WoodEMA 2021

The response of forest–based sector to changes in global economy

Koper, 2021

University *of Ljubljana*
Biotechnical Faculty
Department of Wood Science and Technology

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

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Koper, Slovenia, 2021

PREFACE

We are very pleased to present the proceedings of the international scientific conference “The Response of the Forest-Based Sector to Changes in the Global Economy”, held in Koper, Slovenia, from 16 to 18 June 2021, organised by the University of Ljubljana, Faculty of Biotechnology, Department Wood Science and Technology, under the auspices of the international association WoodEMA. Due to the COVID-19 situation, the event was organised as a hybrid conference. It was a combination of a live event for those who could travel to Slovenia, and streamed lectures and online discussions that included those who could not travel. The conference was a resounding success. It brought together 22 researchers from six countries locally, and more than 130 international experts and scientists from 14 countries who followed the conference online.

The main topics of the conference were production management, production and business management, digitalisation of the economy, marketing, human resource management, quality assurance and quality management, the circular economy, eco-innovation, renewable energy from wood biomass, properties of wood and wood-based materials, wood modifications, wood processing technology, wood products, furniture and interior design.

These conference proceedings are the permanent record of what was presented. They show the state of development at the time of writing of all aspects of many important topics and for this reason will be invaluable to all experts, scientists and workers in the wood industry.

It is appropriate that we record our thanks to all the authors without whose professional contribution there would have been no conference. Last but not least, we are grateful for the tremendous support of the international association WoodEMA, which has been with us every step of the way to our success.

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CIRCULAR ECONOMY CONCEPT AS A RESPONSE TO CONTEMPORARY GLOBAL CHALLENGES

Rossitsa Chobanova

Abstract: The paper provides some arguments for understanding circular economy as a concept, responding to contemporary global challenges, resulting from the climate change and intensive usage of resources in limited quantities. It has considered the forestry sector, where the most of solutions could be developed. The theoretical and methodological background for the study is the Hegelian doctrine for economic and social development. Applying this doctrine circular economy is understood as a new stage of economic development with a different goal, subject and mean for achieving the goal comparatively to the free market economy one. The content of the goal of circular economy development is transforming, addressing not only resource productivity and efficiency, but also waste minimization, and many other areas of circularity. The analyses have shown market forces are limited and not strong enough to achieve the new goal of economic development, reflecting the needs of society, vital for its future. It was shown the new instruments include state regulation and respective monitoring, analyzing and drawing conclusions and recommendation, using new indicators, developed for monitoring economic processes and for new economic policies concerning achievement of the new goals of society. The above notion is argumented on the case of the good practice of Europe. Evidence and content of a new policy for a new stage of economic development focused on circularity on European level has been provided, first achievements are registered.
Keywords: circular economy, concept, stage, economic development

1. INTRODUCTION

The contemporary global challenges have placed new emphasis on the discussion around understanding the concept of circular economy. They have concerned issues like global warming, limited resources of vital importance – clean water, soil, air, etc. requiring among others, forest based sector response.

The importance of developing such new emphasis is argumented by the outcomes of research for the most respectable international organizations. According to them by 2050, the world will be consuming as if there were three planets (OECD, 2018). Global consumption of materials such as biomass, fossil fuels, metals and minerals is expected to double in the next forty years (OECD, 2018). On other hand annual waste generation is projected to increase by 70% by 2050, (World Bank, 2018). Several global initiatives have taken place to meet those challenges. To deal with Goal n.12 of the 2030 Agenda for Sustainable Development aims to ensure sustainable consumption and production patterns. Paragraph 28 of the 2030 Agenda reads: “We (Countries) commit to making fundamental changes in the way that our societies produce and consume goods and services. Governments, international organizations, the business sector and other non-state actors and individuals must contribute to changing unsustainable consumption and production patterns, including through the mobilization, from all sources, of financial and technical assistance to strengthen developing countries' scientific, technological and innovative capacities to move towards more sustainable patterns of consumption and production. We encourage the implementation of the 10-Year Framework of Programmes on Sustainable Consumption and Production. All countries take action, with developed countries taking the lead, taking into account the development and capabilities of developing countries". As defined by the Oslo Symposium in 1994, sustainable consumption and production (SCP) is about "the use of services and related products, which respond to basic needs and bring a better quality of life while minimizing the use of natural resources and toxic materials as well as the emissions of waste and pollutants over the life cycle of the service or product so as not to jeopardize the needs of further generations". The Johannesburg Plan of Implementation also called for all countries to promote sustainable consumption and production patterns, with the developed countries taking the lead and with all countries benefiting from the process, taking into account the Rio principles, including, inter alia, the principle of common but differentiated responsibilities as set out in Principle 7 of the Rio Declaration on Environment and Development. Furthermore, the Plan called in its Chapter 3 "Changing unsustainable patterns of consumption and production" for governments, relevant international organizations, the private sector and all major groups to play an active role in changing unsustainable consumption and production patterns and more specifically, through its Paragraph 15, to "Encourage and promote the development of a 10-year framework of programmes (10YFP) in support of regional and national initiatives to accelerate the shift towards sustainable consumption and production to promote social and economic development within the carrying out capacity of ecosystems".

2. METHODOLOGICAL ASPECTS

Responding to contemporary challenges the circular economy concept emerges as an alternative to the linear free market economy, in which secondary resources are rarely used. Even more: "The transition to a circular economy is not limited to adjustments aimed at reducing the negative effects of the linear economy. Rather, it is a systemic change that builds long-term sustainability, generates business and economic opportunities, and delivers environmental and societal benefits" (EMF, 2013). The basic concept for the development of the circular economy refers to the system of production and consumption, which relies on recycling, reuse, repair, processing, product sharing, changing consumption patterns and new business models and systems. There are many concepts of circular economy and of solving the problems of development, which are widely reflected in the academic literature, including modern academic reviews, official documents of the European Commission (see EC, 2018), OECD, G-7, etc., as well as the work of non-profit and non-governmental organizations, primary among which is the Ellen MacArthur Foundation.

The development of society faces new challenges, the overcoming of which is of vital importance, and their solution becomes more important than increasing profits. These challenges before society are accompanying by transition to a new stage of economic development. This transition is justified by the inability of the goals set within the old stage to be achieved by applying the relevant tools, I.e., it is necessary to change the paradigm for economic development due to the discrepancy between the set goals and the achieved results of the implemented policy (Chobanova, 2020a). Applying Hegel's doctrine, economic development we define as a process of continuous change, the quantitative accumulation of which leads to qualitatively new characteristics of the goal, subject and means to achieve the goals associated with the emergence of new "stages" of this development. Regarding mechanisms for overcoming the negative consequences of the market on the development of man (his freedom and community identity) and society (its integrity), discussed by Hegel it could be assumed they are analogous to the impact of the consequences of the global warming, the lack of vital resources and the generation of social tensions. In terms of solutions to these social problems, the economy, if left to function only through its inherent market mechanism, is blind to the needs of the social community, according to Hegel. Logically, the need arises to determine the current state and development of the national economy. From the point of view of the abovementioned interpretation of development, today there is a transition from the stage of economic development the aim of which is to increase the profit at the enterprise level and the GDP at the national/macro level to a new one, defined by circularity of economic resources. The transition from market linear to circular economy is accompanied by a changing the means or mechanism for achieving the goal - free market - and the main subject, implementing policy for the development - the entrepreneur or, the business sector in general. The core of the new subject is the EC, and of the new mechanism is the EU policy towards circular economy development (Chobanova, 2021).

3. EU POLICY FOR CIRCULAR ECONOMY DEVELOPMENT

The transition to a more circular economy in Europe has been accompanied by the implementation of several specific policy measures. In 2015, the EC adopted the first action plan to accelerate Europe's transition to a circular economy (EC,2015). It is aimed at strengthening global competitiveness, promoting sustainable economic growth and creating new jobs. This action plan contains 54 measures for "closing the chain" of the product life cycle – from production and consumption to waste management and the market for secondary raw materials. Five priority sectors have been identified to accelerate the transition along the value chain: plastics, food waste, critical raw materials, construction and demolition, biomass and bio-based materials. The strategic documents of today's EU institutions include: a clear program for efficient use of resources; a roadmap to Europe with an efficient use of resources; the package for circular economy; changes in renewable energy policy aimed at addressing resource issues. In March 2020, the European Commission adopted new plan focused on the design and production of a circular economy, ensuring that the resources used remain in the EU economy for as long as possible. The plan aims to reduce residual consumption in the EU, double the percentage of circular use of materials and contribute to economic decarbonization by reducing carbon and material waste in the EU (EC, 2020b. The transition to a circular economy is also on the agenda of world forums. This was the focus of discussions during the 2019 Annual Meeting in Davos. The four key priorities that emerge for the coming year are the following:

- Leadership is crucial; consumption and production to promote social and economic development within the carrying capacity of ecosystems]
- Use the potential of the Fourth Industrial Revolution;
- Supply and value supply chains;
- Cooperation is key.

The problems of digitalization and circularity in development will be at the center of discussions at the forum in 2021. The implementation of the developed visions, strategies and relevant policy measures requires the development of appropriate tools. In the first place, they concern the definition of appropriate indicators.

4. MONITORING OF CIRCULAR ECONOMY IN EUROPE

The monitoring of the development of the circular economy in the European Union is based on the identification of the main areas of manifestation of the circularity of the use of resources and on the determination of available indicators for its measurement. This approach enabled evaluation process of monitoring, developing a strategy and implementing policies. The following areas have been identified as areas of economic and social development that are characterized by circularity: sustainable resource management, social behavior and business operations. The content of the indicators and the interpretation of their contribution to the understanding of the circular economy are grouped according to the areas of occurrence of circularity, as follows (European Commission, 2018):

- Sustainable resource management – indicators that examine the performance of the EU Member States in transforming their economies into a circularity by reducing the demand for resources, thus increasing resource security and reducing environmental pressures at home and abroad.
- Social behavior – indicators reflecting the awareness, commitment and participation of citizens in the circular economy. Citizen engagement, behavior change and social norms are an integral part of the success of the circular economy development. This means that people are involved in new forms of consumption (e.g., sharing, product service systems, willingness to pay more for sustainability), re-use (requires a change in attitudes towards repair and renovation), disposal (separation of waste streams) and delivery of “waste” to recycling/sorting sites).
- Business operations – indicators that depict eco-innovation activities to change and adapt business models according to the principles of the circular economy. Business activities and their digitalization are the engine of the circular economic transition. They promote circularity throughout the life cycle of the use of materials, starting with how and what materials are delivered (quality, environment and health standards). The design stage of business operations is especially important for the possibility of reuse/re-production/recycling and increase the durability of goods for longer retention in the economy. Recycling is a key

business operation that is crucial to increasing the circular economy. The monitoring and evaluation of circularity have become the basis for the development of the vast majority of economic development policy measures.

5. CIRCULARITY INDICATORS

From the point of view of the circularity of resources as an indicator of economic development, an economy is more developed and becomes more efficient when it reduces the absolute level of resources it consumes to produce a unit of production, or when it increases the production produced per unit of resources, consumed by it. Resource efficiency is usually measured by the "resource productivity indicator" – the leading indicator of the Resource Efficiency Index, which shows the use of material resources in terms of economic growth. Resource productivity is defined as the ratio of gross domestic product (GDP) to the domestic consumption of materials, which measures the total amount of materials that are directly used by an economy. It is measured in EUR per kilogram. If the GDP grows faster than the material consumption, resource productivity improves and the dependence of economic activity on material consumption weakens. In other words, the economy is able to produce more without a proportional increase in resource consumption. It is also known as the "relative weakening of dependence". The endorsement of resource efficiency is one of the European Commission's flagship initiatives in the framework of the Europe 2020 strategy. It is measured by the Resource Efficiency Index, a set of indicators regularly published by Eurostat since December 2013. The index includes a leading indicator – resource productivity, an indicative table of indicators covering water, land, materials and carbon, as well as thematic indicators assessing priority policy areas. The Circular Economy Monitoring Framework established by the European Commission covers four areas of circular economy development and their respective indicators (European Commission, 2018):

1. Production and consumption. This area includes four indicators:
    - Self-sufficiency of raw materials for production in the EU;
    - Green public procurement (as an indicator of aspects of funding);
    - Waste generation (as an indicator of aspects of consumption);
    - Food waste.
2. Waste Management. This area includes two indicators:
    - Percentage of recycling (the share of waste that is recycled);
    - Specific waste streams (packaging waste, bio-waste, e-waste, etc.).
3. Scrap. This area includes two indicators:
    - Contribution of recycled materials to the demand for raw materials;
    - Trade in recyclable raw materials between EU Member States and the rest of the world.

The relative decoupling occurs when the growth rate of resource use is lower than the growth and economic growth, so that resource productivity increases. The absolute reduction in resource consumption is a consequence of the weakening of dependence when the growth rate of resource productivity exceeds the growth rate of the economy

4. Competitiveness and innovation. This area includes two indicators:
   - Private investment, jobs and gross value added;
   - Patents related to recycling and secondary raw materials as an example of innovation.

   The logic and structure of the monitoring framework broadly follows the logic and structure of the European Circular Economy Action Plan.

6. ASSESSING THE CIRCULAR NATURE OF EUROPEAN ECONOMIC DEVELOPMENT

Analyses of the data for the ten indicators of the monitoring framework provide a broad picture of the increasing circular nature of the EU economy (see European Commission, 2018). The areas of European economic development where circularity is important can be characterized, as follows: Production and consumption: progress towards more circular trends in production and consumption can be observed, e.g., regarding waste generation; significant room for reducing the efficiency gap between Member States and different materials.

The EU is largely self-sufficient for most non-metallic minerals such as building materials and industrial minerals; for EU critical raw materials (European Commission, 2015), the EU relies heavily on imports, which emphasizes the need for secure access and diversification of supplies. The generation of household waste in the EU per capita fell by 8% between 2006 and 2016 to an average of 480 kg per capita per year; there are large differences between Member States (between 250 and 750 kg per capita per year) and the generation of household waste is still increasing in several Member States.

The trend outlined in the data on total waste generation (including industrial and commercial waste but excluding large mineral waste) per unit of GDP is positive, showing a decrease of 11% compared to 2006. According to preliminary estimates by Eurostat, food waste in the EU decreased from 81 to 76 million tons (i.e., by about 7%) between 2012 and 2014, which is equivalent to a decrease from 161 to 149 kg per capita. In terms of waste management: between 2008 and 2016, the EU rates for recycling municipal waste increased from 37% to 46%. Five Member States recycle more than half of their municipal waste, while some countries are approaching the2030 recycling target of 65% proposed by the Commission (European Commission, 2015), however, five Member States are still below 25%.

The concept of the circular economy marks the features of a new stage of economic development, where the aim is to meet the challenges of tensions in a globalized world, which are strongly related to resources in limited quantities. The content of the goal is a transformation aimed not only at productivity and resource efficiency, but also at minimizing waste and many other areas of the cycle. Analyses show that market forces do not have enough potential to deal with these important issues, which are vital for its future.

7. CONCLUSION

The circular economy concept is characterizing the response to contemporary global challenges. It is associated with a process of transition to a new stage of economic development. The introduction of an improved understanding of the content of the concepts of "economic development" and "stage of economic development" are an important step towards a better monitoring and predicting new processes in the real economy, and better defining respective policies for economic development. A stage of economic development is defined as a period of time with approximately constant aim, subject and means for achieving the aims. Transition to a stage is a period of accelerating changes of aims, subjects and means. It is characterised by rethinking goals and strategies, by developing alliances for cooperation, following common goals and values.

The Hegelian doctrine provides instrumentation to characterize the circular economy as a new stage of social and economic development. The content of the goal of circular economy development is transforming, addressing not only resource productivity and efficiency, but also waste minimization, and many other areas of circularity. The analyses have shown market forces are limited and not strong enough to achieve the new goal of economic development, reflecting the needs of society, vital for its future. The new instruments include state regulation and respective monitoring, analyzing and drawing conclusions and recommendation, using new indicators, developed for monitoring economic processes and for new economic policies concerning achievement of the new goals of society.

The introduction of the concept of circular economy is associated with a transition to a new stage of economic development accompanied by a change in the purpose of economic development - from maximizing the profits of companies and maximizing the GDP growth at the national level free in market economy to a cost/waste-free and secondary use of resources, especially those whose depletion threatens the lives of humanity, such as limited amounts of water, soil, air and water. I.e., moving towards a circular economic development goal aimed at creating ecosystems that overcome the causes of new global social tensions. Focusing on forestry based sector provides great opportunities in this respect. The concept of circular economy development as a response to contemporary challenges also includes changes of subjects and mechanisms used for achieving of new goal of development. On the level of the European union the European union plays the role of the new subject, and its policy is the main mechanism used for developing circular economy.

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SELECTED MODERN MANAGEMENT TRENDS AND THEIR APPLICATION BY COMPANIES IN THE WOOD PROCESSING INDUSTRY IN SLOVAKIA

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Abstract: The rapid pace of development of the world economy, as well as the changing turbulent environment in which companies operate, are forcing them to adapt to the conditions of global competition and to find ways to succeed in the market. The survival of companies in the market and their prosperity are conditioned by the progressive tendency of the development of modern tools applied in a highly competitive environment. Individual management methods and tools can be applied at different levels of management and in different areas. Increasing demands are placed on the management of organizations in the wood processing industry, which results in the emergence of new management trends. The main aim of the paper is, based on the analysis of theoretical knowledge, to identify modern trends, methods, and tools in management of the wood processing industry reflecting current changes and challenges in the environment, and to find out their application by Slovak wood processing companies.
Keywords: management trends, management tools, wood processing industry in Slovakia

1. INTRODUCTION

The lack of sophisticated approaches to information retrieval and analysis, as well as the entire management process, puts many companies at a disadvantage.The area of management represents a rapidly developing sphere. Currently, Industry 4.0 dominates the world. It brings not only revolutionary changes in production and logistics, but fundamentally changes the society itself and the economy of the country (Richnák, 2019). Richnák (2020a) talks about logistics technologies, which in today's revolutionary conditions are a prerequisite for effective results in business management in the form of economy and efficiency. Their use and continuous improvement must be one of the essential activities of business management. Richnák (2020b) notes that significant changes and advances have occurred during the ongoing Fourth Industrial Revolution. Based on these facts, trends in logistics have emerged and are constantly evolving. Applying modern management trends that can help a company navigate the current turbulent environment by managing change, simplifying excessive complexity, taking full advantage of the opportunities of globalization and technological advancement, processing large amounts of data, and utilizing the potential of employees and customers can contribute to this, or monitor performance indicators in the company.

It can be said that the change in the economic and business environment has greatly affected the penetration of new trends into management practice, also in the wood processing industry. Whereas in the past, modern management methods and tools were applied only by large innovative companies, especially with foreign capital, today many of them are becoming an essential part of the work of managers in all types of organizations. The penetration of new trends and their application by companies reflects current changes and challenges in the environment.

2. SELECTED MODERN MANAGEMENT TRENDS

Based on the analysis of theoretical knowledge, it was identified a few modern trends, methods, and tools in management reflecting current changes and challenges in the environment. The balanced scorecard (BSC) is an adequate tool to select a balanced set of indicators and objectives that reflect the strategic vision of the organization (Quesado et al., 2018). Benchmarking is defined as the process of measuring products, services, and processes against those of organizations known to be leaders in one or more aspects of their operations. Big data analytics (BDA) is increasingly becoming a trending practice that generates an enormous amount of data and provides a new opportunity that is helpful in relevant decision making (Saggi et al., 2018). Management tools are first and foremost perceived as reducers of organizational complexity. Regarding to customer relationship management, while the traditional CRM, implemented through computerized software and database systems, is commonly adopted by large corporations, there is evidence that social media have also become an emerging trend in facilitating the implementation of CRM activities by small companies (Charoensukmongkol, 2017). Digital transformation represents a process where digital technologies create disruptions triggering strategic responses from organizations (Vial, 2019). Evidence and arguments have been presented promoting employee engagement surveys as a key source of competitive advantage and financial profitability (Albrecht et al., 2018). Change management is a structured approach to implementing change in an organization. Customer satisfaction and loyalty has also been considered by many firms to be a powerful intangible asset for competitive advantage in the global arena (Asadpoor et al., 2017). Strategic planning is the management process used to create a long-range plan of how to achieve an ideal end-state or a set of goals. Talent management means identification of key positions which have the potential to differentially impact on sustainable competitive advantage (Whissal et al., 2019). Organizational time management requires managers to set time priorities by considering both the urgency and the importance of all tasks.

3. RESEARCH FINDINGS AND DISCUSSION

The object of research was formed by a sufficiently large and representative sample of companies (N=32) operating in wood processing industry in the territory of the Slovak Republic. The respondents, due to the focus of the research, were mainly company executives, directors, and managers at least middle management.

Tab. 1 shows a summary of selected researched modern management trends and evaluation of knowledge these methods and tools, as well as the extent of their usage by companies. The results are presented for the sample of companies in the wood processing industry operating in Slovakia, regardless of their classification characteristics.

Table 1. Usage of modern management trends (%)

Method	Unknown	Known, but not used	Used
Balanced Scorecard	31	28	41
Benchmarking	3	25	72
Big Data Analytics	38	25	37
Complexity Reduction	59	22	19
Customer Relationship Management	25	12	63

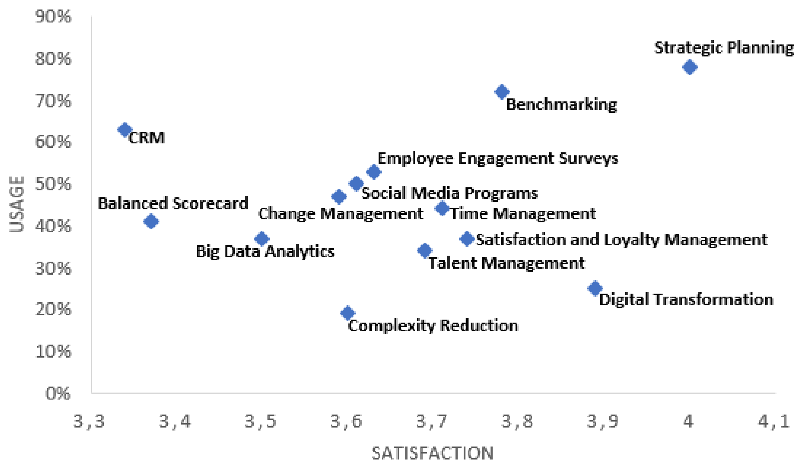
Digital Transformation	56	19	25
Employee Engagement Surveys	19	28	53
Change Management	31	22	47
Satisfaction and Loyalty Management	22	41	37
Social Media Programs	16	34	50
Strategic Planning	6	16	78
Talent Management	28	38	34
Time Management	6	50	44

Source : own processing

According to the Tab. 1 we can state that respondents from the sample representing companies in the wood processing industry make the greatest use of the strategic planning, up to 78% of them. Only 6% of respondents do not know this method. Only slightly fewer companies (72%) use benchmarking, while 3% of companies do not know this method. The third most widely used management tool is CRM, which is used by 63% of companies. The least used methods in companies were complexity reduction (19%) and digital transformation (25%), which are used by less than a third of companies.

