shipping space, based on the chair transport in knocked-down state. The most popular Thonet chairs, No. 14, made of bent wood were sent thanks to dismountability across the ocean in a box with a minimum of unused space. Thus, Thonet have introduced industrial wood bending, together with dismountability to industrial production of furniture.

Popular concept of furniture dismountability was re-introduced by Ikea in the 50`s of 20th century, by the Lovet table. The difference between Thonet`s dismountability and Ikea furniture dismountability was that Thonet`s furniture was usually assembled before a sale to the customer, but the Ikea furniture was sold to the end user disassembled, in the flat pack boxes. Therefore, furniture sold in disassembled (knocked down) state is so called “flatpack furniture” or “ready-to-assemble furniture” (RTA). Thanks to this approach the production costs of flatpack furniture are reduced by the cost of expensive assembly process and giving it a competitive advantage to non-dismountable furniture. Ikea brand made the flatpack furniture popular around the world. The market share of RTA furniture today is still increasing. Thanks to innovations, new materials and technologies flatpack furniture is still being developed and improved. The design principles of the old masters cannot be fully implemented for this kind of furniture, because nowadays furniture is not only made from solid wood and classic joints. The RTA furniture is made primarily from wood and plastic composite materials.

2. CNC TECHNOLOGIES

The introduction of computer-controlled machining centers, CNC machining technology has been a big stride for furniture industry. NC (numerical control) and CNC (computer numerical control) machining technology has been developed in the 40`s and 50`s of the 20 century in the United States and is associated with the industry automation. The birth of this technology is mostly attributed to John T. Parsons, who first applied it in the aviation industry. In this sector, it is still probably the most used for the production of complex shape components. The use of CNC technology today is already common throughout the world and in a variety of industries. CNC machining technology is currently characterized by a decrease in purchase price, a large range of machining parameters and the possibility of adapting to almost any type of product. This technology is becoming more affordable and more attractive even for smaller manufacturers within the furniture industry. It began to be used within the furniture industry in the 80`s. In order to assess the application of this technology in the production process it is necessary to know its advantages and disadvantages.

Some of the advanteges are: automation of the manufacturing process, high accuracy and speed of processing, high reliability and versatility with low maintenance, exclusion of technology breaks for new settings, flexibility of production and the possibility of integration into production lines and others.

Also important are disadvantages: higher purchasing and operating costs, higher knowledge demands on the operator, lower production speed compared to large series production of the various specialized machines

An important opportunity of near future in competing by quality, production cost and cheap labor productivity can be the production strategy for the production of furniture using CNC technology. CNC technology purchase price is higher, but in its thoughtful use, the return on investment can be surprising. The evidence of CNC technology productivity could be, for example, seen in Ireland. Country, which has only a minimal stock of timber (hardwood is imported from North America and softwood from Scandinavia), thanks to this technology and entrepreneurial people has unbelievable results. In spite of the higher cost of timber, Irish furniture manufacturers are able to produce with profit, thanks to the usage of CNC technology.

The flatpack furniture is nowadays mostly produced with a help of CNC machines. A 32 mm span jointing system for furniture, introduced in production after the Second World War, becomes the past therefore new possibilities that this technology brings are appearing. Contemporary flatpack furniture is characterized by the assembly process that uses jointing elements made out of different materials. The furniture assembly itself requires only basic tools and manually skilled customer. Unfortunately, a quite common problem is the missing connecting hardware in the package or its higher price, that relates to hardware`s limited ability to joint the furniture strongly.

„Anyone who has ever recklessly tried to put together a flatpack cupboard without consulting the instructions knows that this usually results in several mismatched pieces of wood bolted unsteadily together, and a mysterious pile of leftover screws“. (McCormick, 2006)

3. WOOD PRODUCTS WITH INNOVATION CONCEPT

The goal of this work is to highlight the possibility to link the CNC technology, the new composite wood materials and innovative design in to form flatpack furniture using a minimum of connecting hardware. Consequently, the furniture article for future could be known as “no-tools-required furniture” (NTR furniture), which is gaining popularity in the United States. Its design is based on the use of CNC processing technology and thus is also known as “design for CNC manufacturing” (Haviarova et al. 2006). A sophisticated structure, which does not require any assembly tools and generally any jointing hardware, is a main feature of NTR furniture. The popularity of this specific furniture in the United States, where people migrate for job reasons very often, is caused by its easy and quick dismountability. At the time when people move, they don’t have to sell this furniture with the house. For this reason, NTR furniture is sometimes indicated by acronym “nomadic furniture”. One of the main factors in NTR furniture development was rapid prototyping, a design method used for rapid and accurate production of product prototypes (architectural models, models of machinery, etc.) with the help of CNC equipment. Good examples of such furniture was produced by “The Simple Furniture Company” (Figure 1 and 2). In Europe, this furniture is being lately designed as well but it will probably take some time before it will appear in the production of European furniture companies. The Lobbyist chair and rocker from Dominik Lutz is the fine exemple of the EU designs.

Figure 1. (left) and 2. (right). Rekindle cofee table (left) and Surfin table from The Simple Furniture Company

Figure 3. (left). Lobbyist chair and rocker from Dominik Lutz

In general, the furniture design for CNC manufacturing is mostly being a subject of work of furniture design students and furniture technology students. As a university course this topic is in the United States taught very intensively, inter alia, in Wood Research Laboratory, Purdue University (Kodzi et al. 2007). A particularity of this furniture design consists in jointing system of its parts. The construction joints are often characterized by rounded corners, which are due to rotational movement of the most frequently used tools - router bits. One of the basic principles underlying the jointing of this furniture is based on the sliding parts in the slots and grooves. A similar jointing principle is used for dinosaur models, which are compiled by perpendicular sliding of profile parts made out of sheet materials (Oh et al. 2005). Sometimes this system is also compared to a puzzle game, again due to the similarity of jointing.

4. CONCEPT APPLICATIONS

Three successful prototypes of RTA furniture, produced with the aid of CNC machining technology are demonstrated at this point. The first example, depicted in Figure 4 is a multi-purpose table “Multi-Layout Table”, by industrial design student Nathaniel Grady (Purdue University, IN, USA). The second example (Figure 5) is an armchair with the option of upholstery and joints with magnetic holding, a student of furniture design, Ondřej Zahradníček (Mendel University in Brno, CZ).

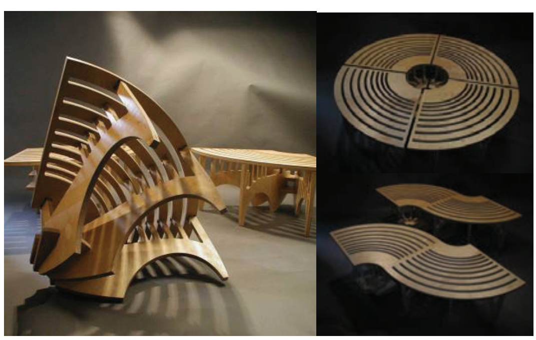

Figure 4. Multi-Layout Table by Nathaniel Grady

Figure 5. Armchair from Ondřej Zahradníček

The third example is probably the most globally conceived piece of furniture of this design concept. It is an adjustable rocking chair "Ellipse Rocking Dream" made out of plywood (Figure 6). The author of the design is Hongtao Zhou (Purdue University, IN, USA), who used for his furniture design the finger joint that was also tested for its mechanical strength. Design Emphasis Award (International Woodworking Fair, Atlanta 2006) illustrates the quality of this furniture design.

Figure 6. Rocking chair Ellipse Rocking Dream, by Hongtao Zhou

5. CONCLUSIONS

In this contribution, a new furniture production program option for the future, based on new technologies, creativity and innovations was introduced – furniture CNC manufacturing design. It is obvious that product innovation and competitiveness are not the only important factors in the strategy of furniture companies (Gazo et al. 2005, Quesada et al. 2007). The internal organization, quality of communication, teamwork, project management, relationships with business partners, national policy all play equally important role. A balanced combination of all strategic factors and flexibility should be the aim of any company that wants to be successful in a competitive environment.

Nowadays the "CNC manufacturing design" is being developed in educational courses and very rarely produced by furniture companies. Even though this design offers many advantages it will probably take some time before customers will be able to find this furniture design in their stores. The concept of furniture design for CNC manufacturing requires a complex knowledge of furniture creation, including the techniques of designing, computer modeling, prototyping, manufacturing, jointing, etc.

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FACTORS INFLUENCING CONSUMERS' PREFERENCES FOR WOOD-FRAMED HOUSES

Miriam Olšiaková, Vladislav Kaputa, Eva Drličková, Miloš Krššák

ABSTRACT

The paper presents findings of the survey focusing on consumer preferences in relation to wood-framed houses. In Slovakia, wood is one of the oldest building materials. Due to its availability, machinability and good structural properties, it achieved an irreplaceable place in the construction industry since the first settlement of Slovakia. Nowadays, various construction materials become substitutes to wood. Consumers have various expectations connected with wood properties. Slovaks strongly consider durability, fire safety, energy efficiency and maintenance. The survey also aimed at the tools of marketing communication that are supposed to be the most trustworthy to customers intended to own or live in wood-framed houses.

Keywords: preferences, wood-framed houses, marketing communication

1. INTRODUCTION

There is a prediction of growing population around the world which results in increasing demand for housing. As the global population increases, an increasing number of housing units will be needed. Housing density, as well as green building, represent significant factors in sustainable urban development (Dunse et al., 2013). Thus, high-rise buildings made of environmentally friendly, renewable materials will play an important role in a more sustainable built environment. Human dwellings must offer many different and often conflicting purposes to meet the broad needs of consumers. As a shelter, physical or technical quality is important. From the practical point of view, function is a very important requirement. Dwelling as a capital good should meet the expectation of economic quality (Thomsen, 2014). In each case, meeting consumer preferences for the materials used in buildings is critical. In order to support sustainable future built environment, it is imperative that policy makers, planners, architects, and construction companies should understand consumer housing and material preferences (Vasanen 2012). There were elaborated many consumer preference studies specific to building materials that have been conducted in academic as well as in the professional field focusing in visual evaluations of wood or specific products made from wood, haptic perceptions of products such as flooring (e.g. Broman, 2001; Berger et al., 2006; Kaputa and Paluš, 2014; Høibø et al., 2015).

Since the nineties of the last century, wood buildings have often been described by attributes such as modern and of highly desirable structures. This signature was obtained on the basis of a number of factors that show that modern wood buildings represent a good quality of housing achieved by rapid construction with excellent energy properties and a ratio between quality and cost. Wood is a perfectly usable material with many remarkable properties such as low weight, high strength and good thermal insulation properties (Pajtinka, 2012). Nowadays, wood begins to be perceived as a strategic resource and the share of use of wood in architecture is constantly increasing. Therefore, research and development centres in Europe and all over the world deal with essential and nano-characteristics of wood. It coves issues of flammability and fire protection, sound insulation, stability, structural systems and environmental requirements, but also issues of designing wooden buildings which meet market requirements and expectations (Kaputa, Kalamárová, 2014). Moreover, wood is called a new concrete and it is assumed that wood will be the most used construction material of the 21st century. We can state that wood has become popular and it is back in a new quality in various engineered products such as CLT (Cross-laminated timber), Glulam (Glue-laminated lumber), LVL (Laminated veneer lumber), LSL (Laminated strand lumber), Particle board and many others.

Understanding the consumer preferences for wood versus other materials in various applications within urban housing is limited, especially in relation to varying individual backgrounds. It can result in knowledge and experience differences with respect to building materials. This, in turn, may relate to varying attitudes when it comes to durability and environmental issues. Although consumers' preferences have just little influence on material selection, therefore they are weak predictors of building material's use in multifamily construction. On the other hand, information about consumer preferences is valuable for those who make these decisions. This is particularly important when new building systems and materials are introduced. Preference for building materials is related to tradition and should be studied in the context of their use, because people moving into urban areas may have different preferences than those who grew up in cities (Craig et al., 2002).

Knowledge about consumers' attitudes, associations and reactions toward wood and processed wood-based materials is one of particular attributes influencing the creation of appropriate marketing and development strategies. The main issue is to find those attributes that distinguish the material from alternatives and that are correlated with consumers´ preferences. The preferred attributes should be enhanced in product development and emphasized in market communication and promotion efforts. On the other hand, "unpopular" attributes should be reduced or compensated to overcome attitudinal barriers among customers (Solomon, 2006).

Wooden buildings have been historically considered as a synonymous of a rural dwelling. A higher standing in society was connected with a stone house. However, the present situation is completely different and the wood constructions are equivalent to other constructions (Štefancová, 2011). Wooden constructions are characterized by the fact that their construction is mostly made of wood or wood-based materials. A certain group of buildings can be labelled rather than wooden-assembled, since the used filler materials are not wood-based (e.g. glass, mineral and polystyrene insulation). The basic division of timber structures from the construction standpoint is: Log, Pillar, Half-timbered, Skeleton, Pre-fabricated (panel), Post and beam, and Cellular (Dudas and Jochim, 2008).

Wood-framed houses are known to have many positive properties. Wood is a renewable and universally useable material. It does not produce non-organic waste. It is used for both load-bearing and filler constructions as well as in furniture and carpentry. It also has positive mechanical properties. The main positive one is the low weight to carrying capacity ratio, which makes wood a more solid material than any other (Štefancová, 2011). Wood-based technologies are very perspective. They can meet the customer's requirements regarding aesthetics, healthy living, economy, interior design, or fire safety (Pajtinka, 2012). Each building helps to create two spaces. The interior one which is directly defined by the architectural work and the outer one – an urban space. For each of these spaces there are characteristic other requirements for their properties. Residential wood-framed houses are mainly created for the needs of internal use that influences the building requirements (Štefko a kol., 2010).

Besides knowing the consumers preferences and attitudes towards wood as a construction material, it is needful to know the best way how to communicate with them. This is also the aim of this paper.

2. METHODOLOGY

Questioning as the method for data obtaining has been utilised. The questionnaire was composed of closed questions. The respondent either selected one of the answers or indicated his preference on the scale. The scale in the questionnaire included values from 1 to 10, where 1 presents the smallest and 10 the highest value. The questionnaire was distributed during February and March 2018, and the distribution was done in a printed and an electronic form.

Based on Fornell (1996) we have used the consumer satisfaction index (CSI) for which a weighting factor (WF) and a weighted score (WS) have been calculated. The CSI is used to monitor and compare differences between the expected and perceived customer satisfaction. Before calculating the weighting factor, it is necessary to calculate the degree of importance of the individual consumers' requirements for wood buildings characteristics, which is calculated similarly to the degree of satisfaction (in case of accepted level of satisfaction with certain characteristics), resp. degree of confidence (in case of attitudes towards marketing communication tools) using the weighted arithmetic mean.

It is necessary to know a degree of importance (expressed as a weight of certain characteristic) in calculating a weighting factor (WF):

$$\mathrm{WF} = \frac{\mathrm{W}i}{\sum_{i=1}^{\mathrm{N}} \mathrm{W}i} .100\,[\text{in } \%] \qquad (1)$$

where: *Wi* – weight of certain characteristic; *N* – number of wood-framed house characteristics.

Multiplying a degree of satisfaction (Ii) by a weighting factor (WF) the weighted score (WS) is calculated:

$$WS = \frac{Ii.WF}{100} \qquad (2)$$

where*: Ii* – degree of satisfaction with certain characteristic of wood-framed house; *WF* – weighting factor for certain characteristic of wood-framed house.

Consumer satisfaction index (CSI) is a sum of weighted score expressed as percentage.

$$CSI = \sum_{i=1}^{N} WS\,.\,\frac{100}{x_n} \qquad (3)$$

where*: N* – number of wood-framed house characteristics; *WS* – weighted score; x_n – number of offered answers on a scale (width of scale).

We have followed the next steps to achieve the objective of the study:

- The number of consumers willing to live in a wood-framed house is based on a positive attitude of respondents to this issue.
- Preferred characteristics for wood-framed house and the level of satisfaction are based on the degree of importance and the degree of satisfaction. The calculated degree of importance relates to the individual requirements affecting a choice of wood-framed house. Subsequently, the requirements were ranked according to the calculated degree from the highest to the lowest. Thus, we obtained an order of requirements according to the weights given by respondents. The order according to satisfaction with the requirements was set through the degree of satisfaction.
- The lowest acceptable level for wood-framed houses' demands is expressed by the satisfaction index.
- Perceived confidence level of selected tools of marketing communication was calculated using the degree of confidence. Subsequently, the forms of communication were ranked in descending order. Thus, we obtained an order from the most to the least credible marketing tool.

The survey sample was comprised of respondents aged 18-60. They were divided according to the attractiveness of their economic status marked in the query. New housing is to be financed either from private or commercial sources. That is why we were particularly interested in economic active respondents – only responses of those respondents were analysed. Economic position was expressed within the three groups:

- Potential group – consisting of students, unemployed no more than 1 year, and persons on parental leave,
- Non-attractive group – consists of unemployed over 1 year and disabled persons,
- Attractive group – consists of employed respondents and early retired or retirement pension beneficiaries.

3. RESULTS AND DISCUSSION

We analysed 207 properly filled in questionnaires out of 235 distributed. Further, group of potential and attractive respondents (described in Methodology) was selected what represented 98% of the sample. Table 1 introduces results of analysis of the respondents who expressed willingness to live in a wood-framed house. Total share of such respondents is 74% from the group marked as "potential" and "attractive" in the sample. So, Table 1 shows the assessment of the requirements for wood-framed houses. There were examined all the indicators explained in the part Methodology.

Table 1. Assessment of the requirements for wood-framed house

Requirements for wood-framed houses	Order by weight	Degree of importance	Weighting factor (%)	Order by satisfaction	Degree of satisfaction	Weighted score
Fire safety	9	9.05	12.16	9	7.71	0.94
Lifespan	8	9.01	12.10	7	7.37	0.89
Energy Efficiency	7	8.93	12.00	8	7.42	0.89
Heat-insulation properties	6	8.66	11.63	6	7.03	0.82
Ratio of price and quality	5	8.53	11.46	5	6.92	0.79
Maintenance	4	8.18	10.99	4	6.74	0.74
Environmental friendliness	3	7.94	10.67	3	6.47	0.69
Acoustic properties	2	7.22	9.70	2	5.82	0.57
Speed of construction	1	6.93	9.31	1	5.45	0.51
TOTAL	-	74.45	100%	-	-	6.84
Consumer Satisfaction Index						68.4%

Respondents have identified the requirement fire safety, lifespan, and energy efficiency as having the greatest weight in case of wood-framed houses. The order slightly changed in the lowest acceptable degree of satisfaction with requirements, where the highest demands were on fire safety and energy efficiency followed by lifespan. The lowest values in the both analysed indicators had environmental friendliness, acoustic properties and speed of construction (in descending order). The consumer satisfaction index stood at 68.4%.

The impact of marketing communication on respondents

The influence of marketing communication on the decision to live in a wood-framed house has been investigated. We have found that marketing communication can affect 53% of respondents who already were thinking about living in a house based on wooden construction. Further, 12% of respondents who did not initially thought about wood-framed house would but would reappraised their attitude based on the impact of marketing communications. Interesting finding is that 21% of respondents are so convinced to live in a wooden house that marketing communication would have no impact on them. The remaining 14% of respondents are not interested and any form of marketing communication will change their attitude. Table 2 presents the degree of confidence of different tools of marketing communication within those respondents to whom marketing communication has some impact.

Table 2. Degree of confidence of different tools of marketing communication

Tools of marketing communication	Order by weight	Degree of confidence	Weighting factor (%)
Word of mouth	10	7.83	13.17
Public relations	9	7.71	13.00
Personal sale	8	7.59	12.77
Promotion	7	6.41	10.78
Viral marketing	6	5.55	9.33
Guerilla marketing	5	5.29	8.90
Advertising	4	5.03	8.46
White book	3	4.96	8.34
E- newsletter	2	4.79	8.06
Social networks	1	4.30	7.23
TOTAL	-	59.46	100%

According to the degree of confidence, the biggest influence had word of mouth, followed by public relations and personal sale. The least confident tools are white book, e-newsletter, and social networks (in descending order).

4. CONCLUSIONS

Findings from consumers' preferences studies and their favourite marketing communication form indicate that their preferences are affected by various attributes with regard to their age or economic activity. In general, the results should be relevant for decision makers involved in setting the appropriate marketing mix adapted for wooden constructions. So, the findings can be utilise by manufacturers and retailers of wood buildings. The results allow to design such forms of marketing communication that consumers regard as most effective and trustworthy. The survey provides an assessment of consumer requirements for wood-framed houses based on their expectations. The companies will know on what to focus in designing and promoting wood buildings.

Results in the area of consumers preferences and their attitudes towards wood as a construction material and wood-framed houses are significant, because wood si becoming more popular than ever before. In the global trend toward the construction of buildings that meet ecological needs, wood has some clear advantages over traditional construction materials such as steel and concrete. With advances in engineered wood materials and components come possibilities to construct increasingly larger buildings – a trend being witnessed around the world.

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APPLICATION OF THE BAR-CODE TECHNOLOGY IN A SYSTEM OF PRODUCTION MANAGEMENT: CASE STUDY OF SERBIAN PRODUCER OF WOOD-BASED PANEL FURNITURE

Miljan Kalem, Danica Lečić-Cvetković, Branko Glavonjić

ABSTRACT

The use of automated machines that have large capacities and large grade of flexibility represent one of the preconditions to the companies for furniture production in Serbia to respond to high demands of the market. In order to use automated machines, it is necessary to apply the technology which will distribute all information that are necessary for performing operations on the machines in the right time and in the right form. One of the most commonly used technologies to distribute and convert information between the information system and automated machine is the bar-code technology. In this paper, the significance of bar-code technology for the operation of the automated machines is presented, using the case study of the company for production of wood-based panel furniture. Additionally, the ability of using bar-code technology in the performance of other activities of the company is also presented. The aim of this paper is to present how the application of the bar-code technology facilitates production management in the company for the production of wood-based panel furniture by speeding up the performance of the operations in the company.

Key words: bar-code, furniture production, automated production, information system, production management

1. INTRODUCTION

Modern business conditions, which are reflected into increasing needs imposed by customers and large competition at the market, impose a large business challenge for every company for production of wood-based panel furniture. In order to attract customers` attention, the company must produce a product which is interesting for them. The product should be different from other products at the market and at the same time has to be economic for production. Beside organizational measurements, of which the most important are typization and standardization of products assortment and design of products according to the demands of customers, it is necessary to use automated machines that have a high capacity and high degree of flexibility. In order to make the use of automated machines possible and so that these machines can achieve their maximum capacity, it is necessary to use the technology, which distributes all information necessary for the operation of these machines. Information must be distributed to the machine at the right time and in the right form.

The same information is used in one company but in the different form. The operator uses the information in one form, an information system uses the information in the other form and the machine needs the information in the third form, so it is necessary to use the technology for distribution of information through the system and converting information from one form to the other. One of the most commonly used technology for distribution and converting information in the production systems is bar-code technology. The role of bar-code technology is to distribute information through the production system in the appropriate form in the fastest way.

Development of information technologies provides a wide range of options for selecting the technology that the company will use for distribution and converting of information in its production system. Besides a large number of new technologies, one of the most used technologies, although it has been existing for a long time, is the bar-code technology. Advantages of the bar-code technologies are simple to use, low cost of implementation, low cost of servicing, efficient and safe for work.

In this paper, the example of application of the bar-code technology for distribution and converting information between information system and machines in the selected company for production of wood-based panel furniture in the Republic of Serbia was presented. Also the ability of using bar-code technology in performing some other activities, primarily activities related to the raw material and finished products storage.

The main goal of this paper is to present the procedures and principles of application of bar-code technology in the production management system on the example of the company for the production of wood-based panel furniture.

The research presented in this paper was done in the selected company for production of wood-based panel furniture, currently one of the largest companies in this area in the Republic of Serbia. The paper consists of five chapters. After the introduction, the second chapter presents development of bar-code technology. In the third chapter the example of application of the bar-code technology in selected company and results of the research are presented. In the fourth chapter the conclusions of the research are presented, while the fifth chapter consists of a list of references.

2. BAR CODE TECHNOLOGY

Development of modern concept of management is narrowly connected with increasing use of new technical resources and technical achievements. Implementation of a high degree of automation in the system of production management implies application of modern information and Internet technologies in the process of management. Use of modern technologies, method and resources is conditional from objective needs to develop modern production. Complete functions of production management, which increase the volume of production, and increase the complexity of production, are conditioned by modern technologies. Using computer and information systems accelerates processing and transfer of large amount information, which are necessary for decision making (Lečić-Cvetković D., 2015).

Bar-code technology, as one group of information technologies has a wide range of applications in different industries. One of the applications of bar-code technology is in the manufacturing companies, which can achieve better business results using bar-code technology.

Bar-code technology appeared in the1930s, when a young student Wallace Flint came to an idea to accelerate the process of payment of goods at the cash register. After World War II bar-code technology started to develop, but its full application in the practice was experienced in the 1970s with the development of lasers (Jaćimović D.,2010).

The meaningful series of the dark lines and light fields between the dark lines are represented the bar-code which carry certain information. Using the bar-code reader, the information are read and in the right form distributed, stored and processed in the information system. (Kalem M.,2018).

Bar-code reading system comprises of a handheld electronic device and a bar-code reader. The handheld electronic device comprises of an operation-processing unit and a memory unit, and the bar-code reader is attached to the handheld electronic device comprised of housing, an output end and a bar code acquisition unit (Mobilogics International Co., Ltd.).

Due to the increasing use of bar-code technology since 1997, there is a need to legally regulate its using. The European Article Numbering Association (EAN) association was established. Today, more than 100 countries are the members of this association. Every member of this association has unique numbers consisted of three digits and this number is assigned by the EAN associate. This number shows which country is the origin of goods from. Every country, which is a member of this association, is assigned a unique number to the companies from its country, which is consisted of five digits. The companies have range of numbers on disposal, which consist of four digits and this number marks the goods of a company. Beside these twelve digits, which make the bar-code, the bar-code has a thirteenth number. This number is a control number, obtained by combining the previous twelve numbers (https://www.gs1.org/standards).

Beside the EAN 13 bar-code that is the most often EAN bar-code used in the practice, a large number of other codes are also in use, but small number of other codes have found their use in practice. Beside EAN 13, the most frequently used codes in the practice are: EAN 8, code 128, code 39 and many types of 2D codes (Jaćimović D.,2010). Beside EAN and UPC bar-codes, there are internal bar-codes, which companies use in its practice.

Even though barcoding has grown to have many applications in retail trade and stores selling consumer goods, there is still space for improvement in business processes in specific business systems. If implemented in the large production systems as a support to ERP systems, it can make a difference in the business processes, especially in terms of improving sales processes through the improvement of warehouse processes. Timely and updated information on the current state of stocks or shipping schedule are prerequisite to competitiveness in the global trade (Pihiri I.,2011).

In this paper, the influence of the application of bar-code technology on the process of production management in the company for production of wood-based panel furniture is presented. Factors which can influence the performances of the company, the relations between achieved business results and the exploitation of man-power belong to the factors of productivity. Technical factors influence to the productivity through technical realization, which implies changes of technical structure fixed assets and technical conditions of work. This implies the introduction of new and modern equipment in the structure of fixed assets which leads to the change of work conditions and increase of productivity (Glavonjić B.,2010).

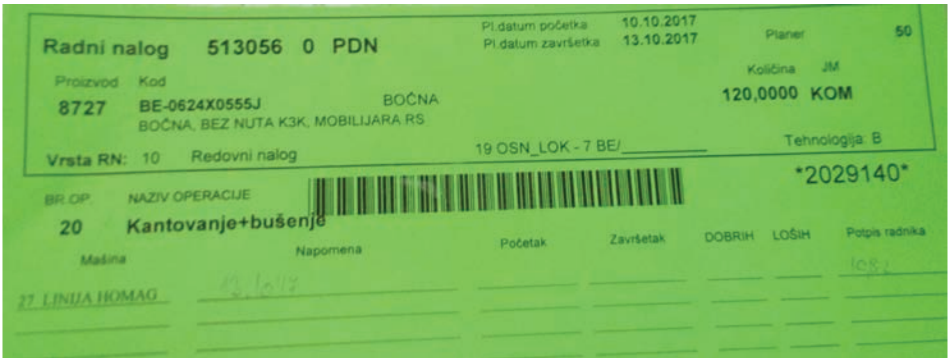
3. APPLICATION OF THE BAR CODE TECHNOLOGY IN THE SISTEM OF MANAGEMENT PRODUCTION

Wood based panel furniture belongs to the group of furniture with low selling price and for this reason it is necessary to provide high productivity and economy of this production. One of the main conditions to achieve high productivity and economical production is using of automated machines that have a high degree of flexibility. Since the production of panel furniture is relatively simple production process, which consists of the three operations for the largest number of products, to perform this operations relatively small number of machines are used.

Production process in the company where the research was conducted for the production of largest numbers of the products is consisted of the following three operations: cutting component elements of the products from the panel, edging the component elements and making link elements on the component elements. Panel cutting is done using three horizontal cutting machines, which have a capacity approximately as the lines for edging and drilling. All information necessary for the work of this line are distributed using the bar-code technology.

Figure 1 shows document working order with bar-code. Beside bar-code, this document contains verbal data that refer to the name of the component element, the name of product, which the component element belongs to, the number of component elements, which should be produced and the scheduled time of the start and end of working order. Also, this document contains the designate working places where the production operations have to be performed on component elements.

The mentioned verbal data are necessary for the workers on machines, in order to read what operations have to be done on the component elements. The same information machines get by loading data from the bar-code on document working order. Beside those, verbal data at the working orders, which workers use to control the performance of production operations.


Radni nalog 513056 0 PDN
Pl.datum početka 10.10.2017
Pl.datum završetka 13.10.2017
Planer 50
Proizvod Kod
8727 BE-0624X0555J BOČNA
BOČNA, BEZ NUTA K3K, MOBILIJARA RS
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Vrsta RN: 10 Redovni nalog
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BR.OP. NAZIV OPERACIJE
20 Kantovanje+bušenje
Mašina Napomena Početak Završetak DOBRIH LOŠIH Potpis radnika
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Figure 1. Working order with a bar code (Company Data, 2018)

Information system in selected company has a key role in the application of the bar-code technology in the system of production management in this company. The information system is used for creating the unique internal bar-code, which is necessary for making operations on the line for edging and drilling of the component elements and all products from the product range.

The process of creating a new bar-code starts with the entry of a new product in the information system. When the new product is created by the project team, after that product is approved for production by higher management, the product is entered in the information system. Entry of the information about the new product and component elements of product in the information system is the first step in the application of bar-code technology in this company. The dimension of component elements of the product, places where connection elements are produced, tools used for processing the component element, sides on which the edging track have to be apply, are just some of the information which are entered in the information system and they are necessary for the operation of edging and drilling of the component elements. Based on the mentioned information and information about the name of the new product and the code of the décor in which the new product will be produced, the information system will create a unique code for the every component element of the product, and based on this code, a unique bar-code. Information about the product and component elements of the products are entered in the information system using the document named Bill of material (BOM). This document in selected company is created by the worker who has a large work experience and very well knows the product range of the company.

After the bar-code is created for every component element of the product, it is necessary to load the bar-code in the line for edging and drilling of elements, i.e. in the machines on this line. Loading of the bar-code means loading the definite operations, which are necessary to perform for the loaded bar-code on the machines.

The process of loading the bar-code in the machine is consisted of crossing the bar-code reader across the bar-code that is printed on the paper. Information necessary for line operation for edging and drilling of component elements of products are: the dimensions of elements, edge of elements where edging track has to be applied, width, thickness and color of the edging track, positions of the connection elements, dimensions of the connection elements, places for opens and grooves on the elements with their dimensions and tools which are used for every operation. When the bar-code is loaded in the machine, the machine automatically adjusts all previously assigned parameters for that bar-code, considerably faster and more precisely than in the case when the machine is adjusted by a worker. Also, the possibility of a data entry errors in this case is reduced to the minimum.

In the case that machine does not find the loaded bar-code in the information system database, the machine gives an opportunity to enter all information manually. The operator on the machine has the duty to enter all necessary information for every component element and its bar-code in the machine and to enter all information necessary for machine operation. The operator enters information in the machine using the documents created in the department for constructive production preparation and information from the information system database.

After the information related to a certain component element are once loaded into the machine (database of information system), when reloading the same bar-code, the machine automatically does necessary adjustment of parameters for this component element.

The bar-code technology also allows to collect and send information on the object currently being processed on the machine to the information system database. This enables to determine the exact status of the product in the production process at any time. Besides this, these information enable the creation of more precise production plans and analyze eventual fault on the machines.

The advantages of applying bar-code technology in the line for edging and drilling are numerous. The most important advantage of applying bar-code technology in this line is shortening the preparatory-finishing time, which is reflected in the increase of productivity.

Also, one of the advantages of applying the bar-code technology on automated machines is the automation of the process for controlling the performance of operations. In this case, the machine itself controls every object in the production and in the case of a fault, the machine stops operating until the fault is not solved. Another advantage of using this machine is the equal duration for executing of the same operation on the same component element, which allows precise planning and scheduling of the production process.

Application of automated machines and bar-code technology in the company where this study is conducted also enables elimination of the stocks between machines in production, since they enable harmonization of machines capacities.

Beside the presented advantages of the application of the bar-code technology in this company, which relate to the execution of operations of the technology process i.e.

production management, this technology can be applied in the observed company in the storage of raw materials, as well as in the storage of finished products where they can also achieve great advantages and improvements of these processes.

Since the reception of the raw material in this company is performed manually, i.e. the worker manually records the quantity of the received material in the storage, time, name of the supplier and the place where to store the goods in the storage, in this segment this company has an opportunity to apply the bar-code technology. Considering the fact that this company has information system, which has the possibility, in addition to internal bar-codes, to use EAN codes, by which the supplier encoded materials, the application of bar-code technology in this segment of business will significantly accelerate the process of reception of raw materials, facilitate the recording and storage of raw materials. In case if the company used the bar-code technology, the worker in storage would load the bar-code from the row material automatically in the information system, entering all necessary information about the received row.

The storage of finished products is another place in this company where there are opportunities for application of bar-code technology. Manual recording of received and finished products, the position of products in the storage, the quantity and type of products, which need to be delivered from the storage are tasks, which can be significantly accelerated using bar-code technology. Box with the finished products already contains bar-code of products located in there. This bar-code is also used by the business partners of this company for their needs, so, application of the bar-code technology can provide numerous advantages for this company. Primarily, the application of bar-code technology can provide accelerated analysis of quantity of products in the storage and create production plan more precisely.