We also researched the satisfaction of respondents with selected modern management methods . Only respondents who used the tool answered the question about the satisfaction assessment. Satisfaction was rated on a scale of 1 to 5, with a value of 5 meaning that they were very satisfied with the tool and a value of 1 indicating that they were very dissatisfied. In general (according to Fig. 1), it can be stated that the respondents were satisfied with the tools used, as the average satisfaction rates were above the level of 3 points (when the respondent was neither satisfied nor dissatisfied) upwards. Respondents were the most satisfied with strategic planning method, which rated an average of 4.00 points and was the most widely used. Digital transformation was evaluated with an average of 3.89 points and the usage rate was the second lowest. The CRM method was the third most used and the rate of satisfaction was the lowest (3,34 points).

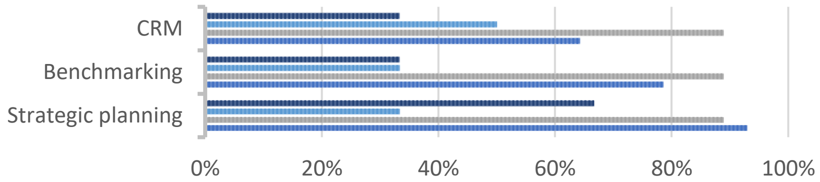
Figure 1. Modern management trends- usage and satisfaction



Source : own processing

In the next part, there are provided the results of applying the three most used methods regarding the classification characteristics. Categorization of companies was realized based on the number of employees for large (above 250 employees), medium (above 50, up to 250 employees), small (above 10, up to 50 employees) and micro (up to 10 employees).

Figure 2. Modern management trends used by different sized enterprises

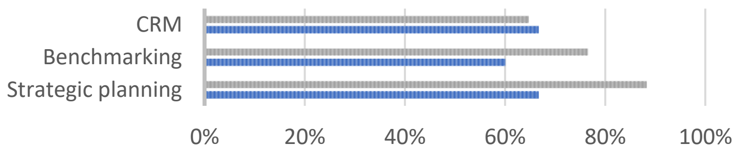


	Strategic planning	Benchmarking	CRM
Micro	67%	33%	33%
Small	33%	33%	50%
Medium	89%	89%	89%
Large	93%	79%	64%

Source : own processing

We can notice a higher rate of usage of all three methods by large and medium-sized enterprises. The strategic planning method was applied by more than half (67%) of micro-enterprises as well. In the next criteria, we researched the identification with selected management trends according to the presence of foreign capital in the ownership structure of companies.

Figure 3. Modern management trends used by different capital structured enterprises

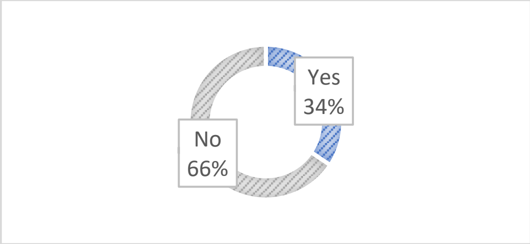


	Strategic planning	Benchmarking	CRM
Foreign	88%	76%	65%
Slovak	67%	60%	67%

Source : own processing

The results (Fig. 3) show a higher rate of usage strategic planning method and benchmarking in foreign companies and a comparable rate of usage (higher in favor of Slovak companies) in the CRM method. We also researched from the respondents, in case they know some of the above methods but do not use them, whether they are considering future usage of these methods in their management practice in the next five years. The results are shown in the Fig. 4.

Figure 4. Modern management trends- usage in the future



Source : own processing

Regarding to this research question, only 34% of the entire sample of companies said they were considering it. The remaining 66% of companies are not even considering the application of modern management methods, that they have not yet used, in the next five years.

4. CONCLUSION

In today's world of globalization and rapid technological development, the rule is that if a company wants to be successful, it must seize every opportunity, whether in the form of an enticing opportunity or a risk. The next step may be to find out about new management trends and their subsequent implementation in various areas of the company. These trends are helpful in improving the operation of the company from operations to processes related to production or transactions. External factors influencing the company literally force managers to think about whether the processes in the companies are still effective after such a long time. Ongoing new industrial revolution is bringing changes and development of progressive technologies also in logistics. Their use and continuous improvement must be an essential activity in business management (Richnák, 2021).

Thanks to the introduction of modern management trends, every company can already improve its operation in all directions, because these trends can be applied to various areas and functions of management, according to their needs. Managers who have contained a sufficient amount of necessary information are able to choose from a large number of methods and tools the "right" one, most suitable for their future growth.

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INCREASING BUSINESS EXCELLENCE THROUGH THE IMPLEMENTATION OF EFFECTIVE QUALITY MANAGEMENT SYSTEMS IN THE CONDITIONS OF THE WOOD PROCESSING INDUSTRY IN SLOVAKIA

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Abstract: The article deals with the conditions of implementation of quality management systems in the conditions of companies in the wood processing industry in Slovakia. It presents the results of several researches that were carried out during the years 2015 - 2020, which identify the conditions in which quality management systems in Slovakia arise, characterize the most common causes, reasons and problems in their successful implementation and also want to point out that building of quality management systems can have a positive impact on the continuous improvement of quality parameters, reducing unproductive costs, increasing customer satisfaction and thus on the overall performance of companies in the wood processing industry in Slovakia.

Keywords: quality, quality management system, wood processing industry, performance

1. INTRODUCTION

The current period of economic development together with the market economic environment are characterized on a global scale by high pressure on organizations from customers and society itself, whose ever-increasing demands and requirements encourage organizations to achieve ever greater effects of business activity by finding new sources of self-empowerment market position. In order for organizations to be able to satisfy the general and specific needs of their customers in this connection, they must constantly increase the level of quality of their own products and services, also because quality is a decisive factor in stable economic growth in the future. Quality management and its activities performed within the company serve to fulfill the set goal, which significantly affect the overall success of business activities, the required return on investment and evaluate the economic effects associated with quality through costs and benefits that the quality assurance process itself brings. The aim of the paper is to present the research results, in which was investigated the extent of utilization of quality management systems for quality improvement in wood processing enterprises (WPI) in Slovakia.

2. MATERIAL AND METHODS

Quality management system an assist organizations in enhancing customer satisfaction. Customers require products with characteristics that satisfy their needs and expectations. These needs and expectations are expressed in product specification and collectively referred to as customer requirements. The quality management system approach encourages organizations to analyse customer requirements, define the processes that contribute to the achievement of product which is acceptable to the customer, and keep these processes under control.

The adoption of a quality management system should be a strategic decision of an organization. The design and implementation of an organizations quality management system influenced by:

- Its organizational environment, changes in that environment and the risks associated with that environment,
- Its varying needs,
- Its particular objectives,
- The products it provides,
- The processes it employs,
- Its size and organizational structure.

ISO 9000 specifies requirements for a quality management system where an organization:

Needs to demonstrate its ability to consistently provide product that meets customer and applicable statutory and regulatory requirements,

Aims to enhance customer satisfaction through the effective application of the system including processes for continual improvement of the system and assurance of conformity to customer and applicable statutory and regulatory requirement. (Gejdoš, 2011)

Results of many studies (Brun 2010; Talib 2013; Nguyen *et al*. 2018; Alharbi *et al*. 2017; Rebelo *et al*. 2016)Total Quality management TQM characterized as a strategy that aims to generate and transfer more efficient and superior services, through achieving cooperation between organisational members achieve a comprehensive integration among organisational staff and their functions in order to gain better enhancement, progress and preservation of products and services quality to achieve customer satisfaction, applying various TQM practices such as training, process management, customer management, etc. influence employees that performance which then directly affect the whole organisation performance, especially in their financial performance.

3. RESULTS AND DISCUSION

The data were obtained through an on - line research questionnaire. The first database of enterprises was the data of the Statistical Office of the Slovak Republic, which was subsequently verified by Internet databases. The questionnaire was filled more than 1000 enterprises (324 wood processing enterprises) that have been researched, and despite the relatively low return of filled - in questionnaires stemming from unseen causes, we can say that a survey sample of enterprises is relevant, has sufficient denunciation, which is also verified by selected mathematical and statistical methods.

From the Figure 1 methods, tools and concepts used to improve quality into wood processing industry (WPI) in Slovak republic, the highest percentages received in the evaluation the answer that enterprises do not use any of the methods and concepts. These percentages reached 46%, 7 basic quality tools use 24% of enterprises and Process management use 17%.

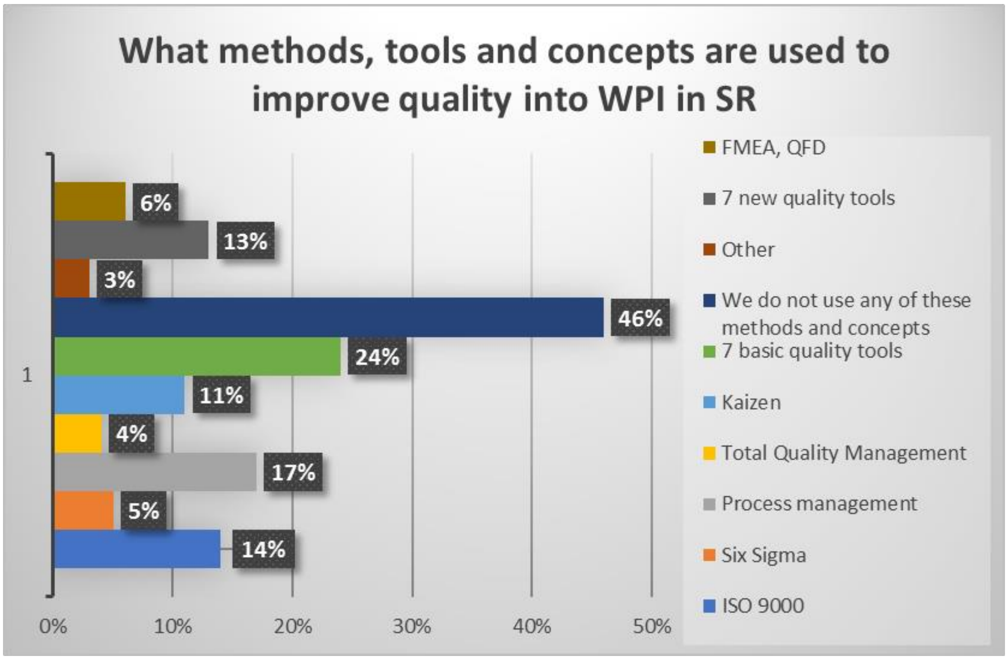

Figure 1. Methods, tools and concepts used to improve quality into wood processing enterprises in the Slovak Republic

As can be seen from Figure 2, the most preferred reason for the implementation of quality management systems was Improving product quality, second Increase customer satisfaction and third Customers requirement as a guarantee of quality.

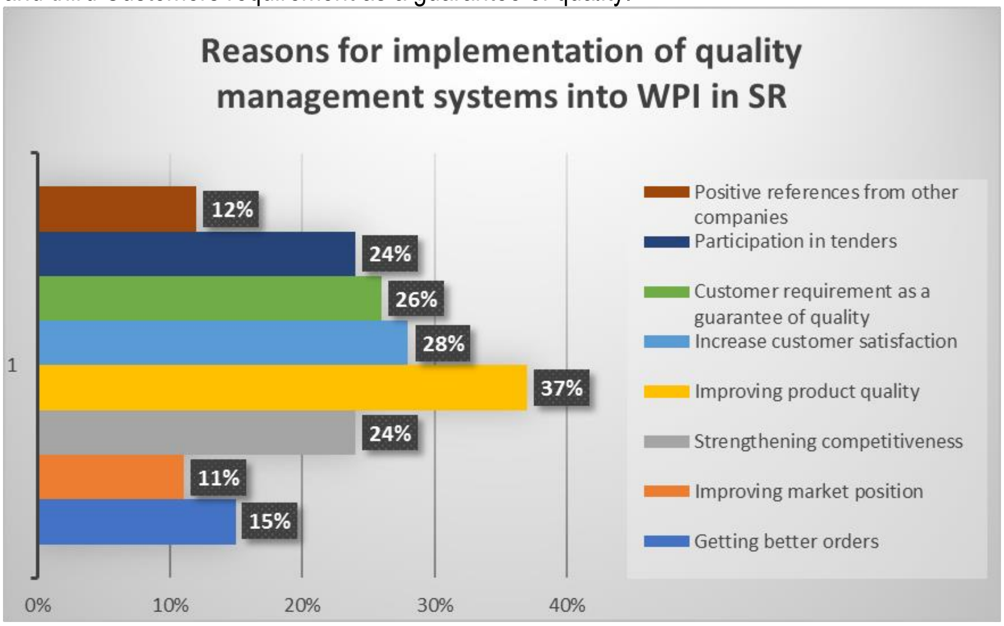

Figure 2. Reasons for implementation of quality management systems into wood processing enterprises in the Slovak Republic

Figure 3 shows benefits from the implementation of quality management systems into WPI in SR. The most responses were that companies do not identify any benefits, it stated up to 35% of responses, followed Costs reduction, Increase customer satisfaction, Improving economic performance and Increase productivity and process efficiency which were in the range of 18-23%

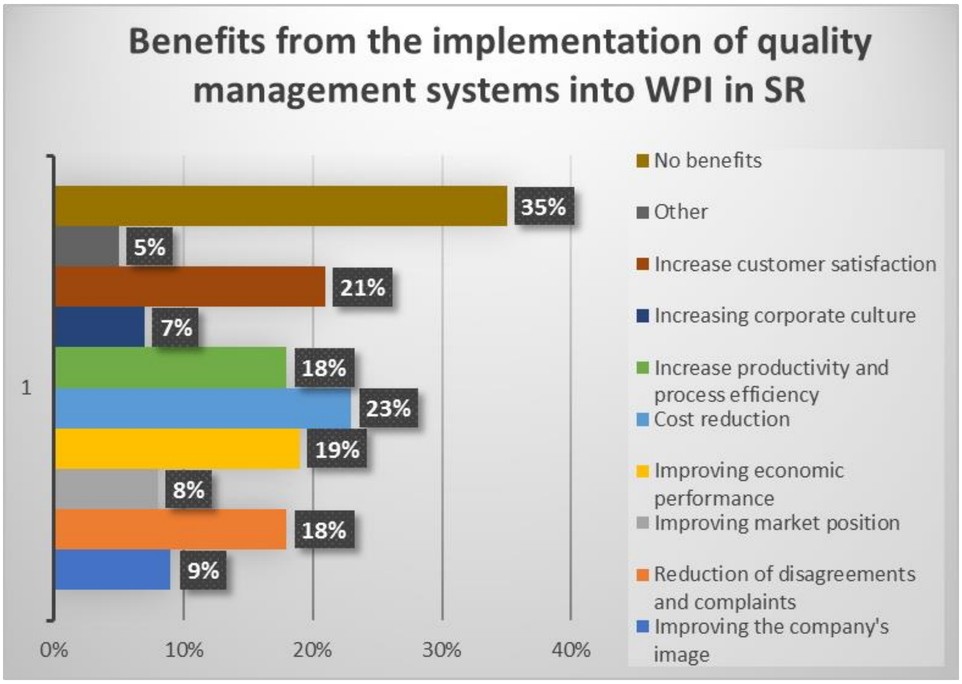

Figure 3. Benefits for implementation of quality management systems into wood processing enterprises in the Slovak Republic

The next part of the article presents the results of correlation analysis. According to the results of correlation analysis, where the value of the correlation coefficient reached 0.583, there is a statistically significant correlation relationship between the DSP industry in Slovakia and the implementation of QMS. This fact has further examined using one-way analysis of variance and we came to the conclusion that timber industry enterprises is largely not implemented QMS, for the furniture industry enterprises, the situation is slightly better, where either have implemented QMS, or can be implemented in accordance with ISO 9000. In the pulp - paper industry, the situation is best which is documented by Figure 4, with 0 on the x axis represents the Wood industry, 1 - Furniture industry and 2- Pulp - paper industry.

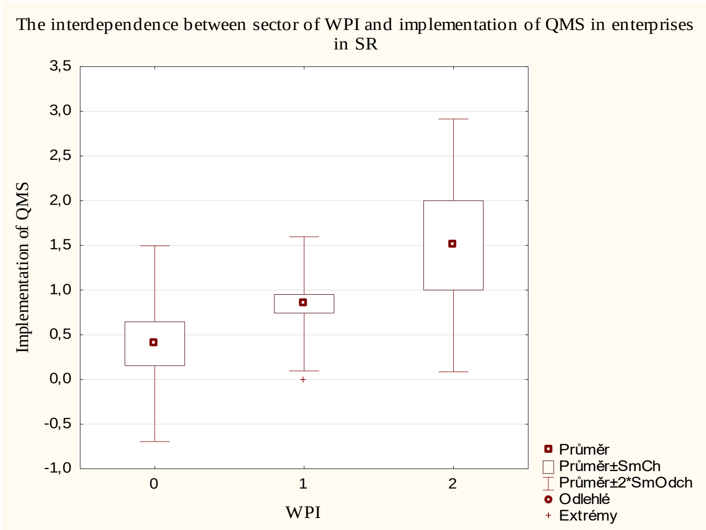

Figure 4. The interdependence between sector of WPI and implementation of QMS in enterprises in SR

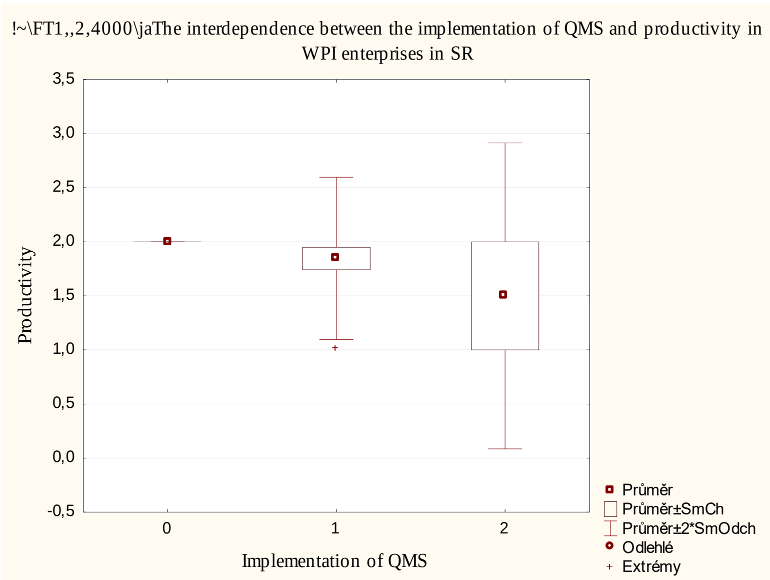

Figure 5. The interdependence between the implementation of QMS and productivity in WPI enterprises in SR

Figure 5 presents a statistically significant correlation relationship between the implementation of the QMS and the benefits for businesses in the form of an increase in labor productivity, with 0 on the x-axis means that enterprises fail to implement a QMS, 1 - implemented QMS according to ISO 9001 and 2 - have implemented QMS according to another standard. Correlation coefficient stood at 0.539 Thus, we can conclude that businesses in Slovakia have implemented QMS (either ISO or other standards) mainly indicated that they saw an increase of the indicator such as labor productivity.

4. CONCLUSION

Based on the research results, we can state that companies in the wood processing industry in Slovakia do not use methods and tools of quality management or it is limited to the use of only basic methods of quality management. This fact also affects the benefits that companies have identified by implementing quality management systems, where it can be seen that many companies could not identify any benefits. Nevertheless, companies in the wood processing industry in Slovakia are trying to implement quality management systems mainly in sectors with higher added value, such as the furniture and pulp and paper industry, where they are trying to increase the quality of their products, reduce unwanted costs and losses and increase customer satisfaction. The results show that companies that are dedicated to quality management achieve better economic results, because quality is the way to be successful.

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PRODUCTION MANAGEMENT MODEL IN SME's IN SOME SOUTH-CENTRAL EU COUNTRIES DURING PANDEMIC

Denis Jelačić, Darko Motik, Andreja Pirc Barčić, Leon Oblak, Petra Grošelj, Matej Jošt

Abstract: Small and medium enterprises play a key role in the economy of the European Union as the main generators of employment and economic development. According to the official statistics the EU, more than 98 % of all enterprises are small and medium. Similar situation is among wood processing and furniture manufacturing enterprises in Croatia and Slovenia, two south-central EU countries. In order to be successful, the enterprises have to harmonize various parameters through strategic planning, preparation, organization and decision making. Through the period of global pandemic of Covid-19, small and medium enterprises suffered the most. To be able to survive, they had to reconsider their view on the parameters of production management. This research was trying to establish the way of thinking among managers in SME's regarding production management parameters and to create the model for production management in small and medium wood processing and furniture manufacturing enterprises.
Keywords: small and medium enterprises, wood processing, furniture manufacturing, Covid-19 pandemic, production management model

1. INTRODUCTION

Small and medium enterprises (SMEs) play a key role in the economy of the European Union as the main generators of employment and economic development. They are a significant part of the economy and industrial system of every country. There were more than 25 million SMEs in EU-28 in 2018, which accounted for 99.8% of all enterprises in non-financial business sector. They were generating 56.4% of value added, and 66 % of jobs were generated by SMEs.

According to The Small Business Act of Europe (SBA) Fact Sheets and SMEs basic figures created by European Commission in 2019 for the year 2018, Croatia and Slovenia, have the similar numbers to EU average. In Croatia, 149.541 SMEs represent 99.7% of all enterprises. They employ 68.9% of all persons employed and generate 59.4% of value added. In Slovenia, 145.996 SMEs represent 99.8% of all enterprises. Slovenian SMEs employ 72.0% of all persons employed and they generate 64.5% of value added.

In Croatia and Slovenia both, most of the SMEs, especially those in wood processing and furniture manufacturing are situated in rural areas. Therefore, they play important role in social cohesion and development of rural areas in each country. Wood processing (C16) and furniture manufacturing (C31) companies in Croatia and Slovenia are highly export oriented, and the share of export of C16 is around 5% and the share of export of C31 is around 4.5% of all export of non-financial business sector. The percentage of SMEs' exports meet the above numbers that represent total Croatian industry.

Any kind of crisis could have a large impact on small and medium enterprises because of their size and structure. Especially if that crisis cause major problems within supply chain, such as Covid-19 pandemic caused by period of lockdowns on different levels for different countries.

The stability of supply chain is of great importance for SMEs, and micro and small enterprises are getting more vulnerable if it gets largely disturbed. Covid-19 pandemic and lockdowns caused a large disturbances on the market and that is one of the reasons for pushing a large number of SMEs into bankruptcy. Therefore, small and medium enterprises have to respond to the challenges that pandemic created on the market and modify their business models.

The aim of this research was to investigate the current situation in small and medium enterprises in wood processing and furniture manufacturing regarding driving parameters of business and production management system in the time of disturbed situation on the market caused by Covid-19 global pandemic.

2. RESEARCH METHOD

A survey was provided to the company managers of micro/small and medium enterprises in C16 and C31 in Croatia and Slovenia. The questionnaire in the survey consisted of five questions on company characteristics related to manufacturing program, size of the company, type of production and technology in the company, and management model. The main part of the questionnaire was a ranking of seven driving parameters of the business and production management system. The survey was conducted in late 2020 and early 2021.

In Croatia, the sampling frame were enterprises in C16 and C31 which email addresses were in public access databases. An emailed survey was the approach used in this study. Questionnaires were sent by email to 246 companies. 187 companies confirmed acceptance of the email. The total of 81 responses were received. The response rate was 43.3%.

In Slovenia, the survey was conducted via 1KA, an open-source online survey application. The sampling frame were enterprises in C16 and C31 with more than 5 employees, which email addresses are in public access databases. The survey link was sent to 621 companies and 131 completed the survey. The response rate was 21.1%.

Data were analyzed in SPSS Statistics 25.0. When *n* objects are ranked, the agreement and correlation among *m* sets of the ranking can be measured. Spearman's rank-order coefficient of correlation was used for two sets of ranking and the Kendall's coefficient of concordance W for more than two sets of ranking. Both coefficients can take values on the interval [0, 1], with no agreement at value 0 and perfect agreement among sets of ranks at value 1.

3. RESULTS OF THE RESEARCH

For the purposes of the investigation of the current situation and perception of the driving parameters of business and production management among the small and medium enterprises in in wood processing (C16) and furniture manufacturing (C31) in Croatia and Slovenia, a total of 867 questionnaires were sent to enterprises, of which 246 in Croatia and 621 in Slovenia. A total of 212 questionnaires were completed, of which 81 (38,2 %) in Croatia and 131 (61,8 %) in Slovenia, with the response rate of 43,3 % in Croatia and 21,1 % in Slovenia.

The first part of the questionnaire sent to companies consisted of questions giving the profile of the companies participated in the survey. In this part of the questionnaire were the questions about the production program, the size of the enterprise, type of the production process, production management model and type of the technology used in the production process. Results are presented in the Tables 1 and 2.

Table 1. Company profile – Production program

	CRO	SLO
Sawmill products	42%	18%
Materials for furniture manufacturing	22%	14%
Kitchen furniture	26%	43%
Living room furniture	27%	45%
Bedroom furniture	23%	44%
children room furniture	20%	42%
Upholstered furniture	4%	9%
Tables and chairs	11%	11%
Joinery - Windows	14%	8%
Joinery - Doors	22%	27%
Parquets and floors	17%	3%
Equipment for different spaces	28%	36%
Garden furniture	4%	9%
Machines and tools for wood processing	1%	1%
Transport equipment	9%	2%
Other	21%	27%

The second part of the questionnaire sent to companies consisted of the seven driving parameters of business and production management, which company owners or top managers should have ranked according to their perception of the importance of the each parameter. Parameters given in the survey were:

- LPOSC - Leadership, Policy, and Organizational Structure of the Company
- PCMPPD - Process Culture, Management Processes, and Production Deadlines
- RPQP - Range of Products and Quality of Products
- MMAC - Marketing and Market Activities of the Company
- HR - Human Resources
- ITMPT - Information Technology and Modern Production Technology
- EFP - Environmentally friendly production

The results of the survey are presented as average ranks of the driving parameters in Table 3.

As shown in the table 3, company managers ranked RPQP as the most important driving parameter for business and production management, followed by PCMPPD, LPOSC and HR.

Table 2. Ranking of driving parameters of business and production management system by mean ranks from survey

	LPOSC	PCMPPD	RPQP	MMAC	HR	ITMPT	EFP
Mean rank	3.7	3.4	2.3	4.7	4.0	4.5	5.5
Ranks	3	2	1	6	4	5	7

Table 3. Company profiles – size of the enterprise, type of production process, production management model, type of technology used in the production process

	CRO	SLO	all		CRO	SLO	all
Response share	38.2%	61.8%	100.0%	Mostly computer aided technology	23.5%	11.5%	16.0%
Less than 10 employees (micro)	29.6%	59.5%	48.1%	Mostly classic technology	22.2%	19.1%	20.3%
Less than 50 employees (small)	40.7%	32.1%	35.4%	Mostly hand tools and machines	9.9%	11.5%	10.8%
Less than 250 employees (medium)	29.6%	8.4%	16.5%	A combination of all of the above	44.4%	58.0%	52.8%
Individual production	35.8%	61.8%	51.9%	Work for a known customer	63.0%	74.8%	70.3%
Small series production	39.5%	27.5%	32.1%	Work for an unknown customer (showrooms and retail stores)	0.0%	1.5%	0.9%
Serial production	24.7%	10.7%	16.0%	A combination of work for a known and an unknown customer	37.0%	23.7%	28.8%

Spearman's rank-order coefficient confirms a significant strong positive correlation ($r_S(7)=0.883$, $p=0.008$) between the mean ranks of Croatian and Slovenian companies. Both Croatian and Slovenian companies evaluated RPQP as the most important driving parameter (Figure 1). However, its mean rank was lower in Slovenia (1.98) than in Croatia (2.75). In Croatia HR was the second most important driving parameter, while PCMPPD was second in Slovenia. Both countries assessed RPQP, LPPOSC, PCMPPD and HR as the four most important driving parameters.

Spearman's rank-order coefficient shows a fairly strong positive, though not significant, correlation ($r_S(7)=0.714$, $p=0.071$) between the mean ranks of micro and small companies and between small and medium companies ($r_S(7)=0.679$, $p=0.094$). The correlation between micro and medium companies is less strong ($r_S(7)=0.464$, $p=0.294$). Micro and small companies evaluated RPQP as the most important driving parameter (Figure 2) and HR as the second most important. On the other hand, medium companies highlighted LPOSC as the most important driving parameter, followed by PCMPPD and RPQP.

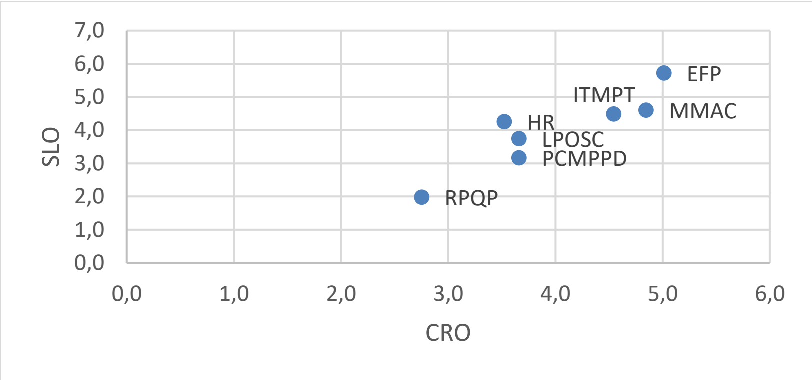

Figure 1: Average ranks for Croatia and Slovenia

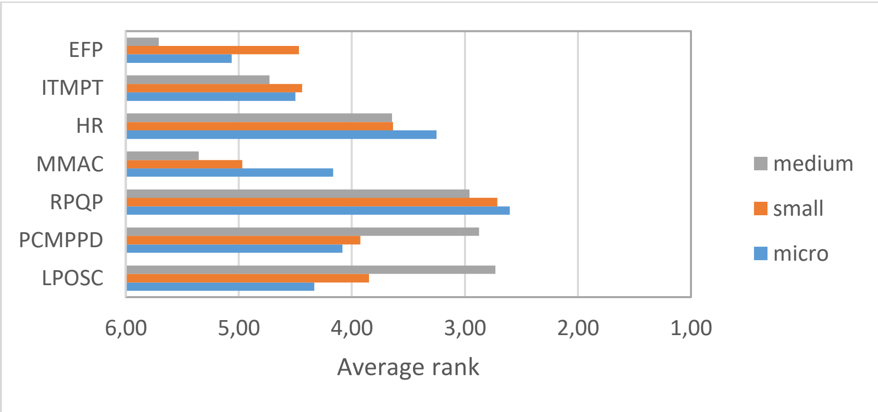

Figure 2: Average ranks regarding the size of the companies

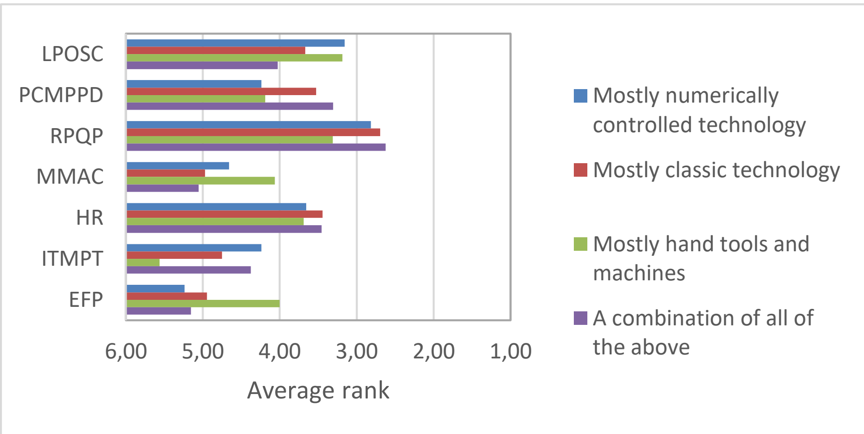

Figure 3: Average ranks regarding the type of the production technology

4. CONCLUSION

According to results of this research, it can be observed that entrepreneurs and managers in SMEs, because of the disturbances in supply chain caused by lockdowns mostly, but because of the other market conditions caused by the pandemic crisis, turn more to assets they have and to those which are reachable, so they turn to quality of the product and changes in the production program, to innovations in leadership and organizational structure of the company instead of modern production and information technology or human resources.

According to given situation with the Covid-19 global pandemic, and according to the results achieved with this research, the second aim was to create the applicable business and production management model for SMEs in C16 and C31 in Croatia and Slovenia. The aim was to create the organization model for small and medium enterprises which can help make decision process in a company easier, faster and which could meet the requirements of the turbulent and ever-changing market for wood products and furniture.

The model is flexible and if the company management makes a decision to go into the innovations in information technology or in human resources, it could bring particular group of parameters up front in the model and make the decision making process easier, faster and more effective.

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IMPORTANCE OF DIRECT MARKETING IN COMMUNICATION WITH CUSTOMERS IN SALES OF HOUSE FITTINGS DURING LOCKDOWN

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Abstract: Direct marketing, as the last tool of marketing communication, included among the traditional tools of marketing communication in the 1970s, is usually paid marginal attention in the theory and in practice. There can be several reasons for this situation, from the nature of the consumer and their needs, the business and its size, to the product and its strengths and weaknesses. During the so-called lockdown, however, its selected techniques gained a more prominent position, even if we do not count social media, they met not only communication, but also sales goals. Therefore, in the presented paper we focus on the extent of the use of direct marketing and the fulfilment of its targets (communication, sales, building relations with customers) in the time of the lockdown in the selling of furnishings. We concentrate on selected retail appliances stores in Slovakia, which operate both physical and online shops.

Keywords: communication, direct marketing, customer, furniture sales

1. INTRODUCTION

The issue of the pandemic caused by the coronavirus COVID-19 has received a great deal of attention since its dissemination from China to other countries of the world in 2020. As it has an impact on all areas of work and private lives, it has become the subject of research by many scientific, government and commercial institutions, and the survey has had a diverse focus, e.g., managing the transition of the education to the online space, the pitfalls of remote working, the availability of medical care, or the financial impact on households and businesses. Polls for the area of marketing have been concentrated, for example, on the change of the consumer behaviour, content and creative presentation of the message, modification in the structure of the communication mix, or reduction of expenses in marketing communication (Go4insight.com, 2021). Since we have been dealing with the so-called below-the-line marketing communication and its significance in interfacing with customers when selling house fittings during the lockdown.

The essence and substance of direct marketing in marketing communication. The definition of direct marketing and its inclusion in the marketing mix has changed over the decades due to the growing importance in practice and subsequent reflection in theory. While in the early 1960s direct marketing was understood as only one of the forms of distribution (retail sales outside stores), in the 1970s it was already explained as a tool of marketing communication with the emphasis on feedback and optimization of responses addressed to the target group (Pelsmacker et al., 2003). As the term mix emphasizes that none of the tools is used in isolation, but it is about their integration and coordination, direct marketing as an instrument of marketing communication strengthens the effect of other devices: advertising, sales promotion, public relations, and personal selling. We can explain marketing communication as a set of mechanisms and mix of techniques applied on the one hand to inform, acquaint with the products, explain their properties, highlight utility, quality, value, usefulness and use, and on the other hand to listen, receive suggestions and requirements of the consumers and respond to them (Kita et al., 2002). We can approach its division from several viewpoints, for instance, according to the environment in which it takes place, in relation to the form, or on the authority of the nature of the message to personal, non-personal, formal, informal, media, non-media, internal, external, above-the-line, below-the-line, and through-the-line (Matúš and Durkova, 2013). We relate the majority of direct marketing techniques with below-the-line communication, which, just like direct marketing, is characterized by more precise focusing on the target group. As with the definition of any other category of marketing, there are many explanations when trying to characterize direct marketing. Štarchoň et al. have identified their common features. The denotations of direct marketing emphasize the communication effect, the achievement of an unmediated relationship and a two-way communication with the target group (Štarchoň et al., 2004). The message that direct marketing delivers is usually private, often tailored to a specific person or a selected segment of the target group. Based on the addressability of individual direct marketing techniques, we distinguish between addressing procedures (direct mail, active telemarketing, catalogue sales, e-mailing, customer clubs) and non-addressed approaches (unaddressed shipments, passive telemarketing, direct response advertising, chat). The object of our further research are the techniques used for the so-called passive direct marketing, i.e., procedures for which the potential use is decided by prospective customers on their own voluntary discretion. The opposites are the methods of active direct marketing, where the need for deployment towards customers is decided by the company. Some direct passive marketing techniques, unaddressed shipment, passive telemarketing, e-mailing and chat, play a significant role in providing customer support, thus participate in the fulfilment of communication and sales goals, others, just like for example customer club, are focused on creating and maintaining relationships with consumers, or motivating them to make further purchases.

Slovaks and furnishings during the lockdown. Household appliances, in other words a summary of objects for the furnishing of rooms, complete the atmosphere of home, workplace, school or medial facility. In general, we divide it according to the following criteria: the material used, the place of utilization, the design, the surface treatment and the degree of the gloss. According to the type and purpose of application, we divide furniture into: cabinet, bed, table, seating and additional fitments (Kollárová and Ungerová, 2020). We focus our research on house fittings with respect to the place of use, e.g., residential, office, school, medical, restaurant, garden, etc. A survey by the European Statistical Office Eurostat shows that up to 9 out of 10 Slovaks live in their own apartment or family house, (Finreport.sk, 2021) which they usually furnish with fixtures during the first furnishing, minor renovations or life changes (especially children´s growth), emphasizing its modernity, functionality, quality and reasonable price. According to a survey by Ikea, Slovak customers of household furnishings only get rid of anything when it is old, damaged and shabby (63%), when they need a different size (19%), if it goes out of fashion (18%), in case they move to another apartment (13%), as long as it is not practical (12%) or they simply do not like it any longer (8%). Apart from the lockdown, 76 % of Slovaks buy house appliances directly in a furniture store and 18 % of them through an online shop (Zererová, 2021a). Slovak consumers had rather quickly realized that they needed to prepare for remote working and studying. Online stores have confirmed a huge increase in interest in office and school furniture (desks, bookcases, armchairs), as well as in the relevant black electronics (Okšová, 2021). Nevertheless, during the lockdown we could also identify a group of customers and corporate entities that needed home furnishings for their new buildings or renovated houses. While furniture retailers responded to the needs of this segment, a part of them approached carpentry workshops with their requests.

2. METHODOLOGY OF THE STUDY AND RESULTS OF THE ANALYZES

2.1. A case study investigating the most sucessful retail companies with furnitures in Slovakia

The subject of the research are retail companies with furniture in Slovakia, operating both physical and online shops, placed in the ranking of the most successful retailers TOP 30 according to revenues achieved for the financial years 2017/2018 to 2019/2020 published on the website https://www.tovarapredaj.sk/top30/. Among the retailers with house fitments, two international companies (IKEA, JSYK) and one domestic company (Decodom) were included in this list during the period under review. Ingka Group is a strategic partner in the IKEA franchise system, which runs more than 374 IKEA stores in 30 countries. Ingka Group operates in accordance with the IKEA´s business idea: to offer a wide range of furniture, home textiles and home accessories with good design and functionality at such prices that as many people as possible can afford. IKEA is a Swedish furnishings company producing and selling house fittingse, home textiles and home accessories. It owns and operates a network of stores in Europe, Asia, the USA and Australia. In Slovakia, it runs an online shop, a department store in the capital city of Bratislava, a pop-up outlet in Košice, and supply points in Košice, Banská Bystrica, Žilina and in Nitra (Zererová, 2021b). The company JYSK is an international network of retail stores of Scandinavian origin that sells everything for the household. The assortment consists of furniture, home textiles and home accessories for the living room, bedroom, dining room, study, bathroom and garden. The first shop was opened in Denmark in 1979 and today JYSK has more than 3,000 stores and 26, 500 employees in 51 countries. In Germany, the shops are called Dänisches Bettenlager. JYSK entered the Slovak market in 2006. Today, it has been operating 47 shops and employs 400 people. JYSK belongs to Lars Larsen group (Kozich, 2021). Decodom has been making furniture for several decades. In 1999, it followed up the success of the largest house fitments manufacturer in the former Czechoslovakia, Mier. The fittings that Decodom produces is based on chipboard panels and vacuum-pressed foil. The products thus maintain the high quality and at the same time are affordable. In the Slovak market, Decodom has taken a leading position in the production and sale of kitchen furniture. Further production programme also includes the production of sector appliances for living rooms, dining rooms, bedrooms, children´s rooms, halls, and offices. Decodom operates its own retail network with 15 stores apart from the manufacturing facility (Decodom.sk, 2021a).

The main purpose is to define the importance of direct marketing techniques in communicating with customers during the lockdown in the sale of furniture. The partial goals are as follows: to define direct marketing and its techniques, which we call passive; to delimit what we mean by house fittings; to identify how Slovaks bought furniture during the lockdown caused by the pandemic of COVID-19 and which type of amenities they showed the increased interest in; to find out the importance of selected direct marketing techniques in communication with customers; and to draw conclusions. As information sources, we used university textbooks, professional publications, a collection of scientific works, as well as the Internet websites. In the processing, we applied standard scientific methods, as follows: researching, description, analysis, deduction, and content analysis. Through the implemented content analysis, we focused on examining selected techniques of direct marketing in the following quantification procedures: unaddressed shipment – leaflets, telemarketing, information e-mails, chat, newsletter, customer club, online planner, and Facebook.

2.2. Significance of direct marketing in communicating with customers during the lockdown

Already with the onset of the first wave of the pandemic in 2020 and the imposed government measures, which resulted in the closure of retail stores, restrictions on customer traffic and a huge increase in online sales, which further caused various problems, a large proportion of sales saw increased demands on customer centre staff. During the year (2020/2021) marked by the pandemic and related measures taken, IKEA customer service recorded a sevenfold increase in online order and a fivefold growth in purchaser queries, which were handled not only by e-mails, or telephone, but also actively on the IKEA Bratislava Facebook page (Zererová, 2021c). IKEA customer service provides its acts of assistance using telemarketing in the Contact Centre. Calls to a telephone number are charged according to the tariffs of a specific mobile operator within seven days of the week, from 09:00 a.m. to 08:00 p.m. except public holidays. In the months of March, April and partially June 2020, JYSK buyers would wait 90 minutes to get through to the customer line. The company was forced to solve this crisis situation not only by apologizing, but also by offering shopping vouchers or gift cards. While the Customer Service Centre of JYSK received a total of 29,000 e-mails in April 2019, they obtained altogether 105, 000 of them in April 2020. The phone calls almost doubled in the same period. In the autumn of 2020, the workload of the centre continued not only under the influence of the measures imposed due to the pandemic, but also with the approaching days of Black Friday and Christmas. The Customer Service Centre made use of the assistance of employees from other departments, or directly from JYSK sales shops and began implementing new tools to send customers bulk information, which would make the work of the centre´s workers more efficient. The Customer Service Centre has even reduced telephone hours so that employees had more time to respond to e-mails and suggestions on the Facebook page (Buch, 2021). JYSK Customer Services, similarly to IKEA, carries out telemarketing only on working days, from 10:00 a.m. to 04:00 p.m. Slovak purchasers are often served by Czech call centre operators, which can cause a language barrier for some Slovak customers. Decodom can be contacted by consumers using passive telemarketing on the so-called green line, i.e., calls are free of charge, in order to remove the financial barrier on the part of buyers, between 09:00 a.m. and 05:00 p.m. without further restriction. JYSK customers who prefer electronic communication can contact the specific e-mail address - zakaznik@jysk.com. On the contrary, IKEA and Decodom purchasers can contact these companies through the contact – response form. This type of communication differs from the newsletter in forms, content, design, and frequency. The newsletter, content-oriented to the company, its products and services, as well as upcoming supporting activities, offer all objects of research for subscription. The product leaflet of JYSK is on average valid for 13 days, with 2 to 3 product flyers coming into force within one month (Kollárová and Ungerová, 2020). Throughout the lockdown, however, consumers could order the goods with delivery to their address or pick them up at the stores, which serves as a supply point. The periodicity of the Decodom product circular is one calendar month. During the lockdown, both companies stopped distributing leaflets to the letterboxes, they were available only in an electronic form on the websites. IKEA prepares a list of discounted products on a monthly basis, valid only for the members of the customer club. IKEA and JYSK actively communicate with their customers on their Facebook sites, also in the form of answers to questions related to, for example, complaints, ordered goods, or the accessibility of the stores; which strengthens the availability and effect of the chat service. On the contrary, Decodom cancelled the chat throughout the lockdown. In the time of the lockdown, the online planner replaced the distribution and communication function of direct marketing techniques. At Decodom, those interested in an interactive kitchen planning filled out a contact form and waited for confirmation of the connection date (Decodom.sk, 2021b). The same principle is implemented by IKEA – in terms of an interactive kitchen planning and purchasing. The international company, unlike the domestic one, also offers customers individual planning, for instance, of the dining room, children´s room, bathroom, or a walk-in closet. The completed design also includes the dimensions of the assembly and its price. (Ikea.com/sk, 2021) JYSK does not offer such devices.