4. CONCLUSION

Results of research conducted in the selected company for production of wood-based panel furniture presented in this paper points to the fact that the application bar-code technology has a great advantage and it has positive influence at the company's business results. The application of the bar-code technology enables the operation of automated machines in the company that, with their characteristics, provide a highly productive and flexible production process. The main role of the bar-code technology is reflected in connecting the information system and all of the information related to a particular product with the machines involved in the production process.

Loading of bar-code from document working order eliminates manual entry of data related to the object of production. This significantly shortens the production preparatory-finishing time, reduces opportunity for errors, eliminates a great quantity of paper documentation and needs less storage space. All this have direct influence on the increase of productivity and better business results.

Beside the advantages in the system of production management, implementation of the bar-code technology in other departments of the company can significantly facilitate the performance of a large number of other activities, primarily those ones, which are related to the storage of raw material and finished products. Implementation of bar-code technology in the storage of raw material and finished products allows faster, more precise and easier processing of data related to the quantity of goods in the storage.

The future directions of the research will be focused on the application of RFID technology in the company for furniture production, as modern technology for tracking products in the company, and provide certain advantages over the bar-code technology. Significance and advantage of application of RFID technology in the system of production management in the company for production of wood-based panel furniture will be the main subject of the future research.

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THE SPECIFITY OF FURNITURE PRODUCTION PROBLEMS OF MICROENTERPRISES IN POLAND

Renata Stasiak-Betlejewska

ABSTRACT

The subject of the research analysis in the paper is an analysis of the production system in the group of furniture micro-enterprises. The analysis focuses on the difficulties occurring in the manufacturing process, production delays and causes of its occurrence. The interpretation of the analysis results is in the form of recommendations regarding maintaining production liquidity in the analysed type of enterprises.

Keywords: production management, micro-enterprise, furniture industry

1. INTRODUCTION

Production management is the management of the production process by which goods and services are made. Research on production management can be found in a large and growing volume of literatures including the big number of concepts derived from Japanese automobile industry [5]. According to Filippini (1997), Just in time (JIT) and Quality Control (QC) - two building blocks of the Toyota Production System [12] are becoming two key areas of the production management discipline. Issues of the product manufacturing management analysed in the paper are referred to the production management [2,13, 8]. According to O'Connor (1994) there are principles of production organization such as:

1. convert designs into products, at the lowest cost. A production system takes inputs - raw materials, capital, machinery, labour, information, time and other resources - and transforms them into outputs in the form of products and services of higher value than the inputs. It may also be reviewed as a value-adding process;
2. all processes are operated or influenced by people, even though the automation has been increasingly adopted to replace human efforts;
3. as far as practicable, nothing should be made that cannot be billed immediately as it leaves the factory.

The management process concerns processes related to the following processes: planning, scheduling, commanding, coordinating and controlling business activities [14]. According to Drucker (1986), production doesn't concern applying tools to materials but applying of logic to work, so the aim of the production management is to understand the logic behind each system of production and to apply appropriate principles. The production organization management methods depends on the production organization form that includes the flow of products, parts and assemblies between the working positions in the full production cycle. Two main methods of production organization can be indicated [1]:

- rhythmic production, otherwise known as repetitive, pipelined, fixed-body or stabilized, the characteristic feature of which is that the direction of the flow of work objects between individual work stations, which are arranged in a fixed order consistent with the process stages, is constant;
- non-rhythmic production, otherwise known as nest, non-pulmonary, unstabilized, unique or variable lot, the characteristic feature of which is that the direction of materials between the positions is variable, and each of the positions may cooperate with other positions with a change in the order of technological operations.

The production system in every company is affected by many factors related to the characteristics of its environment and conditions of the local economy, but also national and global. However, when analysing the environment of the production system, the greatest attention should be paid to internal factors including the personnel employed, research and development activities, the level of production technology, sales and supply organization, marketing measures and methods, financial resources, but also their liquidity or speed of turnover, efficient functioning of economic, accounting and development services. Among the external factors, the greatest role in shaping the production system is played by: the level of technology and distribution of production, the quality of service, the possibility of purchasing modern, high-quality equipment, but also the product price [7].

Poland is one of the world leaders in terms of the value of furniture production and its export. It is evidenced not only by statistical data on production and foreign exchange, but also by the level of development of many Polish companies operating in this industry. The factors that affect this situation are primarily the high quality of furniture produced in Poland and relatively low labour costs. However, it should be realized that these elements may be insufficient to maintain the current growth rate [6]. The value of furniture production in 2016 has already exceeded PLN 42 billion (including micro-companies). Currently, Polish furniture has nearly 26,000 registered entities, of which over 22,000 are micro-enterprises, almost 1,500 are small companies, about 330 - medium-sized companies and 89 - large enterprises. Forecasts for the following years are equally optimistic - by 2020, the sold production will increase to almost PLN 50 billion. The entire furniture industry in 2010-2015 grew at an average annual rate of 8.7%, which is a better result than the entire Polish industrial processing (5.2%) [9]. The furniture production sector in the second quarter of 2016 recorded the highest level of production capacity utilization of 87.1%, with the 78.3% index in the entire domestic processing industry.

Microenterprises are defined as enterprises employing less than ten employees whose annual turnover and / or total annual balance does not exceed EUR 2 million [10]. A frequently repeated view is that the microenterprises are more flexible that faster response to the market situation. An important feature of microenterprises are also high adaptation abilities, which in the world of dynamic changes is desirable from any company that wants to meet the requirements and satisfy the customer and the buyer. Technologies used in small, family carpentry factories differ from those used in large factories producing furniture in a mass or serial way. Selecting machines carpenter should pay special attention to their technical characteristics, in particular the range of functions, power and range of additional equipment. It is also necessary to consider the compatibility of devices with the specificity of production of a given carpentry workshop, which will allow a good correlation between the throughput of machines and the type and scale of carpenter's orders. A modern method which is an alternative to the above-mentioned traditional technology used in carpentry factories is Nested Based Manufacturing, which significantly shortens, and at the same time streamlines the production process, especially in curved cuts. It allows for better use of the raw material and reduction of the amount of waste produced thanks to the option of positioning entire sheets of boards. In addition, it enables better use of time and efficient use of it for other tasks, such as mounting fittings or edge banding, which an employee can perform with greater precision.

The purpose of this work is to analyse the production system organization in a selected carpentries on the example of a microenterprises situated in the Łódź region in Poland. Taking up this task, the author in the extended scope characterized difficulties occurring in the furniture production process in the examined plants, which result in significant delays in the execution of orders and disturbance in the liquidity of small-series furniture production made exclusively for individual customer orders.

2. CHARACTERISTICS OF THE EXAMINED FURNITURE MICROENTERPRISES

The examined microenterprises were founded in period 1990 - 1999 in the Southern part of the Łódź Province that is in the forefront of Polish voivodships in terms of the number of business entities operating in the furniture industry. The analysed plants are modern and dynamically developing family businesses (carpentries) specializing in the production and sale of various types of furniture. Examined microenterprises specialize mainly in the production of the kitchen furniture, room and sliding wardrobes, however, due to the demand on the local market, a significant percentage of manufactured furniture is made to individual customer's order. In the analysed group of enterprises, a small-scale and multi-assortment production is characterized by both a significant level of variability of the manufactured assortment and a high level of generality of imposed procedures and accepted standards, which requires versatility, flexibility and, in some cases, the ability to operate several workstations simultaneously or in small intervals. In this type of activity, the dominant position of the human factor in the production process should be taken into account, which results from the high importance of individual, individual decisions and involvement of people responsible for individual production activities. The high variability and diversity of production in the examined companies resulting from the orders received from customers for the performance of various furniture, enforces a high degree of flexibility that can be achieved only by using the natural human ability to adapt to new, constantly changing working conditions and human creativity, willingness to constantly learn and follow new trends in interior design. Factors mentioned above are major difficulties in the analysed production microenterprises. It was noted there that is not possible to determine the standard time periods needed to execute a given order, because they are different and depend on the type of material, the amount of individual furniture elements and customer guidelines. Products manufactured under orders may differ significantly, which in turn results in a different degree of involvement of personnel in their production. For this reason, analysed enterprises set the date of each order individually, after prior analysis of the supply, the workload of employees, but also the burden on co-operators, if their cooperation in the implementation is necessary. Therefore, when analysing the production system in the carpentries, it is necessary to thoroughly investigate the issue of its timeliness, which being a measure of reliability, is understood as the ability to meet the agreed delivery dates in terms of quantity and quality. Timeliness is also defined as the ratio of the number of orders delivered to the client in the promised period in relation to the number of all deliveries made in a given unit of time.

3. RESEARCH FINDINGS ANALYSIS AND DISCUSSION

Analysing the difficulties in the enterprises production process, it can be concluded that all source reasons for the lack of timeliness should be classified in the following areas:

- delays resulting from incorrect planning that occur at the stage of accepting and planning the implementation of individual orders, and often result from excessive optimism in setting deadlines for execution of orders, improper measurements, incorrect reading and understanding of the client's intentions regarding the appearance of his dream furniture, and the failure to take into account possible shortages or storage other production obstacles;
- delays associated with improper control of production, which arise, inter alia, due to incompatibility of the schedule with the actual production rate, such delays occur during the production phase;
- delays arising as a result of various, unplanned events that are unpredictable, e.g. technological problems, delays in the delivery dates of materials and accessories for production, difficulties occurring during assembly at the customer's already finished furniture, and resulting from incorrect dimensioning or performance incompatible with measurements.

Causes of the above delays can result from: individual human decisions, negligence of staff, incorrect procedures or improper use of them and defective production technology. In order to correctly identify the root causes of production delays occurring in the enterprise, undertaken efforts to obtain details of the conditions and specifics of the work, the type of products and the method of their preparation of the initial materials to finished installation of furniture indicated by the final recipients. In order to analyse the phenomenon, the algorithm of finding causes of delays is presented in Figure 1.

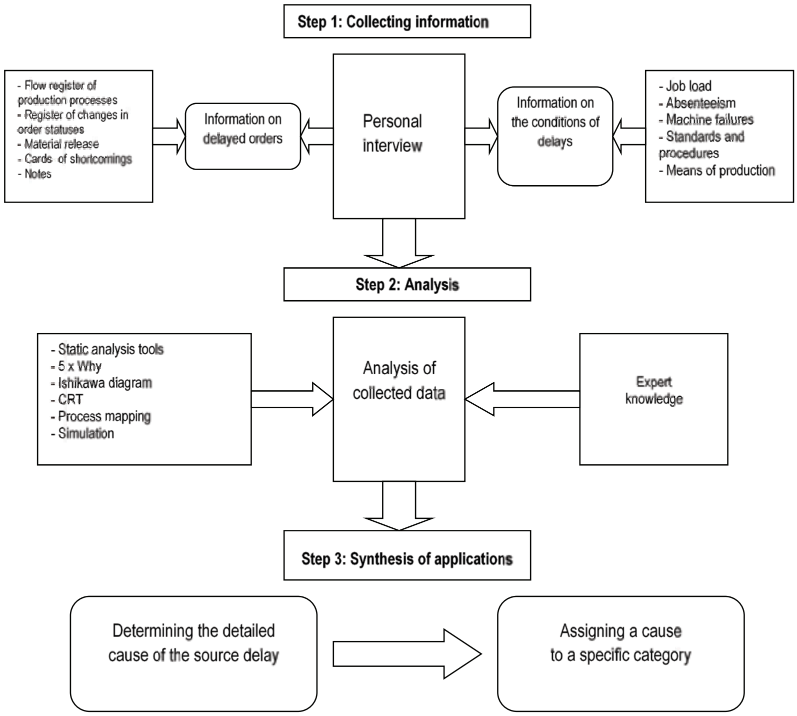

Figure 1. Algorithm of finding causes of delays in the examined microenterprises.

The algorithm consists of three consecutive steps that were carried out in the group of examined group of microenterprises. First step involves collecting information collected e.g. in the register of technological operations (who, where, when and at what time the operation was performed) and in the deficit cards issued by the quality control department. In addition, in the longer term including the period of writing the diploma thesis, data were also collected regarding the conditions in which individual delays occurred in the production process carried out in the carpentry workshop. As part of the implementation of second step, all collected data was subjected to a detailed analysis aimed at determining the source causes of delays in the production system. For this purpose, various tools of cause-and-effect analysis, value stream mapping, simulation and statistical analysis tools are usually used. However, the Ishikawa diagram was elaborated (Fig. 2), because the appropriate visualization of this scheme in the shape of “fish bone” guarantees obtaining a structure ordered between the identified elements of the process. Its essence is a graphic illustration of mutual correlations between effects and causes that may cause them.

The third step of the algorithm for finding reasons for delays involves the synthesis of applications for which a high level of the expert knowledge is needed for a researcher looking for source reasons in terms of both product and technological process, production system and personnel being an important element of the entire manufacturing process.

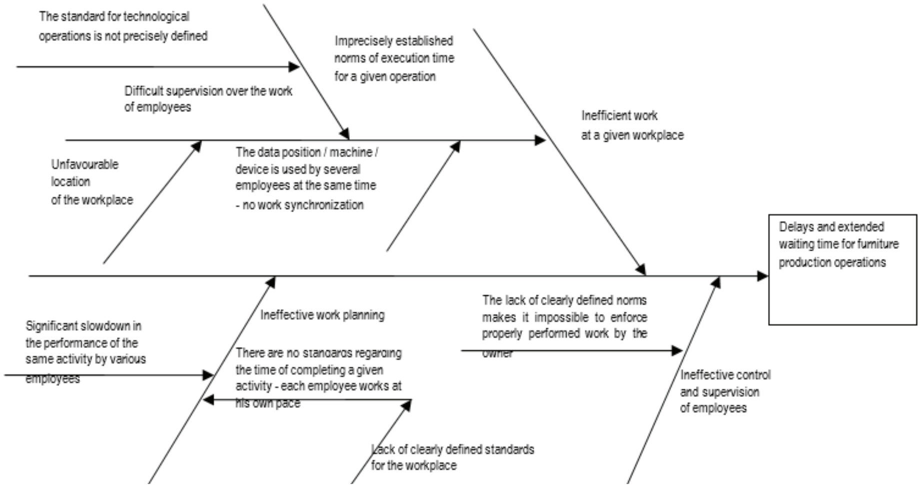

Figure 2. Ishikawa diagram for the problem of production delays occurring in the examined microenterprises.

Standards for technological operations that are not precisely defined and an ineffective control and supervision of employee have been recognized as the reasons of delays in the production process. There was also oral questionnaire, which asked for an individual, and at the same time subjective indication of the reasons for delays in the analysed furniture production processes. All indicated answers were classified into seven categories of events causing delays in the furniture production. The most significant factor that influence on the delays occurring in the production operations is insufficient production capacity (44%) and delays in material delivery (35%). Other reasons of the analysed delays are following: technological problems (9%), delays in services delivery (5%), planning error (4%), production shortages (2%), other causes random (1%). On the basis of the information presented above, it should be stated that according to the owner of the company and its employees, the biggest problem in the implemented production system exists in the scope of insufficient number of machines and employees servicing them. However, it should be noted that the results obtained in the survey indicate, to a large extent, symptoms and not the real causes of delays, which after a deeper analysis of the research problem turns out to be not necessarily in insufficient machine and human resources, but rather in incorrect planning of the furniture production process. Production in any carpentry, not for serial production, but realizing individual customer orders is characterized by considerable seasonality. In addition, attention should be paid to the relatively high share of different types of standards and planning procedures in force at the company, which is a real cause of any production delays. It should be emphasized at the same time that these procedures and standards have a significant impact on the timely and reliable implementation of non-delayed orders, so it does not necessarily mean that they require change, or only improvement.

4. CONCLUSION

In order to maintain production flow in the enterprise, the analysed enterprises management should radically change the approach to the furniture production process, and instead of focusing on solving existing or emerging problems in a reactive manner, the owner should first focus on proactive pre-planning, the aim of which is eliminating defective machines and their components as well as unplanned downtime. It is essential that before taking action to optimize the production system, guarantee the reliability and safety of manufacturing processes by eliminating defective machines and materials, which is largely associated with unplanned downtime. Ensuring safety requires above all a stable production environment that can be obtained by, among others, maintenance of all machines, accessories and assembly elements used in the production process. Considering recommendations regarding the production system maintenance in the analysed enterprises, one should also take into account the fact that the costs of the production being performed are the sum of the costs of tools and the processing of carpentry materials. The management in the examined enterprises should focus on an even load of personnel and machines, which will only be possible if the orders are distributed evenly throughout the calendar year, i.e. obtaining more orders in the autumn and winter to fully use the production capacity and justify the invested in the equipment and financial resources.

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USE OF WOOD IN 3D PRINTING TECHNOLOGY – Case Studies

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ABSTRACT

Additive manufacturing, also known as 3D printing can be considered as a modern technology and it enables the fabrication of complex geometrical shapes, used for prototypes or unique individual pieces. Additive manufacturing technologies have developed greatly over the last decade in terms of technology and printing materials. Special emphasis is placed on the development of cheaper materials derived from natural sources, without the release of harmful substances during the manufacturing process, with the possibility of using waste materials and recycling after service life. Wood or wood residues are among the potential raw materials that could be used for 3D printing in combinations with natural and synthetic polymers. It is anticipated that, with the development of additive technologies, the use of wood will also expand to the area of structural elements, such as in the construction of prefabricated houses. A review of publications on the topic of 3D printing with natural raw materials with an emphasis on wood biomass and technologies, where the use of wood particles is possible, was made. Some case studies of ongoing research as well as student's workshop on 3D printing design and developments will be presented.

Keywords: 3D printing technology, additive technology, wood, wood-plastic composites

1. INTRODUCTION

3D printing is an attractive technology that offers numerous new possibilities for the manufacturing of products. It enables users to create real objects based on a virtual computer model and thus opens up an almost unimaginable number of possibilities. 3D printing is classified as an additive manufacturing (AM) process, where the material is added in layers, allowing users to create a real product directly from a 3D computer model. The primary advantages of 3D printing are the possibility of producing complex products without special tools or moulds etc., for producing prototypes of low-volume customized products or unique one-piece products and efficiently using raw material, leading to low or zero waste (Wimmer et al. 2015). Materials for 3D printing range from polymers (polyamide, acrylonitrile butadiene styrene (ABS), polylactic acid (PLA), polyvinyl alcohol (PVA)) to even ceramic, gypsum, metals (stainless steel, gold and silver, titanium) to even concrete for 3D printing in the construction industry (Kariz et al. 2016). The price of 3D printed parts is dictated by the production time to build the product with the layer-by-layer build process and materials used as filament. Currently, standard polymers used for 3D printing are acrylonitile butadiene styrene (ABS) and polylactic acid (PLA). These filaments are available in either 1.75 or 3.00 mm diameters and are sold in spools at a cost rate of $15–30 per pound. (Tisserat et al. 2015). Plant fiber/plastic matrix composites have special advantages including moderate density, easy degradation, and better economy. This new eco-material would also provide ideas for FDM applications in brand new areas.

Wood is an organic material that is widely available in the form of wood residues. Small pieces of wood, chips and particles can be milled into smaller fractions to provide a fine wood powder, which can then be used as a filler material in 3D printing with conventional plastic materials. Wood powder can also be used for printing in combination with a variety of commercial and natural adhesives. In this way the impact of 3D-printed products on the environment can be dramatically reduced. It is commonly used in the manufacture of wood plastic composite due to significant advantages such as high modulus, low price, good machinability, renewable, abundant, and problem-free disposal. The wood flour has significant advantages as compared to the thermoplastics are considerably cheaper than thermoplastics (200 USD per ton while 1 ton of PLA is 1200 to 2000 USD). Biocomposites using wood flour compounded with polyethylene or polypropylene are used to make a variety of commercial products because they are less expensive and provide unique mechanical properties when compared to neat resins. As the wood flour is incorporated in the thermoplastics the price of material for 3D printers can be decreased, which considerably increase the use of 3D printer in near future. In addition, the consumers will prefer the environmentally friendly materials for their 3D materials. Cellulose is non-allergic, tolerating high temperatures, and is an excellent electric insulator material, which can be processed with many 3D-printing methods. In this study, the recent case studies on the 3D printed products using different formulation of wood/plastic filaments were reviewed.

2. CASE STUDIES

2.1. 3D filament formulation development experiments

FPInnovations and Emily Carr University of Art and Design (Vancouver) collaborated to explore 3D printing of powdered lignin using powder-binding technology (Li et al. 2016). This work is being continued by FPInnovations and includes the development of wood-based filaments for 3D FDM technology. The objects are made from filaments composed of thermoplastic polymers containing lignin filler and fibre materials. In 2012, CCProducts created Laywoo-D3 [36], which contains up to 40% recycled wood fibre combined with a thermoplastic polymer binder (Fig. 1a). ColorFabb, produced by Helian Polymers of The Netherlands, offers WoodfillTM, which contains 25%–30% milled wood fibre in a thermoplastic resin (Fig. 1b). ColorFabb, produced by Helian Polymers of The Netherlands, offers WoodfillTM, which contains 25%–30% milled wood fibre in a thermoplastic resin. Significant efforts world-wide in recent years have led to the production of large quantities of biomaterials in pilot and demonstration plants (Li et al. 2016).

Figure 1. Developing lignocellulosic-based feedstock for 3D printing at FPInnovations: (a) prototypes made using the powder-binding technology; (b) prototypes made using FDM technology (Li et al. 2016)

Using a bio-printer, Swansea University in Wales has prepared 3D-printed wound dressings using nanofibrillated cellulose (NFC) supplied by the Norwegian Paper and Fibre Research Institute (Li et al. 2016). They described their resulting material as strong, able to be kept under moist conditions, and possessing inherent anti-microbial activity—this last perhaps the result of surface modification during the oxidative process used to prepare the nanofibrils. The Swansea group also used more conventional materials to build a 3D scaffolding that effectively formed a collagen-like structure (Li et al. 2016). In a previous study, Wimmer et al. (2015) reported that bio-based filaments can be designed for a variety of product properties, showing good printability. Good type-haptic was achieved, along with good mechanical properties and low warping. A PLA-type filament, blended with 15% PHA, and filled with 15% cellulose (pulp) has delivered reproducible results. The properties of filaments containing plant fibers and 3D printed samples were studied in the literature (Kariz et al. 2016; Le Duigou et al. 2016; Girdis et al. 2017).

The rheological properties of 3D-printed samples produced from different types and contents of wood and thermoplastics, and printing settings were investigated by Kariz et al (2018). They reported that the highest storage modulus, measured with a rheometer, was in samples printed from filament B (PLA), and the smallest modulus was obtained from Filament C (co-polyester with 40% wood). The storage modulus of samples of Filament D (PLA with 35-40 % wood), Filament A (ABS), and Filament B (PLA) exhibited a slight decrease in the storage modulus as the printing layer thickness was increased. However, the storage modulus increased for the materials in Filament E (PLA with 30% wood) and Filament C (co-polyester with 40% wood).

Example 1: Use of wood powder and adhesive as a mixture for 3D printing (Kariz et al. 2016) (Fig 2).

- Paste extrusion, mixture of fine wood powder and commercial PVAc and UF adhesive
- DIY delta 3D printer
- MOE of 3D printed parts depended on used adhesive and wood/adhesive ratio (Fig. 3).

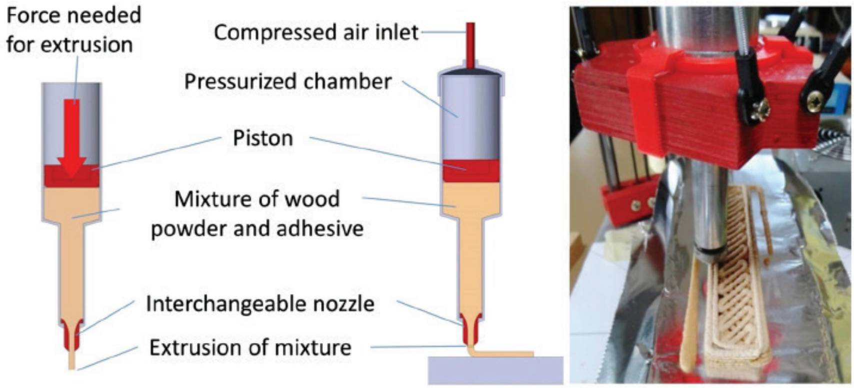


Figure 2. a Test setup for measuring the extrusion force by means of a universal testing machine (left) and the test set-up for 3D printing with a pressurized chamber (right), b 3D printing with a mixture of wood powder and adhesive

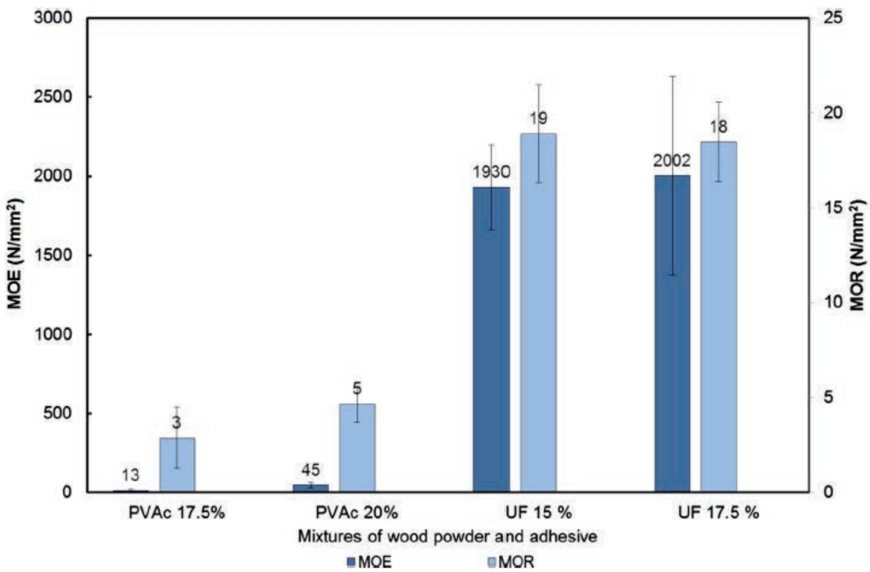
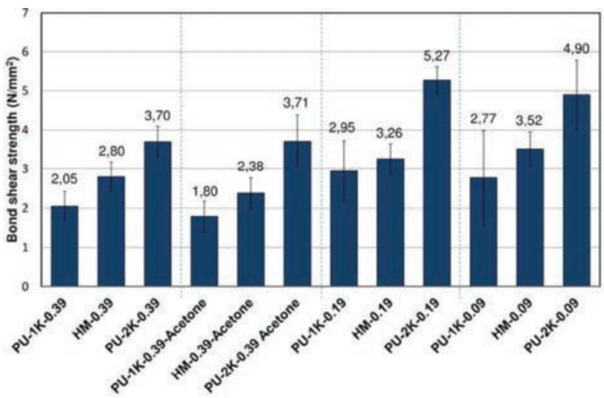


Figure 3. Average bending strength (MOR) and modulus of elasticity (MOE) for the 3D printed blocks made from different mixtures of wood powder and adhesive (n = 5)

Example 2: Adhesive bonding of 3D-printed ABS parts and wood

- 3D printed parts from ABS bonded to wood with different adhesives (1k PU, Hot melt adhesive, 2k PU) and surface treatment (acetone vapours)
- Shear strength of adhesive joints
- Highest strength – joints with 2-component PU adhesive (Fig. 4).



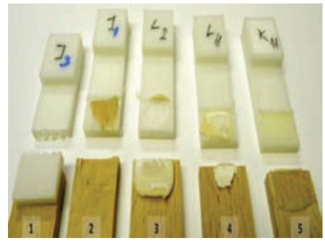


Figure 4. Average tensile bond shear strength for different printing parameters and adhesives (left). Different types of specimen failure. (1) Tensile failure, (2) wood failure, (3) 3D printed part failure, adhesive adhesion failure, and (5) adhesive cohesion failure (right).

2.2 *Furniture elements produced with 3D printers*

3D printing enabled customized design of elements for wood furniture, such as fixtures, fittings, joiners, as well as assisting tools in furniture assembling, such as wood clamp tools or fixtures. Rapidly printed elements can be used as functional or decorative elements of the furniture. Rapidly printed elements can be used as functional or decorative elements of the furniture. Flexibility and cost-efficiency of such small production series represents the opportunity for small companies to engage in new production without big investments. Additive manufacturing of such customdesigned elements significantly decreased the cost of small series, unlike any other existing technology. This is promising direction for practical utilization of biomaterials such as wood waste materials for functional elements (Grujovic et al. 2017).

In a previous study, Kariz et al. (2017) the influence of 3D-printing parameters on the bond shear strength of 3D-printed Acrylonitrile-butadiene-styrene copolymer parts bonded to beech wood was investigated. Three printing settings with different layer thicknesses (0.39, 0.19, 0.09 mm) and a posttreatment method that utilized acetone vapour were used. The three different adhesives applied were commercial one-component polyurethane adhesive, hot melt adhesive for edge bonding, and a two-component polyurethane adhesive. The results show that the type of adhesive had the biggest influence on the strength of the bond. The highest bond strength was achieved using a two-component polyurethane adhesive. The type of failure (failure in wood, plastic, adhesive, or cohesive failure) depended greatly on the type of adhesive and thickness of the printed layer.

Aydin (2015) reviewed nine different 3D printed furniture case studies have been reviewed to find out how AM could be used for furniture production. He reported that AM provided design flexibility and so each piece of furniture could be printed distinctly. Also open-source of designs allows users to develop any of projects together such as "the puzzle chair. AM can be assumed as the future of modern manufacturing system and localization of the manufacturing. It can be said that furniture manufacturing by AM is relatively new.

3. CONCLUSIONS

Manufacturing furniture parts with low volumes or complex geometries, obtaining low-density parts, eliminating raw material waste are common reasons for using 3D printing technology in the furniture industry. Furniture manufacturers can prefer 3D printing for being able to use cheaper raw materials or to ensure certain physical properties by using different raw materials together. As a result, 3D printing may provide opportunity for the manufacturers to obtain cost advantages, process, and product improvements. In addition to purposes like testing, design, prototyping, and production of certain parts and some special assembly tools, the furniture industry has tried to utilize 3D printing to manufacture furniture elements. In addition to taking advantage of the increasing demand for feedstocks, the forest industry could also create new, high-value products for 3D manufacturing technology, starting with newly developed biomaterials such as nanocellulose and lignin.

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INFLUENCE OF SELECTED FACTORS ON THE SHARE OF BY-PRODUCTS IN SAWMILL PROCESSING

Elżbieta Mikołajczak, Marek Wieruszewski, Leszek Wanat

ABSTRACT

This paper attempts to identify the share of wood by-products in sawmill processing of hardwood as well as the main directions for their management. For this purpose, a method of a diagnostic survey was used, carried out in deliberately selected wood industry companies, processing round hardwood, and then both indicator and comparative analyses were carried out. In addition, the question about factors exerting a decisive influence on the type and structure of wood by-products in investigated sawmills was raised. In conclusion, the recommendation regarding the development of this particular segment of the wood market was formulated.

Keywords: wood by-products, sawmill, hardwood, forest- and wood-based sector, Poland

1. INTRODUCTION

The economy of the 21st century is characterized by megatrends, which include, among others the phenomenon of traditional energy resources depletion, including fossil fuels, and progressive pollution of the natural environment. Simultaneously, a growing demand for energy and seeking new energy sources, especially renewable, green ones are observed. The possibilities of using energy from renewable sources are determined primarily by technological, organizational, legal and financial factors. The structure of obtaining energy from renewable sources in the European Union (EU-28) differs fundamentally from the data for Poland. Although solid biofuels are the dominant source of renewable energy in both cases, their advantage is clear in Poland (over 70%). These differences result primarily from geographical conditions specific to Poland, availability of resources, limited sources of financing for green energy investments and legislative barriers.

In accordance with the European Union directive [EU. Directive 2009/28 / E, 2009] Member States are required to provide a specific share of energy from renewable sources in final gross energy consumption by 2020. It is about achieving a 20% share in consumption of energy from renewable sources throughout the Union. For Poland, this target was set at 15%. Research on the assessment of opportunities for Poland to achieve such an ambitious target by 2020 and analysis of the share of energy from renewable sources in final gross energy consumption in Poland in 2005-2016, however, do not confirm Poland's ability to implement the adopted assumptions [Bieńkowska-Gołasa, 2016, Eurostat 2018]. Wood by-products are one of the important components of solid biofuels, being a renewable energy source (RES) with relatively easy availability [Frühwald, 2003; Ratajczak *et al*., 2012, Vis *et al.*, 2016, Mikołajczak *et al.*, 2017]. Solid biofuels include organic, non-fossil substances of biological origin that can be used as fuel for the production of heat or electricity. The basic biofuel is fuel wood (in the form of logs, round logs, wood chips). This group also includes briquettes, pellets and forestry waste (in the form of undersized wood: branches, perches, shrubs, brushwood and stumpwood), wood industry waste (chips, sawdust) and paper industry waste (black liquor/lye). A separate group consists of fuels from plantations intended for energy purposes and organic residues from agriculture and horticulture. The group of solid biofuels also includes charcoal [Energia ze źródeł odnawialnych, 2017; O'Brien and Bringez, 2018].

Research including technological, economic and ecological aspects related to obtaining and use of wood by-products are a reference point for both industry policy and financial policy, as well as earmarked funds supporting the development of green, renewable energy [Hruzik, 2006; Chudobiecki *et al.*, 2009; Verkerk, 2011; Jonsson, 2012] and integral economy in the forest-wood sector [Wanat, 2009; Klus and Wanat, 2015; O'Brien *et al.*, 2017].

In such an economic perspective, the development of research on the optimization of the use of solid biofuels based on wood by-products and constituting wood biomass (as formulated in the Polish law in Article 2, point 3 of the Renewable Energy Act) [Act ... 2015] seems justified.

2. WOOD BY-PRODUCTS IN THE FOREST AND WOOD-BASED SECTOR IN POLAND

Based on the results of the analysis of the wood by-products market in Poland, carried out by the Wood Technology Institute in Poznań [Szostak *et al.*, 2004] and authors' own research, it was noted that the largest amount of post-production waste was generated by the sawmill industry (including veneer production) - around 60%. The main source of by-products is furniture making (14%), followed by the 10.4% wood-based panel industry (10.4%), the cellulose industry / bark / (8%). The share of other industries in the supply of post-production biomass is small: wood joinery - 1.5%, packaging - 1.2%, production of matches - 0.1%.

In the assortment structure of wood by-products, lump waste (46.4%), produced by the sawmill industry (70.1%), dominates. The same industry also excels in the production of sawdust and chips (74.4%). Wooden dust is the most important in the production of furniture (almost 70%) and the wood-based panels industry (29.3%). The bark, on the other hand, comes from the production of fibrous masses (50%) as well as sawmill production and wood-based panels (about 23% each).

The waste from the sawmill industry (lump waste, sawdust and chips) is of key importance in the process of energy use of wood by-products. Lumber production generates about 37.5% of by-products in relation to the wood raw material, and in the case of multi-stage processing (production of floor boards, panels, joiner boards, etc.), the total number of wood by-products may be as high as 43-58% [Mikołajczak, 2011; Wieruszewski and Mikołajczak, 2017].

Table 1. Mean share of selected branches of the wood industry in generating wood by-products

Wood-based industries	**Generation of wood by-products in wood-based industries in Poland [share in %]**			
	Wood waste	**Sawdust and chips**	**Wooden dust**	**Bark**
Sawmill	70,1	74,4	0,0	23,2
Plywood	6,8	2,3	0,7	3,0
Wood-based panels	6,1	6,7	29,3	23,5
Wood joinery	0,9	3,1	0,2	0,0
Packaging	1,2	2,1	0,0	0,0
Furniture	14,9	11,4	69,8	0,0
Fibrous masses	0,0	0,0	0,0	50,1
Matches	0,0	0,0	0,0	0,2

**Source: authors' own elaboration based on [Szostak et al., 2004]*

The assortment structure of obtaining wood in Poland corresponds to the structure of afforestation (Table 2). The main tree-forming species is pine (64.3% of the forest area in the State Forestry - State Forests and 57.7% of private and communal forests). In the mountain areas spruce and spruce with beech prevail. The share of other species, mainly deciduous ones, is increasing (over 30.9% of the forest area), species monocultures are abandoned.

Table 2. The assortment structure for removals in Poland in 2016 (in thous. m^3)

Specification	**Removals by assortments in thous. m^3**					
	Total	**General purpose wood (sawnwood, construction timber)**	**Log wood**	**Special wood (veneer, face veneer)**	**Industrial uses (fibrous masses, particle board)**	**Fuel**
Coniferous wood (timber)	30 078	13 502	269	87	14 553	1 666
Non-coniferous wood (timber)	9 052	2 512	-	206	4 468	1 866
Slash (coniferous and non-coniferous wood)	1 771	-	-	-	382	1 389
Total	40 901	16 014	269	293	19 403	4 921

**Source: authors' own elaboration based on: [GUS, Leśnictwo 2017]*

The sawmill industry is of particular importance in the wood-based sector in Poland considering the further use of wood by-products. It processes over half of the annual supply of wood raw material on the Polish market. There are various views in the literature that allow the classification of wood industry companies in terms of production volume, number of employees, as well as the technical and technological level. In this paper, the following classification of the primary wood processing companies was adopted, taking into account the measure of the annual production (sawing): micro (processing up to 1.5 thous. m^3 of roundwood per year), small (from 1.5 to 15 thous. m^3 of wood), medium (from 15-50 thous. m^3 of wood) and large (above 50 thous. m^3 of wood), referring it to the investigated enterprises (sawmills) processing mainly hardwood [Nov, 2014; Wanat, 2015; Wanat and Klus, 2015]. In the process of primary wood processing on the Polish market, large enterprises play a dominant role, processing more than 50[33] thous. m^3 of roundwood per year and a group of medium enterprises processing from 15-30 thous. m^3. Although small and medium-sized enterprises predominate in the general population of enterprises, the medium-sized enterprises have the greatest significance from the point of view of generating wood by-products. This is particularly true for sawmills whose annual processing of wood ranges from 20-30 thous. m^3.

These companies are characterized by a relatively high technical and technological level (modern band sawing machines guaranteeing individual processing of valuable hardwood and process orientation in enterprise management). Modern technology and the use of agile management methodologies allow to obtain high quality of production and minimize the number of wood by-products. Unfortunately, this is not always possible in the case of wood companies processing softwood. Research on the use of by-products from coniferous wood was conducted by Mikołajczak and Wieruszewski [2017]. The completion of the research is its development, covering the aspects of the use of wood by-products in processing hardwood raw material.

3. MATERIAL AND METHODS

The aim of the research was to identify the share of wood by-products in sawmill processing of hardwood. In addition, an attempt was made to determine the possibility of managing wood by-products for energy purposes in two aspects: directly at the site of waste generation and for further processing into organic fuels. The subject scope of the research was analogously defined.

The paper attempts to verify the research hypothesis, in which it was assumed that the type and structure of wood by-products in the wood industry companies were primarily influenced by technological factors related to the production process.

The research was carried out in selected wood industry companies (subject range), processing 15-50 thous. m^3 of wood raw material annually (medium enterprises). They belong to the most numerous group of companies processing hardwood and at the same time generating significant amounts of wood by-products. It was assumed that the analyzed companies had similar equipment. The raw material was processed using band saws for logs (wide and narrow belt) and other necessary machine tools, including: edgers, cross-cut saws, multi-saws and planers. Each of the factories had debarkers and wood chippers allowing for the fragmentation of wood lumps (wings, slaps, edgings). However, by-products were processed into wood chips. Usually edgings were sent to chipping sticks.

Taking into account permanent features characterizing the investigated companies, including the annual processing of wood raw material and the technical and technological level, the varieties of processed wood species were analyzed (the following deciduous trees were selected: beech, maple, alder and hornbeam), looking for the structure model of wood by-products (waste) in this process.

The research was carried out in a selected region of Poland (Wielkopolska), characterized by a relatively large concentration of medium hardwood processing companies (spatial range) in the years 2013-2017 (time range). From the population of approximately 30 medium-sized enterprises, 5 wood industry companies (subject range) whose annual hardwood processing level range was relatively narrow (20-30 thous. m^3 of wood raw material) were selected for the research. In the paper both previous data and data generated for research purposes were used. Secondary data were taken from public statistics sources, including the 'Forestry' database of the Central Statistical Office in Warsaw. Primary data were obtained directly in the investigated wood industry companies. The paper involved the method of a diagnostic survey (direct expert interview), based on the original questionnaire, addressed to a deliberately selected group of entrepreneurs representing the investigated wood industry companies. The production processes and their conditions in each of the surveyed enterprises were analyzed in detail. The collected data were supplemented with information from public statistics sources, and then aggregated, the necessary calculations were made using the basic measures describing the volume of production and sales. As a result, the discussion and evaluation of the obtained results were made using the methods of both comparative and descriptive analyses.

4. RESULTS

Research carried out in the selected wood industry companies in Poland enabled the identification of the structure of wood by-products in the sawmill industry, depending on the place of their production and form. The structure of by-products obtained from deciduous species was verified in the paper. The characteristics of the species structure of hardwood sawmill production in the researched period were illustrated in Figure 1. The ranking includes the criterion of quality (class) of the processed wood raw material.

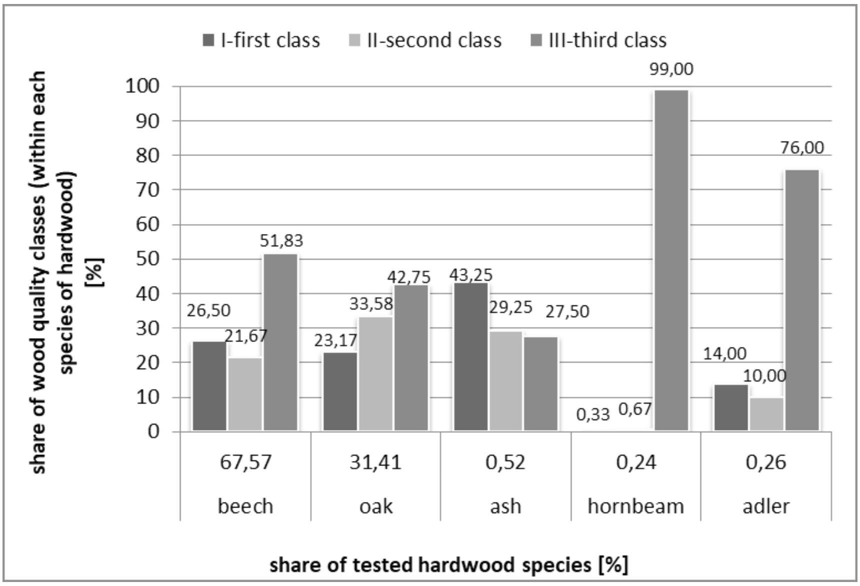

Figure 1. Species structure of hardwood processing in analyzed enterprises of the wood industry (sawmills). The order of species from the left: beech, oak, ash, hornbeam, alder. Source: authors' own elaboration

In the structure of hardwood raw material processing, in addition to the basic group of sawn assortments, which are the result of optimal use of wood, accompanying products are obtained, called by-products of the process of sawing (wood by-products). These include 'wood waste' in the form of sawmill sawdust resulting from sawing by means of band saws (endlessly), used in log saws, as well as circular saws used in cutters and crosscut saws [Ratajczak *et al.*, 2012; Lis 2014]. Based on the analysis of the main production processes in the analyzed sawmills, the most important groups of wood by-products (from hardwood) were identified, including:

1) sawdust;
2) wings, slaps and edgings;
3) chips;
4) bark;
5) other waste (other by-products).

The characteristics of each group were then discussed in detail, apart from the waste defined as 'the other' due to their relatively small and difficult to estimate share in the overall hardwood processing.

4.1. Sawdust

The amount of sawdust produced in hardwood processing varies from 4% to 14% of the volume of the processed roundwood [Lis, 2014; Wanat, 2015]. The share depends on the influence of the following factors: the type of tools for processing (division) of roundwood, the diameter (thickness) of Roundwood and the type of the final product of wood sawing, i.e. the cross-section of hardwood timber.

The analysis of data obtained in the investigated wood companies shows that the least amount of sawdust waste is produced when band saws working at the saw cut of 2.2-2.8 mm are used for timber production (for a 2.2 mm saw cut the share of sawdust is on average 4% of the input material). In turn, when using circular saws, this value reaches 12-16%. A much larger amount of sawdust generates machining on multi-disc saws with a cut width exceeding 3.8 mm.

The amount of sawdust is thus determined by saw couplings (dependent on final products/demand criterion) and the availability of roundwood assortments, optimal for orders/supply criterion/. The increase in the production of sawdust waste is favoured by the increase in assortment fragmentation and diameter reduction of the sawn roundwood. These factors also cause lower production efficiency of basic products: main and accompanying hardwood timber.

The amount of sawdust produced in the process of hardwood sawing by means of band saws is summarized in Table 3. A standardized processing method for basic hardwood species with large-size wood raw material of above 34 cm in internal diameter was assumed. For the purposes of the comparative analysis, the measurement data concerning the volume of sawdust were standardized and expressed in stacked cubic meters m^3(st) and cubic meters (m^3) by means of a conversion factor used in the analyzed sawmills: $1m^3(st) = 0.33\ m^3$.

Table 3. Amount of sawdust generated in the analyzed wood companies in the years 2013-2017 (1 m^3 (st) = 0,33 m^3)

Specification	Unit of measurement	Years				
		2013	2014	2015	2016	2017
Mean annual processing	m^3	24 362	23 131	22 156	26 340	25 482
Volume of sawdust	m^3	1 876	1 712	1 507	2 239	1 809
Volume of sawdust	m^3(st)	5 684	5 187	4 565	6 785	5 482
Share of sawdust	%	7,7	7,4	6,8	8,5	7,1

**Source: authors' own elaboration*

It was identified that the sawdust share ratio in relation to the input material in the analyzed wood companies was at the level of 6-8%. Its value did not differ from the data obtained in the study of other wood industry enterprises of comparable processing volume [dodać źródła..]. It was noticed that along with the increase in the amount (thickness) of hardwood sawing within a separate batch (order), the share of sawdust also increased. This may be due to the increased share in the production of thinner roundwood (with decreasing diameters), which results in the increase in the by-products number.

Although the process of abrasion aims at total minimization of losses, it is assumed that in so-called storing-transport losses (‘dissipation’) of material in a particulate form, part of the material reaching 2% of its assumed (or real) thickness can be lost. This situation results both from the process of depreciation and decomposition of the wood by-products structure, as well as mixing fractions in the process of grinding these by-products.

4.2. Lump wood waste (LWW): wings, slaps and edgings

In the technological process of round hardwood sawing, so-called lump wood waste is produced in the form of: wings, slaps and edgings. They are mainly a by-product in the production of unedged hardwood timber. Further (deepened) wood processing (prefabrication) generates other waste pieces, most often used for energy purposes (heating).

The study used primary data on the sales volume in the analyzed period, taking into account production fluctuations. It was found that the production of lump wood waste (LWW) was on average 6.2% of the roundwood volume. Wings and slaps predominated, accounting for about 73% of the total weight of lump wood waste. The share of edgings and other waste pieces was 27%. Detailed data are presented in table 3. The trade in wood raw material in the form of lump wood waste was carried out by means of a volumetric measurement, i.e. in stacked cubic meters [m^3(st)]. For the purpose of comparative analysis, the data were standardized using a conversion to cubic meters, assuming that 1 m^3 (st) = 0.65 m^3.

Table 4. Amount of lump wood waste in the analyzed wood companies in the years 2013–2017 (1 m^3 (st) = 0,65 m^3)

Specification	Unit of **measurement**	**Years**				
		2013	**2014**	**2015**	**2016**	**2017**
Mean annual processing	m^3	24 362	23 131	22 156	26 340	25 482
Wings and slaps	m^3	1 175	931	740	1 547	1 125
Wood edgings	m^3	457	319	345	507	379
Total volume of lump wood waste	m^3	1 632	1 249	1 086	2 055	1 503
	m^3(st)	25 112	19 217	16 702	31 608	23 130
Share in the weight of the raw material	%	6,7	5,4	4,9	7,8	5,9

**Source: authors' own elaboration*

It was found that during the 5-year research period the amount of lump wood waste generated was similar in relation to the weight of sawing wood: from 4.9-7.8%, with deviations in thickness not exceeding 2%.

4.3. Wood chips

Lump wood waste, including: wings, slaps and edgings (primary processing products) are subjected to fragmentation into chips, which facilitates their storage and transport. Chips, depending on the technological process of barking, can be contaminated with bark or bark-free. In the first case, defibration and heating wood chips are obtained, applicable to the production of panels or as fuel. In the second case, from 'pure lump wood waste' paper and pulp chips are produced, which are a valuable raw material for the panels or cellulose industry (excluding oak and ash chips).

The level of hardwood chips production was determined based on sales data for 2013-2017 (connected with production fluctuations) in the investigated wood companies. In the analyzed period, chips were obtained, the share of which was 13.7% of the processed roundwood volume, including 67% for defibration chips (outside bark) and 33% for paper chips. Detailed data are presented in Table 4, using a conversion from stacked cubic meters [m^3(st)] to cubic meters, assuming that 1 m^3(st) = 0.42 m^3.

Table 5. The number of industrial chips produced from the disintegration of 'wood waste' in the analyzed enterprises in the years 2013-2017 (1 m^3(st) = 0,42m^3)

Specification	Unit of **measurement**	**Years**				
		2013	**2014**	**2015**	**2016**	**2017**
Mean annual processing	m^3	24 362	23 131	22 156	26 340	25 482
Number of chips obtained	m^3	3 459	3 678	3 301	3 372	2 879
	m^3(st)	8 237	8 757	7 860	8 027	6 856
Share in the weight of the raw material	%	14,2	15,9	14,9	12,8	11,3

**Source: authors' own elaboration*

It was found that the share of obtained industrial chips in relation to the weight of the sawing wood was in the years 2013-2017 at a similar level, in the range from 11-16%, with volume deviations not exceeding 3%.

4.4. Bark

For quality and technology reasons related to the optimization of production, debarking of roundwood intended for further processing is used.

The process of barking the sawmill raw material in white means the possibly complete removal of the bark (leaving fragments of a phloem and a phloem with the bark in a total size not exceeding 20% of the wood surface). Due to the limitations of the barker and wood size, only large-size logs with a diameter of up to 60 cm are subject to this process. It was found that mainly round assortments with a significant share of bark underwent debarking. These were usually logs with a diameter at the thinner tip (apical) of above 21 cm. Medium-sized wood and apical logs (about 8% of sawing roundwood) do not undergo barking.

Table 6. Mean share of bark in round wood according to the Polish standard PN–93 D–95000

Wood	**Percentage of bark share**
Pine	8,0
Spruce	8,5
Fir	10,0
Beech	**6,3**
Oak	**21,2**
Alder	**21,8**
Birch	11,5

** Source: authors' own elaboration based on [PN–93 D–95000]*

The quality of barking is of great importance due to excluding the outer bark and bark from the overall volume of sawmill wood. It can be an additional source of income for the plant through the use for energy purposes or sales to external customers (e.g. for gardening companies).

Table 7. Amount of bark generated in the process of preparing the raw material in the investigated enterprises in the years 2013 – 2017

Unit of measurement	**Years**					**Total in years 2013-2017**	
	2013	**2014**	**2015**	**2016**	**2017**		
	[m^3]					**[m^3]**	**[%]**
Mean annual processing	24 362	23 131	22 156	26 340	25 482	121 471	100,0
Bark in total	2 600	2 852	2 162	3 113	3 272	13 999	11,5
Values set for dominant species (oak and beech)							
Oak bark	2 171	2 340	1 826	2 600	2 954	11 890	14,6
Beech bark	340	445	261	433	229	1 707	4,5
Bark of other trees	89	67	75	80	89	402	16,5

**Source: authors' own elaboration*

Previous studies [Hillring, 2006; Lis, 2014; Staniszewski and Nowacka, 2014; Wanat, 2015] indicate that the mean share of bark for hardwood (Table 4) ranges from 6% to 21% (average 8%) of the trunk volume outside bark (bark density is around 300 kg / m^3). The beech bark in young trees is smooth, with age it gets slightly flaky and reaches a share of up to 6% of the volume of the trunk with bark, with a density of about 340 kg / m^3. The share of bark in oak or alder wood is larger and amounts to over 20%, and its density reaches 335 kg / m^3.

The production of the analyzed companies was dominated by oak wood (31.41%) and beech wood (67.58%), the remaining wood assortments were omitted due to their limited share.

The actual amount of bark obtained was determined based on primary data in the analyzed wood enterprises, taking into account the species and size share of roundwood (Table 5). It was assumed that the whole purchased raw material was debarked except for thin wood (8%). As a result, the indexes of bark share in round hardwood were determined: for beech wood at 4.5%, and oak wood - 14.6% respectively.

4.5. The wood by-products model of the raw hardwood material processing

Based on the aggregated partial results of the research, an attempt was made to determine the wood by-products model of the raw hardwood material processing. For this purpose, the data showing the share of by-product types and their percentage relations were compiled (Table 8).

Table 8. Number of hardwood processing by-products in the analysed companies in the years 2013 - 2017 with the use of the appropriate conversion ratio [m^3(st) to m^3]

Specification	Unit of measure-ment	Years				
		2013	2014	2015	2016	2017
Mean annual processing of roundwood	m^3	24 362	23 131	22 156	26 340	25 482
Bark	m^3(st)	7 647	8 388	6 359	9 156	9 623
Wood edgings, slaps, short remnants		2 511	1 922	1 670	3 161	2 313
Sawdust		5 684	5 187	4 565	6 785	5 482
Defibration and heating wood chips		5 107	5 692	5 659	5 539	4 799
Wood chips for paper pulp		3 130	3 065	2 201	2 489	2 057
By-products in total		24 079	24 254	20 454	27 130	24 274
Conversion ratio						
Bark	m^3/m^3(st)	0,34	0,34	0,34	0,34	0,34
Slaps and short remnants		0,65	0,65	0,65	0,65	0,65
Sawdust		0,33	0,33	0,33	0,33	0,33
Defibration and heating wood chips		0,42	0,42	0,42	0,42	0,42
Wood chips for paper pulp		0,42	0,42	0,42	0,42	0,42
Data aggregated in a calculation unit (m^3)						
Bark	m^3	2 600	2 852	2 162	3 113	3 272
Wood edgings, slaps, short remnants		1 061	812	706	1 335	977
Sawdust		1 876	1 712	1 507	2 239	1 809
Defibration and heating wood chips		2 145	2 391	2 377	2 326	2 016
Wood chips for paper pulp		1 315	1 287	924	1 045	864
By-products in total		8 997	9 054	7 676	10 058	8 938
By-products in total inside bark	m^3	6 397	6 202	5 514	6 945	5 666
Share of by-products in the input material (inside bark)	%	26,3	26,8	24,9	26,4	22,2

**Source: authors' own elaboration*

It was found that the share of all researched by-products in relation to the input material (round hardwood) was on average 25%. The variability of this indicator in the range from 22 to 27% results from the diversified assortment of final products (demand criterion).

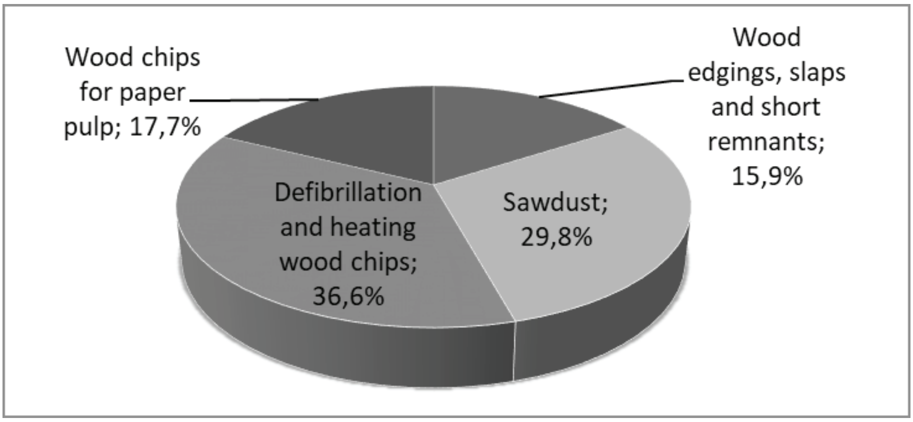

Figure 2. The structure of hardwood-based by-products in the analyzed sawmills in the years 2000-2005
Source: authors' own elaboration

Seeking a model structure of generated wood by-products, the collected data were aggregated, values from particular years of the analyzed period were calculated and the percentage illustrated in figure 2 was determined. The model omits the wood bark as it is not included in the thickness (volume) of roundwood purchased in the State Forestry - State Forests.

5. CONCLUSIONS

In the absence of full, consistent and reliable data on the by-product market in the wood-based sector in Poland, an attempt to identify the waste structure model generated in round hardwood processing can contribute to filling the cognitive gap in this area. This applies to knowledge about the places where wood by-products are made, their types and directions for use, which, combined with an effective certification policy for wood raw material [Paluš *et al*., 2018] may contribute to the optimal use of wood, a material of the 21st century. The paper also complements the research conducted in this field regarding round hardwood [Paluš *et al*., 2015, Mikołajczak and Wieruszewski, 2017; Mikołajczak *et al.*, 2017; Wanat *et al.*, 2017]. As a result, the following conclusions and recommendations were formulated:

- Wood by-products are closely related to the production process and the selection of technologies. Most by-products are made in the first stage of wood processing (primary production in the sawmill). At the stage of further processing, prefabrication (secondary production), the number of valuable byproducts can be significantly reduced.

- In the structure of wood by-products made in round hardwood processing, lump wood waste intended for further processing into wood chips dominates.
- Wood by-products are mainly managed in sawmills. Most by-products were used for purposes of the analyzed wood companies, primarily for energy purposes.
- Chips are predominantly intended for production purposes. Conversely, sawdust, shavings, as well as slaps, edgings and specially produced firewood (firewood) are used for energy conversion.

As a result, the hypothesis put forward at the beginning of this paper that the structure of wood by-products in wood industry companies mainly depended on production and technological factors was confirmed. In addition, the main directions of wood waste management were identified. It was noticed that among individual recipients there was high demand for wood by-products destined for energy purposes. This is particularly evident in rural areas. Sometimes the demand for wood by-products also stimulates local entrepreneurship. Simultaneously, the main recipients of by-products with a significant level of fragmentation are producers of wood-based materials and producers of granules - organic wood fuel.

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MANAGEMENT OF CHANGES IN SLOVAK WOODPROCESSING COMPANIES

Andrea Sujová, Ondrej Remeň

ABSTRACT

Current business environment is characterized by growing dynamics of changes and unpredictability of future development. Competitiveness of enterprises depends on ability to react and adapt to changes. Changeability has become one of factors guarantying success. The paper is focused on a status of change management in wood processing companies in Slovakia. The aim of paper is to present results of empirical research with attention to influence of changes on corporate performance.

Keywords: change management, wood processing company, corporate performance

1. INTRODUCTION

The business success mostly depends on ability to utilize market opportunities. Reaction to changes of environment and customer´s requirements demands to have sufficient current information. Business changes should not respond to changes in the environment, but the changes in the environment should be preceded. All changes in enterprises are executed with the goal to improve the future state of the business. Improvement areas in this case may be different but the goal is the same: sustain the business effective and efficient. Observation of processes capability is a dynamic tool that allows making operational changes in the production process. Simanová and Gejdoš (2017) says that fluctuation of the quality mark values is a natural part of the process and it is impossible to achieve its absolute uniformity but it is necessary to monitor this value.

In response to the need of change in the business environment, change management becomes one of the crucial operational and strategic conception for enterprises that want to achieve sustainable grow and the required level of competitiveness among other business entities. Change management can be defined as a management line consisting in ready reactions to external and internal environment and it is focused on choice of change object, its flexible preparation, realization and use. It is based on prediction of next enterprising challenge and it enables being ready to changes on time. (Kotter, 2000). Successful Implementation of the Change Management is difficult process including critical activities such as trigger the Request for Change (RFC), perform the RFC Analysis, prioritize the change, categorize resource of change, create the Change Advisory Board, schedule the change, build and test the change and finally implement the change (Doherty-Waterhouse, 2006).

The publications dealing with the change management were base for summarizing recent knowledge in the addressed issue. Among authors dealing with this topic belong: Palán, J. *(Substance of change management)*, Kotter, J.P. *(Psychological aspects of change management),* Hammer, M. and Champy, J. *(Reengineering changes)*. The general philosophy for process of change has been specified and published by Drdla M. and Rais K. (2001), Rais K. and Kubíčková 2012, Borovský J. (2005), Slávik, Š. (2005). The authors of this paper have been dealing with change management focused on processes in several publications during years 2015-2017 (see list of references).

Studies from different authors have shown that the success rate of change processes is low. Due to the research of Beer and Nohria (2000) the percentage of successfully performed changes in enterprises is 30%. The author also claims that various fail factors can influence the success rate so much that the value of successfully performed changes is not higher than 7%. Influence of fail factor depends on the nature of the business but according to (Kotter, 1995; Lines et al., 2015; Aleksic et al., 2015), the most common fail cases are caused by people and their resistance to the organizational change.

Within the national economy of the Slovak Republic, the wood-processing industry has a significant position. This industry has the ability to efficiently exploit existing SR forestry resources, which creates the conditions for a sufficient raw material base of all wood processing industries and provides opportunities for timber harvesting. Real timber extraction in the Slovak Republic is increasing in the long run and in the year 2016 the production got up to 9.32 mil. m³ wood. The share of deciduous and coniferous wood extraction does not differ, deciduous wood mining has reached 45% and the mining of coniferous wood is used to be 55%. Casual wood mining accounts for 50.3% of total mining, of which 84.9% was coniferous wood and the share of deciduous wood mining was 15.1%. Foreign timber trade statistics point to the fact that in 2016 2 449 ths. m³ of raw wood was exported, where 84% of these were exported by non-forestry entities and Slovak forest managers exported 16.3%. In 2016 there was a positive development of economic indicators and an increase in the volume of domestic processing. However, there was no significant competitiveness of enterprises and no increase in added value. In 2016, revenue in the WPI (wood processing industry) sector grew by 8.5% compared to 2015. The profit before tax increased by 41.9%. Manufacturing mainly consists of sub-deliveries of semi-finished products for foreign companies with a low degree of finalization. The pulp and paper sector belong to sectors with the best business performance of the SR (MPSR, 2017).

The aim of this paper is to evaluate how Slovak wood processing companies have been dealing with changes in recent years due to the results that has been found out in an empirical research.

2. MATERIAL AND METHODS

The main method of the research was a primary quantitative research via questionnaire method. The research was focused on current state of managing changes in Slovak enterprises. The enterprises from selected industrial branches of Slovak republic have been set as the research subjects. The first database of enterprises comprised the data of the Statistical Office of the Slovak Republic, which was subsequently verified by Internet databases in order to select existing companies. The core sample or population size (N) of the survey was a sample of 2 525 enterprises sent online by a questionnaire. A representative sample (n) is represented by 524 enterprises, which is the number of completed questionnaires. The questionnaire consists of 5 general, classification questions and 30 business-area management issues. The questionnaire was published online and the data collection was in the first half of year 2017. Enterprises were also interviewed directly through employees and indirectly via e-mail communication.

This paper analyzes results of the questionnaire survey of selected industry, namely the wood processing industry (WPI), which is represented by wood, furniture and cellulose industry. The core sample for the research was a database of 300 enterprises, of which 82 represent the research sample for WPI. Answers from the questionnaire have been processed and evaluated by chosen statistical method: descriptive statistics, contingent method and Chi – squared test.

3. RESULTS

The first part of the questionnaire consisted of general descriptive questions. From the question responses gathered from the enterprises of the wood processing industry in the Slovak Republic it was found, that the survey was mainly attended by micro-enterprises with a number of employees up to 10 which represents 45.12% of the whole sample. Small enterprises with 11-20 employees, represent 25, 61% of the sample and enterprises with number of employees from 21-50 represents 14.63% of the sample. Only 7.3% of the sample consists of medium-sized enterprises and 7.3% large enterprises.

For the research it was necessary to know what the main business activity is. From the results it can be seen that almost 87% are represented by enterprises whose main business activity is production. Ownership of wood-producing enterprises is largely pure domestic capital, up to 79.27% of all enterprises from the sample.

The next question was focused at the return on equity (ROE) of the surveyed enterprises. It was found that most of the WPI enterprises (31.71%) belong to a positive ROE value range of 4% to 7%. Subsequently, on the second position have occurred enterprises with a ROE value ranging from 0% to 2% (25.6%), on the third position enterprises with ROE ranging from 2% to 4% and on the fourth position companies with ROE from 7% to 10% (15.85% from all enterprises). The fifth place belongs to enterprises with a negative ROE value (7.32%). The last place according to the frequency of occurrence belongs to companies with a positive ROE value above 10% (3.66%).

The last general question was focused on the business sector in which enterprises operate. Wood processing enterprises accounted for the vast majority of the research are represented with up to 60 enterprises. The rest of the sample was represented by 18 furniture production companies, and 4 cellulosic compiler enterprises.

Questions in the second part of the survey where constructed with the purpose to find out how enterprises perceive to changes. These results can be evaluated as very positive because up to 90.24% of enterprises consider change to be an important factor. The awareness on WPI enterprises in the field of changes is quite positive, as only 4 companies from the survey reported that their awareness in the field of change is zero.

The following tables also provide questions with multiple responses. Relative counts are a percentage of all 82 questionnaires.

Table1. Results of the questionnaire in the field of change management in general

3. In which areas were changes made over the last 10 years? (multiple options could been mark)		
Description of options / answears	**Absolute frequency**	**Relative frequency**
organizational structure	36	43,90%
production program (assortment)	53	64,63%
production technologies	48	58,54%
system and management methods	17	20,73%
business processes	14	17,07%
Information System	22	26,83%
we did not make any changes	0	0%
other	0	0%

4. What types of changes have been made over the past 10 years?		
Description of options / answears	**Absolute frequency**	**Relative frequency**
financial restructuring	15	18,29%
transformational change restructuring	7	8,54%
radical re-engineering change	4	4,88%
gradual optimization changes	47	57,32%
incremental, i.e., unplanned but necessary changes	17	20,73%
we did not make any changes	17	20,73%

5. A fundamental reconsideration and radical reconstruction was carried out in the area of (multiple options could be marked)		
Description of options / answears	**Absolute frequency**	**Relative frequency**
production processes	53	64,63%
logistics processes	18	21,95%
non-production service processes	13	15,85%
purchasing and supply processes	30	36,59%
processes of trade and distribution	18	21,95%
managerial methods	14	17,07%
we did not make radical changes	13	15,85%

8. What were the impulses (reasons) to make the change? (multiple options could be marked)		
Description of options / answears	**Absolute frequency**	**Relative frequency**
financial problems	18	21,95%
low efficiency and quality of production	19	23,17%
non-functioning processes	8	9,76%
customer dissatisfaction	12	14,63%
legislative changes	10	12,20%
competition pressure	43	52,44%
changing needs and requirements of customers	48	58,54%
the existence of market opportunities	25	30,49%
other	0	0%

9. What was the main purpose of implementing the change? (multiple options could be marked)		
Description of options / answears	**Absolute frequency**	**Relative frequency**
cost reduction	52	63,41%
improving quality	48	58,54%
improving process performance	28	34,15%
improving financial performance	24	29,27%
increasing the efficiency of input use (resources)	14	17,07%
increasing customer satisfaction	46	56,10%
gaining a competitive advantage	28	34,15%
other	0	0%

10. Which of these steps do you perform when introducing changes in your business processes? (multiple options could be marked)		
Description of options / answears	**Absolute frequency**	**Relative frequency**
analysis of the starting situation	14	17,07%
identifying necessary changes and analyzing the change requirement	19	23,17%
defining the goal and identifying resources to implement the change	21	25,61%
assembling the project team and agent (team leader) changes	4	4,88%
preparing variants of the change project and the action plan for implementing the proposed changes	4	4,88%
financial and economic evaluation of the proposed changes	27	32,93%
monitoring the effects of change	11	13,41%
we do not perform any of these steps	13	15,85%

11. What analyzes were made before the change was made in its preparation? (multiple options could be marked)		
Description of options / answears	**Absolute frequency**	**Relative frequency**
SWOT analysis	4	4,88%
portfolio analysis	10	12,20%
field strength analysis (factors for and against change)	5	6,10%
financial analysis	36	43,90%
analysis of competition	26	31,71%
analysis of business processes	15	18,29%
satisfaction analysis and customer needs	37	45,12%
other	7	8,54%

12. When making any changes, the external consultancy company was part of the project team?		
Description of options / answears	**Absolute frequency**	**Relative frequency**
reinforcement changes	2	2,44%
a large-scale project involving more changes	3	3,66%
optimization changes in processes	11	13,41%
introduction of new technologies, information systems	14	17,07%
investment projects	5	6,10%
we did not use the services of an external company	55	67,07%

13. Do you monitor the achievement of the desired effects of change after implementation? (only one option)		
Description of options / answears	**Absolute frequency**	**Relative frequency**
Yes	66	80,49%
not	16	19,51%
no, but we plan to implement monitoring	10	12,20%

14. What indicators do you observe in assessing the effects of the changes made? (multiple options could be marked)		
Description of options / answears	**Absolute frequency**	**Relative frequency**
production productivity index (production time + downtime + handling and transport + supervision and control)	34	41,46%
index of the use of the production facility (plant stoppage / production hours used)	11	13,41%
Input Quality Index (Rejected Inputs / Purchased Inputs Total)	4	4,88%
customer satisfaction index (total claims / total sales)	36	43,90%
liquidity and profitability indicators	2	2,44%
changes in financial results (revenue and profit)	34	41,46%
not follow	10	12,20%
other	0	0%

**Source: own elaboration*

The data in Table 1 were aimed at managing changes in WPI enterprises. The most numerous areas where changes were made in the WPI sector were: production program (64.63%), manufacturing technology (58.54%) and organizational structure (43.90%). In question no. 4 surveyed enterprises were asked about the types of changes that have been made over the last 10 years. The most common answear was gradual optimization changes with the response rate 47 enterprises. Results from the answear analysis were wery suprising because up to 17 companies answeared that they did not made any changes. On the oposite in question no. 3 this option was not marked by any enterprise. This derogations may be caused by misunderstanding of the question by companies or by the lack of a free answer option. The fundamental and radical reconstruction was mostly carried out in the area of manufacturing processes. The most frequently cited reason for change was the change in customer needs and requirements as well as the pressure of competition. The main goal of performing changes in WPI businesses was, in particular, cost reduction, quality improvement and also increased customer satisfaction. The most frequently selected answer to the question no. 10 (Which of these steps do you perform when introducing changes in your business processes?) was the option Financial-Economic Assessment of Changes. From the question no. 11 results (What analyzes were made before the change was made in its preparation?), most of the companies have performed financial analysis. Most enterprises have stated that they have not use outsourced services to make or manage the process of change. In question no. 13 up to 66 enterprises stated they were monitoring the effects of the changes, 26 companies stated that they did not analyses the consequences of the changes, but 10 planned to inplement change monitoring.