3. CONCLUSIONS

The pandemic and the imposed government´s courses of action required the introduction of several, often financially demanding, measures for physical shop operators. Those who had not run brick-and-mortar shops and online shops at the same time, operationally turned the stores into points of supply and set up the Click and Pick-Up service. Personal selling was temporarily suspended, and customers began addressing their needs over the phones, e-mails or social media comments. The onset in these channels checked the level of customer support and the suitability of using selected direct marketing techniques. As we have already mentioned, the onslaught on telephone lines, information e-mail addresses and in several cases social media was multiplied if compared with the period before the pandemic. Based on the results of our survey of furniture retailers, two international companies (IKEA, JSYK) and one domestic firm (Decodom), we can conclude that the researched direct marketing techniques fully replaced personal selling and to a greater than usual extent participated in building and maintaining customer relationships, as customer service centre operators have become the only brand representatives with which purchasers came into contact with. At the same time, direct marketing techniques allowed consumers, unlike advertising or sales promotion, to communicate in both interactive directions. According to the information provided, international traders managed to react better to the unprecedented situation than a domestic retailer. They provided customers with a wider range of communication channels and solutions to their needs related to obtaining furniture for several rooms in the construction.

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THE MAIN THREATS TO THE ACTIVITY OF PRIMARY WOOD PROCESSING SECTOR ENTERPRISES IN THE CONDITIONS OF CRISIS OR ECONOMIC UNCERTAINTY

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Abstract: The study attempts to identify the competitive situation of enterprises related to forestry and the wood-based sector in Poland, in a period of economic uncertainty. The trends in the share of active business entities of primary wood processing were identified (ex post), and a forecast of their development in the short term (ex ante) was formulated. On the basis of econometric models, the pessimistic hypothesis was verified, which in effect was falsified.
Keywords: wood-based sector, econometric analysis, sawmill, economic uncertainty, Poland

1. INTRODUCTION

The wood market in Poland is made up of complementary wood-based sectors: forestry (mostly state-owned) and the wood industry (mostly privately owned) [1]. It was initially assumed, based on data from the first half of 2020, that the wood market in Poland would face a serious downturn or even a prolonged crisis [5]. In addition to the pandemic (and therefore a reduction in international transactions), there was an oversupply of roundwood on the Polish market. At the same time, prices were falling due to the competitive import of cheap sawnwood. The global demand for wood was also on a downward trend. However, this situation has changed.

The attempt to assess the competitive situation of wood industry enterprises is not easy. On the economic condition and stability of the surveyed companies, depends the preservation of jobs and good previous competitive position of industry participants. Is it therefore possible to find an optimal, even short-term response for the actors of the primary wood market?

2. MATERIAL AND METHODS

The aim of the study was to assess the competitive situation of Polish enterprises related to forestry and primary wood processing. Their ability to economic activity under conditions of uncertainty was assessed. For this purpose, secondary data were used, obtained from the Central Economic Information Office, the Local Data Bank of the Central Statistical Office and other Polish governmental registers [9,10]. These data were verified and an econometric analysis was done, looking for significant trends over a five-year period (2016-2020).

In the next step, based on the built model, after its verification, a short-term forecast of economic activity in the sector (until the end of 2022) was developed. It was hypothesized that under conditions of economic uncertainty, enterprises in the wood-based sector will reduce their activity, and the supply potential of the industry will decrease by about 30%.

All enterprises active in the Polish wood-based sector were included (the scope of entities covered by the primary wood market) [6]. These entities are classified according to the Polish Classification of Activities (designated PKD) separately for group 1, viz: Section A, Division 02 (forestry and logging) and separately for group 2, viz: Section C, Division 16 (manufacture of products based on wood and cork, except furniture; and products of straw and plaiting materials) [11,12]. The number (volume) of active (registered) business entities (subject scope) in Poland (spatial scope), in the years 2016-2020 (time scope) was analyzed. Econometric forecasting was carried out for the years 2021-2022 (referring to available data from the first quarter of 2021 as part of verification).

Based on secondary data, an attempt was made to build and then select an optimal econometric model. Four models were verified: linear, power, exponential and polynomial. The independent variables (x variable, explanatory variable) were taken as the acquired historical data (number of active enterprises in each group). The dependent variable (y, the explanatory variable) is the forecast (the number of active enterprises in each group in future periods).

The starting point of the analysis was a simple linear model, describing the relationship between two variables. The verification of all models was performed according to the methodology adopted in the literature [2,3]. Thus, reference was made to the formula in which:

a) general form of the model: $y = \beta_0 + \beta_1 x + e$ (1)

x_i – independent [explanatory] variable (vectors of observations of independent variables),
y – dependent [explanatory] variable (vector of observations of the dependent variable),
β_i – unknown structural parameters of the model (vector of unknown parameters),
e – random component (vector of random components).

b) the estimated form of the model: $y = b_0 + b_1 x$ (2)

where b_i – a measure for evaluating unknown structural parameters β_i.

Then the model was estimated (for the linear model by the least squares method) and verified: substantively and statistically. Substantive verification consists in checking the meaningfulness of the signs and values of the estimates of the structural parameters of the econometric model. The key parameter subject to statistical verification was the coefficient of determination R^2. It determines how much of the total variation for the dependent variable y was explained by the model [3]. Based on the comparative analysis, the model was verified and the selected forecast was discussed.

3. RESULTS

At the first stage, the activity of enterprises carrying out the leading activity defined in Section A, Division 02 of the Polish Classification of Activities (forestry and logging) was analyzed. For the period 2016-2020, a matrix of active entities was compiled, and the change in their number over time was illustrated in the graph (Figure 1). Analyzing the number (volume) of active enterprises in the wood-based sector for the period 2016-2020, a general decreasing trend was noted. However, considering only the period of uncertainty (lockdown of pandemic time) and the previous year, it was noted that the graph of active entities is essentially linear, and their total number does not change.

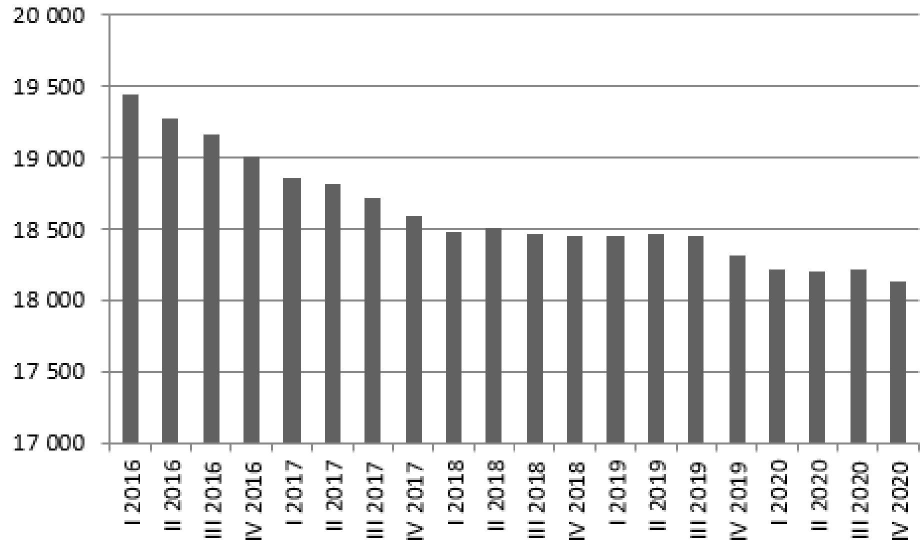

Figure 1. Number of active enterprises related to the forestry and wood-based sector (group 1) from 2016 to 2020 (by quarter).).
Source: Own elaboration based on [https://stat.gov.pl]

Then, based on the secondary data, their econometric analysis was conducted. Models were built and verified, describing changes in the size of the group of enterprises working for forestry and logging. The explanatory variable was the number of active enterprises ex post (x), while the explained variable (y) was the projected number of enterprises in the sector under study in the future (ex ante). The results of verification and comparative analysis of the models based on the value of determination coefficient R^2 are presented in Table 1. Moreover, for all the analyzed models the value of the coefficient of determination was close to or exceeded 0.9.

Table 1. Construction and verification of selected econometric models describing the size of the group of enterprises working for forestry and logging (explanatory variable x: number of active entities ex post)

Econometric model	Equation	Determination coefficient R^2
Linear	$y = -59{,}97x + 19238$	0,897
Power	$y = 19582x^{-0{,}02}$	0,965
Exponential	$y = 19242e^{-0{,}00x}$	0,901
Polynomial	$y = 3{,}162x^2 - 126{,}3x + 19482$	0,963

Source: Own elaboration

In the next step, a forecast was made for the verified econometric models. It illustrates the potential activity of entities (their number) in the wood-based sector in the short term. The results are summarized in Table 2.

Table 2. Forecast of the number of active entities in the wood-based sector based on selected econometric models (variable y: number of entities ex ante) for 2021-2022

Period (quarter/year)	Linear model	Power model	Exponential model	Polynomial model
I 2021	17979	18425	18842	18224
II 2021	17919	18408	18823	18234
III 2021	17859	18392	18804	18250
IV 2021	17799	18376	18786	18272
I 2022	17739	18361	18767	18301
II 2022	17679	18347	18748	18336
III 2022	17619	18333	18729	18377
IV 2022	17559	18320	18711	18425

Source: Own elaboration

An ex-post trend verification was also conducted for the group 2 of surveyed woodworking enterprises only. Active entities producing wood and cork products (excluding furniture) and producing products of straw and plaiting materials were considered, on a quarterly basis from 2016 to 2020. In this case, even during the critical period (lockdown), a stable upward trend, linear in nature, was identified (see: Figure .2).

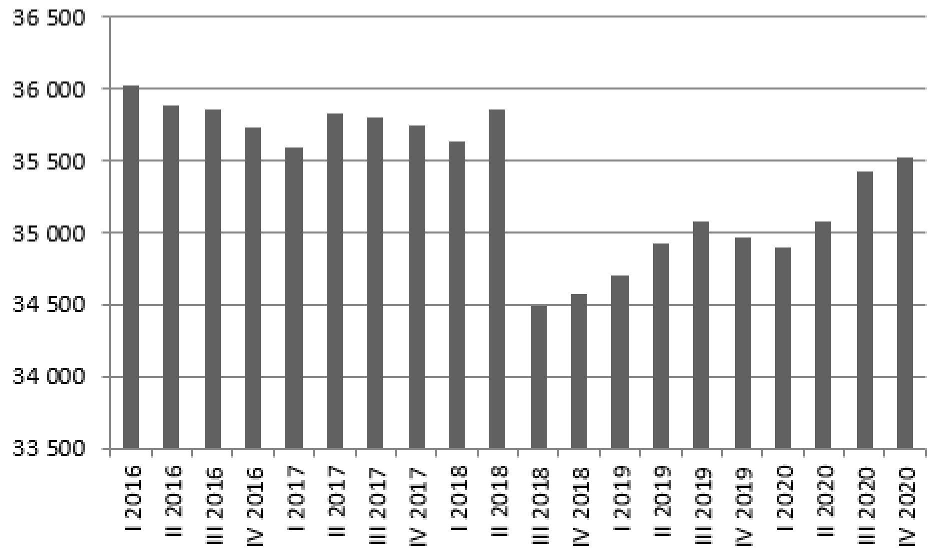

Figure 2. Number of active entities engaged in manufacturing of wood and cork based products (excluding furniture) and manufacturing of straw and plaiting materials (group 2) from 2016 to 2020 (by quarter).
Source: Own elaboration based on [https://stat.gov.pl]

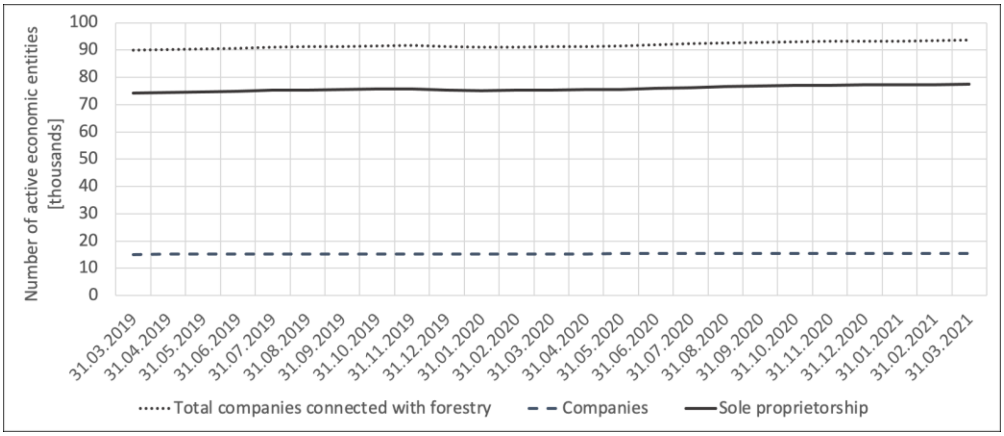

Figure 3. Aggregate number of active enterprises related to forestry and the wood-based sector combined from 01/03/2019 to 31/03/2021.
Source: Own elaboration based on [https://stat.gov.pl]

In addition, using current data taken from state business registers, an aggregate trend was verified, illustrating the situation in the critical period from 01.03.2019 to 31.03.2021. It turned out that the number of active enterprises related jointly to forestry and the wood-based sector (primary wood processing) in Poland, remained stable during the pandemic uncertainty, as illustrated by the linear trend (see: Figure 3). Of course, constructing a forecast based solely on data from the pandemic period would, perhaps surprisingly, have an optimistic character, confirmed by a small but steady upward trend.

4. CONCLUSIONS

Based on the research carried out, as well as descriptive analysis, the following conclusions and recommendations were formulated:

1) Analyzing the change in the number of active entities related to forestry and the wood-based sector during the period of economic uncertainty, it was noted that the study group maintains relative stability and even a slight optimistic growth trend in the short term.

2) The working hypothesis formulated in the introduction was verified negatively. It assumed that under conditions of economic uncertainty (pandemic), the potential of entities active in forestry and the wood-based sector would decrease by about 30%. It turned out that this sector defended itself against the threat of mass bankruptcy.

3) It was noted that the developed econometric model for short-term forecast of the development of the sector under study (the best fit was a power model), allows for an optimistic prediction of an increase in the number of active enterprises in the wood industry in the future. It seems that the competitive situation of the wood-based sector was first influenced by the institutional policy [5] of the state during the pandemic period (the so-called anti-crisis shield) [6]. However, above all, the tendency to build a network of cooperation between forestry and the wood industry [4,7], which is one of the strongest factors in shaping the competitive potential of the industry [8] and the wood market in Poland, proved to be effective.

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THE IMPACT OF THE COVID-19 PANDEMIC ON THE CROATIAN WOOD PRODUCTS MARKET

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Abstract: This article presents an analysis of the current situation in the Croatian wood products market based on year-on-year indices of production, exports and imports in the wood processing and furniture production sectors. Data for this analysis were collected from the Croatian Chamber of Commerce. The aim of this paper is to find the answer to how the Covid-19 pandemic affected the movements of production, exports and imports in the two main Croatian wood sectors.
Keywords: wood products market, production, export, import, year-on-year indices

1. INTRODUCTION

The World Health Organization (WHO) on March 11, 2020 declared a pandemic of COVID-19, that emerged in late December 2019, but quickly spread to other countries in Asia, Europe and North America (Remuzzi and Remuzzi, 2020). The WHO has urged affected countries to slow the spread of the virus by imposing suppression measures, ranging from strict controls on travel, social gatherings and commercial activities (Anderson et al., 2020; Wells et al., 2020). There are now confirmed individuals with COVID-19 in nearly every country of the world. The Oxford COVID-19 Government Response Tracker (OxCGRT, 2021) systematically collects information on several different common policy responses that governments have taken to respond to the pandemic on 20 indicators such as school closures and travel restrictions. It now has data from more than 180 countries.

According to Čavrak (2020), fact of a sudden stop of the economy or his lockdown in almost all parts of the world at the same time, makes an important difference of this economic crises than all those recorded by economic history. Croatia had the slowest way out of the last financial crisis, which lasted a full six years, and has exhausted the resources of households and businesses, and limited the fiscal capacity of the state to the current intervention. The Government of the Republic of Croatia, Croatian Institute of Public Health, Ministry of Health and others institutions has launched a web-pages with numerosly informations about pandemic. Due to the spread of coronavirus in Croatia and neighboring countries and the possible effects of the new situation on the domestic economy, the Croatian Chamber of Commerce has launched a page with the latest recommendations and instructions for business people regarding coronavirus infection.

Economic theories are dynamic by nature (Samuelson and Nordhaus, 2003), and now we are witnessing almost everydays changes that are caused by the pandemic of COVID-19. In this new and dynamic conditions it is necessary to strive for a new standards using the tools of 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 strategies for 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). According to Rozga and Grčić (2002), by using a different 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 economics indicators in the (near) future. This article offers a focus on the Croatian wood sector and position of Wood processing (C16) and Furniture manufacturing (C31) in the time of pandemia.

2. MATERIAL AND METHODS

The base for this reserch are data gathered from the Croatian Chamber of Commerce (CCE, 2021) and data gathered from the official government website for accurate and verified information on Coronavirus in the Republic of Croatia (OGRC, 2021). According to Croatian Standard Classification of Occupations (NKD 2007), two main wood manufacturing sectors are 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).

Database include year on year production indices 2020/2019 for sectors C16 and C31, export and import values for period 2017-2020 in two main wood manufacturing sectors, as well as shares of export and import in whole Manufacture sector (C). Data gathered for these analysis are shown in Table 1. and Table 2.

Table 1. Year on year production indices for sectors C16 and C31

Sectors	2020/2019											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
C16	101,0	94,5	87,4	81,1	83,7	99,2	89,2	90,4	102,7	101,3	98,3	106,0
C31	110,9	107,1	77,7	40,6	61,9	83,0	100,6	102,1	93,3	92,5	86,0	93,5

Table 2. Export and import in mil.EUR and shares of C for subsectors C16 and C31

Year	Export				Import			
	C16		**C31**		**C16**		**C31**	
	mil.EUR	% of C	mil.EUR	% of C	mil.EUR	% of C	mil.EUR	% of C
2017	645,4	4,6	328,3	2,3	258,7	1,2	279,0	1,3
2018	707,7	4,9	269,6	1,9	304,7	1,3	311,1	1,3
2019	743,2	4,9	262,4	1,7	358,5	1,4	379,3	1,5
2020	704,0	4,7	249,3	1,7	328,1	1,4	338,7	1,5

Also, database include the number of daily COVID-19 cases from the begining of pandemia on Feb 26, 2020 in Croatia. Due to the size of the original database containing 432 data on the number of daily coronavirus infections, in Table 3. are shown only 16.2% of all original data, which include the last 10 weeks of this year, precisely the period from February 22 to May 2, 2021.

Table 3. Daily new COVID-19 cases in Croatia for period Feb 22 – May 2, 2021

From	Feb 22	Mar 1	Mar 8	Mar 15	Mar 22	Mar 29	Apr 5	Apr 12	Apr 19	Apr 26
To	Feb 28	Mar 7	Mar 14	Mar 21	Mar 28	Apr 4	Apr 11	Apr 18	Apr 25	May 2
Week in 2021	w8	w9	w10	w11	w12	w13	w14	w15	w16	w17
Mon	72	91	94	129	150	300	138	422	410	410
Tue	343	394	491	691	956	1487	735	1936	2106	1797
Wed	688	747	962	1445	1891	2623	1649	3099	3117	2904
Thu	544	667	777	1197	1673	2422	3217	2927	2885	2439
Fri	505	590	823	1112	1802	2362	2599	2698	2529	2007
Sat	520	658	823	1186	1790	2234	2535	2627	2535	2046
Sun	356	394	561	834	1321	1376	1617	1565	1254	944

3. RESULTS AND DISCUSSION

Searching for the answer to how the Covid-19 pandemic affected the movements of production, exports and imports in the two main Croatian wood sectors, we performed a three different analysis.

3.1. Pandemic of COVID-19 in the Croatia

On February 25, 2020, Croatia confirmed its first case, and on March 11, an epidemic was declared in the entire territory of the Republic of Croatia. On the same day, the World Health Organization declared the previous epidemic a pandemic. The movement of the number of newly infected with Coronavirus in Croatia since the beginning of the pandemic, according to quarterly periods, is shown in Figure 1.

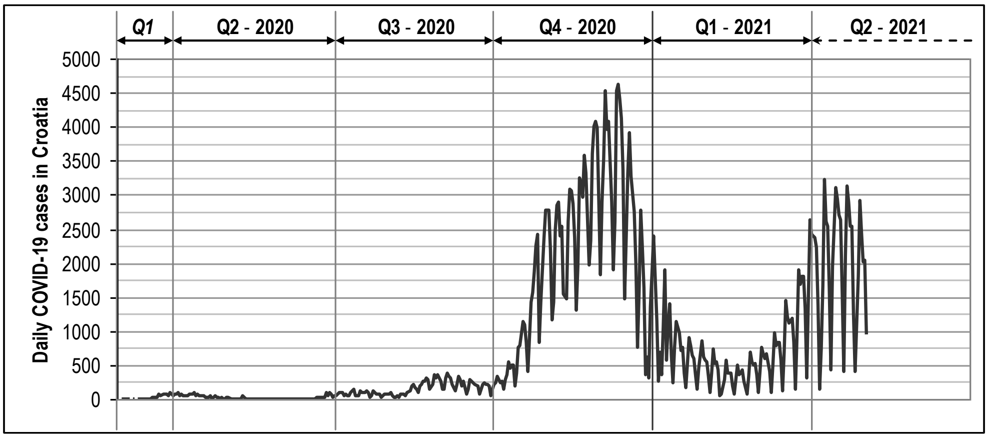

Figure 1. Daily new cases in period Feb 25, 2020 - May 2, 2021

From the curve of the pandemic shown in Figure 1, we can se that the "worst wave" starting in the last quarter of last year (Q4, 2020; Max 4620) is behind us, and that we are now in the middle of the "new wave" that started in the half of February this year, with maximum od 3217 infected on Apr 8, 2021.

Analyzing the weekly highs of those infected with Coronavirus in Croatia from December 10, 2020 to May 2, 2021, we came to the current trend according to which the end of this wave can expected in mid-July this year (Figure 2). This is just one possible scenario, but also we have to be aware about a possibilities of one or more subsequent waves.

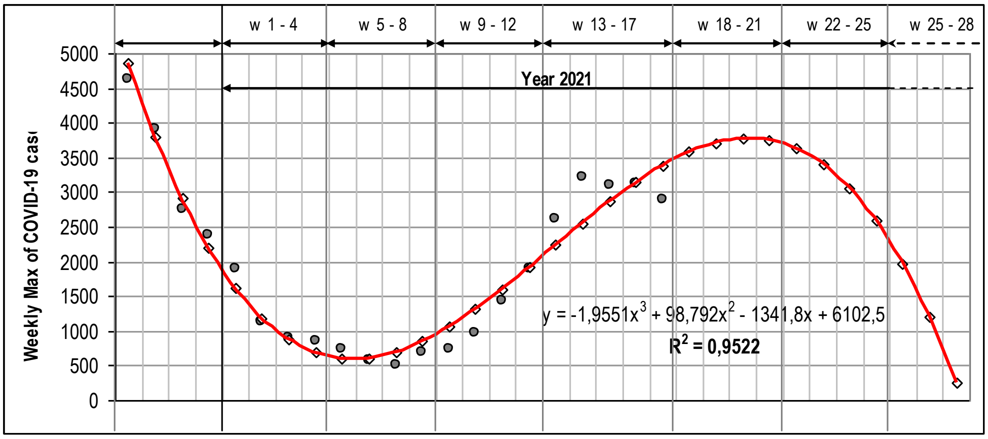

Figure 2. Weekly Maximum of new cases in period Dec 7, 2020 – May 2, 2021

3.2. Production in sectors C16 and C31

Analyzing the year on year production indices 2020/2019, on the base on average gross indice in 2019 for sectors C16 and C31, we calculated a gross indices of production for all months in years 2019 and 2020. The results of these analyses and movement of production in two main Croatian wood manufacturing sectors are shown in Figures 3 and 4.

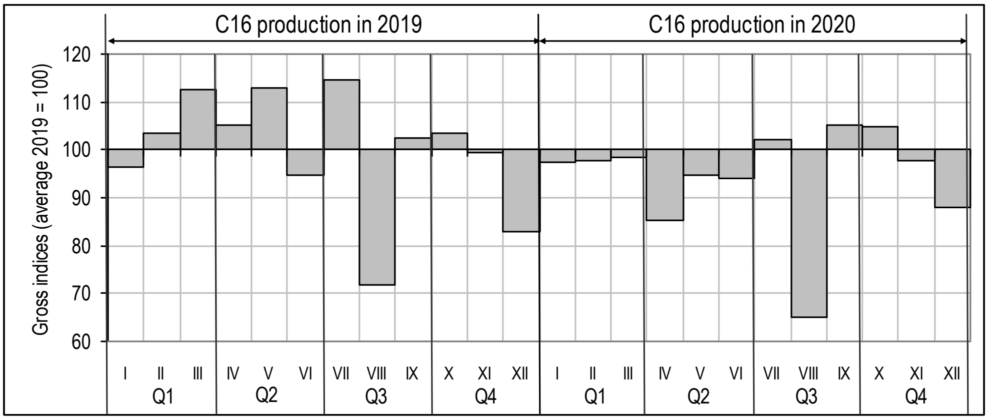

Figure 3. Gross indices for C16 production in 2019 and 2020

For sector C16, the most significant decline in production was recorded in July and December in both analyzed years, while sector C31 recorded a drastic decline in production in the second quarter of 2020.

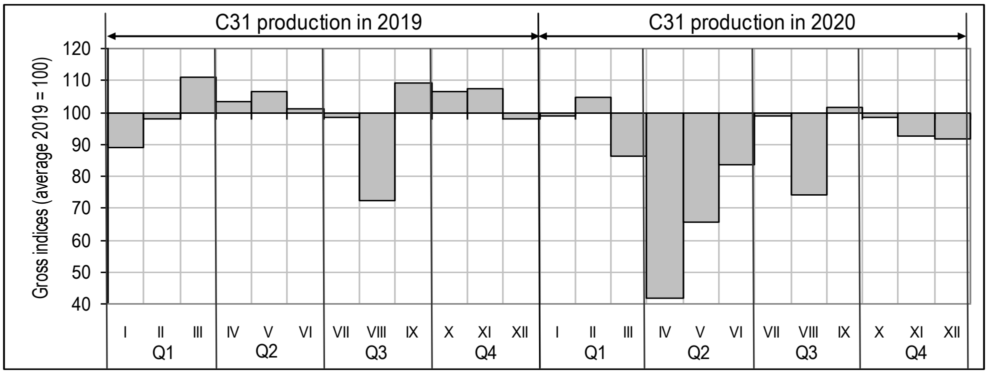

Figure 4. Gross indices for C31 production in 2019 and 2020

3.3. Export and import in sectors C16 and C31

The movement and comparison of export from 2017 to 2020 in sectors C16 and C31 are shown with chain indices in Figure 5, same for import in Figure 6.

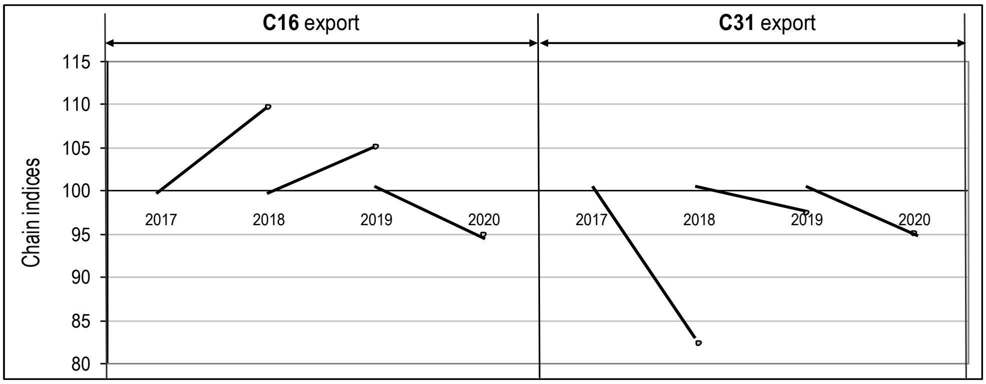

Figure 5. Chain indices for export in sectors C16 and C31

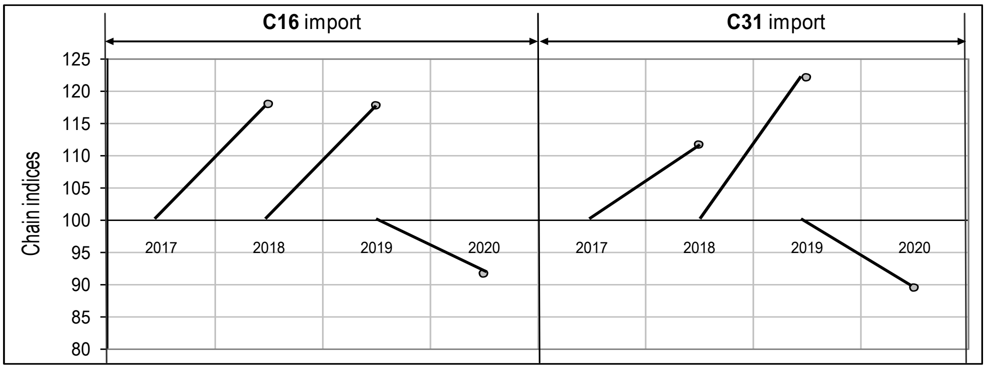

Figure 6. Chain indices for import in sectors C16 and C31

Comparing the movement of export and import from 2017 to 2020 in both sectors C16 and C31, the most significant decline was recorded in pandemic year 2020.

4. CONCLUSION

The curve of the pandemic in Croatia, shown in Figure 2, have a theoretical character. On the empirical data and analyses of production, export and import is very hard to predict the acceleration and deceleration phases of a pandemic, and their impact on Croatian woodworking sectors C16 and C31. The depth and duration of this crisis will depend on the public health response that involves controlling the spread of the virus, and in the case of a successful response the outlook for economic recovery could be more positive.

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COVID-19 CRISIS INFLUENCE ON BULGARIAN FURNITURE INDUSTRY AND FORECASTING THE POST CRISIS DEVELOPMENT

Nikolay Neykov, Radostina Popova -Terziyska

Abstract: The entry of the furniture sector into a crisis resulting from the pandemic impact on employment and production would create lasting problems, both with the livelihood of people in poorer areas of the country and with investments that ensure economic growth. These features put the sector in a difficult situation and maintaining competitiveness will be of key importance for future development. The purpose of this study is to estimate the change in the production and trade of furniture in Bulgaria during the severe pandemic periods and forecast the development of the sector after that.
Keywords: COVID – 19, crisis, furniture, production

1. INTRODUCTION

The Coronavirus pandemic is seriously affecting global furniture manufacturers in Europe, United States, as well as Bulgarian companies. At the beginning of the crisis of Covid-19 in Germany there was a decline in the volume of furniture production by up to 28%, and office furniture manufacturers in the US are under pressure due to the flight of the urban population and the largest furniture manufacturers report large losses and double-digit revenue from sales. Furniture companies are finding that they can work with dispersed employees, saving significant costs. There is an increase in the production of home furniture as consumers focus on the home environment in which they are forced to spend most of their time, many of them decide to modernize it. (World Trade Report, 2020)

Furniture businesses all over the world will have to evolve to accommodate this fluid situation. The website will become the business card, the store, and the showroom. Prioritizing digital merchandising and online presence can help to navigate through this difficult time. The digital activities will include a series of podcasts or webinars, virtual product tours, 360-view showroom presentations, and more.

Major impact of Covid-19 on the furniture industry will be through the supply chains. Furniture brands need to develop an effective supply chain response plan to mitigate risk and prepare for any interruptions that the coronavirus outbreak can cause. This can involve, among other things, aspects like supplier engagement response with cross-tier risk transparency, inventory critical part identification, production-capacity optimization, demand management, logistics-capacity pre-booking, and route optimization. Many brands and thought leaders in the industry are looking to innovate with what they believe will be the key driving force in the months to come: eco-friendly furniture. (COVID-19 Impact on Global Hotel Furniture Market, 2020)

The brands have also started identifying an increasing consumer preference for multifunctional and customised furniture as one of the prime reasons driving the office furniture market growth during the next few years. The identification of these trends was done after careful study of the market size, trends and industry analysis. (Global Furniture Market Analysis Trends, 2021)

In Bulgaria, about 30% is the decline in furniture production at the beginning of the crisis and the industry is among the most affected in the country. The sector is export-oriented and at the beginning of the pandemic almost 80% of the companies took actions for partial or complete dismissal of employees. The sector employs more than 45 000 people, and companies that work entirely for export face a very difficult situation, so some of them are closing their production. Experts point to some guidelines such as investing in virtual stocks and finding partners to add value to products. (Timberchamber data). Implementation of new technologies (see Antov et. al. - a and b, 2021) and materials could be vital for faster recovery.

COVID-19 has had, as well as otherinfluences, an impact on the area of human resources management in the field of motivation (Hitka et. al., 2021). First, the lockdown and effective closure of large swathes of the economy led to drastically reduced demand and precipitous declines in consumer spending for consumer durables such as automobiles, domestic appliances and furniture that are not readily and easily purchased on-line . The crisis and lockdowns led to drastically reduced demand and precipitous declines in consumer spending for consumer durables such as automobiles, domestic appliances and furniture that are not readily and easily purchased on-line (Harris et. al., 2020).

2. METHODOLOGY

Graphical comparison and descriptive statistical indicators like averages, cumulative growths and standard deviations have made in the analysis. In the current study in order to reveal, the sort term effects of COVID 19 have been implemented Autoregressive Moving Average Model (ARMA). Data are indexes on monthly basis in Short-term Business Statistics (STS) of Eurostat for Production and Turnover for industry C31 “Manufacture of Furniture” for the period from January 2006 until February 2021. The preliminary analysis has been made by the Shapiro-Wilk test (Ghasemi and Zahediasl, 2012) for normality and Phillips - Perron unit root test for stationarity. Post analyses are Portmanteau test (Ljung and Box, 1978) for white noise and Shapiro-Wilk test. Additionally we performed moving average estimation of the first six months after the last available data for February 2021. The methodology described above has been chosen due to lack of the profound information in the period of COVID 19, which make the ARMA model appropriate. Data is based on the difference between current period and the previous one and make the integration inconsistent to the current research purposes. The appropriate model has been chose by the statistical significance of the coefficients.

3. RESULT AND DISCUSSION

In the Figure 1. are presented the index time series for production ant turnover for C31 in Bulgaria during the examined period.

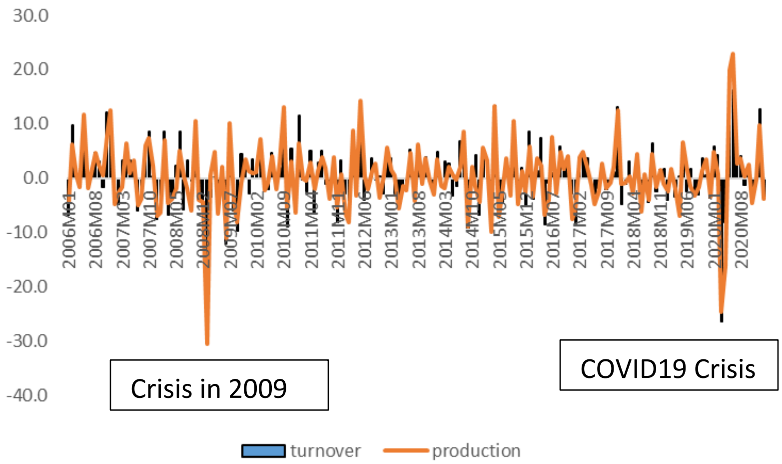

Figure 1. Turnover and production in Manufacture of furniture in Bulgaria

As its obvious from the Figure 1. The COVID19 crisis caused greater effect on the turnover than to production. In compare in the previous crisis in 2009 the main problem appeared in the production volumes. The lowest points in the turnover in the two crises are -18% for the first one and - -26.3% for the COVID 19. It seems that the market driven downturns are in the core if the problems today for the Bulgarian production of furniture. For the production the fall in the 2009 was in about -30.5% and in 2020 -24.5%. In manner of the lowest points the both crisis are comparative, but not in duration or producers behaviour. In the first one there are negative trend before appearance of the crisis. It is obvious from the greater production downturn in compare to turnover. The producers were aware of the problems. This is not the case in the current crisis. It appeared immediately and the effect on the turnover was almost the same for the production. Here appears the hypothesis, that the producers of furniture in Bulgaria have become more adaptive to the markets. There is one more big difference between two crises. This from 2009 is much more severe in duration and cumulative effect. It lasted for more than 11 months with period of instability afterward, with cumulative negative effect of almost 47%. COVID 19 effect is about 34% for the turnover and 40.6% for production. In the current situation there is a compensatory development right after the downturns - 33.6% upward shifting for turnover and 42.9 for the production. Until the end of the February 2021 the growth of the industry's market and production is about 13%. It has gone into the usual boundaries of the industry, but more unstable. The standard deviation of the sales increased from 4.49% for the non-crisis periods to 7.87%, for the production the increment is from 4.73% to 9.42% after the COVID19 downturns and compensatory jumps. The producers are insecure in their expectations. The Figure 2 reveals some more on the behavioyr of the markets in the period of COVID 19.

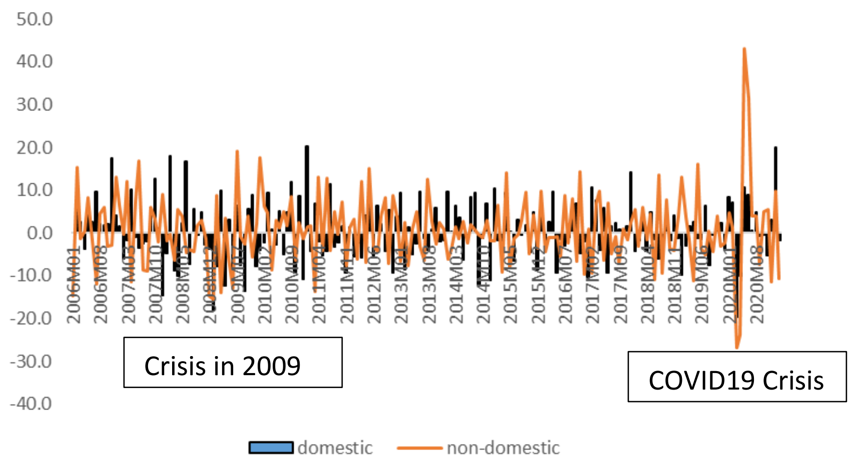

Figure 2. Turnover in domestic and non-domestic markets in Manufacture of furniture in Bulgaria

Lines in the Figure 2 show that there is no clearly presented lowest point in downturns of the sales in the crisis in 2009. In difference, the COVID situation shaped the clear flops in sales in about one – two months negative changes of revenues. The afterward compensations described above is caused mainly by the external market. It is the apparent reason for the fluctuations in total turnover. It forms the instability after the biggest downturns in March and April 2020, i.e. standard deviation of the domestic market is 7.52% which is 1.3% more than the usual one in 2010 – 2019 and for non-domestic 13.08%, which is double of the usual one – 6.504%.

During the implementation of forecasting methods was found that the only normally distributes data are for Domestic market turnover (Shapiro-Wilk p=0.63). Consequently, for the production and domestic market turnover have been applied ARMA models (2,2). The simple moving 12 months moving average for other data have been applied. The ARMA model is following:

$$\hat{y_i} = 0.486 + 0.954y_{i-1} - 0.603y_{i-2} - 1.243\varepsilon_{i-1} + 0.726\varepsilon_{i-2} + \varepsilon_i \qquad (1)$$

Where y_i is the index in month i; ε_i are the residuals of the month i

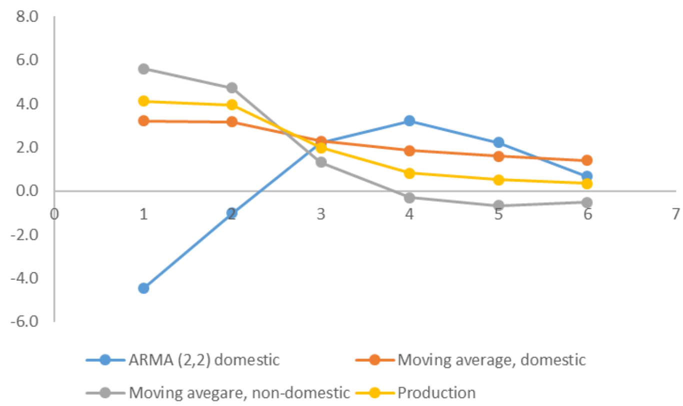

Figure 3. Six month forecast for the growth of Bulgarian C31 for the period March – August 2021

The figure presents that due to model specifics the growth has typical shape. Despite the forecast became not so reliable for the every month after the March the results present that the growth cam be expect to be in the interval (-4% ÷ 2%) for ARMA and around 2% for every other model. This means that can be expected, that the growth of the industry will be in the usual boundaries, without any major fluctuations. The pessimistic perspective can be described as 0.5 % – 0.7 % if data after the April 2020 are taken into account.

3. CONCLUSIONS

Analyzes have shown that the crisis with COVID 19 has so far not had as significant consequences as in 2009. The sector has become much more adaptable to the external environment. Foreign markets have begun to influence much more significantly in recent years, unlike in 2009 and before. The COVID 19 crisis was compensated within two months. This is an interesting phenomenon that deserves in-depth research. The forecast is for weak growth. Sales fluctuations can cause producers to be cautious, as was the case in 2008-2011. The crisis shows that the sector has become resilient. The problems are dealt with immediately after their occurrence. The results show that growth can be achieved with the help of the external market, and security in crisis situations with the help of the domestic. This is especially true of the COVID 19 crisis.

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SUSTAINABLE USE OF WOODEN PACKAGING AS PART OF THE CIRCULAR ECONOMY OF BULGARIA

Velichka Marinova, Antoaneta Stoyanova, Damyan Kirechev

Abstract: Preserving the quality and quantity of the used natural resources as a raw material for the production of wooden packaging is one of the circular economy's tasks of each country. The report focuses on the production and use of wooden packaging in Bulgaria, thus ensuring the implementation of effective management in the process of their quality control. Thinking about sustainable development in packaging comes down to the use of recyclable and reusable wooden packaging and is linked to the entire supply chain - from raw materials to the final user.
Keywords: wooden packaging, sustainable use, circular economy

1. INTRODUCTION

In the coming decades, Europe will face environmental challenges that are unprecedented in scale (EEA, 2019). The culture of use of natural resources today is in direct correlation with the growing pressure on their extraction and the impact on the climate (Eurostat, 2018). Forests cover about a third of the world's surface and are crucial for ecological processes (climate regulation and forest ecosystems), as well as for human well-being (Katila, Pierce Colfer, De Jong, Galloway, Pacheco, & Winkel, 2019). Draft EU Forest Strategy after 2021 (New EU Forest Strategy post 2021) states that maintaining healthy and sustainable forests will support the goals of the circular bioeconomy. Preserving the quality and quantity of forest resources as a raw material for the production of wood products, including wood packaging is one of the tasks of the circular economy of EU countries.