Within the contingencies, we were interested in the structure of responses to Question 3: In what areas your enterprise was performing changes according to the business size. The results are shown in Table 2.

Table 2. Contingency Table - Enterprise Size vs. Areas of Change

Observed abundances	OS	PP	PT	MS&M	BP	IS	**Count**
0 to 10 employees	20 54,05%	22 59,46%	20 54,05%	12 32,43%	8 21,62%	11 29,73%	93
11 - 20 employees	6 28,57%	16 76,19%	12 57,12%	1 4,76%	2 9,52%	5 23,81%	44
21 - 50 employees	5 41,67%	8 66,67%	8 66,67%	1 8,33%	2 16,67%	2 16,67%	26
51 - 250 employees	3 50,00%	4 66,67%	5 83,33%	2 33,33%	0 0,00%	2 33,33%	16
Over 250 employees	2 33,33%	3 50,00%	3 50,00%	1 16,67%	2 33,33%	2 33,33%	13
Together	**36**	**60**	**48**	**17**	**14**	**60**	**192**
p-value	0,41426	0,68897	0,6716	0,6716	0,44188	0,88691	

**Abbreviations: OS – organizational structure, PP – production program, PT – production technologies, MS&M – management system and methods, BP – business processes, IS – information system / *Source: own elaboration*

The contingency table (Table 2) shows that from 82 surveyed enterprises up to 36 of them made a change in organizational structure (OS), representing 44% of enterprises in percentage terms. From the research results, it is possible to say that this change is mainly done by small businesses with a number of employees from 0 to 10 with a rate of response of up to 20, representing 54.05% of this category (business size). In the table it is also possible to see that 53 enterprises, representing 65% of the total number of enterprices participating in the survey, have made a change in the production program (PP). For all categories (business size), it has been found that at least half of the enterprises are making this change in the production program and in the category of small enterprises with a number of employees ranging from 11 to 20 the response rate represents 76.19 %. Next, the table shows that 48 enterprises, representing 59% of all 82 surveyed enterprises, are making a change in production technologies (PT). From research results we can say that this change is mainly done by small enterprises with a number of employees from 0 to 10, with the response rate of 20, which represents 54.05% of this category - according to the largest number of enterprises. In the field of manufacturing or manufacturing technology change the largest percentages (83.33%) are represented by enterprises in the category 51 to 250 employees. Changes in manufacturing technologies can be defined as the most commonly implemented change from all six areas. Only 21% of the sample of 82 enterprises are making changes to the system and management methods (MS & M), of which 32.43% (12 enterprises) is represented by the small enterprise category. Business process (BP) change implementation response rate is only at the value 17% where enterprises in the category 51 to 250 employees does not make this change at all. Changes in business processes are the least changed from all six areas of change. Information system (IS) change implementation rate is 27% of the sample and it is mostly performed by enterprises ranging from 21 to 50 employees, representing 16.67%. The chi-quadrate test according to p-values doesn´t show that statistically significant dependence in any area of change in relation to enterprise size.

The following table (Table 3) lists the numeric and percentage values of each type of change that has been implemented over the past 10 years in the WPI sector. For the purpose of examining this addiction, we have offered six options of answears with the possibility to select more than one answer. Based on percentages, we’ve determined whether individual business responses match or differentiate. The table uses the abbreviations for the different types of changes: transformational-restructuring change - TZR, financial restructuring - FR, radical renewal change - RRZ, gradual optimization changes - POZ, incremental changes - IZ, unrealized changes - NZ

Based on the data from Table 3, it is possible to state that the type of change in financial restructuring (FR) is made by 15 enterprises, representing 18% of the research sample. From the percentage results we can see that this change is the least realized by enterprises with a positive ROE of 0% to 2%. This type of change increases revenue and optimizes the capital structure. Significant differences occurred in the transformation-restructuring change (TZR), which is implemented by only 6 enterprises with a ROE of 4% to 7% and one enterprise with a negative ROE value. Only one enterprise category with a

ROE value of 4% to 7% implements radical renewal change (RRR). in general, WPI sector enterprises has rarely implemented this type of change. The most commonly marked and implemented type of change in the WPI sector was gradual optimization changes (POS) with the response rate of up to 47 enterprises in each ROE category. Incremental, in the meaning of unplanned changes are made by 17 enterprises (21%) from the whole research sample. This change occurs least by enterprises with a positive ROE of 7% to 10%, and that only by one enterprise out of thirteen.In the last category the reseach results where wery suprising, as 17 research companies said they had not made any changes in the past 10 years at all.

Table 3. Contingency Table - ROE vs. implemented types of changes

Observed abundances	FR	**TZR**	**RRZ**	**POZ**	**IZ**	**NZ**	**Count**
Negative ROE	2 33,33%	1 16,67%	0 0,00%	4 66,67%	1 16,67%	1 16,67%	6
Value from 0% to 2%	2 9,52%	0 0,00%	0 0,00%	10 47,62%	3 14,29%	7 33,33%	21
Value from 2% to 4%	4 30,77%	0 0,00%	0 0,00%	6 46,15%	3 23,08%	5 38,46%	13
Value from 4% to 7%	4 15,38%	6 23,08%	4 15,38%	15 57,69%	8 30,77%	2 7,69%	26
Value from 7% to 10%	2 15,38%	0 0,00%	0 0,00%	10 76,92%	1 7,69%	2 15,38%	13
Value over 10%	1 33,33%	0 0,00%	0 0,00%	2 66,67%	1 33,33%	0 0,00%	3
Together	**15**	**7**	4	**47**	**17**	**17**	**82**
p-value	p=0,5469	**p=0,0319**	p=0,1068	p=0,5733	p=0,5692	p=0,1416	

Source: own elaboration

The chi-quadrate test results show that statistically significant dependence (a = 5%) was confirmed in the study of the dependencies between ROE and the types of changes that have been made in the past 10 years. Based on the calculations in the table, it can be stated that each category of enterprise is significantly different in this type of change. The critical value of the test criterion p = 0.03196 is less than 0.05 and therefore we can confirm the dependence. Among the observed statistical features, it is possible to see moderate dependence.

4. CONCLUSIONS

Change is an integral and essential part of every business and business management and can be activated by many factors, whether from an outside or internal environment. An important role for WPI environment is therefore the ability to adapt to change, as businesses do not survive without changing the current environment. Change management is therefore one of the key elements of successful business management, and its effective management becomes a tool for increasing competitiveness.

From the results of the management of changes in the WPI environment of Slovakian enterprises, proposals have been made to increase the success of the changes. In the first area of general information, despite the positive findings of perception and awareness of change, it is necessary to include in the process of change and communication of all employees affected by the implementation of changes and not just the management staff. No major deficiencies in the field of change management where detectet, but nevertheless 13 researched enterprises from the study should take some of these steps to implement changes in business processes, and 26 enterprises should monitor the effects of changes after their implementation for better evaluation of the results brought by the changes. It is also posible to state that enterprises should be encouraged to make changes, especially in the financial field, which is necessary to secure the funds and subsequently the actual implementation of the change, and is also needed to avert the crisis. An important area of change in the environment of WPI is also organizational and production change.

The need for WPI enterprises to successfully manage the change is to determine the reasons for change, to develop a detailed strategic analysis of the business and its surroundings, to define achievable goals and to determine the appropriate method for implementation.

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THE IMPACT OF THE ISO 9001:2015 REQUIREMENTS ON THE CONTROL OF EXTERNALLY PROVIDED PROCESSES, PRODUCTS AND SERVICES IN THE SMALL AND MEDIUM WOOD INDUSTRY ORGANIZATIONS

Renata Nováková, Alena Pauliková, Jana Šujanová

ABSTRACT

The amended standard ISO 9001:2015 in section 8.4 Control of Externally Provided Processes, Products and Services specifies requirements, which organizations must provide so externally provided resourcesfor the processes, products and services are in conformity with these requirements. The certification, which organizations on the basis of fullfilment of requirements gain is nowadays a necessary prerequisite to strenghten their position in the competitive environment. This is a reason why it is important for the small and medium entreprises, in wood processing industry, to be able to orientate themselves and provide to auditors of quality correct proofs and information. It is equally important to know the needs and expectations of interested parties. One of such party is external employees who provide services in small and medium-sized organizations.

1. INTRODUCTION

The revised ISO 9001: 2015 standard is based on the principles of quality management:

- customer focus
- leadership
- engagement of people
- process approach
- improvement
- evidence-based decision making
- relationship management.

This international Standard can be used by internal and external parties:

- The ability to consistently provide products and services that meet customer and applicable statutory and regulatory requirements
- facilitating opportunities to enhance customer satisfaciton
- the ability to demonstrate confirmy to specified quality management system requirements.
- addressing risks and opportunities associated with its context and objectives

The quality management system requirements specified in this International Standard are complementary to requirements for products and services.This International

Standard employs the process approaach which incoporates PDCA cycle (Plan-Do-Check- Act) and risk- based thinking.

2. CONTROL OF EXTERNALLY PROVIDED PROCESSES, PRODUCTS AND SERVICES

As has been said in abstract, the organization shall ensure that externally provided processes, products and services conform to requirements. This requirement will also apply to small and medium-sized enterprises engaged in the wood-processing industry. The organization shall determine the controls to be applied to externally provided processes products and services when:

a) products and services from external providers are intended for incorporation into the organization´s own products and services
b) products and services are provided directly to the customer by external providers on behalf of the organization
c) a process, or part of a process, is provided by an external provider as a result of a decision by the organization

The organization shall determine and apply criteria for the evalutation, selection, monitoring of performance and re-evaluation of external providers, based on their ability to provide processes or products and services in accordance with requirements. The organization shall reat-in documented information of these activities and any necessary actions arising from the evaluations.

The subject of our interest will be subchapter no. 8. 5 Production and provision of services. For this reason, it is necessary for small and medium-sized forest-based organizations to concentrate on the requirements stated in this subchapter.

Controlled conditions shall include, as applicable:

a) the availability of documented information that defines:
   1. the characteristics of the products to be produced, the services to be provided, or the activities to be performed,
   2. the results to be achieved
b) the availability and use of suitable monitoring and measuring resources
c) the implementation of monitoring and measurement activities at appropriate stages to verify that criteria for control of processes or outputs and acceptance criteria for products and services, have been met,
d) the use of suitable infrastructure and environment for the operation of processes
e) the appointment of competent persons including any required qualification
f) the validation and periodic revalidation, of the ability to achieve planned results of the processes for production and service provision, where the resulting output cannot be verified by subsequent monitoring or measurement
g) the implementation of actions to prevent human error
h) the implementation of release, delivery and post-delivery activities.

An important part is also subchapter 8.5.3 Property belonging to customers or external providers. The standard requires that an organization treats property belonging to a customer or an external providerscarefully. The organization shall identify, verify, protect and safeguard customers´ or external providers´ property provided for use or incorporation into the products and services.

When the property of a customer or external provider is lost, damaged or otherwise found to be unsuitable for use, the organization shall report this to the customer or external provider and retain documented information on what has occurred. Just for specification a customer´s or external provider´s property can include materials, components, tools and equipment, premises, intellectual property and personal data. Such formulated requirements are, however, incomplete for many medium-sized enterprises, and it is therefore necessary to specify what is actually part of the outsourced processes.

For example: External procurement always has the essential service characteristics and management activities that are required for outsourcing can largely depend on the nature of the processes, products and services. It is also important for organizations to apply risk-based thinking. Risk-based thinking is linked to planning, review and improvement requirements. One of the key benefits of a quality management system in small and medium-sized enterprises in the wood-processing industry is that it acts as a preventive tool.

3. APPLICATION OF THE REQUIREMENTS FOR PRODUCTION AND SERVICE MANAGEMENT IN SMALL AND MEDIUM-SIZED ENTERPRISES IN THE WOOD-PROCESSING INDUSTRY

The woodworking industry in Slovakia currently produces goods worth around € 3 billion per year and provides approximately 40,000 jobs. It is also an important factor in sustainable employment in rural area as well. The pulp sector is the most stable sector of the pulp and paper industry. Woodworking companies can be divided into three groups: sawmills, pulp and paper and furniture manufacturers.

3.1. Saws

Most of the originally larger Slovak sawmills were taken over by foreign companies. As a result of the crisis, several smaller companies operating in the sector have broken down. On the contrary, large multinational companies have mostly made a reduction in the number of employees. An exception is the largest investor in Slovak woodworking - the multinational Kronospan concern, which closed its plant for the production of floating floors in Prešov. However, the main investment of Kronospan in Slovakia remains the Bučina DDD chipboard factory, where it also built a training center for the entire group. Prešov production programs were transferred to Poland and Germany. The wood industry will in the future affect the change in the species composition of timber supplies.

3.2. Pulp and paper industry

Wood deficiency is a key problem for producers and is usually addressed by imports of wood from Ukraine, Hungary, the Czech Republic and other countries. Timber imports account for about a quarter of annual paper consumption. Pulpwood drains wood mainly from power plants and wood power plants. Pulses in the Slovak Republic process deciduous wood, which causes its considerable deficiency. In view of this situation, Slovak pulp mills became raw material competitors. Packaging producers have a more favorable status compared to papers and pulps, especially in terms of energy intensity of production and lower modernization costs. There are several manufacturers of packaging in the SR. Production of corrugated board cartons, used for the transport and storage of various products, for example, the DuropackTurpak Packaging in Martina, which seeks to benefit from the boom in the automotive and electrical industry, and specializes in sana packages applicable to automotive components and large-screen TVs. On the other hand, Grafobal is specialized in smooth cardboard packaging and mainly invests in the graphic design of packaging.

3. 3. Furniture industry

Furniture manufacturers in the Slovak Republic focus mainly on exports. Currently, he works on only a few major furniture manufacturers in Slovakia. On the other hand, over 11,000 tradesmen have the furniture and joinery industry in their business.

*"Business in furniture industry in Slovakia is not easy. Slovak furniture makers have to face great competition from abroad, which often pushes furniture prices downwards and unfortunately, sometimes the quality level also drops. When we associate this fact with the fact that the largest Slovak furniture companies are producing for the multinational company Ikea, which has become very popular with us, it is really difficult for other companies to push and keep on the market " (*Trend Top v priemysle 2011).

The analysis was carried out on a sample of 445 furniture manufacturers. Furniture manufacturers achieved sales in excess of EUR 833 million. €. The average amount of sales in this business area was about 1,878 million EUR.

The Oxford Dictionary defines an English verb that outsource as an input under a contract from a source outside or outside the organization.

The term externally ordered process refers to the process that an organization needs for its quality management system, but it does not know or does not want to manage itself and therefore outsources it to an external participant. In some cases, the organization does not purchase an externally ordered process in a conventional way. For example, you can get a service from your own business or from another component of your organization without making a financial transaction.

Although at first view it may seem that there is no difference between externally ordered processes and sub-deliveries of products, these concepts differ significantly. While in the case of subcontracting we are usually interested only in the quality of the delivered product (product or service) externally ordered processes must be managed, even if the result is also delivery of the product. This is therefore a much wider complex of tasks.

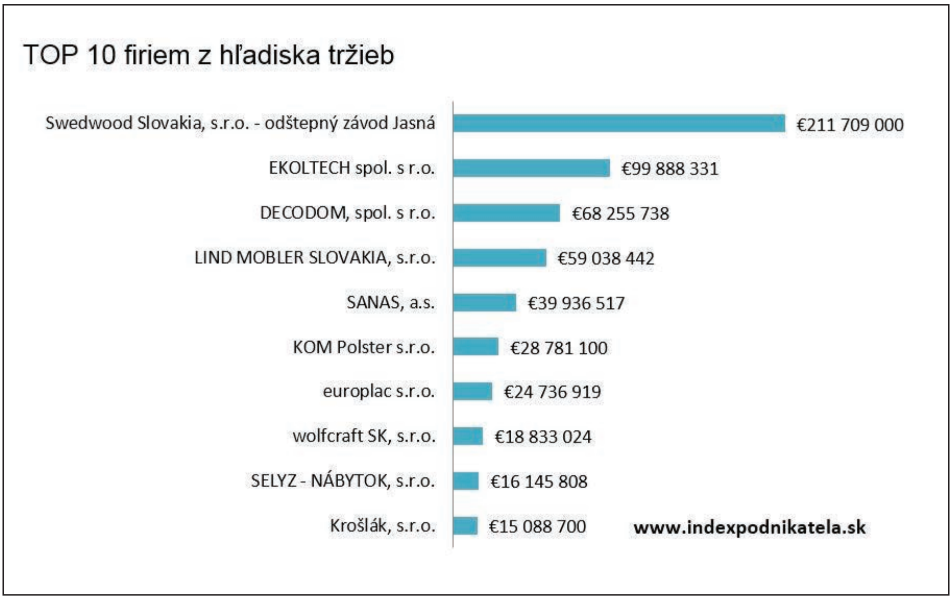

Figure 1. Receipts TOP 10 companies

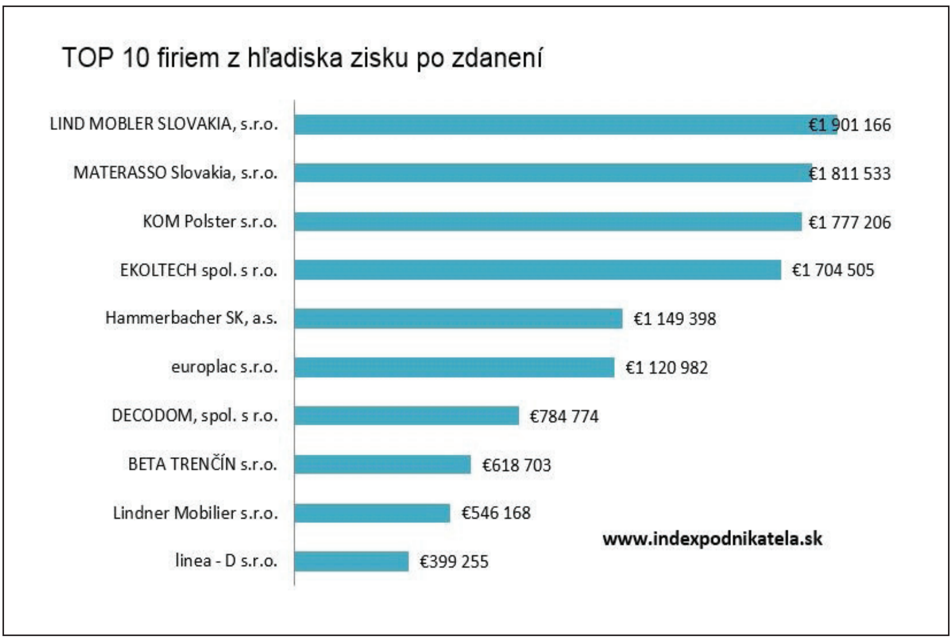

Figure 2 Profit netto TOP 10 companies

Services that could be the subject of outsourced processes by external providers in the woodworking industry:

- Professional advice
- transportation
- Product Handling
- mounting
- Warranty and post-warranty service
- Packaging, translation and palletizing
- Wholesale and retail trade
- IT services
- Services related to safety and health at work……….etc.

4. UNDERSTANDING CONTRACT WORKERS' NEEDS AND EXPECTATIONS

According to ISO 9001:2015 and ISO 45001:2018, clause 4.2,due to their effect or potential effect on the organization's ability to consistently provide products and services that meet customer and applicable statutory and regulatory requirements, the organization shall determine:

a) the interested parties that are relevant to the quality management system as well as in addition to workers, that are relevant to the OH&S management system;

b) the requirements(the relevant needs and expectations) of these interested parties (workers) that are relevant to the quality management system as well as the OH&S management system;

c) which of these needs and expectations are, or could become, legal requirements and other requirements.

The organization shall monitor and review information about these interested parties and their relevant requirements.

One of contract workers' requirement is the health and safety workplace where they perform their contract activities (ISO 9001, ISO 45001).

For example, in the specific pilot study there was indicated the need to characterize the wood dust exposure in this kind of industry. A statistically adequate number of personal samples for inhalable and total dusts should be collected. It would also be valuable to perform the biological exposure assessments. The study shows that larger firms are aware of occupational and safety related issues but need to institute better control programs. On the other hand, we had poor and disappointing responses from smaller firms, so there is a need for focused assessment of smaller firms, since very little is known about the health and safety issues in smaller firms (2010, Verma).

5. CONCLUSIONS

The aim of our contribution was to point to the requirements of the revised ISO 9001: 2016 standard. Since these requirements are very broad, it may be that organizations do not quite understand how to proceed and what relevant evidence should be. Services are generally associated with human potential and people are also the driving force behind processes. It is therefore important to address their safety and health. In wood industry organizations there are most often occurred health and safety characteristics: wood dust, noise, and bioaerosol exposures and injuries. For this reason it is necessary to properly inform the interested parties, which provides services as contract workers, about the loads, exposures and applicable personal protective equipment in the respective organization.

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FORMALDEHYDE EMISSION STANDARDS FOR WOOD-BASED PANELS AND TESTING CAPACITIES IN SERBIA

Milanka Điporovic-Momčilović, Mlađan Popović, Ivana Gavrilović-Grmuša, Jasmina Popović, Ahmad Hakky Mohamad

ABSTRACT

Wood composite panels produced with formaldehyde-based resins present one of the major sources of formaldehyde emissions in the interior. This problem has become publicly recognized during 1970ies, and since then the significant efforts were addressed to control the formaldehyde emission from wood-based panels. The European and USA regulations on this subject have led to further improvements in the resin development, and to the technology of wood based panels in a broader aspect. Today, the regulations in Serbia concerning the formaldehyde emission standards are based on the accepted European standards, and the same applies to the testing methods. The capacities for testing the wood based panels on the free formaldehyde were developed in Serbia during the 1980ies, firstly at the Faculty of Forestry of the Belgrade University. The analysis of existing capacities for formaldehyde testing in Serbia is given in this paper, as well as the possibilities for further improvements in this field.

Keywords: formaldehyde, wood based panels, emission standards, test methods

1. INTRODUCTION

Formaldehyde (HCHO) is one of the simplest organic compounds and the first member of the homologous series of aliphatic aldehydes. It is a colorless, water-soluble, toxic gas with a pungent odor (Seymour, Kauffman, 1992). As one of the key commercial products of methanol, the formaldehyde accounts for almost one third of the global methanol demand (Wickham, Hartley, 2013). On the other side, the formaldehyde itself is a valuable resource or intermediate for various end-use products (Figure 1).

Due to its availability, low cost and high reactivity, it is one of the key crosslinking agents in the organic synthetic industry. It readily reacts in the poly-condensation processes with the series of other monomers such as phenol, urea, melamine and others, thus creating the synthetized polymer adhesives, lacquers or plastics. Hence, the main use of formaldehyde is in the production of the urea-formaldehyde (UF), melamine-formaldehyde (MF) and phenol-formaldehyde (PF) resins, which are dominantly used in wood industry as the adhesives for various wood based panels and wood plastic composites (Wickham, Hartley, 2013). For these applications, the UF resin still has the major role (Figure 1). In 2001 the UF adhesive alone has amounted for 80% of the 6 million tons of total formaldehyde based adhesive consumption by the European producers of wood-based panels (Athanassiadou, 2008).

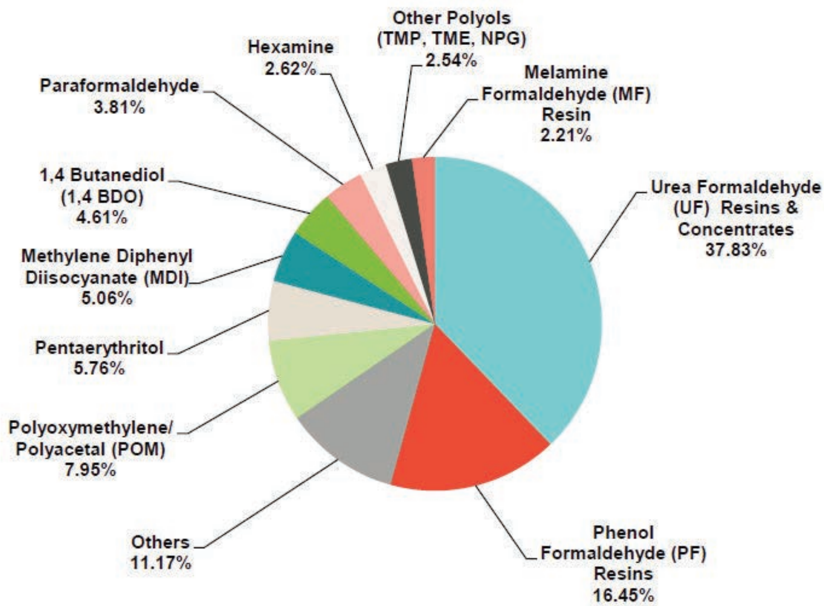

Figure 1. Global formaldehyde demand by derivative in 2015 of the total 17472 kMT of formaldehyde (Axelsen, 2015)

The introduction of UF resin in the wood industry and its dominant involvement in the furniture and other interior products has laid the foundations for the formaldehyde emission problem. Although it belongs to the group of thermo-reactive adhesives, the cured UF adhesive (in wood-based panels) is susceptible to the hydrolysis of its weakly bound formaldehyde from N-methylol groups, acetals and hemiacetals, but also from methylene-ether linkages at high relative humidity, which altogether increase the content of emitable formaldehyde and create the source of long term subsequent formaldehyde emission (Dunky, 1998). Hence, the wood based panels containing formaldehyde based resins, especially UF resin, are recognized as the sources of formaldehyde in indoor environment. The increased concentration of formaldehyde in the surrounding air can cause various harmful effects on human health, such as the irritation of eyes, nose, throat and skin, which in more severe cases can lead to asthma and allergic reactions (Kaden et al., 2010). In addition, the International Agency for Research on Cancer (IARC) of has classified the formaldehyde into the Group 1, as carcinogenic to humans.

In the historical perspective, the problem of formaldehyde emission from wood based panels bonded with UF adhesive had been publicly recognized during 1970s in USA, and soon after, this concern has spread across the developed countries of Europe.

This paper presents the overwiew and comparison of different globaly improtant formaldehyde emission standards that concern the wood based panels and products. In addition, the capacities and the potential for formaldehyde testing in Serbia are also evaluated.

2. METHODOLOGY

The methodology of this research is based on the content analysis and comparative analysis. The content analysis has been applied to study and understand both the standards that regulate the formaldehyde emission from wood based panels and the standards that define the procedures for testing of the formaldehyde emission from such products. Comparative analysis was used to compare the procedures of testing the formaldehyde emission and evaluating the product performances in the aspect of certification and quality control, as defined by different standards and regulations.

The formaldehyde emission limits, testing procedures and certification schemes were evaluated and compared between the standards and regulations developed in European Union, USA and Japan, as being the leading economies and legislators in this field.

3. FORMALDEHYDE EMISSION STANDARDS AND REGULATIONS

3.1. Emission limits

Herewith is the overview of the formaldehyde emission limits for wood based panels in European Union, USA and Japan. European Union defines the formaldehyde emission limits in the standards developed by the European Committee for Standardization (CEN). The standards such as EN 636, EN 312, EN 622-1 and EN 300 defines the requirements for the plywood, particleboards, fiberboards and oriented strand boards (OSB), respectively; while the EN 13986 presents the harmonized standard that defines the emission limits for the panels used in construction (Table 1). All of the above mention standards classify the wood based panels into two emission classes, E1 and E2, with E1 class having the same emission limits. In addition, the E1 emission class has become mandatory for the most of the European countries.

Table 1. The emission classes for wood based panels according to the EN standards

Emission class	Standard	Emission value (mg/m³ of air)	Perforator value [a] (mg/100g of dry board)
E1	EN 13986 [b]; EN 636 [c]; EN 622-1 [d]; EN 312 [e]; EN 300 [f]	≤ 0.124	≤ 8
E2	EN 13986; EN 636; EN 622-1	> 0.124	> 8 ≤ 30
	EN 312; EN 300	> 0.124 ≤ 0.3	> 8 ≤ 20

[a] Unfaced particleboards, fiberboards and OSB
[b] Wood-based panels for use in construction - Characteristics, evaluation of conformity and marking
[c] Plywood - Specifications
[d] Fibreboards - Specifications - Part 1: General requirements
[e] Particleboards - Specifications
[f] Oriented Strand Boards (OSB) - Definitions, classification and specifications

The first regulation act in USA concerning the formaldehyde emission from wood based panels has been established in 1984 by the US Housing and Urban Development Agency (HUD). The aim of this regulation was to lower the exposure to formaldehyde inside the prefabricated (mobile) homes, thus setting the upper emission limit of 0.2 ppm for plywood panels and 0.3 ppm for particleboards. The large chamber method (ASTM E1333) was selected as the testing method for the formaldehyde emission. However, much stringent requirements of formaldehyde emission from wood based panels has been established by the California Air Resources Board (CARB), which has identified the wood panels bonded with formaldehyde based resins as the main source of formaldehyde in the interior. During 2008 the CARB establishes the Final regulation ATCM 93120, the Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products. This regulation, above other measures, sets the standards for emission limits that were applied in two phases. The introduction of second phase, implying more stringent requirements, has occurred in the period of 2010-2012 (Table 2). The CARB regulation includes wood based composite panels such as plywood (with veneer of composite core), particleboards and medium density fiberboards (MDF); but it further includes the products consisting of wood based panels, such as the laminate floorings, furniture etc.

Table 2. Phase 1 and Phase 2 Formaldehyde Emission Standards for wood based panels (CARB, 2008)

Phase of implementation	HWPW [a]	PB [b]	MDF [c]	Thin MDF [d]	Period of **implementation**
	Upper emission limit (ppm)				
P1	0.08	0.18	0.21	0.21	2009
P2	0.05	0.09	0.11	0.13	2010-2012

[a] Hardwood Plywood; [b] Particleboard; [c] Medium Density Fiberboard; [d] MDF with thickness ≤ 8 mm

Following the Californian regulations, the Environmental Protection Agency (EPA) have proposed the rule to implement the Formaldehyde Standards for Composite Wood Products Act, enacted as Title VI of Toxic Substances Control Act (TSCA). The requirements of this rule are largely in accordance with the CARB regulation, with the formaldehyde emission standards identical to the standards currently in place in California (EPA, 2016).

In order to improve the indoor air conditions in residential and public buildings, the Japanese Ministry of Construction has amended the Building Standard Law (BSL) in 2003. In the aspect of formaldehyde emission, the new regulations sets the emission limits for building materials, including the wood based materials (Eastin, Mawhinney, 2011). These restrictions are based on the emission class of the panel product, the type of habitable room and the ventilation frequency of the room (Ruffing et al., 2011). However, this regulation does not refer directly to the final products, yet it concerns the materials from which they are built and the built-in non-movable products. Additionally, there are series of standards regulating the emission limits for wood based panels, such as particleboards (JIS A 5908), fiberboards (JIS A 5905) and plywood (JAS 233). These panels are classified by their emission rating, identified by the letter “F” and the number of stars. The panels with the emission class of two and three stars are subjected to the BSL restrictions, while this is not the case with the most stringent emission class, i.e. the use of the panels with four stars in interior is unlimited. The emission limits for all of the classes are given in the Table 3.

Table 3. Formaldehyde emission classes for wood based panels in Japan

Emission class	Mean value of emission [a] (mg/L)	Maximum value of emission [a] (mg/L)	Panel type [b]
F*	> 1.5 ≤ 5.0	> 2.1 ≤ 7.0	only for PW
F**	> 0.5 ≤ 1.5	> 0.7 ≤ 2.1	PB, FB, PW
F***	> 0.3 ≤ 0.5	> 0.4 ≤ 0.7	PB, FB, PW
F****	≤ 0.3	≤ 0.4	PB, FB, PW

[a] Formaldehyde emission test is based on desiccator method, according to JIS A 1460 (the result presents the concentration of formaldehyde from the test piece absorbed into the water).
[b] PB - particleboard; FB - fiberboard; PW - Plywood.

3.2. Certification

According to the standard EN 13986 the product certification is under the responsibility of notified certification body. The manufacturer is also required to conduct the initial type testing and to maintain the regular factory production control (FPC). The FPC testing for E1 class of particleboards, fiberboards and OSB are to be performed once during the 24 h, and once a week for the E2 class of panels (EN 13986, 2004).

The CARB regulation requires that manufacturers of wood based panels must maintain the records for a period of two years, which include: tracking information for each composite wood product; product information; purchaser information; product transporter information; identification of the CARB approved third party certifier. This regulation also details the requirements for distributors, importers, fabricators and retailers of finished goods. The certification of the products are done by the third party certifiers, which are in turn approved by the Executive Officers of the Californian ARB.The procedure for product certification includes the formaldehyde emission testing by the large chamber method (ASTM E1333) selected as the primary test method. The use of medium sized chamber (ASTM D6007) is also permitted as the secondary test method, but only after the established equivalence with the primary method (CARB, 2008).

Japanese BSL requires that both primary and secondary products must be certified by third-party testing facilities and to be identified by their emission class. The quality control of wood based panels should be conducted by manufacturer in order to ensure the compliance with the formaldehyde emission limits. However, in practice, the testing is often conducted by the agencies accredited by the Japanese Standards Association (Ruffing et al., 2011).

3.3. Comparison of emission standards

It is relatively dificult to compare the emisson standards of different origins. There are two reasons for this and the first one concerns the differences between the testing methods, which includes the type and characteristics of the equipment, the sample preparation procedure, the sample dimensions and the testing conditions. Another aspect that complicates the comparison of the emission standards is related to the units of measure of the formaldehyde emission limits. However some efforts have been made in experimental comparison between preferential testing methods from different regions.

Risholm-Sundman and coworkers (2007) have made the experiments comparing the chamber method (EN 717-1) with the desiccator method (JIS A 1460). They have come to the relation between the emission values obtained by those two methods, with determination coefficient of 0.73. Herewith is the formula for the emission values of chamber method (EN 717-1) expressed in the following form (adopted from Risholm-Sundman et al., 2007):

$$C = \frac{D - 0.0463}{6.8561} \quad [\mathrm{mg/m^3}] \quad (1)$$

D - formaldehyde emission expressed as the concentration of formaldehyde from the test piece absorbed into the water (mg/l)
C - formaldehyde emission from the wood-based panels being tested is expressed as the concentration in the air of the test chamber (mg/m^3).

From the table 4 we can notice that the Japanese formaldehyde emission limit for F**** class of panels, when calculated for the emission value that corresponds to the chamber method (EN 717-1), is well below the requirements for the E1 class of the panels, which is 0.124 mg/m^3. However, due to the uncertainty of experiment results, we can assume that the Japanese F*** class does not differ much to that of the European E1 class.

Table 4. Comparison of formaldehyde emission values between the JIS A 1460 and EN 717-1 methods using the experimental relation (Risholm-Sundman et al., 2007)

Emission class	JIS A 1460 (mg/L)	EN 717-1 calculated (mg/m^3)
F**	2,1	0,300
F***	0,7	0,095
F****	0,4	0,052

Also, there is a problem when comparing the formaldehyde emission values between the European chamber method (EN 717-1) and the North American large chamber method (ASTM E1333). Concerning the regulations requirements, the limit values are similar. If we present the formaldehyde concentration in air for E1 class of panels in parts per million (ppm) we shall obtain the value of 0,1 ppm, which roughly corresponds to the CARB phase 2 limit values for particleboards (0.09 ppm) and MDF panels (0.11 ppm). However, the testing conditions of the large chamber (ASTM E1333), which is the primary testing method of the CARB final regulation, requires relatively higher temperature and humidity then the EN 717-1 chamber method. It is reasonable to assume that such conditions increase the actual formaldehyde concentration in air. Hence, it has been reported that the wood based panels tested by EN 717-1 method exhibited 20% lower formaldehyde concentration values then when tested by the ASTM large chamber method (Groah et al, 1991).

From the above we can assume that the Japanese regulations are the most stringent concerning the formaldehyde emission from wood based panels. However, the CARB regulation states the upper limits which cannot be exceeded, and the manufacturers are encouraged to aim for lower emission levels due to the variability in panel emissions (Ruffing et al., 2011).

4. FORMALDEHYDE EMISSION REGULATIONS IN SERBIA

Since the early 1980s, the relevant standards of the former Yugoslavia (JUS) has defined the emission classes for wood based panels in the same way as it was defined in the standards of other leading European countries. For example, the JUS D.C5.031 (1982) that sets the requirements for particleboards also included the requirements for E1, E2 and E3 emission classes. Since 2010, the Serbia has accepted all of the EN standards concerning the wood based panels designating it as SRPS EN. Hence, the formaldehyde emission standards in Republic of Serbia are actually the accepted emission standards of EU.

Beside the SRPS EN standards, the only government regulation in Serbia that concerns the testing of particleboards and OSB on formaldehyde emission is the Rule on the Requirements for Particleboards (Pravilnik o zahtevima za ploče iverice, Sl. gl. RS, 101/2016). It was developed after the cancelation of the Order for Mandatory Attesting of Particleboards for general purpose and construction (Naredba o obaveznom atestiranju ploča iverica za opštu upotrebu i građevinarstvo, Sl. list SFRJ, broj 61/83). However, the above Rule has included the Mutual Recognition Clause, by which the Rule itself does not apply on the general purpose particleboards already legally marketed in the EU and Turkey or legally produced in EFTA countries. In addition, the Declaration of Conformity for a product can be formed on the basis of the Test Report issued by the foreign laboratory, if its national accreditation body has the agreement with the Accreditation Body of Serbia.

Figure 2. The locations of the CARB approved Third Party Certifiers in Europe (https://www.arb.ca.gov/toxics/compwood/listoftpcs.htm)

However, an interesting opportunity has been arise since the CARB regulation started to make the global influence on the production and the market of wood based panels. There are 15 CARB approved Third Party Certifiers in Europe, which are concentrated mostly in the Central (Germany-3, Austria-1, Czech-1 and Poland-2), Northern (Sweden-1 and Denmark-1), Western (France-1 and Belgium-1) and Southern regions (Spain-1 and Italy-3) as can be seen in the Figure 2. On the other Hand, the production capacities of various types of wood base panels are increased in Southeastern parts of Europe in paste few decades. With the Serbia in the very middle of that region, it has an opportunity to develop the testing and certifying center that could answer the needs of both domestic producers and the producers in the surrounding countries. There were several recent demands for testing the formaldehyde emission according to the CARB regulative, applied by domestic particleboard producer. However, due to the luck of the capacities for accreditation according to the CARB demands, those testing were done in foreign laboratories.

Today, there are two institutions in Serbia that have the experience in the testing and certification of wood based composite panels. The one is the Institute for testing of materials (IMS Institute) and the other one is the Faculty of Forestry in Belgrade with its Laboratory for particleboard testing (LPT).

The history of the LPT laboratory begins in the 1977 (with the start of the first particleboard factory in Serbia) and during 1980 the laboratory became authorized by the Yugoslavian Federal Standardization Institute. The laboratory was well prepared for the incoming problem of formaldehyde emission from wood based panels. At that time it had developed the perforator and WKI standard methods, which have also resulted in doctoral dissertation, and started with the formaldehyde release tests on the imported and domestically produced particleboards. The LPT laboratory also organizes the trainings for domestic factories of particleboards and plywood and was very much involved in the commission of needed formaldehyde testing apertures. At the beginning of 1990s there were only two centers in the Former Yugoslavia for testing of formaldehyde release, one in Ljubljana and one in Belgrade.

During 2003 the LPT laboratory gained its first accreditation as a testing laboratory for particleboards, by the Accreditation Body of Serbia and Montenegro, and in 2006 it expands its scope of accreditation on fiberboards. The laboratory kept its accreditation status until the 2016 and the withdrawal of the Order for Mandatory Attesting of Particleboards. New conditions on the domestic market has influenced on drastically low demands for testing, and hence the new situation became economically unsustainable to support further accreditation of LPT laboratory.

On the government level, the significance of the formaldehyde testing and its contribution to the indoor pollution is not yet fully recognized, because in this moment there is no regulations or rule in Serbia with mandatory implementation. It is important to know that the formaldehyde belongs to one of the VOC components that is harmful to human if the indoor concentrations are increased. However, one of the ways to achieve a healthy indoor environment for occupants and building users is the control of sources, eliminating or limiting the release of pollutants in the air (Bloyssen et al., 2011).

It is necessary to direct the efforts on develpment of the quality system for the wood based panels, especialy towards the formaldehyde release testing as to **assure the protection of consumers** of wood based panels and products, in accordance with the development of new types of panels, new ecological standards and the improvement of testing methods and certification protocols in regard to the European regulatives.

5. CONCLUSIONS

The European Union, USA and Japan present the major driving forces in reducing the formaldehyde emission from wood based panels and finished wood products. The Japanese formaldehyde emission limits are probably the most stringent, however, it is difficult to compare these values with enough certainty, since there are much differences in testing methods proposed by different regulations and used in the relevant countries.

In the terms of product certification on formaldehyde release, the Final Regulation of Californian Air Resource Board (CARB) has defined the most thorough procedures for testing and certification of wood based panels and products.

In the aspect of formaldehyde emission standards and testing methods, the Republic of Serbia has adopted the European Standards. There are currently two testing facilities in Serbia capable to determine the formaldehyde release from wood based panels. However, both of them are using the extraction method, the so called perforator method, for determination of formaldehyde content in wood based panels.

The influence of the USA regulations is evident in the Europe by the number of testing institutions certified according to the CARB regulation. Currently, there are no facilities in Serbia and in the close proximity that are approved as the third party certifiers by CARB.

There are both opportunities and needs for the development of quality systems for wood based panels, especially in the aspect of formaldehyde emission testing in order to assure the protection of consumers of wood based panels and products in this growing economy.

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NEW PERSPECTIVES OF THE APPLICATION OF WOOD BASED BUILDING MATERIALS

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ABSTRACT

The article describes the fire resistance tests made on the OPS 300 material – the composite material based on the WWCB Krupinit and polystyrene. According to the test results material fulfils the criteria of the Slovak standard STN EN 92 0201-2: 2017.

The tested material was also evaluated from the environmental point of view. WWCB materials are recognised as materials that are fully degradable and therefor suitable for the sustainable construction production.

Keywords: wood wool cement board, physical properties, insulation, passive house, construction waste

1. INTRODUCTION

During the last years construction production in Slovak republic has growing tendency. As we can see from the Figure 1. in the year 2015 construction production has reached the record value 5148, 4 million EUR. During the period 2013-2017 construction production demonstrates clear steady growth.

Although there are not exact statistics about the share of the reconstruction and maintenance, mainly thermal insulation, of the residential buildings and single-family houses on the construction production, in the year 2017 there was an increase of 1,1% according to the year 2016 with total value of 1364 million EUR. As for the single-family houses the estimation is the year 2045. In the year 2015 55,69% of the residential buildings and 30,67% of single-family houses have gone through the reconstruction (ABS.sk, 2016). It is estimated that in the year 2029 all residential buildings will go through the reconstruction and will have thermal insulation.

Increase of the construction production is closely linked with the production of the construction and demolition waste.

European Commission recognize construction and demolition waste (CDW) as one of the heaviest and most voluminous waste streams generated in the EU. According to (European Commission Environment, 2016) it accounts for approximately 25% - 30% of all waste generated in the EU and consists of numerous materials, including concrete, bricks, gypsum, wood, glass, metals, plastic, solvents, asbestos and excavated soil, many of which can be recycled.

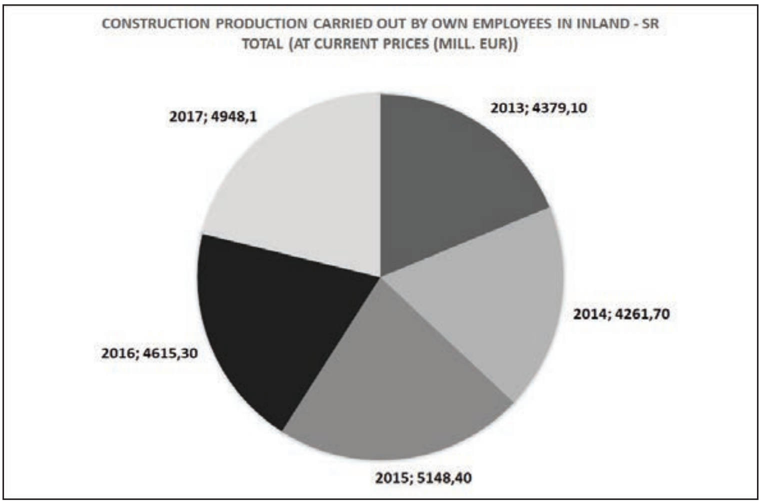

Figure 1. Construction production in Slovak republic during the period 2013-2017
Source: Slovstat

CDW arises from activities such as the construction of buildings and civil infrastructure, total or partial demolition of buildings and civil infrastructure, road planning and maintenance. Different definitions are applied throughout the EU, which makes cross-country comparisons cumbersome. In some countries even materials from land levelling are regarded as construction and demolition waste.

CDW has been identified as a priority waste stream by the European Union. There is a high potential for recycling and re-use of CDW, since some of its components have a high resource value. In particular, there is a re-use market for aggregates derived from CDW waste in roads, drainage and other construction projects. Technology for the separation and recovery of construction and demolition waste is well established, readily accessible and in general inexpensive (European Commission Environment 2016).

From this point of view, it is important to reconsider the environmental load of the construction materials and to support production of those materials that support sustainability of the construction production.

In this article we would like to present material that has a long history and was widely used in construction at the end of the 20th century – wood wool cement boards (WWCB).

Wood Wool Cement Board (WWCB) is a versatile building material made from wood wool and cement where each fibre is coated with a thin film of Ordinary Portland Cement (OPC) that, when cured, partly petrifies the wood. In that way the fibre will last indefinitely as long as the cement film is not damaged. (Leewis, 2014).

Environmentally speaking, cement has a negative CO2 signature and therefore both the wood and cement, when decomposed, are harmless to nature and as a result all homogeneous WWCB products have green labels in Europe. It combines the advantages of both wood and concrete together: as light as wood, as firm as concrete. (Leewis, 2014).

1.1. Wood Wool Cement Boards

The history of the WWCB according to Van Elten (2006) started in the year 1900 when the first mineral bonded board was produced by Mr. Schmidt, a carpenter from Austria using wood shavings and gypsum. Twenty years later Mr. Josef Oberleitner used Portland Cement producing the first Wood Wool Cement Board (WWCB) and several others in Europe followed. In 1960 Braun and Schneider developed mixing and dosing equipment and presses and Canali made complete production lines.

The main characteristics of the WWCB are:

- Fire resistance
- Wet and dry rot resistance
- Freeze-thaw resistance
- Termite and vermin resistance
- Thermal insulation, providing energy savings
- Acoustic performance - sound absorption
- Acceptance of a wide range of finishes

According to the Slovak Construction act from the year 1976 buildings as a whole and their parts must be appropriate for their intended use, in particular with regard to the health and safety of people throughout their life cycle. Buildings must meet the following basic building requirements during the normal maintenance period in an economically reasonable period of service:

- Mechanical resistance and stability
- Flame safety - STN EN 13501 – 1+A1
- Hygiene, health and the environmental conditions - STN EN ISO 10211
- Safety and accessibility in use
- Noise protection
- Energy efficiency - STN EN 73 0540
- Ecological aspects.

After a fire which tore through Grenfell Tower in West London in June 2017 and 72 people died, as the reason of this tragedy was recognised flammable exterior cladding. To prove the fire resistance of the WWCB produced by OP-TIM company in Slovakia we choose the OPS 300 material used also for the building cladding.

2. OPS 300 WWCB fire resistance testing

The OPS 300 wall panel is a lightweight, laminated structure. The core of the panel is expanded polystyrene EPS 70 or EPS 70 NEO with thickness of 200 mm. Both sides of the core are covered with Krupinit K 50 – wood wool cement boards with a thickness of 50 mm.The wood wool cement boards are glued to the polystyrene all over the place with adhesive mortar and polyurethane foam. In the side walls of the polystyrene core there is a slot adjacent to the inner side of the WWCB for joining of the panels. The panel dimensions are: width 500 mm, height from 500 mm to 4000 mm, thickness 300 mm.

The wall panel OPS 300 is designed for the construction of the external walls of family and residential buildings, industrial halls, non-residential buildings, single-storey industrial and agricultural buildings. It is not suitable for the walls exposed to the permanent moisture and the direct application of water. The required flame resistance is min. 30 minutes according to the STN EN 92 0201-2: 2017.

The OPS 300 panel samples were made from the original OPS 300. The OPS 300 panel has a height of 2670 mm, our samples have been cut from the panel to the required dimensions of 500 mm to 500 mm. The adhesive mortar was applied to individual layers of Krupinite and polystyrene. This adhesive mortar matured on the surfaces of each sample for approximately 14 days. Later, Krupinit and polystyrene were bonded with PUR foam and loaded to achieve sufficient bonding of the PUR adhesive foam. The plaster was applied to the sample later and let to mature freely. The plasterboard has been glued to the sample and bolted at the same time. The frame of the sample was from plasterboard, attached to the sample by screws.

Four holes 250 mm deep and 100 mm from the edge of the sample were drilled to place four thermocouples, which measured the temperature during the test by the radiation panel. The other two thermocouples were placed on the exposed side using a fireclay. The last two thermocouples were attached with fireclay to the outer side of the sample. The sample was framed with a 12.5 mm thick plasterboard from all four sides. All eight thermocouples were placed at the same height - 250 mm from the top edge of the sample, for the correct evaluation of the measured values.

The exposed side of the first OPS 300 panel sample was from 12.5 mm thick plasterboard, which is commonly used as a surface finish for the family houses interior.

Plasterboard is a lightweight, durable, easy workable material with a long service life. It isolates against noise and is vapor permeable. Plasterboards are made of gypsum and special high-strength cardboard. They are manufactured in wet conditions or in order to achieve a higher flame resistance of the structure. Plasterboards are easy to manipulate because of the absence of wet processes and also because of their low weight. They are not designed for load-bearing structures.

Before the test, the radiation panel was warmed up to to the operating temperature, which took about 15 minutes. We placed the sample on bricks up to 100 mm high and 200 mm from the radiation panel.

In the first few minutes after approaching the exposed sample to the radiation panel it showed the signs of brownness. Five minutes later, white strips appeared on the surface of the plasterboard. The browning of the plasterboard continued. In the 13th minute, the paper, which forms the upper part of the plasterboard, began to crack and peel off. In such a state the plasterboard remained until the end of the test. After the test, we unscrewed the top plate of the frame and control the inner materials. We also removed the side panel of the frame to see the changes that occurred during the test. We found that the Krupinit board, which was placed behind the exposed plasterboard, remained intact (see Figure

2.). The materials in the sample were warm but intact. The Krupinit board was warm to hand touch also 15 minutes after the test. But the Krupinit boards, which form the core of the OPS 300, have withstood the test, despite the fact that their base is wood.

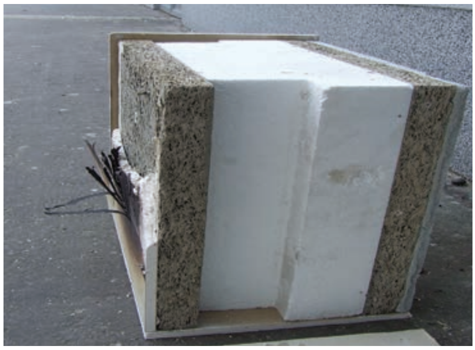

Figure 2. Specimen number one after the test

In the second specimen we used a coarse-grained plaster with a thickness of about 10 mm, which is alternatively used for interior design.

Plasters are kind of surface finishes used to get the desired appearance of building structures, provide hygiene, protect the structure of the building from the effects of weathering. The quality of the plaster depends on the quality of the input material, the optimal choice of the plastering system and the appropriate processing and technological process of covering the structure. There are many types of plasters. Most commonly used include: fine-grained, coarse-grained, silicate, silicone, acrylate, acrylic. The type of plaster must be compatible with the substrate, both in terms of its physical and chemical properties.

The test of the second sample proceeded smoothly, there was no indication of plaster damage on the exposed side during the the whole time of exposition - 30 minutes. After the test, we removed the top and the side of the sample frame for the control of the inner materials (see Figure 3.). We found the integrity of the individual layers of the OPS 300 panel. Interesting was the radiant moisture heat emerging from the Krupinit board.

Figure 3. Specimen number two after the test

2.1. Discussion of the fire resistance test results of the OPS 300 panel

Both samples of the OPS 300 panel were tested using the radiation panel. Tests were performed on various surfaces of the exposed sides: plasterboard and plaster.

The behaviour of the material on the exposed side was assessed visually and based on the temperature record.

Visual results were as follows:

- The plasterboard (Sample No. 1) remained intact, despite its continuous disruption, heat degradation was observed only on the paper surface.
- The coarse-grained plaster, (Sample No. 2), remained intact throughout the test.
- Based on temperature records, the results were as follows:
- Plasterboard (Sample No.1) – after one minute reached 100 °C, after 10 minutes 200 °C. At the beginning of the 30th minute the maximum temperature of 229.2° C was recorded.
- Coarse-grained plaster (Sample No. 2)- after 1 minute and 10 seconds, the temperature reached 100 °C, after 8 minutes and 20 seconds it reached 200 °C. At the 29th minute maximum temperature of 296.7 °C was recorded.

The behaviour of other materials in the OPS 300 panel was evaluated visually and based on the temperature record.

Sample No. 1 materials interfaces:

Krupinit and polystyrene interface - in the first minute the recorded temperature was 17.4 °C, after 10 minutes the temperature was 17.4 °C. In the 30th minute, the maximum temperature of 32.3 °C was recorded.

The temperature of the centre of polystyrene in the first minute was 17.0 °C, after 10 minutes the temperature was 17.4 °C. In the 30th minute, the maximum temperature of 32.3 °C was recorded.

Non-exposed side - in the first minute the recorded temperature was 16,8 °C, after 10 minutes the temperature was 17.4 °C. In the 30th minute, the maximum temperature of 19,9 °C was recorded.

Sample No. 2 materials interfaces

Krupinit and polystyrene interface - in the first minute the recorded temperature was 16,5 °C, after 10 minutes the temperature was 16,1 °C. In the 30th minute, the maximum temperature of 42,4 °C was recorded.

The temperature of the centre of polystyrene recorded in the first minute was 17.0 °C, after 10 minutes the temperature was 16,7 °C. In the 30th minute, the maximum temperature of 18,8 °C was recorded.

Non-exposed side - in the first minute the recorded temperature was 18,8 °C, after 10 minutes the temperature was 19 °C. In the 30th minute, the maximum temperature of 19,9 °C was recorded.

From the surface temperatures comparison of the exposed side of the samples, the temperature in the case of plasterboard increased steeply during the first four minutes, slightly over the next 13 minutes, and from about the 17th minute remained almost constant - about 200 °C. In the case of plaster, the temperature also increased steeply during the first four minutes, from the 4th minute to the end there was a slight, almost linear rise up to about 250 ° C. These different courses could be due to the properties of the surface materials or to the influence of the burnt layer of the paper surface of the plasterboard.

It is also important to state that the OPS 300 is made of Krupinit the WWCB, where the main component is the wood wool. The ignition temperature of the wood wool is in the range from 350 °C to 360 °C. Testing temperatures did not reach this value. The test has proved that in the case of the fire the statics of the building will be not disturbed.

The OPS 300 wall panel was also tested for flame resistance at a specialized Fires s.r.o facility in Batizovce under stationary conditions in the test chamber. Flame resistance reached up to 120 minutes, which is 4 times more than resistance required by the norm.

3. CONCLUSION

In the year 2013 the Cradle to Cradle Products Innovation Institute announced a challenge to Create a building product that is safe, healthy, affordable, effective, and designed to be returned safely to nature or industry after use. Between the final products have been:

- Ecococon straw panels - structural building components built from straw packed into wood frames.
- ECOR Universal Construction Panels - composite panels made from 100% recycled waste cellulosic materials—used cardboard, agricultural wastes, etc.
- Haploblocks - building blocks made from Forest Stewardship Council-certified wood and expanded cork insulation.
- Reinforced wood wool cement boards - made from cement and wood shavings.

Wood wool cement boards or the composite materials based on the WWCB, have not only excellent properties for low energy houses like good thermal insulation and excellent heat buffering capacity (Stasiak-Betlejewska, 2016), but they are also aplicable in wet conditions, they are termit and vermin resistant, can be used as acustic materials because of excellent sound absorbtion and because of the very high vapor permeance there are very well applicable for the reconstruction of historical buildings that have major problems with the humidity.

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ENERGY-EFFICIENT BUILDING DESIGN WITH TIMBER AND GLASS PANELS

Marija M. Janakieska, Kiril Gramatikov, Manja K. Kuzman

ABSTRACT

The usage of timber and glass dates back to a long time ago, but nowadays they are becoming one of the most important materials as far as the energy efficiency is concerned, especially if used as structural elements. Combining those two materials is complicated, from constructive, energy-efficient, sustainable, economic and aesthetic point of view. Moreover, the new technologies in glass production have major impact on the properties, so that the glass can be treated as a load bearing material and can provide horizontal stability of timber structures as well. Furthermore, engineering innovations, such as heat treatment processes, laminating, insulating, coatings and improved connections, contribute to the energy-efficient performance of the glass. In this study, the application of timber and glass as structural elements will be elaborated through case studies of buildings in Slovenia.

Keywords: energy-efficient, timber construction, glass panels, buildings

1. INTRODUCTION

Planning and designing of an energy-efficient building is a very complex process, which requires the balance of the energy consumption, the energy gain and energy storage. The basic design level consists of careful and detailed selection of the components and the materials. The introduction of new products in the construction sector, however, is generally met with hesitation, low awareness, and high uncertainty in the marketplace; therefore, the communication of information is vital to market success [6,1]. During the 2000s, pressure has increased at local, regional, and national levels to find a balance in using forest resources to enhance economic, environmental, social, and cultural benefits [3]. Simultaneously, the role of wood in the modern bioeconomy, and the global emphasis on enhancing sustainable development via increased renewable resource utilization has stimulated large-scale demand for wood products for many end-users, as well as specifying wood by architects [7]. In Europe, the wood products sector plays a pivotal role in the development of a sustainable society, where economic, environmental, social and cultural aspects of using natural resources are taken into account [9]. In this context, wood-based products as elements of restorative environment in combination with glass are the most preferred building materials in terms of energy-efficiency [2] and living comfort.

1.1. Energy-efficient Building Design- Green building concept

A 'green' building is a building that, in its design, construction or operation, reduces or eliminates negative impacts, and can create positive impacts. Green buildings preserve precious natural resources and improve the quality of life. There are a number of features which can make a building ‘green’. These include:

- Efficient use of energy, water and other resources
- Use of renewable energy, such as solar energy
- Pollution and waste reduction measures, and the enabling of re-use and recycling
- Good indoor environmental air quality
- Use of materials that are non-toxic, ethical and sustainable
- Consideration of the environment in design, construction and operation
- Consideration of the quality of life of occupants in design, construction and operation
- A design that enables adaptation to a changing environment

2. THE USAGE OF TIMBER AND GLASS IN CONTEMPORARY ARCHITECTURE

Nowadays we are using timber and glass (timber and glass prefabricated walls) in contemporary architectural planning as construction materials which was formerly rather neglected. With sustainable technological development and appropriate use, timber and glass are nowadays becoming essential construction materials which contribute to energy-efficiency building design [4]. Many building material selection choices are guided by a desire to minimize their negative impacts, either on the occupants or on the environment. There is no doubt that the process of learning about the actual options available in material selection has a tremendous bearing on the actions that professionals take, and the attitudes that they hold throughout their careers. This is no different in the field of design, where, among other subjects, architects and structural engineers are constantly acquiring knowledge about the use of various structural materials, products, and systems.

The choice for glazing through careful architectural design is an important factor in different type of buildings, because it affects directly the energy consumption as well as living comfort (Table 1).

As a natural material requiring minimal energy input into the process of becoming construction material, timber represents one of the best choices for energy-efficient construction, since it also functions as a material with good thermal transmittance properties. On the other hand, the glazing in buildings provides natural daylight and connection with the environment. In the past, glass has been characterized as a material with weak thermal properties, but this is changed in the last few years due to its improved thermal, optical and strength properties, resulting from the development of its production. Both building materials lead to the development of a new type of structures - timber-glass buildings, suitable for the construction of energy-efficient buildings where an optimal proportion and appropriate orientation of the glazing surfaces is crucial for using renewable energy from the sun, which leads to reduction of the building`s total energy demand [4, 5].

Table 1. Advantages and disadvantages of the "Energy-efficient windows and glazing" concept for achieving living comfort [5, 6]

<table>
<tr><th colspan="2">Concept for achieving living comfort: Energy-efficient windows and glazing</th></tr>
<tr><td>
Timber-glass prefabricated walls replacing the classical sheathing boards with glass panes</td><td>

Three-layered insulating glazing replacing the classical boards</td></tr>
<tr><td colspan="2">Advantages
• Quality glazing can reduce heat losses through transparent parts of the building envelope.
• Higher comfort in the interior.
• Receiving energy from solar irradiation on the south, east and west facade.
• Natural daylighting in the interior, reducing the need for electricity lightning.</td></tr>
<tr><td colspan="2">Disadvantages:
• Three-layer glazing is harder, which is why the window frame must also be thicker.
• Effective glazing is more expensive (more layers of glass, low emission coatings, filling with noble gases, better spacer, thicker frame).
• With a large proportion of the glazing of the building there is a danger of over-heating and solar control is necessary, which is more expensive.</td></tr>
</table>

3. CASE STUDIES

Modern houses design focus on encoring high indoor comfort quality and low-energy consumption. In this study, the application of timber and glass as structural elements is elaborated, as well as their influence on the energy efficiency of the buildings on different aspects: the optimal glazing size, glazing arrangement, external shading devices, orientation of glass and timber on the building envelope, and their combination in order to use the solar energy and daylighting. Examples of Slovenian good practice in the construction of energy building design with timber and glass prefabricated walls are presented (Figure 1-4).

Architecture | Kager hiša d.o.o., Structural engineer | Kager hiša d.o.o.
Energy efficiency | low-energy 18 kWh/(m^{2}a)
U-value (W/m^{2}K) | wall 0,15, roof 0,13, floor 0,21, glass 0,50, frame 0,92
Percentages of glazing | 70 %
External shading devices | yes
Construction system | timber-frame, Construction company | *Kager hiša*
House technique | heat pump, comfort ventilation with heat recovery

Figure 1. Residential building in Slovenske gorice, 2012-2013

Architecture | 3BIRO, Janez Koželj, Structural engineer | Gorazd Mravlja Sora Inženiring d.o.o.
Energy efficiency | low-energy 25 kWh/(m^{2}a)
U-value (W/m^{2}K) | wall 0,16, roof 0,16, floor 0,20, window 0,90
Percentages of glazing | 80 %
External shading devices | yes
Construction system | timber-frame, Construction company | *Tesarstvo Kregar*
House technique | heat pump, comfort ventilation with heat recovery

Figure 2. Residential building in Lesce, 2013

Architecture| Mojca Gregorski, Matic Lašič MODULAR arhitekti d.o.o.
Structural engineer | Proding d.o.o.
Energy efficiency | low-energy 38kWh/(m^{2}a)
U-value (W/m^{2}K) | wall 0,12, roof 0,11, window 1,10
Percentages of glazing | 100 %
External shading devices | no
Construction system | timber-frame, Construction company | Remont d.d, Rubner, Avstrija
House technique | floor heating, comfort ventilation with heat recovery, biomass heating system -preparation

Figure 3. Educational building The Polzela Kindergarten, Polzela, 2013-2014

Architecture| Polona Filipič, Peter Šenk, Marko Pretnar et al. Structural engineer | CBD d.o.o.
Energy efficiency | low-energy 40 kWh/(m^{2}a)
U-value (W/m^{2}K) | wall 0,12, roof 0,11, window 1,10
Percentages of glazing | 100 %
External shading devices | no
Construction system | timber-frame and timber ribbed roof structure support
House technique | floor heating, comfort ventilation with heat recovery, biomass heating system -preparation

Figure 4. Tourist information office in Postojna

4. CONCLUSION

A strong knowledge of the advantages and the disadvantages of timber and glass prefabricated panels is one of the main points for improving energy-efficiency in contemporary building design in the modern architecture. The well-being of people, the industry and the economy depends on a safe, reliable, sustainable, affordable, efficient and economical use of energy.

Respecting these facts, the energy-efficient properties of timber-glass buildings are excellent, compared to other types of buildings, not only because they use less energy for heating, which is environmentally friendly, but also due to highly valuated living comfort represented by beautiful aesthetics of combination of glass and timber as materials, connection with nature and outside environment and natural day-lighting which reduces the cost of electricity.

The examples of Slovenian good practice in the construction of energy building design shows that timber and glass as materials offer many possibilities of designing structures with highly attractive shapes which simultaneously meet the energy efficiency standards with low energy consumption and low U-values of the elements of the building.

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FACTORS AFFECTING THE SUPPLY OF ENERGY WOOD IN **SLOVAKIA**

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ABSTRACT

The key concern of the EU energy policy is to increase the share of renewable energy. The main idea focuses on increasing utilization of biofuels and forest based biomass. Therefore, it is necessary to estimate and forecast the development of supply of energy wood. The main objective of the study is to identify a set of factors affecting the level of energy wood supply in Slovakia. The study determines the coniferous and non-coniferous energy wood supply shifters. The econometrics approach of modelling was applied to create the models of energy wood supply in Slovakia. The results showed a set of significant explanatory variables for both types (softwood and hardwood) of energy wood. Supply of softwood energy wood was determined by the costs linked to felling operations and by the actual volume felled. On the other hand, the supply of hardwood energy wood was determined by the ratio of higher rotation age classes of forest and the volume of incidental felling. The developed supply models were the basis for the elaboration of prognosis of the energy wood supply in Slovakia.