Modern European society is a "green" society in which policies and technologies should promote sustainable resource-saving and energy-saving production. The European Union's main goal is to make Europe a "recycling economy", supporting long-term sustainable development, achieving stable growth and employment. The role of waste management in the context of the transition to a circular economy is increasing. The main challenge is to go beyond the perception of waste as a "problem" and as a "resource" (European Parliament, 2017). The circular economy can play a key role in the future success of wood products (Heräjärvi, Kunttu, Hurmekoski, & Hujala, 2020). This determines the question of the effectiveness of the multiple reuse of packaging products, as well as the production of waste or recycled materials as relevant and significant. As part of the European Union, Bulgaria should implement policies on the objectives of achieving resource-saving production and sustainable consumption within the forestry and forest industry.

The aim of the report is to examine and analyze the problems of modern supply and use of wooden packaging. They stem from the impact of various interrelated factors and conditions related to the sustainable consumption of goods and from the new market requirements of the "circular economy" for the production of environmentally friendly packaging. The use of wooden packaging and their recycling will contribute to the protection of the environment and the sustainable development of packaging activities.

2. THE FOREST SECTOR IN BULGARIA

The forest sector in Bulgaria by 2020 covers the forest territories of Bulgaria, which occupy 4149 thousand ha or 37,6% of the country's territory. 3775 thousand ha (91%) of these are forests. The state ownership of the forest territories prevails – 75,6% of their total area (MAFF, 2020). The report of Ministry of agriculture, food and forestry summarizes that the insufficiently developed forest infrastructure and the unsatisfactory condition of some of the forest roads create a precondition for excessive use of wood in the forest areas. Climate change and its consequences are identified as one of the main threats to the development of the forestry sector in Bulgaria (MAFF, 2014). Forest tree species that also determine the appearance of forest ecosystems are expected to show individual responses to climate change (EEA, BG, 2020), especially the coniferous crops in the southern parts of Bulgaria, which are particularly vulnerable. This requires efforts to be directed towards meeting the objectives set out in Priority 1 of the National Strategy for Sustainable Forest Development 2013-2020, which are improving sustainability and maintaining healthy, productive and multifunctional forest ecosystems, contributing to reducing the negative consequences of climate change, by increasing their resilience and ability to adapt to them (MAFF, 2013).

2.1. Wooden packaging in the scope of the forest industry

Industries in the forest sector are diverse and include different stages of wood processing (Neykov & Popova-Terziyska, 2020). The scope of the forest industry includes activities related to woodworking and production of wood materials. One of these wood processing activities is the production of wooden packaging. Manufacture of wood packaging is an economic activity in the field of forestry and forest industry in Bulgaria (NSI, 2008). Covering the whole process from timber extraction to wood material production, the processing stages from extraction to the final product include: 1) Harvest - Extraction of wood raw material; 2) Wood processing - Production of shaped materials (boards, beams, details) and Production of packages - related to the production of packaging. The general supply chain of wooden packaging can be divided into different sub-chains, depending on the location of the companies and the type of production: *Harvest → production of shaped materials (boards, beams, details) → production of packages (pallets, crates, boxes)*.

The term “wood packaging material” means wood or wood products used for the maintenance, protection or transport of goods in the form of packing boxes, cases, crates, drums and similar packings, pallets, pallet boxes and other loading boards, pallet collars and reinforcement, whether or not it is actually used in the transport of objects of any kind; processed wood produced by glue, heat or pressure or a combination thereof, and packaging material, entirely made of wood with a thickness of 6 mm or less (Regulation (EU) No 607/2012, 2012). The application of wooden packaging material is intended primarily for transport packaging. Transport packaging or tertiary packaging means packaging designed to facilitate the carriage and transport of a number of articles or group packages in order to prevent their physical handling or damage during transport.

Packaging as a product indirectly represents the use of resources with a short life cycle. The change to a sustainable pattern of social consumption and behavior requires the use of products and services, which meet the consumers' needs in an efficient and effective way and at the same time using fewer resources and causing less pollution. This largely applies to packaging. The population needs to focus on the use of reusable packaging, as well as to minimize the consumption of redundant packaging (EEA, BG, 2020). The widespread use of wood as a packaging material is due to its inherent complex of properties, determined by the composition and, such as cellulose, hemiocellulose, lignin, tannins and resins. Of particular importance for the quality of wooden reusable packaging are the properties: bulk density, durability, humidity, odor, resistance to chemical and biological influences.

The analysis of the state of the formation of packaging waste and the management policy in the period 2010 - 2019 shows great dynamics in the production of packaging in Bulgaria, incl. and on wooden packaging. The produced packaging for the period increased by 72%, from 321,2 thousand tons to 554,5 thousand tons. The produced wooden packages increased their supply more than 4 times, from 18,7 thousand tons to 79,6 thousand tons. The increase in the share of placed on the market wooden packaging shows steady growth, as, in 2010, the share of wooden packaging was 5.8% of the total packaging produced and increased to 14,4% in 2019. This shows an increase in the importance of the use of wooden packaging in the production and trade of goods. The high quality of the wood for packaging is also determined by its possibilities for long-term use. Wooden packages (of wood, cork, and other wooden materials) have the highest share of reusable packages. For the period 2010-2019, the increase in the share of durable packaging remained positive, as according to the Executive Environment Agency (Executive Environmental Agency) the share of wooden packaging is higher - between 85 and 92%, followed by the share of glass packaging. The wooden packages placed on the market from 2010 till 2019 are presented in Table 1.

Table 1. Placed on the market packaging, incl. wooden packaging, 2010-2019

Indicator/Year	2010	2011	2012	2013	2014
Total placed on the market, tone	**321197**	**314639**	**328797**	**350043**	**378668**
2010 = 100	100,0%	98,0%	102,4%	109,0%	117,9%
Incl. wooden packaging, tone	**18741**	**21444**	**20121**	**24725**	**48725**
2010 = 100	100%	114%	107%	132%	260%
in % from total, tone	5,8%	6,8%	6,1%	7,1%	12,9%
Indicator/Year	**2015**	**2016**	**2017**	**2018**	**2019**
Total placed on the market, tone	**392547**	**421145**	**453194**	**497493**	**554489**
2010 = 100	122,2%	131,1%	141,1%	154,9%	172,6%
Incl. wooden packaging, tone	**45612**	**51400**	**59589**	**65011**	**79649**
2010 = 100	243%	274%	318%	347%	425%
in % from total, tone	11,6%	12,2%	13,1%	13,1%	14,4%

Source: NSI (BG), EEA (BG)

The realization of the goals for a resource-efficient economy presupposes in their production activity the enterprises to realize continuous investments in fixed assets with ecological orientation, as well as to make expenses for ecological activities. In the wood products sector, there is a steady increase in the total cost for acquisition of tangible and intangible fixed assets with ecological purposes, to reach in 2019 (National Statistic Institute) up to BGN 4441 thousand (including for waste water - BGN 1075 thousand, for the air - BGN 2521 thousand and for forests - BGN 845 thousand). The costs for maintaining of tangible fixed assets with ecological purpose reach BGN 13588 thousand, incl. BGN 11631 thousand for waste recovery and treatment and BGN 949 thousand for forests. The total costs for environmental services (for collection and treatment of wastewater and waste) for the sector are BGN 1069 thousand, incl. BGN 996 thousand for waste.

Waste management continues to be a problem for the Bulgarian economy. In addition, Bulgarian companies will continue to incur environmental costs, which will affect the prices of their products. This implies a serious mobilization of public and private resources in order to speed up the transition to a sustainable and circular economy. The possibilities for reusable wood packaging and the implementation of a priority order of waste management, according to the objectives in the 7th Environment Action Programme (DECISION No 1386/2013/EU), are part of the successfully implemented measures within the environmental policy.

2.2. Sustainability of forest industry

Modern industrial production requires the use of technologies that are as environmentally friendly as possible. The sustainable approach to resources, the promotion of stable forest management, the implementation of ecological management systems and the guarantee of safe, usable packaging products are part of the implementation of environmental policy in the forest industry. The role of sustainable forestry requires a holistic approach to EU policies aimed at tackling climate change and promoting economic growth (European Parlament, 2020). The European wood processing industry is committed to harvesting timber from forests that are managed following environmental, economic and social principles of sustainability (CEI-Bois, 2020).

In order to preserve the already limited stocks of timber and to reduce their use, in countries with developed economies the inclusion of sources coming from recycling of waste wood products in material balances, apart from technological waste, is rapidly growing. Wood products can be reused, recycled and are a source of energy. In addition, wood produces minimal waste that can be used as a raw material or as an energy source (Beyer, et al., 2011). The reasons for such an approach are not only economic, they are also environmental and social, which determines the important place and attitude to these issues for our country presently and in the future.

According to Chobanova and team (Chobanova, et al., 2018), rational use of wood resources and protection of the environment can be achieved through the implementation of various measures, one of which is the organization of the production of ecological and at the same time resource-saving manufacture. The multiple reuse of wooden packaging can affect the conservation and reduction of the use of forest wood resources.

Thinking about sustainable development in packaging comes down to the use of recyclable and reusable wooden packaging and is linked to the entire supply chain - from raw materials to the final user. Operators placing timber and timber products on the internal market for the first time should, by using a systematic approach, take the necessary steps to ensure that products and those derived from illegally harvested timber are not placed on the same market. In order to meet these requirements, each operator applies measures linked to a system of documented procedures to assess the risk in order to minimize the likelihood of placing illegally harvested timber on the internal market. The due diligence system includes three elements inherent in risk management: *access to information, risk assessment and limitation of identified risk*. The due diligence system should provide access to information on sources and suppliers of timber and timber products placed on the internal market for the first time, including appropriate information on compliance with applicable legislation, country of harvest, tree species, quantity and - where appropriate, the sub-national region and the concession of harvest. Based on this information, operators should make a risk assessment. Where a risk is identified, operators should limit it in a manner proportionate to it in order to prevent the release of illegally harvested timber and timber products into the internal market (Regulation (EU) No 995/2010, 2010).

3. WOODEN PACKAGING AND THE CIRCULAR ECONOMY

The renewed EU Bioeconomy Strategy (European Commission, 2018) improving and expanding the sustainable use of renewable resources and allowing renewable raw materials and by-products to be converted into biologically-based products (e.g. reusable packaging, furniture, etc.). The transition to a circular economy, including a circular bioeconomy, is a huge opportunity to create a competitive advantage for the forest sector on a sustainable basis. The forestry sector is seen as one of the pillars of the European bioeconomy (Lovrić, Lovrić, & Mavsar, 2020). The importance of the forest-based industry for the transition of the economy to a circular model is increasing (Chobanova, Kotseva, & Mouchurova, 2019), improves cooperation in industry (Barčić, Kuzman, Haviarova, & Oblak, 2019), is important for small and medium-sized enterprises (D'Amatoa, Veijonahoa, & Toppinena, 2020), there are a number of industrial practices for waste recovery (de Carvalho Araújo, Salvador, Moro Piekarsk, Sokulski, de Francisco, & de Carvalho Araújo Camargo, 2019). Opportunities are created for: security regarding the wood resource; investments in new machinery, equipment, infrastructure, qualification of workers and staffing and last but not least for sustainable production, management and implementation of the intended use in forests.

According to the regulation on packaging and packaging waste in Bulgaria, the term "packaging" includes products used by each person in the chain from producers to end-users to hold, protect, handle, deliver and present any goods from raw materials to finished products (Naredba za opakovkite i otpadatsite ot opakovki (bg), 2012). It is important to note that the packaging meets the requirements that include as its integral part all related elements and auxiliary materials which actually build it up. The Ordinance on Packaging and Packaging Waste introduces the requirements in the Bulgarian legislation of Directive 94/62/EC of the European Parliament and of the Council on packaging and packaging waste. (Directive 94/62/EC, 1996). Persons who place packaged goods on the market shall take measures to recycle not less than 70% of the total weight of packaging waste, by recycling not less than 30% of the weight of wood packaging waste. General targets for treatment of packaging waste are aimed at: 50% of the weight of packaging waste generated during the same period to be recovered or incinerated in waste incineration plants with energy recovery; 49% of the weight of packaging waste generated during the same period must be recycled.

The analysis of packaging recycling in Bulgaria for the period 2010-2019 shows that there is a continuous trend of increasing quantities. The relative share of recycled packaging is in the range of 62-67%, which is around the EU average. The quantities of recycled wood packaging doubled - from 10 thousand tons in 2010 to 20,8 thousand tons in 2018. The share of recycled wood packaging in total packaging produced and placed on the market for the period is in the range of 4,3-7,5%. Despite the fourfold increase in wood packaging, there is a decrease in the relative share of recycled wood packaging compared to wood packaging produced from 53,8% in 2010 to 32,1% in 2018. This is a serious challenge for the Bulgarian wood processing industry. Despite this problem, the country is fulfilling its commitment to recycling more than 15% of wood packaging. The achieved recovery target changes from 54% in 2010 to 32% in 2018. Data on the dynamics of recycled packaging in Bulgaria; incl. wooden packaging from 2010 till 2019 is presented in Table 2.

Table 2. Recycled packaging, incl. wooden packaging, 2010-2019

Indicator/Year	2010	2011	2012	2013	2014
Total recycled packaging, tone	**197958**	**204938**	**218761**	**230069**	**234901**
% of recycled packaging	62%	65%	67%	66%	62%
Incl. wooden packaging, tone	**10074**	**8904**	**10676**	**14474**	**18421**
in % from total recycled	5,1%	4,3%	4,9%	6,3%	7,8%
in % from total produced	53,8%	41,5%	53,1%	58,5%	37,8%
set target for recovery	15%	15%	15%	15%	15%
achieved recovery target	54%	42%	53%	53%	58%
Indicator/Year	**2015**	**2016**	**2017**	**2018**	**2019**
Total recycled packaging, tone	**251723**	**268724**	**297213**	**325040**	n.q.
% of recycled packaging	64%	64%	66%	65%	n.q.
Incl. wooden packaging, tone	**14923**	**20058**	**19012**	**20869**	**n.q.**
in % from total recycled	5,9%	7,5%	6,4%	6,4%	n.q.
in % from total produced	32,7%	39,0%	31,9%	32,1%	n.q.
set target for recovery	15%	15%	15%	15%	n.q.
achieved recovery target	34%	39%	32%	32%	n.q.

Source: NSI (BG), EEA (BG)

Wood packaging is a particularly challenging waste stream in terms of achieving the EU's waste management targets by 2030, with almost doubling the recycling rate compared to 2012. (European Parliament, 2017). The targets of European (DIRECTIVE (EU) 2018/852, 2018) and national legislation (Naredba za opakovkite i otpadatsite ot opakovki (bg), 2012) for the recycling of wooden packaging are particularly challenging for the many Member States, including and for Bulgaria - the minimum target for recycling by the end of 2025 is 25%, and by the end of 2030 - 30% by weight of wood packaging.

Recycling is one of the possibilities of the waste management system and should be considered in the context of the overall waste management strategy. In doing so, the implementation of recovery and recycling activities must be supported by systematic action plans, and private initiative must be complemented by public participation.

4. CONCLUSION

Under the revised waste legislation of 2018, Europe is moving towards a circular economy. These new rules protect not only the environment but also the health of citizens and close the life cycle of products - from production and consumption to waste management. The production and marketing of packaging are part of these policies. One of the basic principles of the circular economy is to maximize the "return" of packaging waste to the economy. Wooden packaging industry can be crucial to achieving the goals of the so-called circular economy, through the development and implementation of effective tools for the production of environmentally friendly packaging, and actions should be aimed at reducing the use of packaging materials and priority use of reusable packaging, which makes wooden packaging a sustainable example of the whole concept.

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POLICY DECISIONS ON THE FOREST SECTOR GLOBALIZATION

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Abstract. Globalization requires a sustainable development strategy. The current stage of globalization is accompanied by an enormous development of the productive forces of mankind and its rapid growth. Unregulated development can cause environmental destruction and threaten life on Earth. The material and ecological resources of the planet are not unlimited. The reserves of oil, gas, ore, minerals, arable land and forests are limited. These limits impose a natural limitation on humanity's drive for unbridled growth. Forests remain one of the main components of the planet's ecosystem. The quality of the environment largely depends on the presence and condition of forests. Forests play an extremely important and multifaceted role in ensuring sustainable socio-economic development of human society. Forests stabilize natural processes, regulate climate, perform soil protection, water conservation, sanitary, hygienic, recreational and many other environmental and social functions. The Food and Agriculture Organization of the United Nations (FAO of the UN) estimates that forests currently cover about 30% of the world's land area. The total area of forests is over 4 billion hectares. Every year humanity loses more than twenty million hectares of forest area. Degradation and loss of forests cause local, regional and global environmental problems. The world community needs international legal regulation of forest. The recognition of the global role of forests is reflected in several international conventions and treaties. Sustainable forest management is critical to economic and social development, environmental protection and sustaining life on the planet. All UN member states are encouraged to coordinate approaches to forest conservation and protection. Russia is a member of the UN. It actively participates in the legislative mission to implement the assumed international obligations.
Keywords: sustainable development, environment, forestry, greening of economy

1. INTRODUCTION

Sustainability has three dimensions: economic, social and environmental. These three components are in constant dialectical contradiction and form the general trend of development. This trend may or may not be sustainable and lead to economic, environmental or social disaster. The concept of sustainability is similar to the concept of the noosphere, put forward by the Russian (Soviet) scientist V.I. Vernadsky in the middle of the twentieth century.

The Club of Rome has made an enormous intellectual contribution to the problem of sustainability. This international public organization was founded by the Italian industrialist Aurelio Peccei in 1968. The club brings together representatives of the world political, financial, cultural and scientific elite. The main mission of the club was publication of reports to draw attention of the world community to the global problems of mankind. The Club's first report, "The Limits to Growth", was published in 1972 and caused shock in political, environmental and social circles. Model studies have shown that the further development of mankind with physically limited resources of the Planet will lead to an ecological catastrophe in the 20s of the 21st century. The report awakened the ghost of Thomas Malthus, who made similar predictions in the 1798 Essay on the Law of Population. Experts in different fields made calculations and calculated for how many more years the Earth will have enough oil, gas, drinking water and arable land. Earth was compared to a spaceship with limited supplies for the crew's life support. Strategies for "sustainable development" more often resembled a doctor's recommendation to prolong the agony of a doomed patient. The emphasis was often placed on the need for a forced reduction of the global population [1].

An updated and expanded version of the report was presented to the public in 2004 " Limits to Growth: The 30-Year Update". The research paper "A Comparison of the Limits to Growth with Thirty Years of Reality" was published in Australia in 2008. It showed that the changes that have taken place over the past thirty years after the publication of the Club of Rome report are in line with forecasts of economic and social collapse in the twenty-first century [2].

In June 1972, the United Nations Conference on the Environment was held in Stockholm. The main content of the conference was the relationship between the economy and the environment. The USSR did not take part in the 1972 Summit out of solidarity with the GDR, which was not allowed by the Western powers to participate in the conference. USSR did not attach much importance to the Summit, since it believed that there are no ecological threats to growth under the planned socialist economy.

Meanwhile, the 1972 Summit was an important turning point in the formulation of a strategy for human development. It adopted important documents, including: (1) Declaration of 26 principles, (2) an Action Plan with 109 recommendations, (3) a recommendation for the establishment of the UN Environment Program - UNEP. These documents, like most UN documents, were not legally binding and had no enforcement mechanisms. As a result of the Summit, governments established the United Nations Environment Program (UNEP). Today it is the world's leading institution for environmental safety.

As a result of the 1972 Summit, states at the government level have joint their efforts in solving environmental problems that threaten further economic growth and the ecology of the Planet. State environmental policy, strategy, diplomacy, and law have emerged. National ministries and departments for environmental protection began to multiply. They were no more than a dozen before the summit [3].

In 1987, the World Commission on Environment and Development (WCED) published its report "Our Common Future". It is also known as the Bruntland Report, named so after the head of the commission. She was the prime minister of Norway at the time as well. The report defined sustainability as “development that meets the needs of the present, without compromising the ability of future generations to meet their own needs.” This definition has become popular and was widely cited.

2. INTERNATIONAL POLICY DECISIONS FOR SUSTAINABLE FOREST MANAGEMENT

In 1992, twenty years after the 1972 Stockholm Summit, a new United Nations Conference on Environment and Development (UNCED) was held in Rio de Janeiro (Brazil), abbreviated as the Earth Summit or the Rio Summit. The Summit confirmed the main findings of the Brundtland Report. It adopted three most important documents: (1) the Rio Declaration on Environment and Development; (2) Agenda 21; (3) Forest principles. In addition, two important binding agreements were opened for signature: Convention on Biological Diversity (CBD); and the Framework Convention on Climate Change (FCCC).

For the world forest community, the main document of the 1992 Summit is the Forest Principles. The full title of the document is: Non-legally binding authoritative statement of principles for a global consensus on the management, conservation and sustainable development of all types of forests. These principles laid down a unified basis for the formation of forest policies, strategies and plans of states to achieve sustainable management of all forests in the world in the context of rapidly growing globalization. In accordance with the declared principles, states have the sovereign and inalienable right to use their forests, manage them and conduct forestry in accordance with their needs and the level of socio-economic development on the basis of national policies that do not contradict the principles of sustainable development and current legislation. Forest principles have formed the framework content and conceptual approaches to the development and implementation of the national forest policy in the context of its globalization. After the UN Conference in Rio de Janeiro, the process of globalization of forest policy developed in the following directions:

1. Creation and development of institutions that carry out the interaction of states at the global level.
2. Organization and implementation of international negotiation processes on sustainable forest management at the regional and subregional levels,
3. Bringing national forest policies and forest legislation in line with the principles of sustainable development and forest principles.

There is an agreement among countries to assess the sustainability of forest management. The result of such agreements was the Pan-European (or Helsinki process) for European countries, the Montreal process for countries with temperate and boreal forests.