Key words: energy wood supply, supply factors, econometric model

1. INTRODUCTION

It can be very difficult to define the bioeconomy, because the concept has not been identified within clear-cut boundaries. The bioeconomy can be defined as the production of renewable biological resources and the conversion of these resources and waste streams into value added products. McCormick and Kautto (2013) defined the bioeconomy as an economy where the basic building blocks for materials, chemicals and energy are derived from renewable biological resources. Significant changes in the economy are currently caused and represented by the shift from a fossil-based economy to a biomass-based economy. It is expected that bioeconomy will play an important role in the low carbon economy (Scarlat et al. 2015). The key concern of the EU energy policy is to increase the share of renewable energy; therefore the bioeconomy has become an important area of interest in the EU. Biomass and renewable waste, with a share of 64.2% of primary renewable energy production, is the most important energy source in the EU (Parobek et al. 2016). The main idea focuses on increasing the utilization of biofuels and forest based biomass. In line with the EU target of a 20% share of energy from renewable sources by 2020, Slovakia committed to increase its share of renewable energy sources to 14% by 2020 (EC 2009, Kaputa and Sucháň 2015). Therefore it is necessary to know the production potential of forests and potential supply of wood material.

In Slovakia, the most important renewable source of energy is woody biomass from forest and non-forest land. In 2015, the forest sector supplied 1.45 million tons of energy wood of which fuelwood accounted for 835,000 t and energy chips 615,000 t. Current supplies of forest energy biomass cover 1.8% of the consumption of primary energy sources in Slovakia. The supply of wood chips from forest covers less than 30% of the annual demand for energy wood by power plants, heating plants and small and medium size heating units in Slovakia. The remaining 70% is supplied from other sources (MPRV SR 2016).

The modelling of market is the issue which was researched on many different scientific platforms. The models of timber supply represent intersection analysis of ecological information about the forest growth and the development of economic system. In the forest industry land, labour and capital represent the basic resources and it is necessary to understand the optimal allocation of these resources, Using modelling, we can reveal the distribution of these factors and their impact on wood deliveries. According to Binkley (1987) modelling of wood supply is very complicated issue because it can observe temporal linkages between current harvest levels and future forest productivity. However, there is a need for relevant information from the wood processing industry about the development of wood supply as wood is the the elementary resource for every wood processing company in Slovakia. The econometric model of energy wood supply is the fundamental for the future prognosis of energy sector development. Kalamárová et al. (2014) pointed out that wood is a significant renewable resources and is closely linked with many other sectors of the national economy. Therefore, competitiveness of each sector depends on the process of restructuralization of production facilities as well as the process of specialization of production.

Holková (2007) defines the supply as the quantity of a good or services that a producer is willing and able to supply onto market at a given price during a given time period. Of course, the concept of supply is not as straightforward for timber as for many other products. The specification of forest enterprise was described by Zhang and Pearse (2012) as the timber harvested today will not be available in the near future. This specification causes that the supply of wood is affected by specific supply drivers (e.g. forest area, rotation age of forests, incidental felling and others). From this point of view the supplied quantity of timber may not by directly related to its price. Therefore, to define the specific supply drivers for timber, especially for energy wood, may be complicated.

The main objective of the paper is identification of the key drivers affecting the supply of energy wood in Slovakia and create the model of supply for both types (softwood and hardwood) of energy wood.

2. METHODS

The aim of this study is to identify a set of specific variables, which affects the development of supply of energy wood in Slovakia. The modelling of energy wood supply applied an econometric approach. The data used for the analysis was drawn from the Statistical office of Slovakia (SOSR) (Statistical Office of the Slovak Rrepublic 2016). and from statistical databases of Food and agricultural organization (FAOSTAT, 2016).

Basically, supply of energy wood (SEW) is influenced by the price; however, there is a range of other specific factors determining supply. Kuuluvainen (2014) defines the theoretical model of timber supply as functions of the unit price of timber, per hectare planting costs, the market interest rate, the subjective discount rate, the initial non-forest wealth and the area of forest. For modelling the supply of energy wood in Slovakia during the period of 1995 to 2015, a set of explanatory variables was selected. A set of the following factors were examined – the volume of incidental felling *(IF)*, the volume of actual felling *(AF)*, the area of forest *(FA)*, the price of energy wood *(p_d)*, reforestation *(RF)*, supply of energy wood from previous year *(SEW_{t-1})*, ratio of overmatured stands *(OS)*, cost of forest regeneration *(FRC)*, costs of treatment of young stands *(YSC)*, costs of cleaning and thinning *(CTC)*, employment costs *(EC)*. The authors performed a set of initial tests to exclude variables with weak explanatory power, overlap, or multicollinearity. The final general form of ad hoc model was defined as follows:

$$SEW = f(p_d, IF, AF, FA, RF, TEW_{t-1}, OS, FRC, YSC, CTC, EMC)$$

$$SEW = f(p_d, IF, AF, FA, RF, TEW_{t-1}, OS, FRC, YSC, CTC, EMC) \quad (1)$$

To estimate parameters of the given model, ordinary least squares estimation method was used. The Durbin-Watson test was used to test the autocorrelation of residues and variance inflation factors (VIF) to test multicollinearity in a Statistical Package for the Social Sciences (SPSS Inc., version 18, Chicago, USA). In an effort to reduce autocorrelation of residues and increase the explanatory power of variables lagged, dependent and explanatory variables were included in the model. To be able to interpret directly the estimated model parameters as elasticities, all data were transformed to logarithms.

The following general forms of log function were used

$$\ln SEW_t = \beta_0 + \beta lnX + \gamma lnSEW_{t-1} + \varepsilon_t \quad (2)$$

$$lnSEW_t = \beta_0 + \beta lnX + \gamma lnX_{t-1} + \varepsilon_t \quad (3)$$

where $ß_0$ is a constant, X is a vector of explanatory variables, SEW_{t-1} is a one year lag of the dependent variable, X_{t-1} is a vector of a one year lag of explanatory variables, and ε_t is the error term.

Table 1 summarizes the set of variables used for the models. It provides the variable identifier, name, unit, source, and expected influence (H0) of a given variable on energy wood supply.

Table 1. Set of Variables Used in the Models

ID	**Variable**	Unit	**Source**	**H0**
SEW	Suplly of energy wood	m^3	FAOSTAT	
p_d	Domestic price of energy wood	€/m^3	FAOSTAT	+
IF	Volume of incidentall felling	m^3	SOSR	+
AF	Volume of actuall felling	m^3	SOSR	+
FA	Area of forest corp land	ha	SOSR	+
RF	Reforestation	ha	SOSR	+
OS	Ratio of overmature stands	%	SOSR	+
SEW_{t-1}	Supply of energy wood from preivious year	m^3	SOSR	-
FRC	Costs of forest regeneration (felling)	€/ha	SOSR	-
YSC	Costs of treatment of young stands	€/ha	SOSR	-
CTC	Costs of cleaning and thinning	€	SOSR	-
EC	Employment costs	€	SOSR	-

Due to the differences in the nature of supply shifters for coniferous and non-coniferous energy wood, individual models of supply energy wood were developed and tested for each commodity separately. In this study, the authors considered several variables. Export or import price was used as an approximation to domestic price of coniferous and non-coniferous energy wood.

3. RESULTS AND DISSCUSION

Figure 1 shows the development of energy wood supply in Slovakia as a share of supplied energy wood on the total volume of supplied timber. Energy wood accounted for a small part of total supplied timber in Slovakia and reached up to 2.3 % for coniferous and 4 % for non-coniferous wood. The maximum volume of supplied energy wood over 244,000 m^3 was recorded in 2013.

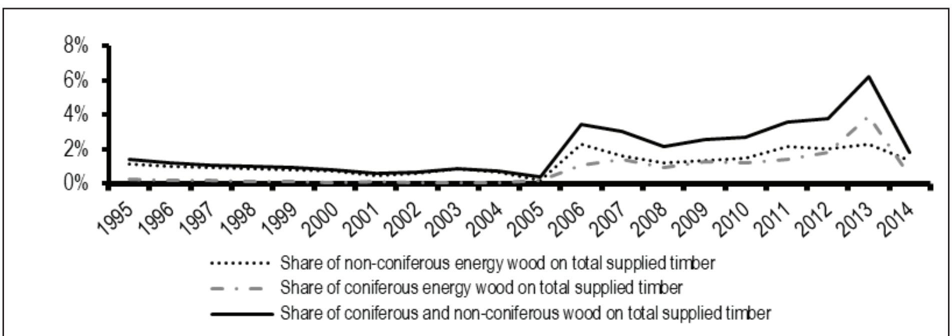

Figure 1. Supply of energy wood (C, NC) in Slovakia

Following the methodology, we experimented with different types of variables which affected supply of energy wood in Slovakia. Final models included only statistically significant variables which greatly influenced the supply of energy wood. Table 2 shows the estimated parameters of coniferous and non-coniferous supply of energy wood models. Table also contains other statistical characteristics of the models. Parameters in both nonlinear models represent the direct elasticities indicating the influence of changes in the explanatory variable on supply of energy wood.

Table 2. Model Results

MODEL	**Short-term Elasticities**					
	Constant	OS	IF	AF	CTC	EC
SEW_C	0.01	2.521***	0.611*			
SEW_{NC}	2791249			7.427***	-2.147*	-5.477*
	Statistical Characteristic					
	R^2	S_e	DW	F		
SEW_C	0.638	0.48	1.337	5.827***		
SEW_{NC}	0.861	0.90	1.540	15.298***		

SEW_C is supply of coniferous energy wood; SEW_{NC} is supply of non-coniferous energy wood; *OS* is ratio of overmatured stands on global volume of stands; *IF* is volume of incidental felling; *AF* is volume of actual felling; *CTC* are costs of cleaning and thinning; *EC* are employment costs; R^2 is a coefficient of determination; S_e is standard error; *DW* is Durbin Watson; *F* is F-test; *,**,*** is statistical significance of coefficient at the significant level 10%, 5% and 1%.

Both incidental and actual felling represent the main source for supplies of energy. The model indicated that the volume of actual felling had the strongest influence on non-coniferous supply of energy wood in Slovakia. On the other hand, the supply of coniferous energy wood was more affected by the volume of incidental felling. The results corresponds to study of Konôpka (2007) that considers the coniferous forest to be less resistant to windthrown. Another factor that influenced the supply of coniferous energy wood was the ratio of overmatured stands on the total supplied wood in Slovakia. We expected that the overmatured stands would be used for the production of energy wood due to their higher sensitivity to harmful factors and low quality parameters of wood. Figure 2 shows the model of supply of coniferous energy wood in Slovakia. The development of estimated values by model is close to real development of supply of coniferous energy wood.

Following Kuuluvainen (2014) a several costs items were tested that affected the energy wood supply. Costs of cleaning and thinning as well as employment costs were the variables which had the statistical strongest influence on supply of non-coniferous energy wood. Figure 3 shows the development of the estimated values of non-coniferous energy wood supply.

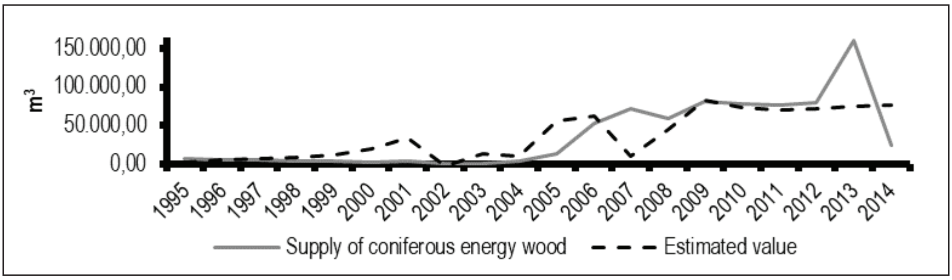

Figure 2. Supply of Energy Wood (C)

The modelled valued closely follow the real development of supply of non-coniferous energy wood in Slovakia (S_e=0,004).

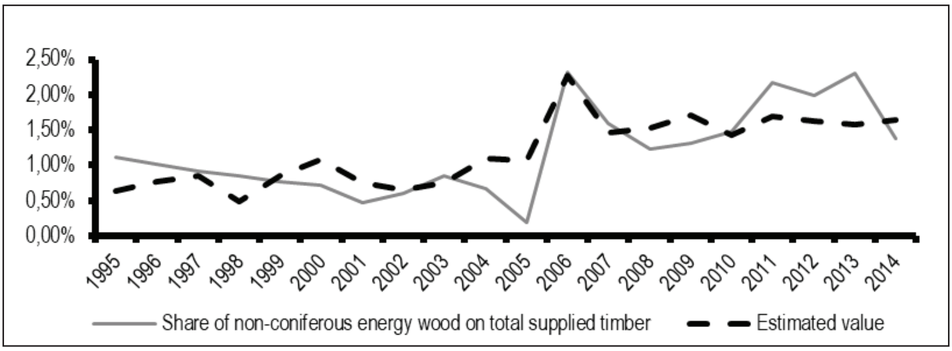

Figure 3. Supply of Energy Wood (NC)

4. CONCLUSION

In Slovakia, energy wood accounts for minimal volumes on the total wood supplies of wood. However, in the lights of economic changes that are related to the orientation of the economy on biofuels, we considered it important to address the issue of energy wood. In general, the results of the study revealed several implications. Firstly, the prices appeared to have an insignificant impact for both coniferous and non-coniferous energy wood in Slovakia. The existence of different explanatory effects for each type of energy wood suggested that their supply was linked to the different drivers. The supply of energy wood in Slovakia is influenced by the volume of both incidental and actual felling. The results show that coniferous energy wood was elastic to the volume of incidental felling and to the rotation age of stand. On the other hand, non-coniferous energy wood was elastic to the volume of actual felling and to the costs.

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STRATEGIC PLANNING FOR THE FORESTRY SECTOR OF THE **ECONOMY OF THE SVERDLOVSK REGION**

Pryadilina Natalia, Damary Roy

ABSTRACT

The forestry sector of the Sverdlovsk region is undergoing a difficult period. Information in the media about most enterprises is usually negative. The main problem is said to be the current lack of a system for regional strategic planning of the forestry sector.

The Forestry plans of the subjects of the Russian Federation (i.e. regions) were defined in the 2006 Forest Code in documents for forestry planning. However, while the regional forestry plans reflect forest management projects, they do not provide the economic landmarks suitable for the effective development of the forestry sector. These forestry plans are also proving insufficient to serve as tools to assess the effectiveness of the powers delegated to the regions of the Russian Federation.

Based on the forestry plans of the Sverdlovsk Region, the authors believe it necessary to prepare, in the near future, a working document on the regional strategic planning of the development of the total forestry sector, built on the principles of business planning. Each topic in it must be targeted, resource-efficient, sustainable, and open to external monitoring and control.

Keywords: forestry planning, forestry sector, strategic development, the Sverdlovsk Region

1. INTRODUCTION

Recently, in the forestry sector of the Sverdlovsk region, a number of problems have arisen that seriously impede its development. Thus a new approach is required to establish a clear direction for the strategic development of the forestry sector within the framework of a regional working document.

The existing regional planning documents related to the forestry sector are obsolete or irrelevant. This situation is typical for regions of the Russian Federation, not only for Sverdlovsk.

The legal framework established by the Federal law No.172 [1] allows the solution of problems in the forestry sector by revamping the existing forestry plans for the regions or “subjects of the Russian Federation”. This means replacing what may be seen as “forest management projects” with instruments for the regional strategic development of the forestry sector based on economic principles.

2. CHARACTERISTICS OF THE REGIONAL FOREST SECTOR

The territorial forestry system of the Sverdlovsk region. Forests occupy 68.6% of the territory of the Sverdlovsk region and are part of the forest zone covering the North-Ural taiga. The area of the forest resources is 15.2 million hectares, of which 12.7 million hectares are covered with forest, and of that total 7.2 million hectares are coniferous plantations.

Amongst the coniferous species, pine predominates (34% of the total forest area in the region), spruce (16%) and cedar (6%). The main reserves of coniferous forests are found in the northern, central and southern parts of the region.

Birch is the leader among deciduous species (36% of the total area, but there are also aspen, alder, linden, willows and poplar.

Territorially the Sverdlovsk state forestry resources are divided into 31 forest districts.

The executive body of state power in the Sverdlovsk Region is the Ministry of Natural Resources of the Sverdlovsk Region. This includes the Forestry Department of the Sverdlovsk Region.

Logging. According to official data, Sverdlovsk Oblast holds the 16th place in Russia for timber reserves. The annual allowable physical volume of timber removals (authorised felling) is 24.2 million m3. The actual volume of logging is however a lot less – only 27% (or 6.5 million m3) of the authorised felling

According to the data of leading forestry specialists, more than 90% of the logging areas in the forests of the Sverdlovsk region are exploited by clearance felling. This can only take a toll on the condition of forest resources. To a significant scale, areas with a predominance of indigenous softwood species are decreasing while areas with deciduous trees are increasing. The speed of this transformation of the forestry sector in the Sverdlovsk region is estimated at 270 km2 per year.

At such rates of regression, the indigenous north taiga forests will last only another 55 years, the medium-tundra forests 140 years, southern taiga forests 60 years.

Forests suitable for felling are very unevenly spread and reserves of the predominant species have poor transport accessibility.

Timber processing. Enterprises of the forestry sector operate in virtually every municipality. In all of them, they play an important social role as core enterprises. The key enterprises of the forestry sector document are: SVEZA Verkhnyaya Sinyachikha, Turinsky Pulp and Paper Mill, Novolali Pulp and Paper Mill, Tavdinsky Plywood and Plate Works, Lestekh.

Sverdlovsk takes 10th place in the forestry sector of the Russian Federation for the harvesting of wood products, the 6th new place for the production of sawn timber and the 4th work place for the production of plywood.

The main indicators of the activity of enterprises of the forestry sector in the economy of the Sverdlovsk region from 2013 to 2016 are given in Table below.

Table 1. Basic Indicators of the Activity of Enterprises in the Forestry Sector of the Svedlovsk Region 2013-2016

Indicator	Year				Year on Year
	2013	2014	2015	2016	2016/ 2015. %
1	*2*	*3*	*4*	*5*	*6*
1. The number of operating enterprises at the beginning of the year by type of activity:	3,087	3,045	2,977	2,977	100.0
• Timber processing and production of wood products	1,356	1,363	1,343	1,343	100.0
• Pulp and paper industry, publishing and printing activities	1,731	1,682	1,634	1,634	100.0
2. The index %.versus the previous year of industrial production for a range of organizations , by type of activity:					
• Timber processing and production of wood products	99.5	93.6	103.8	106.0	102.1
• Pulp and paper industry, publishing and printing activities	66.3	94.5	75.2	97.0	128.9
3. Average number of employees, by type of activity:	15,441	14,622	14,449	12,819	88.7
• Timber processing and production of wood products			7,523	7,491	99.5
• Pulp and paper industry, publishing and printing activities			6,926	5,328	76.9
4. Average monthly nominal wage, by type of activity:					
• Timber processing and production of wood products	15,261	16,191.8	18,053.9	19,288.7	106.8
• Pulp and paper industry, publishing and printing activities	20,488	21,784	22,328.8	25,967.3	116.2
5. Investments in fixed assets in current prices, million roubles, by type of activity:	387.7	284.4	210.3	489.7	232.8
• Timber processing and production of wood products	304.1	229.7	194.1	474.3	244.3
• Pulp and paper industry, publishing and printing activities	83.6	54.7	16.2	15.4	95.0

7. Financial results, million roubles., by type of activity:	- 396.5	462.8	713.7	985.1	138.0
• Timber processing and production of wood products	- 254.3	543.5	584.3	864.2	147.9
• Pulp and paper industry, publishing and printing activities	- 142.2	- 80.7	129.4	120.9	93.4
8. The volume of goods shipped from own production, completed work and services, million roubles, by type of activity:	18,301.1	17,577.0	21,150.2	19,439.3	91.9
• Timber processing and production of wood products	8,610.6	8,366.2	10,106.4	11,314.2	111.9
• Pulp and paper industry, publishing and printing activities	9,690.5	9,210.8	11,043.8	8,125.1	73.5

The main types of forestry product are: sawn timber, plywood, solid wood-particles and wood-fibre plates, paper and cardboard, wallpaper, round wood, wood pellets, furniture, wooden house kits, box packaging, charcoal.

Timber processing is made up of two major of economic activities:

- timber processing and production of wood products
- pulp and paper production, publishing and printing activities.

The forest sector should be a leading sector of the economy. However, as of today the full potential of its production is not being realised. According to 2016 results, the forestry sector enterprises produced goods worth 19.5 billion roubles, and the share of products shipped by them accounted for no more than 1.5% of the manufacturing output of the Sverdlovsk Region. In general, the state of the forestry sector of the region remains difficult.

The main competitive advantages of the regional forestry sector are:

- the region has large volumes of raw materials, i.e. timber, sufficient for a long-term growth in the volume of forest use and the development of woodworking industries
- there are centres for processing timber, including hardwood.
- The main factors limiting the development of the regional forest sector are:
- inefficient forest management (low level of development of the estimated felling area, outdated technologies of timber processing with a high proportion of waste products which might be used for further processing);
- poor quality of the infrastructure for production and road transport, hampering the development of new areas of forest resources;
- insufficient level of development of forest resources, leading to the accumulation of old-growth wood;
- wearing out of the fixed assets of the industry;
- limited potential for innovation
- low share of products with high added value in the total production;
- Inadequate accuracy of state accounting for forests (time perspective of forest management 10-15 years);

- shortcomings of the legislation regulating forestry relations, limiting the opportunities for the development of the forestry business;
- high level of energy and material consumption of production and the continual growth of production services costs, which has led to unsustainable financial states for the majority of forestry enterprises;
- unstable customs standards concerning foreign economic activity;
- absence of certified forest areas in the region;
- the presence in the trade turnover of illegal or unreported timber;
- shortage of management personnel.

3. FORESTRY PLANNING IN SVERDLOVSK REGION

The following documents concern the long-term planning of the forestry sector of the Sverdlovsk Region:

The first document, "The Forestry Plan of the Sverdlovsk Region for 2009-2018" [2], was approved in 2008. It was presented as a set of standard forms with basic information such as the output data of a regional forest management project. It included a number of recommendations which were never made mandatory for forestry management.

The forestry management approach to the development of the forestry plan was also based on operations over 10 years, a period corresponding to the validity of the forestry regulations. A basic shortcoming in the forestry plan is the lack of production orientation when developing forests to meet the demand in the domestic and export markets. The forestry plan is focused exclusively on increasing the efficiency of the use of forest resources through the expansion of the allowable felling area.

The second document is the "Strategy for the Development of the Timber Industry Complex of the Sverdlovsk Region until 2020." [3] The data it contains are long overdue: they take into account information for 2008 (the year of the document's creation) and 2011 (data update year). The data have not been adapted to the changed economic and geopolitical conditions of the present, so that the Strategy and its provisions are no longer up-to-date.

The third document is "the State programme of the Sverdlovsk region: the Development of forestry in the Sverdlovsk region until 2020" [4. The document is fully working and corresponds to the State Programme of the Russian Federation "Forestry Development for 2013-2020 ", but does not address the issues of forestry business.

4. RESEARCH FINDINGS AND DISCUSSION

The legal framework established by Federal Law No. 172-FZ "On Strategic Planning in the Russian Federation" allows for existing forestry plans of the RF regions to be modified from the format of forestry management projects into that of strategic planning documents (with a maximum planning period of 5 years) based on the principles of business planning, such as:

- the feasability of tasks in view of the planned results;
- the guarantee of resources for the tasks planned: in this respect, the forestry plans of the regions of the Russian Federation should differ fundamentally from forestry management projects, the results of which are estimated primarily as output indicators, without taking into account the need for the resources needed to achieve them;
- focusing of planned tasks. All forestry plan activities should have specific persons/ entities responsible for achieving the planned results;
- the time frame for the execution of tasks;
- the ability to monitor the results of the achievement of planned tasks.

Only then can the projects be justified taking into account responsible persons, prospective investors, terms and expected results.

To implement the proposed conceptual approach to the development of territorial programmes for the development of the forestry sector, their structure should be determined by programme-target methods, with a distinction between output (results) and input (resources).

The structure of the proposed document for strategic planning of the forestry sector development is presented in the Figure below.

Figure1. Structure of Regional Documents for the Strategic Planning of the Development of the Forestry Sector

A central issue in the creation of regional programmes for the development of the forestry sector is the time horizon for planning - the timing of the plan.

The optimal option is a period of 5 years. Scheduling with time horizons beyond this cannot provide reliable results in an unstable and unpredictable situation at the macroeconomic level (high inflation and interest rates for credit, and the like).

5. CONCLUSION

In the opinion of the authors of the article, a forestry plan in the format of the regional forestry document for the strategic development of the forestry sector can become an effective tool, allowing the forestry sector once again to achieve its objectives in harmony with the newly developed Federal strategy on the use, replacement, protection and defence of forests of each region of the Russian Federation.

With effective planning and forecasting, sustainable development of the proposed regional forestry sector will inevitably take into account the problems mentioned in this paper (inadequacies supporting legislation, insufficient reporting by the state of different forests, etc.). Owing to the fact that forestry resources belong to the state, certain basic issues can be resolved only at Federal level.

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PRODUCTION OF *SALIX VIMINALIS* (L.) WITH USING ALTERNATIVE METHODS OF FERTILIZATION

Martin Lieskovský, Miloš Gejdoš

ABSTRACT

The aim of the paper is to evaluate the production of *Salix viminalis* (L.) with using of alternative fertilizer types. As alternative fertilizers sludge from the waste water treatment plant and wood ash were used. The work is focused on the production of fast-grooving willows from which the *Tordis* clone was selected. On plantation has been analyzed three areas during the two vegetation periods. Alternative fertilization methods were used on two areas. The third reference area was left without fertilization in order to quantify the difference in production on individual areas. When the measurements were completed, the harvesting and determination of the circular base was carried out, according to fertilization methods. The hypothesis, that the application of wood ash and sludge to increase production has been confirmed. By using wood ash during two vegetation periods, the relative increase were 16% higher than the reference area without fertilization, and this difference was statistically significant in the statistical analysis.

Keywords: fast-grooving trees, alternative fertilizer, dendromass, sludge from the waste water treatment plant, wood ash

1. INTRODUCTION

Demand for the use of renewable energy sources from biomass impacts on the natural production potential of dendromass in forestry. Therefore, as a solution, fast-growing trees (FGT) are available which, during a short rotation period, are able to produce large amounts of dendromass. They can be grown on plantations, with minimizing production costs and maximizing available space. These are based on low-quality agricultural land that is not core area to food production.

In the intensive cultivation of FGT, nutrients are taken from the soil, so they need to be supplemented. Appropriate fertilizers, which would be an alternative to industrial fertilizer production, is wood ash. At present, ash is treated as waste and is disposed of in dumps. At the same time, it could be used as an inexpensive fertilizer while reducing the volume of waste deposited in dumps.

Another cheap and easily available alternative for FGT plantation fertilization is sludge from waste water treatment plants (WWTP). Sludge from WWTP also contains nutrients that support plant growth and, in contrast to ash, also contain nitrogen, which significantly increases production.

It is also necessary to focus on the use of alternative fertilizers, to verify their properties and impact on the growth and production of FGT as well as soil properties, and to include them in normal use in case of positive results in practice. This would save on the costs of dumping and also reduce the production of industrial fertilizers that are harmful to the environment.

The main aim of this work was to evaluate the production of FGT on the demonstration area of the Technical University in Zvolen with using alternative methods of fertilization. Compare fertilizer increases and assess the fertilizer effect on FGT growth.

2. METHODOLGY

2.1. Locality

The research area of the Technical University in Zvolen is located in the cadastral area of the municipality of Budča in its northern part, close to the cadastre of the village Turová, at an altitude of 312 m. above the see level. The surface of the area is oriented to the southwest. The area was established for the purpose of growing the fast-growing trees in 2007 with an area of 0.21 ha for research and as a demonstration object for students of the Faculty of Forestry in Zvolen.

Climatic conditions on the area, according to the climatic atlas of the Slovak Hydrometeorological Institute, fall according to Konček classification into a warm, slightly humid area with mild winters. Climatic indicator of irrigation for months VI. – VII. 150-100 mm of precipitation. Annual rainfall averages 750 mm. The average January temperature reaches -3 to -5 ° C and the average temperature during the vegetation period is 14-15 ° C (Climate Atlas SHMÚ, 2018).

The soil conditions on the area according to the podnemapy.sk service, which is led by the National Agriculture and Food Centre, is suitable for growing FGT. The soil on the area has a rating of 8 and the code for quality of soil is 0514062. The soil type located on the area is fluvial soil, which is conditional on the location of the area that is on the nearby torrent terrace. We can also assume that the groundwater level is high, enough to grow fast-growing willows (National Agriculture and Food Centre, 2018).

The site was farmed a few years ago. The area of the demonstration object is fenced against wild game with the steel mesh on the oak posts. The row spacing is on fig. 1. The roots take of the *Tordis* clones reached 83.5%.

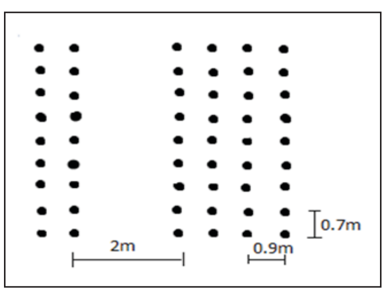

Figure 1. Planning spacing

2.2. Approach for alternative fertilizers application

Measurements was taken after three vegetation periods in a row, after the first measurement 18-19.3.2016 alternative fertilizers were applied. The second measurement was made on 29. 10. 2016 and the third final measurement was 13-14. 3. 2018, where FGT harvesting was also carried out.

2.2.1. Wood Ash application

The wood ash, which was applied on March 18, 2016, was exclusively grid ash. Grid ash is more suitable for soil application than filtered ash. The ash was applied only in near to the clump, respectively in its vicinity. It was not applied all over the soil. Before the ash application, the vegetation cover around the clump was removed, to achieve better contact with the soil, into which it was incorporated, to prevent wind transportation. Almost 1300 ml of ash was applied to each clump, approximately 750 grams. The ash was left for two weeks on air, prior to airborne to improve its properties. In particular, slowing down the release of calcium and slowing the solubility of certain compounds.

2.2.2. Sludge from waste water treatment plant

The sludge was applied to the soil on 16. 4. 2016 and came from the WWTP in Zvolen. The application was similar to wood ash. Removal of weeds around the clump of the willows, incorporation into the soil, breaking of the joints into smaller pieces. The amount of sludge that was applied to one clump was 4 kg.

2.3. Measurement process

Three categories were measured on the research area. The first one was the class of willow clumps, which was used for wood ash fertilization method. The second category was the willow clumps fertilized with sludge, and the third category was as a reference, without fertilization, that served to compare fertilization results and impacts.

The categories and their individual clumps were identified by color labels with sequential numbers due to their recognizability to ensure clarity and continuity in measurements. The labels were worn on the clumps by wire and embedded in plastic foil, due to their durability and identification over several vegetation periods. Within the clump the individual wickers were at the breast height (1.3 m), which is also the measuring point, marked with a non-removable fix. The thickness of the individual wickers was measured at the point of the number. In the case of branching was the measuring point just below the branching. The measurement requirement was the minimum bar thickness of one centimeter. When measured, the wickers were judged to be viable, unbroken, undamaged with fungal diseases or wild game. Using an electronic slide gauge perpendicular to the axis of the strain, a precision measuring of 0.01 mm was performed at the point of the wicker number in the trunk. Thereby measuring at the same location over the three measurements. The measured values were recorded in the field record book.

2.4. Methodology of measurements processing

The measured field data were recorded on excel sheets where they were processed according to clumps, wickers, and fertilization methods. Measurements took place during three vegetation periods. On the area was measured from a non-fertilizer category of 485 wickers within 100 clumps. In the categories where the grid wood ash was used, 519 wickers were measured in 92 clumps. In the last category with sludge using, 490 wickers were measured in 82 clumps.

After measuring diameters (mm) at $d_{1.3m}$, the circular base (g) was calculated individually for each measured wicker within the clump. Formula to calculate the circular base:

$$g = \frac{\pi}{4} \times d^2 \text{ [mm}^2\text{] (1)}$$

g – circular base area
d – diameter at 1,3 m high

After calculating the circular base areas, we calculated the relative increment on the circular base (*ig%*). Calculating the relative increment on a circular basis is the difference in increments between vegetation periods divided by the increment in the first vegetation period and then multiplied by 100. Formula for calculating the relative circular increment:

$$ig\% = \frac{g_2 - g_1}{g_1} \times 100 \quad (2)$$

ig% – relative increment on the circular base
g_1 – circular base area after 1 vegetation period
g2 - circular base area after 2 vegetation period

After calculating the relative increments, increment histograms were generated during the vegetation periods in each fertilizer category. From the created increment histograms, we could conclude that the measured data and changes on the circular base will not fall into the normal distribution. This was followed by confirmation or rejection of this hypothesis by a normal-assay test. The Shapiro-Wilkov W test was chosen to test the normality.

The evaluation of the measurements of the round base increments was determined using the Shapiro-Wilkov W test and the Mann-Whitney U test. A zero hypothesis has been established that randomly selected value from one file will be larger or less than a random value from the second set. For the assessment a critical value based on the materiality level is used. The zero hypothesis in the case of the application of alternative fertilizers on the area and the area without fertilizers is defined as the same, or the critical value is greater in the distribution of the quantities between the non-fertilized area and the fertilizer area. The rejection of the zero hypothesis and the acceptation of an alternative hypothesis occurs when the value of the test criterion is less than the critical value at the specified level of significance and so we can confirm that the influence of the fertilizer on the production was statistically significant. The evaluation was carried out using the statistical program STATISTICA.

Another analysis of the data was the comparison of absolute increments on the circular basis (*ig*) according to the used fertilizer category. The result of absolute increment was calculated as the difference between the sum of increments in the first (second) vegetation period compared to the sum of increments in the following vegetation period:

$$ig = g_1 - g_2 \text{ [mm}^2\text{]} \quad (3)$$

3. RESULTS

The main objective of the paper was to analyze FGT production using alternative fertilization methods. As an alternative, fertilizer wood ash and sludge was used on the research area. Both alternative fertilizers on the research area were more productive than the non-fertilized willows. We can say that fertilization has achieved a positive result. The negative impact: the pH of the soil, to which the willows are sensitive, can be changed. Statistical significance was tested on relative increments Table 1 and 2).

Table 1. Results Shapiro-Wilkov test for normality (α=0,05)

Fertilization	2016		2017		2016-2017	
	W	p	W	p	W	p
Wood Ash	0.52	0,0000	0.69	$1{,}08^{-8}$	0.61	0.000
Sludge	0.946	0.02	0.45	0.000	0.789	6.393^{-7}
Non-fertilized	0.943	0.02	0.879	0.000142	0.916	0.00225

Since the p-value <α, the zero hypothesis is rejected, meaning that the data does not originate from the normal distribution. Statistics W are not at 95% critical. Acceptable Range of Critical Value for Statistics W (0.9524-1.00). Statistics W is not in the 95% confidence interval within the required range (0.9524-1.00).

Table 2. Results Mann-Whitney test, critical p values at the level of significance α=0,05

Sample Files	2016	2017	2016-2017
Ash/Sludge	p =0,0008	p= 0,6019	p= 0,0044
Ash/Non fertilized	p < 0,00001	p= 0,2653	p < 0,00001
Sludge/Non-fertilized	p= 0,1494	p= 0,3078	p= 0,1068

On the basis of the identified critical values, the zero hypothesis was accepted or rejected. In the case where the critical value was less than 0.05, an alternative hypothesis was accepted, i.e. a statistically significant difference in production was confirmed.

The incremental analysis should verify whether the used alternative fertilizer had an effect on production and whether the resulting production difference was also statistically significant based on the Mann-Whitney U test (Table 2). The analysis compare relative increments. During the first vegetation period 2016, the increase in the use of wood ash (50.4%) was statistically significant (p <0.00001) compared to the increase without the use of fertilizer (43.2%). The difference between the relative increase on the circular base using sludge (45.6%) and without fertilizer use (43.2%) was not statistically significant (p = 0.1494), but the difference between sludge and ash fertilization in the increments on the circular base reached a statistically significant difference (p = 0.008).

The analysis of increments during the second vegetation period (2017) showed, that the use of wood ash in the previous vegetation period for production did not have a statistically significant effect. The average increase on the circular base reached with the wood ash (16%), and without the use of fertilizer (14%) the difference was not statistically significant (p = 0.2653). Also with using sludge (18%), a statistically significant difference was not proven (p = 0.3078) as well as between sludge and ash p = (0.6019). When comparing the mean increments on a circular basis during two vegetation periods, the ash (77.4%) compared to the non-fertilized area (66.4%) was confirmed and is statistically significant (p <0.00001), as well as the fact that the ash effect is statistically significant against the sludge (p = 0.0044). The difference between the non-fertilized area and the sludge area reflect, that statistically is not significant (p = 0.1068).

After analyzing and evaluating relative increments, the absolute increments on the circular basis (*ig*) has been calculated (table 3 and 4).

Table 3. Analysis of relative increments on the circular basis

Fertilization	2016		2017		2016-2017	
	Increment	Compare to non-fertilized	Increment	Compare to non-fertilized	Increment	Compare to non-fertilized
Non-fertilized	43.2		14.0		66.4	
Wood Ash	50.4	16.8	16.0	14.2	77.4	16.5
Sludge	45.6	5.7	18.3	29.9	75.5	13.6

From the data of absolute increments on the circular base, the largest increase was measured on the area where wood ash was applied during the first vegetation period (8.7%), larger than the area without fertilization. But during the second growing season, the largest increment was measured on the area where the sludge was applied. The increase was 29.7% larger than on the non-fertilized area (table 4).

During the first vegetation period, a lower increase was observed on the area where the sludge was used, than on the area where wood ash was used. However, one reason for this difference may be the monthly delay with which it was applied to the soil. However, during the second vegetation period, the sludge effect was manifested as well as the application of wood ash. According to Černý (2010), however, the disposable application of sludge is only short-lived and has little impact on harvesting. Therefore, it can be assumed that repeated application would have a greater impact on FGT production.

Table 4. Analysis of absolute increments on the circular basis

Fertilization	Measurement [mm^2]			Increment [mm^2]		Changes [%]		
	1.	2.	3.	1.	2.	Change	Change	Total Change
Wood Ash	323.9	519.6	640.8	195.7	121.2	8.7	14.4	92.7
Sludge	339.8	533.6	671.1	193.8	137.5	7.7	29.7	101.9
Non-fertilized	332.5	512.5	618.4	180.0	106.0			

4. CONCLUSION

The aim of this paper was to analyze the production of FGT plantation with using alternative fertilization methods. As an alternative fertilizer, wood ash and sludge from WWTP was used. Their effect was monitored after application to the soil during two vegetation periods. The hypothesis that the application of wood ash and sludge can increase production has been confirmed. Using wood ash during two vegetation periods, the relative gains were 16% higher, than the reference area without fertilization and this difference was statistically significant in the statistical analysis.

In the work has been done evaluation the dry matter mass production, which is the best indicator of production at FGT plantations. It has reached 6,3 tons with sludge fertilization, with an increase of 4,8 tons more production than on non-fertilized area. Wickers mortality was also observed, which during the first vegetation period was smaller on surfaces with applied fertilizer, but during the second vegetation period, the difference in mortality was not significant.

Given the limited amount of data about the use of sewage sludge from WWTPs and wood ash from FGT plantations in Slovakia, this work contributes to the widening of knowledge and experience that can be used in the future.

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USING THE WOOD FROM IMPROVEMENT FELLING FOR ASSEMBLING SMALL WOODEN STRUCTURES

Zalesov Sergey, Damary Roy, Vetoshkin Yuri, Pryadilina Natalia, Opletayev Anton

ABSTRACT

This paper reviews the experience of using wood from thinning recreational plantations (“improvement felling” to create small wooden structures. Because volumes are small, removal and processing of wood from thinning, in particular cuttings from landscape maintenance, is uneconomical. In addition, skidding felled trees away can easily damage the trees left to grow. It is therefore both more economical and environmentally better to use of cuttings for the manufacture of wooden sculptures, arbours, rest areas and other small wooden structures.

Flawed residues and small cuts are best converted into chips on the spot, and then used to fill the footpath network or serve as mulch around the trunks of standing trees.

Keywords: recreational forest, forest park, thinning, landscape felling, small wooden structures, chips

1. INTRODUCTION

The management of recreational forest necessarily requires the construction and maintenance of tourist pathways and the provision of small wooden structures in recreational areas [1]. Wood cuts from thinning, used on the spot, can serve as raw material for making gazebos, benches, sculptures and other items in the maintenance of specially protected natural areas. One of the ways to minimize the costs of equipping a recreational forest with small-scale structures is the use of trees felled in the course of logging and landscaping. The findings of many studies point to natural wood as the preferred material for recreational furniture and small structures in forests, in contrast to plastic and metal [5, 6, 7].

The example reviewed here is of a reserve on the Urals called “Forests on the Geographic Border of Europe and Asia”. A study was conducted to predict the amount of thinning with the wood cuts subsequently used for the manufacture of small wooden structures.

Traditionally scrap wood and felling residues from thinning have been converted into energy chips [2, 3, 4]. However, in forests of high conservation value and in specially protected natural areas, it is advisable to minimize the impact of heavy equipment on forest ecosystems, as it is unsuitable for the removal of timber. The volume of cuttings in such forests is very small, being focused on dead or dying trees, those not growing properly, and also trees of unwanted species. The removal and processing of this timber is uneconomical.

2. CHARACTERISTICS OF THE REGION STUDIED

An especially protected natural territory "Forests on the Geographical Border of Europe and Asia" with a total area of 2344 hectares is located in the Bilimbaevsky forest of the Sverdlovsk region, Russia. The forest area analysed is a strip of forests on the watershed of the Ural Mountains, near the geographic boundary of Europe and Asia. These forests have significance for water-protection, soil-protection, health and recreation. The Ural ridge is a main watershed, the natural boundary between two parts of the world. Currently, the geographical boundary of Europe – Asia, with a strip of adjacent forests, is a specially protected natural area of the Sverdlovsk region. The distribution of forests of the study area by prevailing species, age groups, area and timber stock is presented in Table 1.

Table 1. Make-up of the Forests in the Area Researched

Prevailing species	Forest area, ha Timber stock, м^3					
	Young stand	Medium-aged	Premature	Mature	Old growth	all
Spruce	4.6 4.0	44.2 557.0	62.3 499.0	24.1 226.0	-	135.2 1,286.0
Pine	313.5 2,425.5	821.6 7734.0	243.8 1603.0	132.7 1381.0	-	1,511.6 13,143.5
Birch	22.9 56	92.3 785.0	122.7 739.0	183.1 1151.0	41.6 235.0	462.6 2,966.0
Alder	-	7.1 49.0	3.7 13.0	-	-	10.8 62.0
Aspen	-	1.0 20.0	-	3.9 90.0	-	4.9 110.0
All	341.0 2,485.5	966.2 9,145.0	432.5 2,854.0	343.8 2,848.0	41.6 235.0	2,125.1 175,675

Thinning is carried out in young growth and medium-aged plantations. The wood of these age groups is recycled by processing into chips. For other age groups of trees, felling is for landscape management and tree health (i.e. "improvement felling"); this leads to the harvesting of large trunks, which can be used to create small wooden structures and rest areas.

3. RESEARCH FINDINGS AND DISCUSSION

In the recreational forests trees are felled mainly with a view to forming aesthetically attractive landscapes. In addition, unhealthy, injured and damaged trees are felled as they are dangerous for tourists. The impact of such felling is generally very low, and the timber from them is of poor quality. Skidding and removal of these trees, even with the use of small-sized machinery, is usually uneconomical because of the small volumes and poor quality. Nevertheless, felled trees can be an excellent raw material for building structure on site. The trunk with its various diameters can be used to create small wooden structures. In particular, large trimmed trunks can be used to construct recreation facilities (Figures 1 and 2).

Fig. 1 - Recreation areas made from large trunks of stem wood

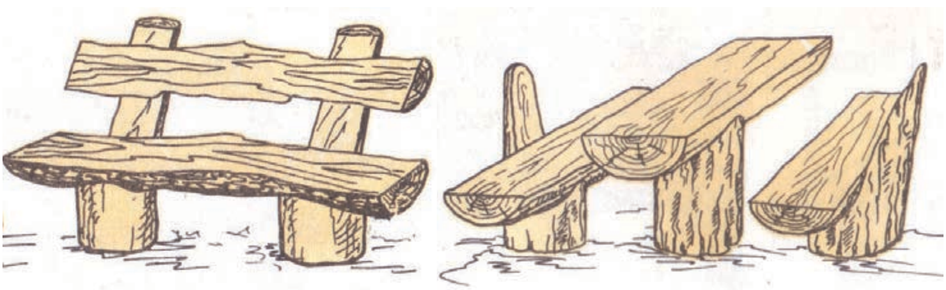

Fig. 2 - Recreational items made from parts of tree trunks from landscape felling.

Recreational equipment can be made from unmarketable and low-value wood, such as large boughs, twisted tree trunks of trees and so on (Figure 3).

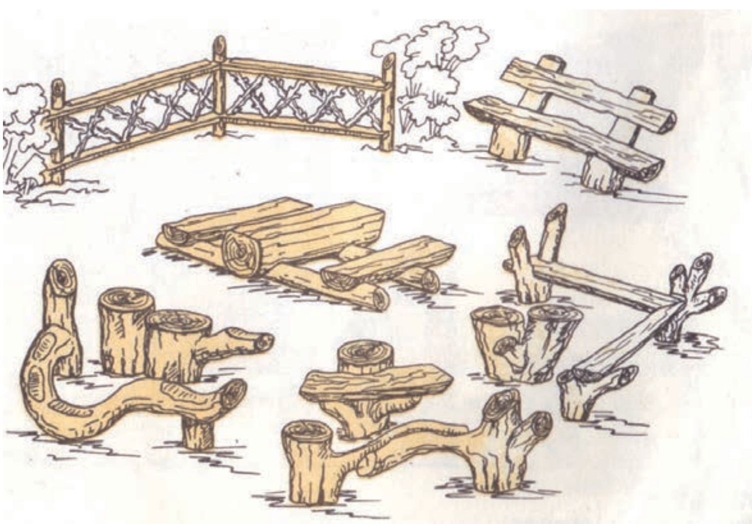

Fig. 3 - Sample design of a resting place made from scraps of stem wood

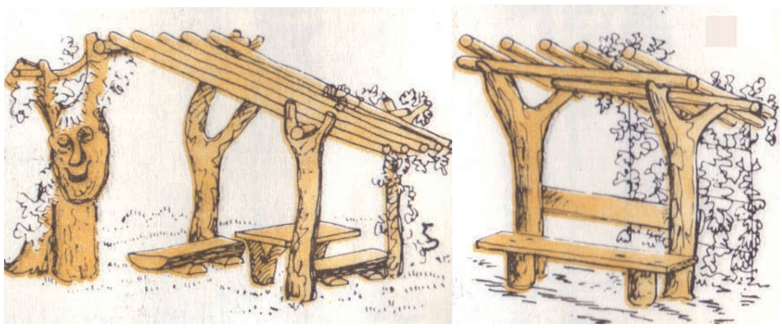

Fig. 4 - Rest places offering protection from adverse weather conditions

Landscape management by selected felling is allowed on an area of 385.4 hectares in mature and over-mature growth. The volume of felling is minimal. As a rule, single trees are cut, those which pose a safety threat to tourists or have an unattractive appearance. Therefore, the main volume of harvested wood for the purpose of creating small wooden structures is from medium-aged plantations, and they occupy an area of 966 hectares.

4. CONCLUSION

The creation of small wooden structures enhances the aesthetic appeal of forest parks and other recreational areas for the population, just as the installation of wooden furniture inside the city does.

Cutting residues, chips and other waste material from landscape cutting can be used for cooking fuel for campers and building fires in established and properly equipped places. However, most of the logging residues are crushed by a mobile machine and converted into chips.

The resulting chips can be used to cover footpaths, as well as serve as mulch around trees planted to enhance the decorative character of the landscape or to expand biological diversity.

Thinning and improvement felling in the specially protected natural area "Forests on the Geographic Border of Europe and Asia" will increase the sustainability of plantations and their recreational appeal.

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FIVE INNOVATIVE INITIATIVES FOR FORESTRY SECTOR DEVELOPMENT IN BULGARIA AND MACEDONIA

Rossitsa Chobanova

1. INTRODUCTION

The paper presents innovative initiatives developed and implemented in the frame of the joint projects of the Bulgarian academy of sciences and Macedonian academy of sciences and art. More concretely, the aim is to improve the competitiveness of the forestry sector businesses in cross-border region: Blagoevgrad and Kjustendil districts of Bulgaria and East, Noth-East and South-East regions in Macedonia contributing to better information, consultation and cooperation between people, SMEs and institutions.

2. INNOVATIVE INITIATIVES

To find solutions how to increase the competitiveness in the specific conditions of the region a field survey based on face-to-face interview with representatives of enterprises in forestry sector took place, along with literature review. Five groups of initiatives for innovation were identified taking into account the answers of majority of 196 entrepreneurs from both Bulgaria and Macedonia. The initiatives are addressing entrepreneurs, the state, and e-services developers. The later include network development, e-consultancy and e-education services development.

2.1. INNOVATIVE INITIATIVES FOR ENTREPRENEUERS

According to the results of the survey several innovative initiatives addressing entrepeneuers were identified. They are ranked as follow (see Fig.1):

Innovative initiatives addressing entrepreneurs predominantly concern:

- Participation in EU programs and projects – supported by 75% of respondents from Bulgaria and by 51% -from Macedonia
- Increasing the production quality - supported by 50% of respondents from Bulgaria and from 32% -from Macedonia
- Production specialization – supported by 50% of respondents from Bulgaria and from 36% -from Macedonia
- Improving the automatization of the production process - – supported by 42.9% of respondents from Bulgaria and from23% -from Macedonia
- ICT training of the staff – supported by 35,7% of respondents from Bulgaria and from 26% -from Macedonia.

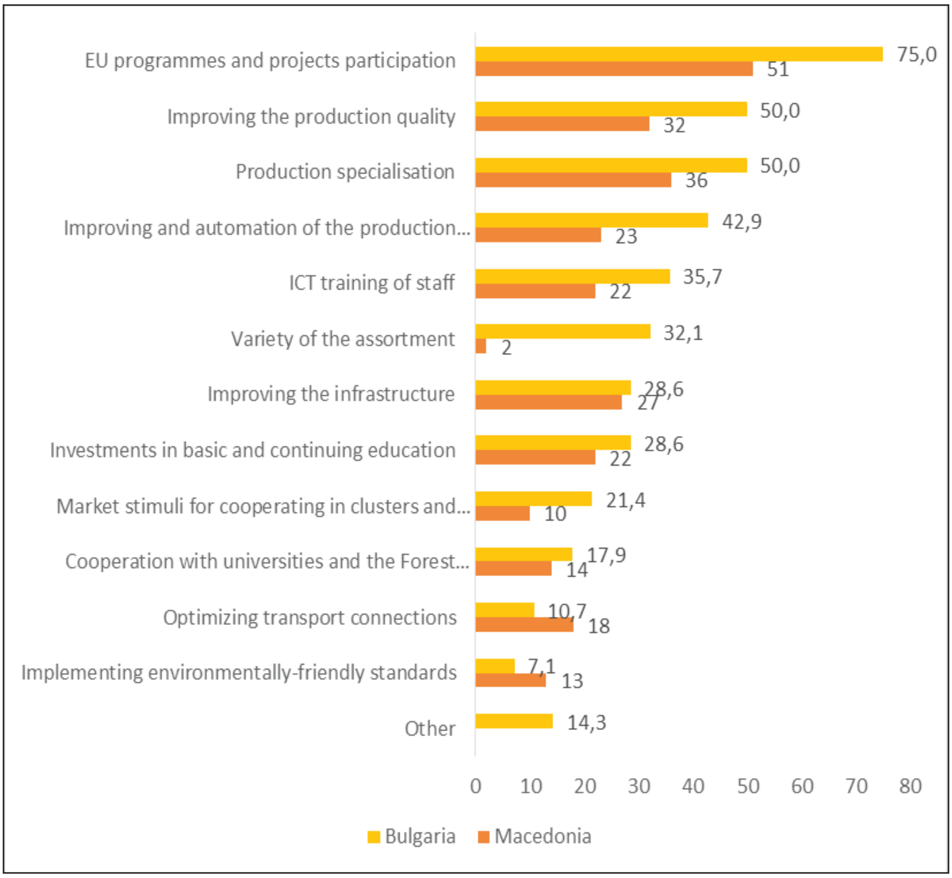

Figure 1. Innovative initiatives for entrepreneurs

It is important to mention that about 10% of respondents find implementation of environment friendly standards an important area for developing innovative initiatives for forestry sector development.

2.2. INITIATIVES FOR STATE INNOVATION POLICY

The second group of innovative initiatives identified has concerned innovation framework conditions, mainly those of infrastructure and respective state innovation policy. The assumption of the results of the survey are presented in Figure 2.

From the Fig. 2 is obvious the problems of transport infrastructure are of significant importance for representatives of the both countries. More concretely the needed support from the state concerns: - maintaining existing roads – supported by 64.3% of respondents from Bulgaria and from 68% -from Macedonia, expanding and building new roads.

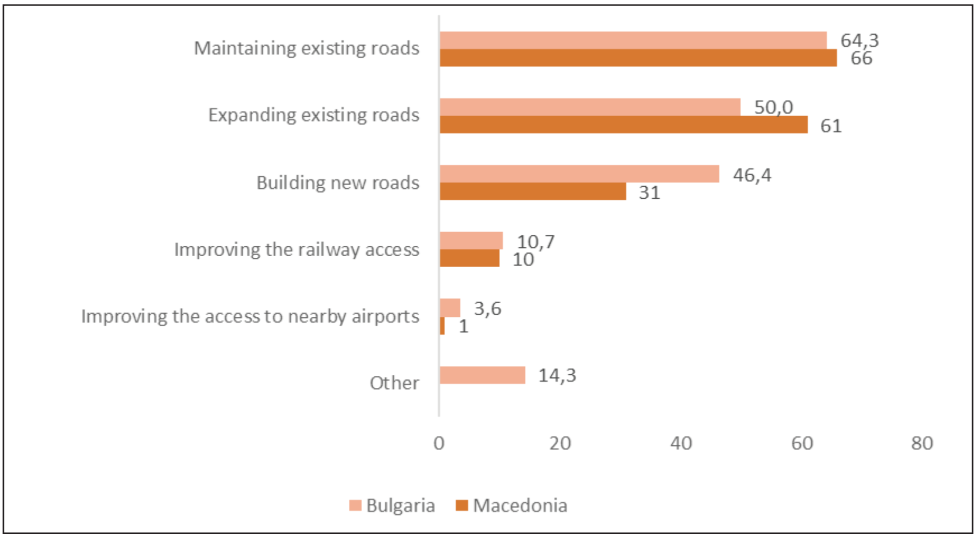

Figure 2. Innovative initiatives for state policy

2.3. INNOVATIVE INITIATIVES FOR E-CONNECTIVITY DEVELOPMENT

In order to achieve better information, consultation and cooperation between people, SMEs and institutions a database of entreprises and their activities along the supply chain in forestry were designed and developed (see. Fig. 3). It was structured using criterion - belonging to one of 5 supply chains identified according to their activity respecting codes of NACE Rev.3.The database consists data forf all – 1941 enterprises along the supply chain in the cross border region - 1190 from Bulgaria, and 751 – from Macedonia (trade rergister, code of activity, EMBC, description of activity). This network has a potential for cooperation along the supply chain between at least 5723 (together with 1 supplier and 1 customer per firm) and 9705 enterprises in the network, if they have in total 2 customers and 2 supplies. Such database exists, There is an open access to the database of 1941 –see:vofis.bas.bg.

Figure 3. Stylized supply chain structure for database development

Developed structured databases of institutions, consisting national and partly European innovation systems, the enterprises are interacting with in the contemporary innovation process. The stylized structure and enterprise interactions in national innovation system are presented in Fig.4.

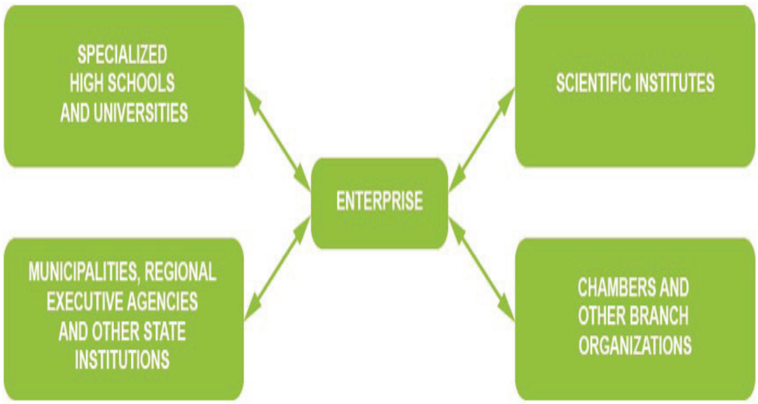

Figure 4. Stylized supply chain structure for database development

2.4. INNOVATIVE INITIATIVES FOR E- CONSULTANCY SERVICES DEVELOPMENT

The assumption of survey results defined the preferred e-services to be performed in a Virtual consultancy Office for enterprises in Forestry sector (VOFIS). They are presented in Figure 5.

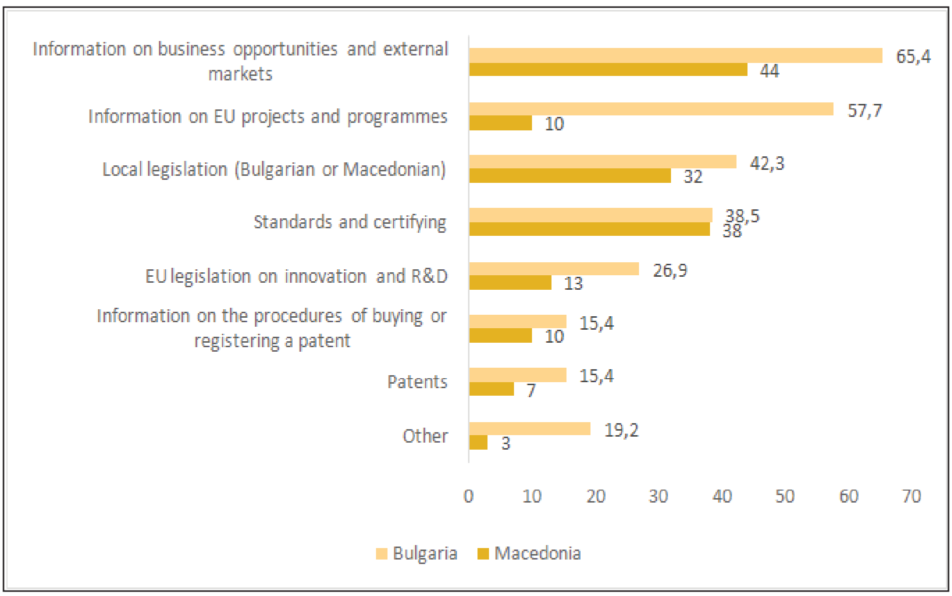

Figure 5. e-consultative services on demand

According to the results of the survey in Bulgaria, a virtual consulting office prerfferably would receive requests for information on business opportunities and external markets, EU projects and programmes, Bulgarian legislation and standards and certification. Such an office from Macedonia would be asked most often about business opportunities and external markets, standards and certifying and Macedonian legislation.

2.5. INNOVATIVE INITIATIVES FOR E-LEARNING SERVICES DEVELOPMENT

Along with e-consultative virtual e-learning services in a Virtual educational platform (VEP) were identified as requested for innovative initiatives development. The most demanded e-learning services by entrepreneurs are ranked in Figure 6.

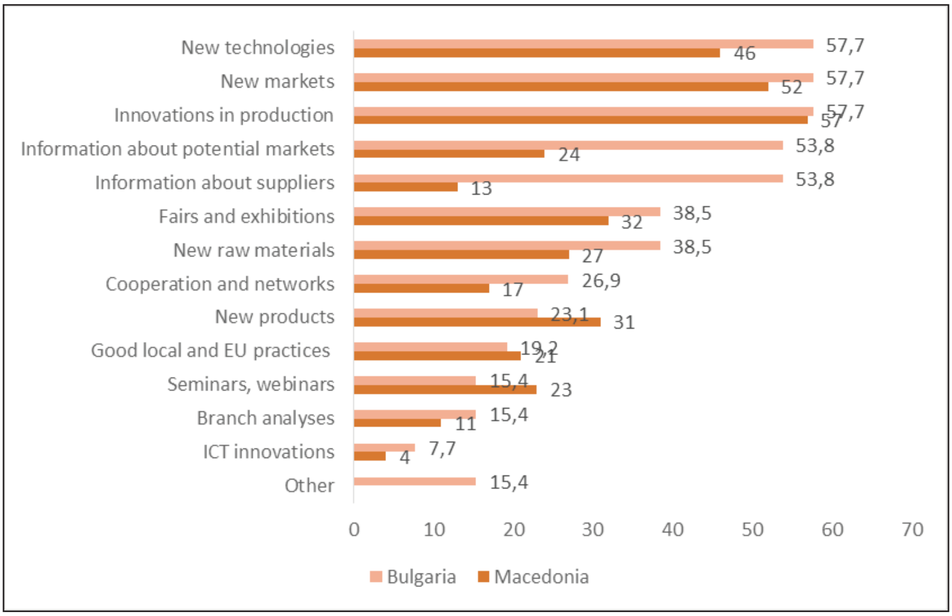

Figure 6. e-learning services on demand

The organisations in both countries demonstrated they need access to a virtual educational platform. The information mostly demanded is for:

- New technologies
- New markets
- Innovations in production
- Information on potential markets
- Information about suppliers
- New products

These answers show that there is a need for a platform where companies in the sector could communicate and exchange ideas, search for potential markets and partners, find new products and new technologies.

3. CONCLUSION

The five groups of initiatives for innovation in forestry sector presented here have been developed and now are implemented in a Joint Bulgarian-Macedonian Virtual consultancy Office for enterprises in Forestry sector (VOFIS) and a Virtual educational platform (VEP).

The functions of the VOFIS are a:) developing a model of cluster optimizing and intensifying the business activities of SMEs in forestry sector along the supply chain in the cross-border region; b) providing needed supporting information, incl. respective standards, for increasing synergy in operations, investment, commerce and management; c) develop contacts with European and world similar networks.

As a supplement of the virtual office activity an electronic platform for distance learning (VEP) was developed. By using the platform any person is able to gain information about the forestry sector and capacities in the eligible area. VEP provides information about the recent novelties and innovations in the world, needed by target the group of the region. The educational platform was constructed according to requirements of the target group. The platform provides respective information on the sector, the main activities, the needed skills, the possibilities for start-ups, the development of women in the forestry and so on. All needed courses were developed according to the requirements extracted from the analysis of the data collected by thr survey, but also took into account existing good practices. All information included in the platform is translated in Bulgarian and Macedonian, but also in English.

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CHANGE IN MASS, VOLUME AND DENSITY OF COMMON HORNBEAM (*CARPINUS BETULUS* L.) IN SHORT SAWN AND SPLITTED FIREWOOD DUE TO AIR DRYING

Ištvanić Josip, Radmanović Kristijan, Lemo Ognjen, Antonović Alan

ABSTRACT

The paper experimentally and theoretically investigates influences to parameters of moisture, mass, volume and density on in short sawn and split Common hornbeam (*Carpinus betulus* L.) firewood. The study was conducted on a sample of 440 pieces of firewood. Each firewood piece was measured and marked with a purpose of measuring mass, dimensions and moisutre in green and dryish condition. Air drying was conducted on well-ventilated and sheltered company area from 05. May. 2016. to 06. October 2016.

The value of firewood moisture before drying was between 50.50 % and 73.47 %. In dryish condition, value of firewood moisture was between 10.57 % and 12.62 %. Considering green condition, loss in mass was between 21.28 % and 38.39 %. Given the green condition, reducing the volume amounted to between 4.08 % and 23.0 %. Considering green condition, density was reduced between 10.41 % and 32.68 %.

Keywords: Common hornbeam (*Carpinus betulus* L.), firewood, mass, volume, moisture, wood density, air drying

1. INTRODUCTION

Firewood in the traditional form of one-meter split wood and round wood, most commonly produced by self-production, is still the most important energy source for the production of heat energy in rural areas of the Republic of Croatia. In addition to the traditional way of production, sale and use of one-meter and longer than one-meter firewood, in recent years, an increasing number of companies started production of short sawn and split firewood, mainly for export, mostly in Italy, Slovenia, Hungary and Austria (Vusić at al., 2015).

When placing firewood on the market, it is possible to measure it by volume or mass. Measuring wood by mass is influenced by the current moisture content, and most commonly is used when dispatching firewood (Poršinsky at al., 2014).

The wood is porous, which means that its volume is not filled with wood, but with water in which mineral substances are dissolved. The higher the share of water in wood, the greater the mass of green wood is. We distinguish dry firewood and green firewood. Dry firewood is when it has been at least 6 months from the felling and green firewood is when it has been less than 4 months from the felling (Vusić at al., 2015).

As there are few months from felling and production to selling of firewood, there is a loss due to the shrinkage. The research results carried out by Zelić at al. (2001 and 2005) indicate that during air drying of firewood the outer conditions significantly slow down the course of air drying of wood. Wood density was conditioned by climate change, and wood mass was often higher than in previous weighing. Loss in the density to the degree of dryness is different depending on the wood species and the length of the sample (Ištvanić at al., 2017).

2. AIM OF RESEARCH

The influence of moisture, mass, volume and density of firewood is of crucial importance to transport, quantity and price of firewood in commercial businesses.

The aim of the paper is to experimentally and theoretically explore the changes that occur in the course of air drying of Common hornbeam (*Carpinus betulus* L.) firewood.

The results of this research should give the answers to how much have this firewood lost in mass, volume, moisture and density during air drying over a given period of time**.**

3. OBJECTS AND METHODS OF RESEARCH

For the purposes of research, the firewood was made in form of 25 cm - short split wood (Figure 1). For the purposes of measurement, 440 pieces of short split firewood marked by numbers were selected, and their mass, volume and moisture in the green and air dried condition were measured. Air drying was conducted on well-ventilated and sheltered company area from 05. May. 2016. to 06. October 2016.

Figure 1. Stack of green and dry split firewood samples

3.1. Production of firewood samples for measurement

After felling of wood assortments in the forest, raw material or long round firewood (longer than one metre) was transported by trucks to the log yard, at the company where the research was conducted. Figure 2 shows the sequence of production short split firewood.

Figure 2. Overview of the production process of firewood following the arrows: the stack of the round wood longer than 1 metre in log yard; cross-cutting of round wood longer than one metre and production of one-metre round wood by a motor chainsaw; splitting one-metre round wood; cross-cutting of one-metre split wood with a band saw to the final length and additional splitting; disposing on pallets and air drying

3.2. Measuring mass, dimensions and moisture contents of samples

3.2.1. Firewood mass

The firewood mass was measured on the laboratory scale and the value was rounded to three decimal places. The firewood was weighed for the first time immediately after it was produced during the month of May, and the second time during the month of October after it was air dried on a well-ventilated log yard. The mass value is defined in kilograms. The percentage of the firewood mass reduction due to air drying is calculated according to the expression 1.

$$\Delta(m)_{rel} = \frac{m_{green} - m_{dry}}{m_{green}} \cdot 100 \tag{1}$$

$\Delta(m)_{rel}$ – relative change in sample mass, %,
m_{green} – sample mass in green condition, kg,
m_{dry} – sample mass in air dried condition, kg.

3.2.2. Firewood volume

Firewood volume is determined by volumetric method. For short split wood a volumetric cylinder with diameter of D_m = 15 cm was used. The measuring was performed in such way that first water level (h_{min}) was measured before immersing firewood in the bath or volumetric cylinder. Then the sample was immersed in the volumetric cylinder and the water level (h_{max}) with sample in it was measured. The difference between the water levels before and after the sample was immersed was calculated. The column of water level difference presents the volume of immersed sample and it is calculated according to expressions 2.

$$V = \frac{D_c^2 \cdot \pi}{4} \cdot \left(h_{\max} - h_{\min}\right) \tag{2}$$

V – sample volume, m³,
D_c – volumetric cylinder diameter, m,
h_{min} – measured level of water before immersing samples in the bath or volumetric cylinder, m,
h_{max} – measured level of water after immersing samples in the bath or volumetric cylinder, m.

The percentage of firewood volume reduction due to air drying is calculated in relative relation to expression 3.

$$\Delta(V)_{rel} = \frac{V_{green} - V_{dry}}{V_{green}} \cdot 100 \tag{3}$$

$\Delta(V)_{rel}$ – relative change in the volume of the sample, %,
V_{green} – sample volume in green condition, m³,
V_{dry} – sample volume in air dried condition, m³.