The Montreal Process in 1994 began as a result of the adoption of the Forest Principles by the 1992 Summit. It is also known as the "Working Group on Criteria and Indicators for the Conservation and Sustainable Management of Temperate and Boreal Forests". During the Montreal Process, the following basic definitions were agreed upon:

- criterion - a category of conditions or processes on the basis of which sustainable forest management can be assessed;
- indicator - a measure (measurement) of one or another side of the criterion.

Following the 1992 Earth Summit, the UN founded the Intergovernmental Panel on Forests (IPF) and later its successor, the Intergovernmental Forum on Forests (IFF) to implement the Forest Principles and Chapter 11 of Agenda 21 on "Combating Deforestation". During 1995-2000, IPF/IFF developed forest sector issues including deforestation, traditional forest knowledge, international cooperation, financial assistance, technology transfer, development of criteria and indicators for sustainable forest management, trade and the environment. In 2000, the UN Economic and Social Council (ECOSOC) established UNFF with the aim of "... the management, protection and sustainable development of all types of forests and strengthening the long-term political commitment of countries in this regard ..." following the IPF/IFF and other milestones in the development of international forestry policy.

In 2000, the UN headquarters in New York hosted the Millennium Summit to discuss the role and tasks of the UN in the third millennium. It brought together the largest number of world leaders in history. The Summit adopted the Millennium Declaration and the Millennium Development Goals (MDGs). They focused on the global issues of the new millennium, in particular the equitable distribution of the benefits of globalization while preserving the human environment goals.

In 2002 in Johannesburg, South Africa, thirty years after the Stockholm Summit and ten years after the Rio Summit, held the World Summit on Sustainable Development (WSSD), abbreviated as Earth Summit 2002 or Rio + 10. The summit was convened to discuss sustainable development. The final Johannesburg Declaration, together with other international agreements, laid down the "Johannesburg Implementation Plan" for the decisions taken.

In 2012, twenty years after the Rio Conference on environment and development, the next summit took place - the United Nations Conference on Sustainable Development (UNCSD), abbreviated as Rio +20. The formal discussion focused on two main themes: (1) how to build a green economy to achieve sustainable development, eradicate poverty and help developing countries to embark on a green path out of poverty; (2) how to improve international coordination to create an institutional framework for sustainable development.

The main document of the summit was a 49-page text titled "The Future We Want". In this document, 192 heads of government reaffirmed their political commitment to sustainable development and a sustainable future. The document was a confirmation and development of already existing action plans, such as the "Agenda 21" adopted by the 1992 Summit. Other results included:

- Supporting the Sustainable Development Goals (SDGs) after the end of the Millennium Development Goals (MDGs) in 2015, in response to criticism that the previous goals underestimated the environmental factor in economic development.
- Attempting to make UNEP a leading environmental force by allocating more financial resources, strengthening governance and giving more important coordination functions.
- Agreement by governments to explore possible alternatives to a modern Gross Domestic Product (GDP) indicator for accounting for environmental, social factors and assessing nature's environmental services, including biodiversity and carbon sequestration.
- General recognition that "fundamental shifts are necessary in social production and consumption to achieve global sustainable development". The UN believes that this could lead to tax shifting on pollutants and landfills.
- Call on governments to urgently return ocean stocks to sustainable levels and implement science-based plans to do so.
- Country commitments to end fossil fuel subsidies.
- More than 400 voluntary commitments by countries to sustainable development.

The final document "The Future We Want" has caused controversy between government delegations and civil society organizations. Representatives of public organizations with the participation of anti-globalists attending the Summit at the plenary session "retracted" from the text of the final document, considering it weak and inadequate. They demanded that the phrase "with the active participation of civil society" should be removed from the document. At one of the actions, representatives of civil society "thanked" the organizers of the Summit for giving large corporations the future they want. It should be recognized that, despite international obligations, many governments do little to fulfill their global obligations, except for the adoption of relevant national acts and documents.

3. PARTICIPATION AND ROLE OF THE INTERNATIONAL ORGANIZATIONS

On December 17, 2007, the UN General Assembly approved the Non-Binding Document on All Types of Forests, which countries agreed earlier this year at the UN Forum on Forests (UNFF). The objectives of the new instrument were:

- Strengthen political commitment and action at all levels to implement effective sustainable management in all types of forests and achieve the global goals on forests;
- Strengthen the contribution of forests to the achievement of international development goals, primarily the Millennium Development Goals (MDG), in particular environmental stability and poverty eradication;
- Provide a common framework for national action plans and international cooperation.

The UN did not provide for the allocation of any international funds to finance the non-binding agreement. It was assumed that the obligations under the agreement were funded by the national governments themselves on a voluntary basis. However, in April 2001, to support UNFF activities and the implementation of the non-binding agreement ECOSOC (ECOSOC Resolution E/2000/35) established a special mechanism for cooperation of UNFF member countries called the Collaborative Partnership on Forests (CPF) in April 2001. CPF membership includes 14 leading international organizations of the UN system:

- Center for International Forestry Research (CIFOR)
- Food and Agriculture Organization of the United Nations (FAO)
- International Tropical Timber Organization (ITTO)
- International Union of Forest Research Organizations (IUFRO)
- Secretariat of the Convention on Biological Diversity (CBD)
- Secretariat of the Global Environmental Facility (GEF)
- Secretariat of the United Nations Convention to Combat Desertification (UNCCD)
- Secretariat of the United Nations Forum on Forests (UNFFS)
- Secretariat of the United Nations Framework Convention on Climate Change (UNFCCC)
- United Nations Development Program (UNDP)
- United Nations Environment Program (UNEP)
- World Agroforestry Center (ICRAF)
- World Bank (WB)
- International Union for Conservation of Nature (IUCN).

All of these organizations participate, within their mandate, in coordinating the activities of states on sustainable forest management. CPF coordinates the efforts of partner organizations to implement UNFF solutions.

UNFF does not have a UN mandate to design and implement forestry and investment programs. This role is assigned to the governments of interested countries with the involvement of their own and borrowed funds, with the help and participation of CPF organizations, banks and the private sector. The coordinating role of the CPF is of great importance in this process.

In September 2015, at the historic UN summit, world leaders adopted the program: "The 2030 Agenda for Sustainable Development" [4]. This program consists of 17 Sustainable Development Goals (SDGs) and 169 targets. The UN Program works closely with the Forest Stewardship Council (FSC), which contributes to the achievement of a significant part of the sustainable development goals. The interaction of these concepts, in turn, contributes to the sustainable economic development of the country.

4. RUSSIAN POLICY DECISIONS FOR SUSTAINABLE FOREST MANAGEMENT

Russia has actively joined the legislative mission to implement the international obligations it has assumed. This is evidenced by the following list of documents:

- Order of the Government of the Russian Federation No. 1522-p of August 19, 1992 on the creation of an interdepartmental commission to develop proposals for the implementation of the decisions of the 1992 Summit. However, the implementation of the plan required a significant restructuring of the economy, which was physically impossible in the 90s.
- Decree of the President of the Russian Federation No. 236 of February 4, 1994 "On the state strategy of the Russian Federation for environmental protection and sustainable development".
- Decree of the Government of the Russian Federation No. 496 of May 18, 1994, approved the Action Plan of the Russian Federation on environmental protection for 1994-1995. The plan

provided for the preparation and implementation of 96 measures for the preparation of legislative and other legal acts, as well as targeted programs for solving environmental problems in the country.

- Federal Law No. 16-FZ of February 17, 1995 "On Ratification of the Convention on Biological Diversity".
- Federal Law No. 34-FZ of November 4, 1994 "On Ratification of the Framework Convention on Climate Change".
- Government Decree No. 155 of February 19, 1996 approved the 1996-1997 Action Plan in the field of environmental protection and natural resource use.
- Decree No. 440 "On the Concept of the Russian Federation's Transition to Sustainable Development".
- Resolution of the Government of the Russian Federation No. 559 "On the design of a draft state strategy for sustainable development of the Russian Federation"
- Project "Medium-term program for 1997-2000. Structural adjustment and economic growth".

Russian Forestry responded to the UN call and Russia's international obligations with the following documents:

- The concept of sustainable forest management in the Russian Federation, approved by the IV All-Russian Congress of Foresters in 1998.
- Criteria and indicators of sustainable forest management in the Russian Federation were introduced by order of the head of Rosleskhoz in 1998.
- The system of compulsory certification of standing timber and secondary forest resources 1999.

However, in 2000 the Federal Forestry Service was liquidated. A process has started to replace the 1997 Forest Code with a new one that is more market-oriented, economic and entrepreneurial in the forest. The system of unified forest management in the country was destroyed. Accordingly, the developments of the Government and the former Forestry Service remained on paper.

After the adoption of the new Forest Code of the Russian Federation [5], the question arose about the instruments to be used to bring international obligations on sustainable forest management to the attention of the forest operators.

The Forestry Code of 2006 in Chapter 10 "Management in the field of use, custody, protection and reproduction of forests" named these instruments in the following order:

- forest plan of the constituent entity of the Russian Federation,
- forestry regulations,
- forest development project,
- state or municipal expertise of a forest development project,
- state inventory of forests,
- state forest register,
- state cadastral registration of forest areas,
- state forestry control and supervision.

Unfortunately, none of the above instruments, based on their declared name, is responsible for the implementation of the international obligations of the Russian Federation according to the principles of global forest policy and sustainable development of the forest sector. The Forestry Code of 2006, in contrast to the Code of 1997, generally ignored the issue of the priority of fulfilling international obligations in the field of forest management and forestry in the development of forestry legislation. This priority was established earlier by the Forest Code 1997 [6] in the Article 3 as follows: "International treaties of the Russian Federation apply to relations arising in the use, custody, protection and reproduction of forests, directly, except for those cases when for the application of an international treaty requires the adoption of a domestic legal act. If an international treaty of the Russian Federation establishes rules other than those provided for by this Code, the rules of the international treaty shall apply". It should be noted that almost all of the above tools have been moved down at the regional level, which have got the main powers in the field of forest relations.

Among the powers that the Russian Federation holds (Article 81), there are no such instruments for the Russian Federation to benefit from the international processes. Strategic planning can play this role, as it is indicated by the international experience.

Currently, the implementation of sustainable development goals in Russia is carried out through a set of projects under the Decree of the President of the Russian Federation of May 7, 2018 No. 204 "On national goals and strategic objectives of the development of the Russian Federation for the period up to 2024" [7]. The decree defines 9 national development goals of the country and outlines the key provisions of 12 national projects. These projects now assume the role of national forest strategy for sustainable development of the country, ensuring a balance of economic, environmental and social goals.

National forest project "Ecology" was created in Russia for the period from 2018 to 2024. Its total budget exceeds 4041 billion rubles [8]. This project should reduce the negative human impact on the environment. It includes 11 federal projects aimed at eliminating illegal landfills, reducing air pollution, improving the quality of drinking water, and increasing the forest area. One of these projects is the Forest Conservation project, which should be implemented at the regional level [9].

4. CONCLUSION

Since the early 1990s, the fate of the world's forests has ceased to be the subject of the interests of only a narrow circle of forestry and environmental protection specialists. An important direction in the process of globalization of forest policy has become the agreements of countries at the level of individual regions on assessing the sustainability of forest management and monitoring how forests in individual countries fulfill their ecological, economic and social functions. The Russian Federation, being a participant in all international processes shaping the global forest policy, has assumed the corresponding obligations on sustainable forest management and sustainable development of the forest sector.

The ongoing globalization in the Russian forest sector will inevitably lead to the greening of production. The existing demand for forest products within the country is not stimulated by the governmental programs, unlike, for example, the automotive industry. The purchasing power of the population remains generally low. The mechanisms of financial support for the population and incentives for the market wood products remain undeveloped. Russia's obligations and agreements under international treaties require additional costs and will reduce the already low profitability of the wood industry. The investment climate in Russia remains at an extremely low level. In these conditions, one can hardly hope for an influx of foreign advanced technologies and know-how in the country. All this is largely a consequence of the lack of a purposeful state strategy and planning in the field of custody, protection, reproduction and use of domestic forests. These policies, strategies and plans should be based on advanced management practices, stimulating demand and attracting domestic and foreign investment in the country's green economy.

Political decisions to ensure sustainable forest management should be aimed at solving the most pressing issues of national forest policy and at harmonizing national forest legislation with the international law. The most relevant areas of development of legal support include:

- adaptation of forestry legislation to market economy conditions
- contracting forest production in the field of protection, use and reproduction of forest resources;
- synchronization of preparation and adoption of the federal laws and by-laws necessary for the full functioning of forestry legislation.

The adaptation of forestry legislation to the conditions of a market economy should be carried out with the unconditional preservation of the priorities of the laws of nature over economic laws. It is advisable to include among the priorities the following areas:

- improvement of the legal framework necessary for the implementation of the adopted forest policy;
- formation of a system of strategic planning for the development of the forest sector;
- creation of favorable conditions for investment and strengthening of state support for the forestry sector.

In order for the forest legislation of the Russian Federation to correspond to its status of the largest forest power, it must develop policies considering the world experience and modern trends.

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STRATEGIC PLANNING AS A TOOL OF SUSTAINABLE FOREST MANAGEMENT

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Abstract. In the context of the forest policy globalization, strategic planning becomes one of the most important tools for sustainable forest management. Forestry is characterized by a long growth period. It predetermines the need to develop long-term strategic forecasts and plans for the development of forest resources, protection and replanting, timber supply and demand. The development of forest markets requires to balance supply and demand of forest resources. A strategic approach to forest planning requires formulation of a development goal. It should be based on the analysis of external and internal factors. It demands alternative scenarios for developing the forest sector. Monitoring and adjusting the strategic plans should take into account changing conditions. Almost all developed economies have strategic plans for developing their national forest sectors. They provide linkage and coordination of forest development and other economic branches. The planning process is to be consistent with financing, legal and organizational regulation of the economy. The main strategic goal of forest planning is to increase its contribution to sustainable social, economic and environmental development of the nations. Achieving this goal involves the use of market leverage. As an example, two countries are compared - the USA and Finland. Their experience in forest strategic planning can be interesting and useful for other nations.
Keywords: forestry, strategy, programs, planning

1. INTRODUCTION

There are many definitions of strategy and strategic planning. The pioneer and classic of strategic planning I. Ansoff in his work "New corporate strategy" defined the strategy as "one of many sets of decision-making rules regarding the behavior of the organization" [1]. More often, strategic planning is defined as a function of strategic management, which is the process of choosing the goals of an organization and ways to achieve them. An essential element of developing a strategy and strategic planning is the selection and setting of goals, and the setting of development priorities.

Preparing a strategic plan is a multilevel process. It covers several stages, including the following: vision, mission, values, goals, external environment, strengths and weaknesses, strategies and programs. Vision is the first step. It is presented in the form of a description of the subject of planning in the future in terms of its desired size, type, activity, etc. In other words, it is necessary to look into the future and see markets, customers, processes, location, etc. The mission identifies the goals and activities of the planned entity. When developing it, it is necessary to analyze all the details and express the mission shortly, realistically and reasonably. Values show the relationships with society, customers, employees, local community, etc. The goals clearly state the end results to be achieved in the long term. The analysis of the external environment examines the factors that pose a threat to the current business strategy and the factors that make it possible to achieve goals through changes in plans (economic, political, market, competitive, etc.). Analysis of strengths and weaknesses is necessary to understand whether the subject has sufficient internal resources to take advantage of external opportunities. Strategies are rules and guidelines by which missions and goals can be achieved. Programs are the ultimate element. They outline plans for the implementation of key strategies. They should cover resources, goals, time frames, timelines, budgets and targets. Of course, all of the above elements (vision, mission, values, goals, external environment, strengths and weaknesses, strategies, programs) must be interconnected and consistent with each other.

The planning horizons depend on the subject and the object of planning. As a rule, the larger the complex object, the more global is the goal and the longer is the planning horizon. Strategic planning can span many decades for the national states. Large companies have global goals and long horizons. Small companies may have may be several years horizon or less, given the dynamism and volatility of today's markets. Mitsubishi, for example, has developed a strategy for 500 years ahead.

2. BACKGROUND

Forestry is known to be characterized by a long reproduction period. This predetermines the need to develop long-term strategic forecasts and strategic planning for the development of forest resources, custody, protection and reproduction of forests, supply and demand for forest products, development of forest products markets and ensuring the right balance of supply and demand for forest resources.

The planning horizons in the forestry sector make up decades. Developers are usually multidisciplinary teams, which represent different specialties, practitioners, politicians and civil society groups of interests. The inputs for developing the forest plans are economic, environmental and social indicators. The output is the achievement of the setup strategic goals and priorities.

Currently, almost all countries that have developed forest sector have official strategic forest plans. Their experience should be interesting and useful for the other countries.

By 1950s, the United States and Finland, after many years of predatory exploitation of their forests, had essentially depleted their forest resources. Thus they were forced to radically change their forest policies. They have strengthened the role of the state in forest management and passed it three major functions: (1) initiator, (2) organizer and (3) coordinator of all forest-related actors. Forest entities include governmental agencies, businesses, banks, research and the population. The population is not homogeneous. It is usually represented by public organizations with different levels of trust in government bodies and big business. The results of the concerted actions were the following: (1) formulation of the state forest policy at all interrelated levels of management, (2) the formation of forest relevant forest legislation, and (3) the development of strategic forest plans and mechanisms for their implementation. In the United States, this work was carried out by the Federal Forest Service under the Department of Agriculture (USDA Forest Service) oversighted by the Congress. In 1949 Finland has created for the same purpose a state committee for the improvement of national forests under the leadership of Academician Y. Ilvesallo, a forest manager by profession [2]. In recent years, these countries have taken a consistent course towards environmentally sustainable multipurpose forest management. Forest management and forest planning are fully subordinated to this course.

3. US EXPERIENCE OF THE STRATEGIC FOREST PLANNING

The Forest Service is a department of the US Department of Agriculture (USDA). Since its inception in 1905, it continuously provides analysis and strategic planning of the national natural resources. National forecasts of 1958 and 1970 are milestones on this analysis [3, 4].

The Resources Planning Act (RPA) Assessment reports on the status and trends of the Nation's renewable resources on all forests and rangelands, as required by the Forest and Rangeland Renewable Resources Planning Act of 1974. The USDA Forest Service has conducted natural resource analyses for over a century. The 1974 RPA legislation established a periodic reporting requirement and broadened the coverage to all renewable resources on U.S. forests and rangelands. The RPA Assessment includes analyses of forests, rangelands, wildlife and fish, biodiversity, water, outdoor recreation, wilderness, urban forests, and the effects of climate change on these resources. [5, 6].

The current plan for 2010 is titled The Future of America's Forests and Ranges: A Forest Service Assessment under the 2010 Resource Planning Act. This is the fifth plan since the approval of the Planning Act (RPA) in 1974. The plan is an assessment of the current state and conditions of maintenance of forests and rangelands in the United States (all types of property). It identifies the driving forces behind changes in natural conditions and predicts the effects of the influence of these forces 50 years ahead until 2060. The report offers several alternative development scenarios. The input to the scenarios is population growth, global and national economic growth, demand for wood products and energy, land use change and climate change. The main report is accompanied by a variety of special case publications, general technical reports (GTR) and journal articles. The main findings of the report are as follows:

Further development of land infrastructure will threaten the integrity of ecosystems. Climate change will change ecosystems and reduce their capacity to produce food and utility. Competition for the use of products and services of natural ecosystems will increase. Geographic variations in the response of resources to external forces will require adaptation of regional and local strategies to the local conditions in order to properly manage change in the most favorable and least harmful direction. The results of the plans should be used by forest managers and policymakers at all levels to adapt local strategies for sustainable natural resource management.

The content of the report is presented in fourteen chapters. Following the introduction, the main findings of the assessment are presented in the first two chapters. The second chapter analyzes end-to-end relationships between resources. The third chapter covers each resource separately. Chapters four and five describe global trends and future scenarios for forecasting.

Chapters 6-14 present conclusions for individual resources or resource sectors. They start with historical data from previous forecasts. Changes in trends are of particular interest, since the future forecast is linked to historical development. Future conditions, demand and supply are projected for the next 50 years (from 2010 to 2060) for all resources with sufficient baseline data. The forecasts do not include any policy changes. The five-year update should assess the potential effect of the policy change on the future of resources and adjust the forecast. The final document summarizes the results of more detailed technical forecasts and accompanying documents. These original forecasts and documents provide more detailed information on data, methods and results of the forecasting. All reports are made available on the USDA Forest Service website.

It is necessary to note the close interaction of the Forest Service with other agencies in the preparation of the Resource Planning Act (RPA)Assessment. The Forest Service concentrates only on those resources where it has sufficient research potential. It also draws on the expertise of other federal agencies that are responsible for other resources and often refers to their analytical reports. For example, Resource Water Quality Assessment relies on data from the Environmental Protection Agency. The RPA Assessment does not analyze renewable energy, with the exception of wood energy, as the Department of Energy conducts a comprehensive analysis of the country's energy sector. The forest resource assessment does not summarize existing research on the status and trends of renewable resources, but instead examines the many interacting factors that may affect natural resources in the future. This focus is a unique contribution that provides policymakers and managers with the information they need to design meaningful strategies and plans.

The authors of the forecast emphasize that the results are not inevitable. They are based on the assumption that the current policy remains unchanged and will be adjusted along with changes in the resource policy during the entire forecasting cycle. The forecast notes that there are many methods that resource policy and management strategy can use to change unfavorable trends. Changes in markets, technologies, trade flows, governmental policies, social values will all play an important role in adjusting the impact of adverse factors. Today's markets are efficient enough to stimulate goods, but they are not effective for enhancing the ecosystem values. Paying for ecosystem values theoretically may motivate landowners to maintain natural values, but sufficient progress has not yet been made in this area. Other programs, such as the promotion of land conservation and trade in land use permits, can also contribute to the sustainable development of forests and pastures. Timely action is needed on the part of politicians and managers. The results of the forecast provide only a scientific basis for the decision-makers.

4. FINNISH EXPERIENCE OF THE STRATEGIC FOREST PLANNING

In addition to the USA, the experience of Finland in forecasting and strategic planning of the forest sector is also interesting. Finland is a small, but advanced country in sustainable forest management and a close neighbor of Russia.

The forestry and timber industry in Finland has traditionally been the leading sectors of the Finnish economy. These industries laid a solid foundation for the impressive economic successes of this country in the post-war years.

Finland's forest policy is based on forest planning and the activities of forest organizations. Planning is carried out both at the regional and country level, taking into account environmental, economic and social aspects [7].