3.2.3. Firewood moisture content

The moisture content of the firewood was measured by the gravimetric method (Pervan, 2000). This method was carried out using laboratory scale and drying oven. After the drying of the samples in the drying oven and measuring the mass first of moist samples and then dried samples after several months of air drying, the moisture content of the firewood was calculated according to the expression 4.

$$u = \frac{m_1 - m_2}{m_2} \cdot 100 \tag{4}$$

u – sample moisture content, %,
m_1 – initial mass of the sample, kg,
m_2 – final mass of the sample, kg.

3.2.4. Firewood density

Firewood density was calculated according to the definition that wood density is the ratio of mass and volume of the firewood. It was calculated according to expression 5:

$$\rho = \frac{m}{V} \tag{5}$$

ρ – firewood density, kg/m^3,
m – firewood mass, kg,
V – firewood volume, m^3.

The percentage of firewood density was calculated according to the expression 6:

$$\Delta(\rho)_{rel} = \frac{\rho_{green} - \rho_{dry}}{\rho_{green}} \cdot 100 \tag{6}$$

$\Delta(\rho)_{rel}$ – relative density change of the sample, %,
ρ_{green} – sample density in green condition, kg/m^3,
ρ_{dry} – sample density in air dried condition, kg/m^3.

4. RESULTS AND DISCUSSION

4.1. Descriptive statistics of measured values

Table 1 shows descriptive statistics of mass, volume, density and moisture content of green and dry short split firewood.

Table 1. Descriptive statistics for the short split firewood (L = 25 cm)

Firewood size	*Short split firewood (L = 25 cm)*						
	Size	N	Min.	Median	Max.	Average	Std. dev.
m_{green}	kg	440	0.6450	1.3350	2.1850	1.3417	0.3164
m_{dry}	kg	440	0.4400	0.9250	1.5600	0.9274	0.2173
$\Delta(m)_{rel}$	%	440	21.28	30.75	38.39	30.78	2.72
V_{green}	m^3	440	0.00062	0.00131	0.00207	0.00130	0.00030
V_{dry}	m^3	440	0.00053	0.00115	0.00184	0.00115	0.00027
$\Delta(V)_{rel}$	%	440	4.08	11.43	23.00	11.66	3.34
ρ_{green}	kg/m^3	440	894.81	1036.34	1158.08	1033.34	45.81
ρ_{dry}	kg/m^3	440	704.42	807.93	899.21	809.94	43.64
$\Delta(\rho)_{rel}$	%	440	10.410	21.499	32.686	21.551	4.057
u_{green}	%	46	50.50	61.28	73.47	61.81	5.53
u_{dry}	%	46	10.57	11.51	12.62	11.54	0.40

4.2. Relative change in mass, volume and density of firewood

Figure 3 shows a reduction in the mass of dry short split firewood with average value of 0.4143 kg. The mass reduction expressed in percentage, considering to green wood condition is 30.78 %. Since we know that wood during air drying also losing water and shrinking, which also result in mass decreasing, these results are not surprising. Figure 4 shows the course of air drying of the total amount of short split firewood in the researched time period. From this graph it can be seen that their mass at the very beginning of the air drying process was 630 kg, and to the end of the mass process it decreased to 440 kg, which represents a reduction of 190 kg.

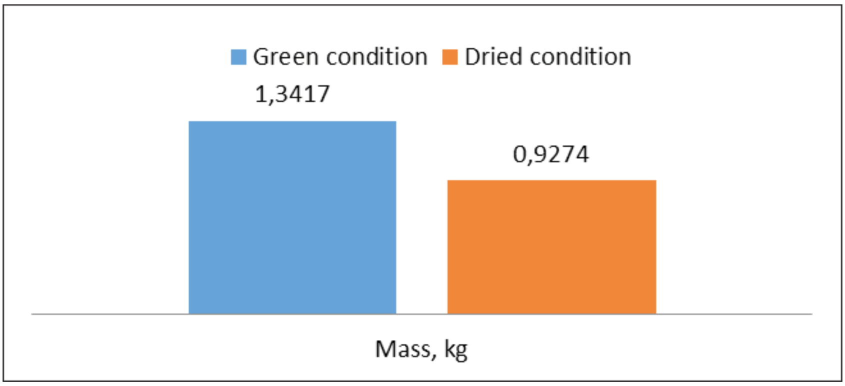

Figure 3. Change in the mass of firewood due to air drying

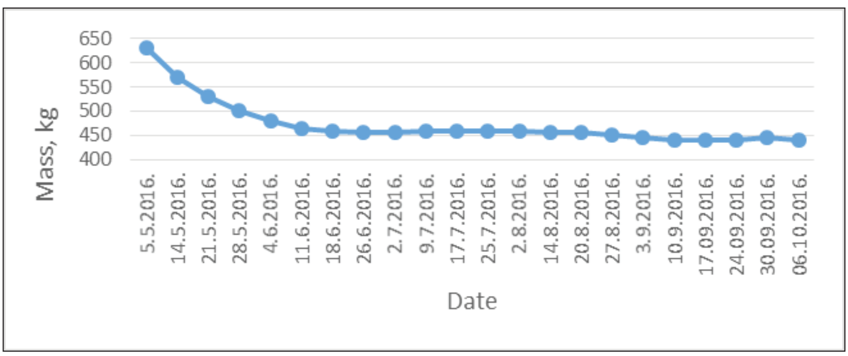

Figure 4. Graphic representation of the mass loss of dry short split firewood bulk due to air drying

The research results of the common hornbeam short split firewood volumeare shown in Figure 5. According to expectations, a volume decrease from 0.001297391 m^3 in green state to 0.00114726 m^3 in the dry state. The difference between mean volumes is 0.000150131 m^3. Viewed in percentages, the volume decrease was 11.66 % given the green state.

From these results it can be seen that by air drying of short split firewood it comes to the wood shrinking, and consequently the reduction of volume.

The bulk density parameters of the common hornbeam short split firewood are shown in Table 1 and in Figure 6. As the density itself depends on changes in the mass and moisture content, and how they both of these parameters have been reduced in this study it was expected reduction in the short split firewood density.

Thus, in Figure 6 it can be seen that the density from the average of 1033.34 kg/m^3 in the green state, with air drying, decreased to an average of 809.94 kg/m^3 as it was in the dry state. Also, from Table 1, it can be seen that the percentage decrease in density in terms of the green state was 21.55%.

The variations in the density of individual short split firewood ranged from 894.81 kg/m^3 to 1158.08 kg/m^3 for the green state, while those variations for the dry state ranged from 704.42 kg/m^3 to 899.213 kg/m^3.

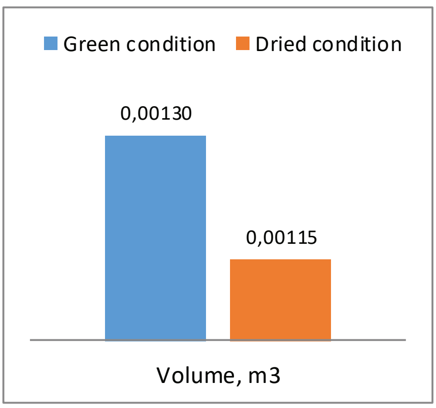

Figure 5. Change in the volume of firewood due to air drying

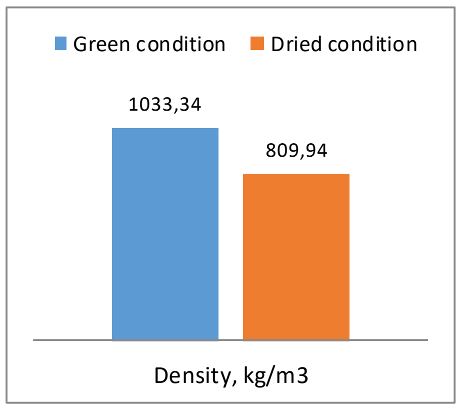

Figure 6. Change in the density of firewood due to air drying

5. CONCLUSION

Based on the results of this research it can be concluded:

- Air drying reduced mass, volume and density regardless of the shape of the common hornbeam short split firewood,
- The moisture of short split firewood with air drying was reduced from 61.81% to 11.54%,
- The mass firewood has decreased after the air drying process. The average mass reduction was 0.4143 kg per split firewood, while this amount for the entire palette was 190 kg. Expressed in percentages, this would mean a 30.88 % mass reduction in terms of the green state,

- By air drying, there was also a reduction in the volume of short split firewoods. On average, the reduction was amounted to 0.000150131 m^3 per single split firewood. If it were to show that in percentages the value would be 11.66% less due to the green state,
- The density was reduced in average of 223.40 kg/m^3, or in percent it would amount to 21.551% considering the green state.

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INSTITUTIONAL AND INDUSTRIAL SYMBIOSIS CASE STUDY **OF COOPERATION FOR DEVELOPMENT IN FORESTRY** AND WOOD-BASED SECTOR

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ABSTRACT

In the forest- and wood-based sector in Poland there is an institutional model based on the natural monopoly of the State Forests. The wood market is made up of the forestry and timber sectors, which relations are shaped to a limited extent by the market mechanism. In a perspective in which development is not programmed solely by the primacy of competitiveness, it seems necessary to accurately identify development factors based on cooperation of partners. Using the diagnostic survey method, the TOPSIS method and descriptive analysis, an attempt was made to assess the conditions shaping the model of intersectional cooperation. The research was carried out on the basis of the experiences of two institutional partnerships in Poland, operating in relatively independent functional forest areas in the Opolskie Voivodeship and Wielkopolska.

Keywords: forest- and wood-based sector, industrial symbiosis, forest functional area, Poland.

1. INTRODUCTION

In the Polish forestry and wood sector, the market and competition function in a particular way. This is a characteristic model of an institutional structure based on a natural monopoly. The wood market is composed of two complementary sectors of the economy: forestry and wood processing, together with the market environment: institutional, business, social and cultural. The mutual relations of market participants are shaped to a small extent by the market mechanism [Wanat, 2009; Wanat and Klus, 2015]. However, since development is not organized solely by the primacy of competitiveness, it opens up space for cross-sectoral cooperation. In the case of the forest-wood sector, the development is based on the richness of forest resources [Chudobiecki and Wanat, 2015].

In the forest-wood sector, it seems necessary to take into account the coexistence of economic, environmental and strictly industrial issues. It is worth noticing that the concept of "sustainable development" stems directly from forestry management. Hans Carl von Carlowitz defined the concept of economic activity in forestry as the gaining of suitable, i.e. only industrial wood that can be reproduced by means of natural restoration in the forest. The idea of von Carlovitz was promoted in 19th century Europe as Sustained Yield Forestry [Chudobiecki and Wanat, 2015]. On this basis, the term "sustainable" has become the key word in the theory of sustainable development.

When discussing the traditional model of economy, it is perceived that there is a need to look for new ways of development, including the so-called green growth path. Questions arise concern the social responsibility of future generations, using the resources of the green economy somehow metaphorically approached „on the cuff". It is not possible to dispense with this human responsibility and constant concern for the state of resources and the quality of life of future generations [Francis, 2015].

This reflection is accompanied by a concept of economic symbiosis, referring to detailed solutions in the form of eco-industrial parks (ecological industrial parks, eco-industrial parks, eco-parks). This idea stems from the partnership cooperation of entities operating in a separate, well-defined area (functional area). It combines the experiences of various sectors, including enterprises, local governments and residents in the process of implementing „green economy" initiatives. In fact, one of the objectives is to achieve measurable economic benefits inter alia due to joint management of raw materials, energy and waste, while reducing the negative impact of industry on the natural environment. However, the basis for such cooperation constitutes mutual relations between partners. In this process, it is possible to shape a system within which the activities of entities will be carried out in a closed economic cycle (e.g. production waste may be reused in another plant as a substitute for the primary raw material) [Kaputa *et al.*, 2017; Mikołajczak *et al.*, 2017].

In its theoretical concept, the Eco-industrial Park (EIP) can be seen as a specific example of a functional area. It is not a matter of merely imitating passive features (terrain, real estate, infrastructure, etc.), but of using „more than a part of an industrialized area" [Doniec, 2011]. In order to give the new structures an economic identity, an individual management strategy, a method and operation activity are required. Conditions are arising for the creation of new industrial communities, called "green enterprise parks" in Polish conditions. The trend, based on the idea of "eco-industrial symbiosis", seems to indicate a new direction of development for the forest-wood sector [Graczyk, 2005; Chudobiecki and Wanat, 2015]. The starting point in the process of shaping functional areas in forestry are the already successfully operating Forest Promotion Complexes, managed in Poland by the State Forest Enterprise.

The accurate identification of the economic (industrial) chain: raw material-process-product, including the formation of by-products in this chain, is the basis for the creation of symbiotic links between enterprises. The use of "unwanted streams" has proven to be an important element of competitive potential. The industrial processing chain is supplemented by materials, reused in the production cycle, created as a result of the consumption of finished products (recycling). Taking the analysis of the state of knowledge as the starting point, using case studies, a diagnostic survey method and descriptive analysis, this paper attempts to assess the conditions (expressed through objectives and relations) that make up an integral model of intersectional cooperation [Potkański *et al.*, 2016]. These conditions were examined on the basis of the experience of cooperation between two separate institutional partnerships in Poland as follows: The project is part of the Partnership of the

Niemodlin Forests [Wanat, 2017] and the Notecka Forest Promotion Complex [Kusiak, 2007]. These selected examples of cooperation between local governments and non-governmental organizations and the State Forest Holding (SFP), State Forests and local enterprises, formed the background for the research on the development of functional forest areas. This task is further justified by the fact that in forest- and wood-based industry the needs of business practice still prevail over theoretical reflection.

2. THE OBJECT AND THE SCOPE OF RESEARCH, MATERIAL AND METHODS

The development of an industry market based on the resources of the "green economy" depends to a large extent on economic policy tools, including legislative policy. Moreover, shaping the competitive position of the forest and wood sector is closely related to the principle of sustainable development, which determines the strategic objectives of forest management in Poland [Graczyk 2005; Rykowski, 2005]. Furthermore, the assumptions of industrial symbiosis, transferred to the field of forest sciences, lead to optimization of the influence of social, economic and cultural functions of forest on the integral development - economy and society while maintaining the renewability of forest resources and environmental protection [Chudobiecki and Wanat, 2015; Słodowa-Hełpa, 2015].

The effect of industrial symbiosis within the sector is the creation of permanent structures, which are an institutional reflection of the real cooperation of enterprises. This process usually starts with a mutual exchange of excess resources and a common organization and management system that reduces costs. In the theory of industrial ecology, companies imitate nature this way: within it, nothing is waste, and every element is constantly processed and managed. It is natural, therefore, to take action to use a stream of all materials as follows: primary, semi-finished, inferior quality and, finally, waste as a raw material. If these activities cannot be carried out during the production process, it is planned to use the remaining part of the material stream within the partner's structure (technology) - located as close as possible [Doniec, 2011]. This creates a natural space for the creation of both functional areas (as well as EIPs /Eco-industrial Parks/) at the interface between forestry and the wood industry. These areas may include both enterprises and other partners who, by developing a system of symbiotic links between themselves, transfer natural models to the anthropogenic world.

In order to develop functional areas it may be important to meet at least some of the requirements necessary for the creation of an industrial ecosystem. These include as follows: effectiveness of business partners' operations, rational management of the environment and identification of an important common part of partners' leading activities. The implementation of the postulate of business efficiency depends on the ability to include own production of partners in the process based on symbiosis. This effectiveness can be achieved in various dimensions: economic (reduction of production costs, additional revenues from sales and management of production waste), environmental (limiting the use of resources by increasing the degree of their use in the production process) and social (creation of new jobs, positive impact on the functioning of local communities, improvement of the inhabitants life quality).

The starting point for the analysis of the factors of creation and operation of the functional areas in the forest-wood sector was the author's qualitative research. It used a diagnostic survey method using a questionnaire. The analysis was combined with the assessment of resources (competitive potential) on the ground of spatial management. On this basis, the main areas of impact were identified as follows: natural, institutional (legal), economic and social. The aim of the study was to assess the conditions (expressed in terms of objectives and relations) that make up an integral model of inter-sectoral cooperation [Potkański *et al.*, 2016; Potkański and Wanat, 2017]. These conditions were examined on the basis of the experience of cooperation between the two selected institutional partnerships as follows: The project is part of the Partnership of the Niemodlin Forests and the Notecka Forest Promotion Complex. In both cases, the participation of the State Forest Enterprise is an important and somehow vital factor. This is a kind of an obvious assumption, when in Polish conditions the prospects of establishing development potential in functional forest areas are analyzed.

2.1. Partnership of the Niemodlin Forests

The cooperation of Opolskie communes, historically diverse in terms of population, culture and economy, although it seemed difficult, became a dream of active inhabitants of these areas and their local leaders. The establishment of the Niemodlin Forests Partnership was determined by the Council of the Proszków Commune, when on 30 June 2003 it adopted a resolution on the establishment of the association of local government units "Green Communes". (IX/69/2003). The following joined the "Green Communes": Niemodlin, Komprachcice, Łambinowice, Tułowice and the Opolski Poviat.

The next stage of building the partnership was the accession of the commune of Prószków along with the self-governments of Komprachcice, Łambinowice, Niemodlin, Tułowice and Strzeleczek to the Leader+ programme in the years 2004-2006. In the years 2007-2015 the Partnership of Niemodlin Forests (since 2006 with Dąbrowa commune) was a local operator of the Leader programme under the Rural Development Programme. In the new financial perspective (2015-2022), the Partnership covers 8 communes (including Biała commune from 2015). The Local Development Strategy is a strategic document, and its financing tool is the Rural Development Programme 2014-2020.

Apart from institutional resources, the potential of cooperation is determined by natural resources. They include the forests of the Niemodlin Forests complex with an area of 48.19 thousand ha, which are administered by three forest inspectorates as follows: the Opole Forest Inspectorate (Dąbrowa district), the Prószków Forest Inspectorate and the Tułowice Forest Inspectorate. Most of the water reservoirs (708.50 ha) are administered by the State Forests Fishing Farm in Niemodlin. The point of reference for organizing the activities of the Niemodlin Forest Partnership is the diagnosis of the state of development of the functional area [Local Development Strategy... 2015]. Taking directional initiatives, justified in a rational and social way, eliminates the fears that they are to be perceived by the inhabitants as only apparent actions, supporting only the institutional partnership (i.e. themselves), not the community and specific people, inhabitants of the Niemodlin Forests. The diagnosis of the Niemodlin Forests microregion covers the development of 8 communes of the Partnership for Niemodlin Forests, which have a population of over 75 thousand and an average population density of 84 inhabitants per km².

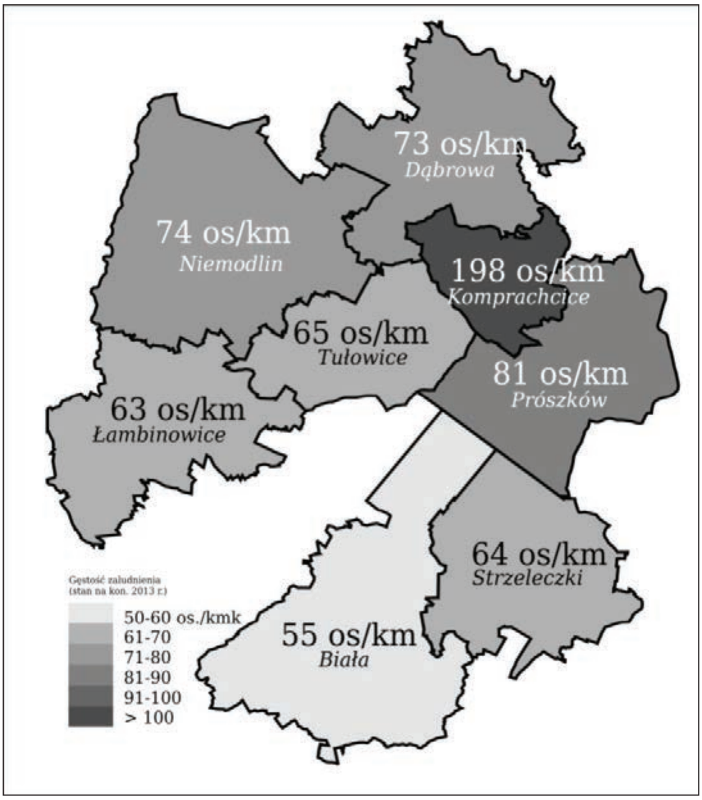

Figure 1. Potential of the communes of the Niemodlin Forests Partnership (according to population density in os./km² [number of people per square kilometer]) Source: Internet site Niemodlin Forests [http://boryniemodlinskie.pl/accessed 10.03.2018]

The research used: quantitative secondary data (statistical information, reports) and qualitative primary and secondary data (obtained from surveys). The observations were supplemented with data defining the state of key conditions: existence (places of work, income), identity (natural and cultural resources, environment, public space) and quality of life in the functional area [Local Development Strategy… 2015].

2.2. The Forest Promotional Complex - Notecka Forest

In 2004, the Forest Promotion Complex “Notecka Forest” (FPC) was established. It covers forest areas located in the Wartańsko-Notecki inter-branch, on a length of 100 km, with an area of 137 thousand ha, constituting the largest compact forest area of this type in Poland. The forest complex is located in seven forest districts (Karwin, Krucz, Międzychód, Oborniki, Potrzebowice, Sieraków, Wronki), subordinate to three regional directorates of the State Forests (in Piła, Poznań and Szczecin).

Administratively, the area is part of two voivodships (Wielkopolskie and Lubuskie), eight poviats (Czarnkowsko-Trzcianecki, Gorzowski, Międzychodzki, Międzyrzecki, Obornicki, Poznań, Strzelecko-Drezdenecki, Szamotulski, Chodzieski) and 20 rural gminas: Chrzypsko Wielkie, Czarnków, Drawsko, Drezdenko, Kwilcz, Lubasz, Międzychód, Obrzycko, Pniewy, Połajewo, Rogoźno, Rokietnica, Ryczywół, Santok, Sieraków, Skwierzyna, Suchy Las, Szamotuły, Wieleń, Wronki and six communes: Drezdenko, Międzychód, Wieleń, Wronki, Czarnków and Obrzycko [Anders and Kusiak, 2005].

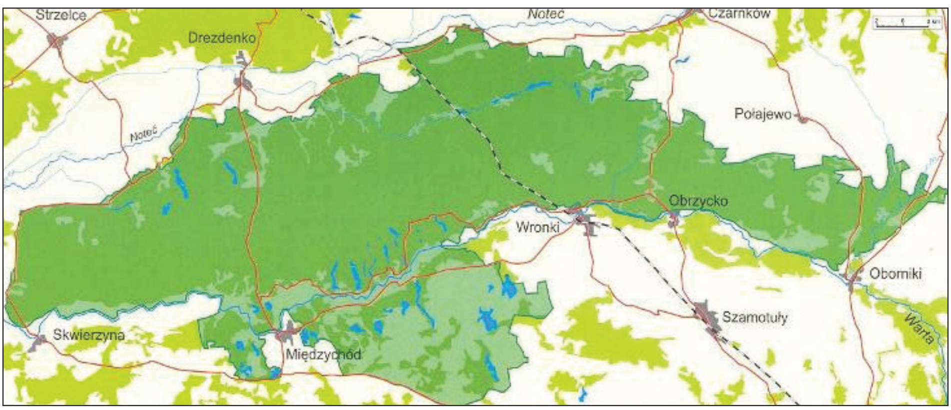

Figure 2. Potential of the Forest Promotion Complex of the Notecka Forest (FPC)
Source: Economic and Social Programme of FPC Notecka Forest [Kusiak, 2007]

The Notecka Primeval Forest comprises varied stands with a predominance of pine trees. In the context of the challenges of sustainable development, which should be also met by forest management, the “Economic and Protective Programme of the Notecka Forest Promotion Complex” has been prepared [Kusiak, 2007]. Its implementation is to ensure rationalization of economic effects of forest production and enable preservation of a unique cultural landscape, while supporting promotion of natural and tourist attractions of the forest.

The Forest Promotion Complex of the Notecka Forest does not include extraordinary and unique natural values. With a few exceptions, which are enclaves of pine forests, it is predominantly economic in nature. The value of this forest complex is its size, compactness, readability of borders defined by rivers, small population, significant wood resources.

Stands are a typical monoculture with a single species and single storey composition and an unstable age structure. The basic threats for these stands were and still are fires, insect pests and deer. The second group of threats includes increased anthropogenic impact (e.g. fast and devastating for the environment development of tourist infrastructure, or annual collection of mushrooms on an industrial scale). A new and hitherto unknown danger is the project to launch an oil and gas mine in the middle of the Forest.

The task of the Notecka Forest Promotion Complex (FPC) is to work out and then make the right business decisions, with greater socialization of management and support for science. This concerns in particular the integration of sustainable forest management and active nature conservation objectives and the improvement of cooperation forms with the public on forest management.

The research used secondary data obtained from the Economic and Protective Programme of the Forest Promotion Complex of Notecka Forest [Kusiak, 2007]. The qualitative analysis and evaluation of the cooperation model also took into account the results of consultations conducted among the members of the Social and Scientific Council of the FPC Notecka. The TOPSIS (Technique for Order Preference by Similarity to an Ideal Solution) method was used to identify the impact of cooperation factors. It allows one to sort different objects in order to compare them according to specific features, based on a synthetic indicator [Wysocki, 2010].

3. RESULTS

On the basis of the conducted analyses and author's research, the most important results, formulated separately for the Partnership of Niemodlin Forests and the Notecka Forest Promotion Complex, were summarized in the conclusion, referring to particular elements of the integral model of cooperation [Potkański *et al.*, 2016].

3.1. Niemodlin Forests Microregion

The municipalities of the Partnership of the Niemodlin Forests combine specific geographical, natural and historical as well as cultural conditions. They determine the cohesion of the area, going beyond the administrative neighborhood. The partnership is based on the richness of nature and local culture, and in particular on the forest resources of the Niemodlin Forests. The analysis was carried out in three areas as follows: the standard of living (economic activity and unemployment), local identity and development potential.

The Niemodlin Forests Microregion is diversified in terms of entrepreneurship. This is linked to geographical location, working traditions and cultures, and to access to outlets. Provided for the communes around Opole (Dąbrowa, Komprachcice and Prószków), entrepreneurship is of a service and concerns basic services. In turn, the communes of Biała, Łambinowice and Strzeleczki have over 10% share of services related to agriculture, forestry and fisheries. In gminas traditionally considered to be Silesian (Prószków, Biała and Strzeleczki) there is a greater industry specialization. Different observations were made in the "displaced" municipalities, such as Niemodlin, Tułowice and Łambinowice. These communes are characterized by liberal, open creation of their own business activity, resulting in faster adaptation to changes on the labour market, which unfortunately favors lowering the quality of services [Wanat, 2017].

Unemployment in the municipalities of the Niemodlin Forest is a problem analogous to the situation on the domestic market. The exception is the municipality of Niemodlin, where the share of the unemployed to people of working age is 11.4%, and the municipality of Łambinowice. The situation of three age groups, key for the labour market, is characteristic as follows: (1) up to 35 years of age (young people marginalised in the process of applying for jobs requiring experience, going abroad, usually taking well-paid jobs, but differing in their education); (2) over 55 years of age (group marginalised by employers as less productive, having low qualifications, not being professionally mobile); (3) women (eliminated from the labour market due to the necessity of caring over the dependent persons and lack of work continuity).

The Niemodlin Forest area is characterised by demographic phenomena typical for Poland: aging of the population and economic migration (a regressive pyramid of the population's age). The main barriers for the development of the area of the Niemodlin Forest are its peripherality and unequal development. Apart from the capitals of communes and towns located by railways, the public transport system is poorly functioning. There is a lack of coherence in spatial planning. Many investments are of a chaotic nature, increasing peripherality. Unfortunately, there is no support for the initiative to create a Forest Promotion Complex for the Niemodlin Forests, which would strengthen the potential of the dynamic Partnership and mobilize the State Forests to take the role of the leader of local development.

The division of the Niemodlin Forests' identity into the displaced communities (the population coming from the borderlands and eastern Poland) and the indigenous communities (Germany, Silesia, the population declaring itself not to be Polish) is a significant obstacle to undertaking joint initiatives. A positive example is the activity of Volunteer Fire Brigades and foresters from the three forest districts, which includes the partnership area. However, most of the effective actions are carried out by informal movements.

3.2. Notecka Forest Microregion

A slightly different perspective was emphasized in the case of the analysis of the functional area located between the rivers Warta and Noteć. Taking into account the specificity of the Notecka Primeval Forest area (habitat poverty, boronic character, dominance of pine trees, disturbed layout of age classes of stands, unfavorable water balance, compactness of the complex, fire hazard, susceptibility to harmful insects, influence of deer, especially adverse human impact) and administrative division and resulting economic complications - searching for a model of integrated measures seems to be a necessity. One of the basic tasks of the State Forests should be the improvement of works in forest management, taking into account ecological demands, and effective use of the power of intra- and cross-sectored cooperation.

A significant step towards better use of the Notecka Forest's assets was the creation in 2004 of the Local Tourist Organisation, to which the communes joined as follows: Skwierzyna, Bledzew, Międzychód, Przytoczna and Santok. It has become a best practice to establish an "Agreement between the two", covering the northern part of the Notecka Primeval Forest, and concerning the cooperation of two districts: Czarnkowsko-Trzecianeckie and Strzelecka-Drezdeneckie [Wanat and Lis, 2009].

Among the advantages of the region, local governments see above all as follows: the priority of high forest cover (Skwierzyna commune), unpolluted natural environment (Międzychód commune), very good conditions for tourism development and the possibility of small-scale economic activation (Obrzycko commune); an ideal place for agro-tourism development (Czarny and Strzyca commune); no burdensome industry and ecological character (Wieleń commune); excellent natural and landscape values creating a kind of "Notecka Switzerland". (Lubasz commune); a convenient place to relax in silence (Wronki and Drezdenko commune) [Kusiak and Kusiak-Dymek, 2002; Kusiak, 2003; Kusiak, 2007].

Table 1. Diversification of the impact of cooperation factors of the studied partnerships in functional forest areas against the background of an integral model of intersectoral cooperation

INTEGRAL MODEL OF COOPERATION		**Identification of the power of factors influencing the effectiveness of the partnership**	
AIMS **Strategic Management**		**Niemodlin** Forests	**Notecka** Forest
I.	Composition of the partnership	Very Strong (I)	String (II)
II.	Potential for partnership	String (II)	Very Strong (I)
III.	Functional network	Very Strong (I)	Average (III)
IV.	Development programming	Average (III)	Very Strong (I)
V.	Strategic Integration	String (II)	String (II)
VI.	Integration of services and infrastructure	String (II)	Average (III)
VII.	Monitoring and evaluation	Average (III)	Average (III)
RELATIONS **operational management**		**Niemodlin** Forests	**Notecka** Forest
VIII.	Public relations	Average (III)	Average (III)
IX.	Internal communication	String (II)	String (II)
X.	Trust	Very Strong (I)	Very Strong (I)

**Source: authors' own elaboration based on [Potkański et al. 2016]*

All-Poland non-governmental organizations joined in the activities for the benefit of the Notecka Forest. Schools, including those with a natural profile, such as the Forest School Complex in Goraj, are natural partners in local activities. There is a lack of effective cooperation with universities from Poznań (e.g. Poznań University of Life Sciences) and Gorzów Wielkopolski. An important partners are also Roman Catholic parishes, whose network covers the entire Notecka Forest. It was noted that the large number of self-government units creates certain complications in establishing coherent, comprehensive and lasting cooperation. In principle, local governments are more interested in cooperation, but this usually concerns their immediate neighbourhood.

The study results on the differentiation of the cooperation factors impact of the studied partnerships in functional forest areas, determined by the qualitative method and verified using the TOPSIS method, followed by the framework of an integral model of intersectoral cooperation [Potkański *et al.,* 2016, Potkański and Wanat 2017], are presented in Table 1. It was shown that the activities of the Partnership of Niemodlin Forests and FPC Notecka Forest fit into the structures of the proposed model. Both partnerships are characterized by a similar approach to operational management (relations), giving priority to trust and internal communication. On the other hand, in terms of strategic management (objectives), the diversification of cooperation priorities was determined by the characteristics of the potential of each of the functional forest areas. In the case of the Niemodlin Forests, priority was given to the composition of the partnership and the creation of functional networks. On the other hand, for the Notecka Forest the priority in establishing cooperation turned out to be the potential of partnership (the potential of the functional area) and accurate development organization, with which all its participants will identify.

4. CONCLUSIONS

The experience of research on aspects of intersectoral cooperation in the Opolskie Voivodeship (Niemodlin Forests) and Wielkopolskie Voivodeship (Notecka Forest) may be a point of reference in shaping local development policies. These can also be used as recommendations for the State Forests organisational units, which would like to undertake actual cooperation with other entities and local governments within the framework of functional forest areas, in particular areas with economic orientation, based on wood.

Despite the emergence of formal examples of partnership between local governments and organisational units of the State Forests, it should be stressed that the potential of the forest and wood sector is used in this respect only to a small extent. It was noted that the key factor determining the development of cooperation in functional areas selected for forest research is relations (i.e. operational management), which are based on mutual trust between current and future partners. On the other hand, effective implementation of objectives in already established partnerships is determined by individual, characteristic features of specific functional areas. Therefore, both the natural resources (potential) are of the highest importance, in connection with the proper programming of their economic use (the Notecka Primeval Forest), and sometimes the composition of the partnership in connection with establishing an effective network of functional connections (the Niemodlin Forests). It seems that the correct identification of factors determining the success of a partnership may result in the conclusion of development. Obviously, this does not mean marginalising the other factors identified as components of an integral model of cooperation.

Moreover, in the establishing process of the forest-wood functional areas potential, the following factors have been pointed out, which are conducive to the creation of partnerships:

1) use of cultural, natural and institutional resources;
2) communication infrastructure of the functional area with larger centres;
3) focus on joint, cross-linking and complementary projects;
4) promotion of innovative, environmentally friendly projects;
5) increasing worker mobility,
6) creation of places conducive to the introduction of economic activity;
7) development of tourist, recreation and sport services and infrastructure;
8) education, promoting competence, qualifications and motivation of the residents.

The competitiveness of the forest-wood sector continues to be determined by the strong conflict between its productive, recreational and protective functions. It seems that this conflict can be limited by the increased specialisation of industry players and their symbiotic links, including wood-based Eco-industrial Parks (EIPs) and forest functional areas.

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