Initially, the forest productivity targets were addressed in the programs TEHO (1961), MERA I (1964) and MERA III (1969). All programs, as well as USA (RPA) assessments, had a long-term and alternative character [8, 9].

The MERA III program considered four alternatives that predicted the development of the forest sector from 1970 to 2015. The lowest (initial) program kept the costs of forestry at the level of 1968. The highest (maximum program) assumed the highest level of costs and the most complete realization of the biological potential of forest plantations. Between these two forecasts, two other alternatives were embedded: program minimum and MERA. The latter was recommended as an optimal program, since a more complete realization of the biological potential of nature required increased costs and thus reduced the amount of net income.

Sustainable forest management was ensured by tightening legal norms and strengthening state control over all forest owners. At the same time, the main role was assigned to economic levers, including government subsidies, preferential taxation and lending.

In 1985, Finland presented a new program "Forest-2000". It was focused primarily on the efficient use of the potential of forest resources, achieved through the strategic forest policy of the previous years. According to this program, the stock of wood by 2000 compared to 1985 was supposed to increase by 5%, and by 2020 - by 10%. Annual growth, respectively, increased by 6 and 12%, the share of pine grew up to 50 and 65%. The annual volume of felling by the end of the planning period increased by 20, and thinning - by 40% [10].

The main part of the increase in growth (60%) and the annual reserve, as in previous programs, was obtained by Finnish foresters by replacing two-thirds of forests with elite plantations, taking into account their optimal fitting to the growing conditions. Approximately 20% of the increase was provided by drainage of waterlogged forests and the introduction of fertilizers.

In 1998, the Finnish government approved a new national program "Forest 2010". The new program attempted to balance the economic, environmental, social and cultural aspects of sustainable forest management. The development of the new program was initiated by the following main reasons: (1) A sharp decline in early 1990s of the government subsidies to private forest owners in the wake of the economic recession; (2) The previous Forest 2000 program did not fully meet the economic and environmental situation of the 1990s and therefore did not enjoy sufficient political support within the country; (3) Changes in forestry legislation [11].

The success of these programs can be seen in Finland's improved forest statistics. The country's statistics testify high efficiency of silvicultural and logging programs. The current concern is no longer the depletion of forests, but the excessive accumulation of timber reserves. According to many foresters, rational forest rejuvenation would significantly increase the use of solar energy by the trees, and, consequently, their annual growth. An obstacle lays is the constant decline of the interest of small Finnish forest owners in the rational use of their land due to increased wealth and alternative income. In addition, the current situation in international markets is unlikely to allow Finland to implement its development plan in the near future.

In contrast to the American forecast estimates (RPA), the Finnish programs (TEHO, MERA, Forest-2000, etc.) were state programs, a kind of governmental business plans. They were substantiated in detail and supported by the necessary financial, administrative and legal resources, which became the key to their successful implementation.

In February 2015, the National Forestry Strategy of Finland was adopted, which defined the main goals of the forest sector until 2025 (updated in 2019) [12]. At the regional level, regional forestry programs have been developed, taking into account their future development.

5. CONCLUSION

The structure of the strategic plans of foreign forest services is quite homogeneous and contains the following main sections:

- mission of national forest services and their main functions;
- general goals and objectives of forest services, consistent with their main functions;
- ways to achieve the goals and objectives of the forest services, the necessary financial, labor, information and other resources;
- key external factors, which are outside the control of forest services, that influence the achievement of the goals;
- methods for monitoring and revising the strategic forest management plans.

The central idea of these long-term programs (strategies) is to find ways to significantly increase the production of wood-processing industries based on an increase in forest productivity. Their development, carried out by the largest specialists in Finland (with the participation of professors Ervasti, Heikinheimo, Kuusela, Mäkinen, etc.) has convincingly shown what huge reserves in increasing the productivity of forests can be revealed by science and the practice based on it.

Of course, the revolutionary aspect of forest planning in these countries was the advanced planning technology based on participation of all subjects of forest relations, including the general public. Whereas in the past these plans were heavily dominated by technocratic approach without public participation.

The experience of these countries shows that public discussion of projects has a positive impact on the decision-making process, making it more transparent. Involving representatives of target groups, such as officials, entrepreneurs, public figures and local citizens in the planning process, creates the preconditions for harmonizing different interests and helping to avoid possible conflicts.

The measures taken to strengthen the role of the state in forest management and the development of strategic forest planning both in the United States and in Finland have provided a truly breakthrough in the development of the forest sector of the economy, which has become an example for other countries.

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KEY CONCEPT OF INDUSTRY 4.0 IN PRODUCTION MANAGEMENT IN SLOVAK WOOD PROCESSING INDUSTRY

Patrik Richnák

Abstract: The industry is experiencing global change with the emerging Industry 4.0. This new key concept is fundamentally changing the shape of not only business processes but also the entire company. Technologies of a physical, virtual or combined nature are coming to the fore and are also affecting production management in every company. The main purpose of implementing Industry 4.0 in production management is to modernize, robotize and digitalize the production process in order to ensure more efficient and higher quality production at lower costs. The aim of the paper was to identify the key concept of Industry 4.0 in production management in the Slovak wood processing industry based on the knowledge content and a questionnaire survey. In the theoretical part of the paper, we obtained information and knowledge related to the topic of the paper from journal and conference sources. In the practical part of the paper, the questionnaire survey of 52 wood processing companies operating in Slovakia was evaluated.
Keywords: digitalization, Fourth Industrial Revolution, Industry 4.0, production management, Slovak industry

1. INTRODUCTION

The Fourth Industrial Revolution began in the 21st century and represented the integration of ICT with production processes and activities. Smart factories have automated processes and activities, digital business operations and information support on all organizational levels. The digital environment includes business partners, suppliers, buyers, users and the market with which the smart factory communicates through the Internet (Fonseca, 2018). The Fourth Industrial Revolution, also labelled Industry 4.0, was beget with emergent and disruptive intelligence and information technologies. These new technologies are enabling ever-higher levels of production efficiencies. They also have the potential to dramatically influence social and environmental sustainable development (Bai et al., 2020). The never ending digital transformation converts organizational and management concepts into operational reality, within which hierarchical structures are less and less applied and new trends from the sphere of management dominate (Čambalíková, 2021). The Fourth Industrial Revolution marks a new qualitative leap in industrial production by linking people, machines and products through the creation of a new production system that enables faster and more targeted information exchange. This change is moving towards a future in which humans will collaborate with robots and will be supported in their work activities by web-based technologies and intelligent assistance systems. (Gorecky et al., 2014).

The term Industry 4.0 stands for the Fourth Industrial Revolution which is defined as a new level of organization and control over the entire value chain of the life cycle of products; it is geared towards increasingly individualized customer requirements. Industry 4.0 concerns the strict integration of human in the manufacturing process so as to have continuous improvement and focus on value adding activities and avoiding wastes (Vaidyaa et al., 2018). Industry 4.0 is characterised by the merging of technologies that blur the boundaries between the physical, digital and biological spheres (Čambalíková, 2020). Salkin et al. (2018) state that, in terms of manufacturing and service management, Industry 4.0 focuses on the creation of intelligent and communication systems, such as machine-to-machine and human-machine interactions that deal with the flow of data from intelligent and distributed systems.

The concept of Industry 4.0 focus on the interaction of production side. Based on strong industrial base, it integrates information and communication technologies, and aims to build smart factory and intelligent production. The focus is on creating smart products and processes that place greater emphasis on Internet of Things (IoT) and control logic. To a certain degree, Industry 4.0 hopes to reduce labour costs through intelligentialize (Zhou and Le Cardinal, 2019). Intelligent manufacturing is due to increased requirements following the modernization of modern production systems by integrating all the elements needed to make the decisions of a common system. Because there is a need to process large amounts of production data, intelligent capabilities work on sensors, intervene and make decisions with or without human intervention (large data analysis, machine learning, cloud computing) (Türkeș et. al., 2019). Digital transformation is the use of technology to radically improve the performance or impact of businesses (Čambalíková and Szabo, 2020).

Industry 4.0 and its associated technologies are increasingly being presented as essential to improving the productivity of manufacturing companies. By focusing on instant communication between machines and objects, it is possible to make manufacturing systems more flexible to product changes and more responsive to unexpected events (Rosin et al. 2019). Industry 4.0 technologies can benefit operations management in several ways, such as lowering the processing time of a product, manufacturing cost reduction, up-gradation of value chain coordination, increased process flexibility, better customer service, higher product customization, among others (Fettermann et al., 2018). Čambalíková and Szabo (2019) state that the introduction of digital technologies, which allows businesses to expand into new markets, but at the same time brings with it instability, macroeconomic disruptions in the form of cyber-attacks, which are gradually becoming a risk for all businesses using digital technologies.

Industry 4.0 provides an automatic solution to various manufacturing industries and other related areas. This consists of various manufacturing and digital information technologies to collect, transfer, store, analyse and proper monitor information system (Javaid et al., 2020). The capabilities realised by Industry 4.0 bring considerable benefits to companies including customization of products, real-time data analysis, increased visibility, autonomous monitoring and control, dynamic product design and development, and enhanced productivity (Dalenogare et al., 2018)

2. RESEARCH METHODOLOGY

The main objective of the paper was to identify the key concept of Industry 4.0 in production management in the Slovak wood processing industry based on the knowledge base and questionnaire survey. In order to provide a comprehensive view, it was necessary in the first part of the paper to define the terms and concepts related to Industry 4.0. Subsequently, in the next part of the paper, the questionnaire survey was evaluated. From the survey, we focused on selected data that identify Industry 4.0 in production management in wood processing enterprises in Slovakia.

The survey involved 52 companies operating in the wood processing industry in Slovakia. According to the business size classification, 7.7% of small companies, 44.2% of medium-sized companies and 48.1% of large companies participated in the questionnaire survey. The legal form of the companies was also recorded when the companies were identified. 71.1% of the companies involved in the survey were limited liability companies. This legal form made up the majority of the sample of respondents. The companies that indicated the legal form of joint stock company had a share of 28.9%. The Slovak Republic is divided into 8 regions. Based on the geographical distribution, the wood processing companies involved were mostly from the Nitra Region. This region participated in the survey with a share of 28.9%. Banská Bystrica Region (19.2%) and Žilina Region (17.3%) also had a higher percentage. The companies from the Košice Region participated in the survey the least. This region was represented with a share of 1.9%.

3. RESEARCH RESULTS AND DISCUSSION

In this part of the paper, selected data from the questionnaire survey dealing with the key concept of Industry 4.0 in production management in the Slovak wood processing industry were analysed.

The Fourth Industrial Revolution brought about the interconnection of the physical, cyber and socio-economic worlds. Bringing these three worlds together creates a revolutionary approach in production management. For this reason, we asked respondents in the questionnaire whether they perceived the Fourth Industrial Revolution to be underway. From the aggregated data, we obtained that 80.1% of wood processing companies register the Fourth Industrial Revolution. 18% of the respondents perceive a partial revolution in progress. The Fourth Industrial Revolution is not perceived at all by 1.9% of the companies surveyed.

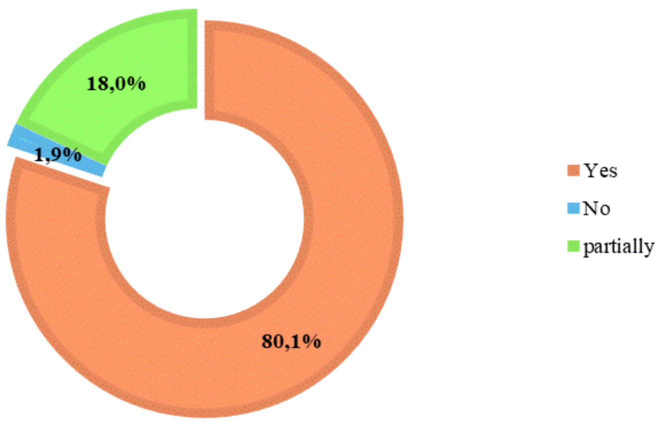

Figure 1. Wood processing companies perceive the ongoing Fourth Industrial Revolution. Source: own research

The use of Industry 4.0 in the company digitises individual business areas. Digitalisation also significantly affects production management. From the responses of wood processing companies, we were informed that 61.5% of the respondents use Industry 4.0 in production management. Partial use of Industry 4.0 was identified by 21.2% of wood processing companies. At the same time, we collected from the respondents that 17.3% of the respondent companies do not use Industry 4.0 in production management.

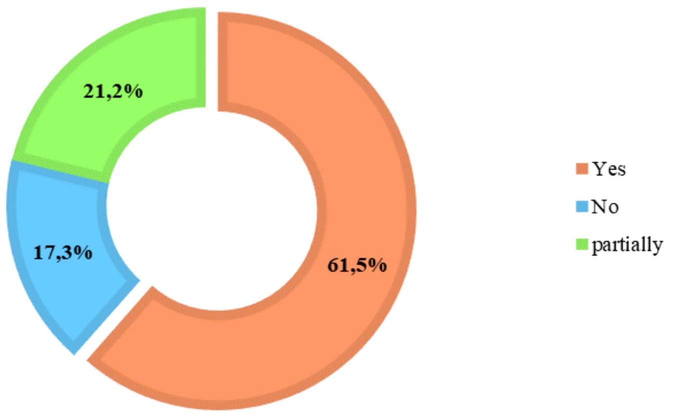

Figure 2. Wood processing companies use Industry 4.0 in production management. Source: own research

In the context of the use of Industry 4.0 in the production management of wood processing companies, we wanted to know which stage of the production process is most significantly affected by Industry 4.0. From the obtained data we can conclude that Industry 4.0 with the largest percentage (88.5%) influences the production stage. The pre-production stage was identified by the respondents with a share of 75%. Wood processing companies in Slovakia make the least use of Industry 4.0 in the post-production stage. This production stage reached 67.3%.

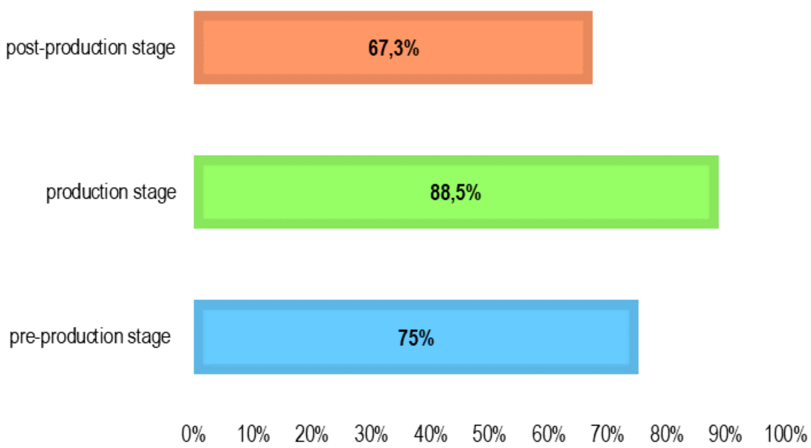

Figure 3. Using Industry 4.0 according to the stages of the production process. Source: own research

The use of Industry 4.0 technologies in production processes is associated with the Industry 4.0 era. The range of Industry 4.0 technologies is diverse. It includes artificial intelligence, augmented reality, autonomous robots, big data, RFID, sensors and other technologies. As part of the survey, we asked respondents whether they plan to implement Industry 4.0 technologies in production management. Wood processing companies in Slovakia plan to implement Industry 4.0 technologies with a share of 57.7%. Partial plans with Industry 4.0 technologies were indicated by 42.3% of companies operating in the wood processing industry. Only 12.3% of the respondents do not plan to implement any technologies related to the Fourth Industrial Revolution in production management.

4. CONCLUSIONS

We have now witnessed significant advances in the industry, helped by the key concept of Industry 4.0. Industry 4.0 is characterised by the adoption of digital technology such as artificial and augmented reality, additive production, advanced analytics, Internet of Things and other technologies. Digitalisation of the production process is an inevitable trend forward. Production industries are now changing from mass production to customised production. Rapid advancements in manufacturing technologies and applications in industries are helping to increase productivity and efficiency.

On the basis of the selected aggregated responses that dealt with Industry 4.0 in the production management of wood processing companies in Slovakia, we obtained that 80.1% of wood processing companies register the Fourth Industrial Revolution. From the responses of wood processing companies, we were informed that 61.5% of the respondents are using Industry 4.0 in production management. From the data obtained, we are informed that Industry 4.0 with the highest percentage (88.5%) is influencing the production stage of production process. Wood processing companies in Slovakia plan to implement Industry 4.0 technologies with a share of 57.7%.

Industry 4.0 will continue to be a key topic in the production industry in the coming period, as the Fourth Industrial Revolution represents a change that affects the entire production process, which is being digitised, automated and uses many smart technologies.

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INFLUENCE OF THE COVID-19 PANDEMIC CONSEQUECES ON THE WOODEN PREFABRICATED HOUSING MARKET

Renata Stasiak - Betlejewska, Emilia Grzegorzewska

Abstract: The coronavirus pandemic is changing the world around us. The growing fear for one's own health increases the awareness of the need to focus attention on technologies that are safe for health. This trend is gaining momentum in many areas, including construction. The industry is increasingly focusing on materials and solutions that are healthier for the user and better for the environment. The article presents a list of the best wooden architectural projects that were created in the world during the pandemic. Market trends within size and development are analysed in the paper. The basis of the analysis are data from reports that reflects how COVID-19 has impacted this market and its growth. Construction is already in the perfect storm. Industrialization, globalization, and digitalization have been key drivers of change in all industries.
Keywords: construction, wooden prefabrication, market, pandemic

1. INTRODUCTION

Buildings play a vital role in shaping and framing our livelihoods, society, and environment that we live, work, and interact within. In the transition to a low-carbon, resilient, and sustainable society, buildings play a dominant role in the use of energy and are among the largest sources of greenhouse gas (GHG) emissions in most countries. New buildings are an important source for future emissions, especially in rapid economically developing countries with growing populations, where we will see most of the expected doubling of floor space addition by 2050 [United Nations Environment Programme 2020].
According to the research findings and global forecast of the International Energy Agency (IEA) the overall global energy demand was decreased by 5 % in 2020 and emission of CO_2 related to the energy using was decreased by 5%. It is noticed as the effect of energy and gas emission reduction that was noted as one of the largest reduction in the past 30 years due to industrial and transport change in demand.
The COVID-19 crisis has taken various forms across the world, and early scenarios of the COVID-19 pandemic often depicted waves, including a second wave in late 2020 [CCSA 2020]. After the initial shock in the economic activity in Europe in the first half of the year, the EU economy rebounded in the third quarter, as containment measures were gradually lifted. However, the resurgence of coronavirus infections led to another decrease in economic activity in the last quarter of 2020 [de Vet, J.M, et al. 2021].
The EU construction sector is perceived as a very sensitive to economic cycle [International Labour Organization, 2020]. The EU construction sector provides 18 million direct jobs within the EU and contributed about 9% to the EU's GDP in 2019, accounting for about €1.216 billion [European Commission, 2021]. It is important to note that the construction industries face challenges associated to several innovations related to new technologies on energy efficiency that are addressed to climate changes. It is claimed that the green transition and the need to

shift to a circular and climate neutral economy will have significant positive effects on the sector [FIEC 2020]. Global building construction growth slowed to 2.6% in 2019 due to the lowest growth rates in North American and European markets recorded since 2008 and only modest growth recorded in Asia. The COVID-19 pandemic has led to a decline in investment activities throughout 2020 [United Nations Environment Programme 2020].

In February 2021, construction production decreased by 1.6% in the EU compared with January 2020; in the euro area the decrease amounted to 2.1% [Eurostat 2020]. Development of the construction production in period January 2020 – February 2021 in European countries is presented in Figure 1.

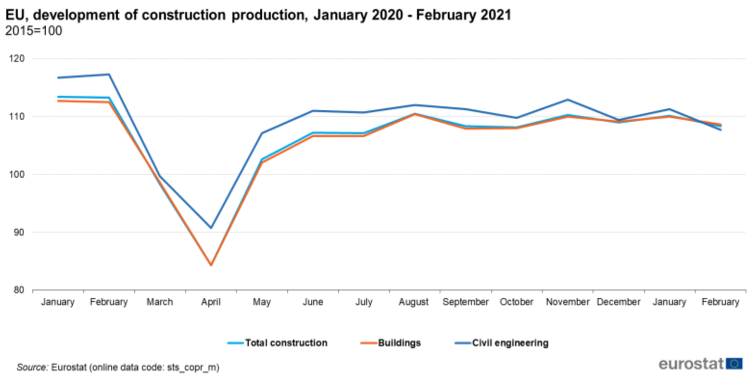

Figure 1. Development of the construction production
in period January 2020 – February 2021 in European countries.

The Covid-19 crisis was particularly strongly felt in Italy, France and Luxembourg, where construction activities fell by 70.4 %, by 65.2 % and by 54.5 % respectively between February and April. The construction sector performance stabilized, with production in November 2020 levels recovering to 97.5% of the pre-crisis level of February 2020 [European Commission 2021].

The RICS Global Construction Monitor (RICS 2020a), a survey of close to 2000 industry professionals across the globe, highlights the scale of the impact of government lockdowns on construction activity in the second quarter of 2020. Approximately 25% of projects were reported to have been put on hold as a result of Covid-19 related lockdowns as workloads took a big hit. Furthermore, 44% of respondents globally reported that they were receiving tender bids below realistic cost estimates [United Nations Environment Programme 2020].

In 2020, numerous countries have implemented stimulus programmes that target the building sector to respond to the COVID-19 crisis. According to the Global ABC survey results [United Nations Environment Programme 2020] Mexican National Housing Commission aims to support renovation and extension activities in low-income Mexican households. In England, a Green Home Grant scheme aims to fund domestic energy efficiency improvement measures, which also stimulate the economy.

The EU Commission aims to double renovation rates to increase energy and resource efficiency. A series of initiatives and commitments to achieve lower emissions in the buildings sector have been made by organisations in an effort to support the low carbon transition. In 2020 South Korea has implemented initiative related to a ‘Net-Zero Society’ that concerns building zero energy public facilities such as schools and shifting to an economy powered by solar, wind, and hydrogen. The first Net-Zero carbon community in China is being constructed by the Qingdao Energy Group. Energy supplied to the site will be zero-carbon and continuous monitoring will ensure zero-carbon operation. It is estimated that over 8,600 tonnes of carbon per year will be saved. The Danish Climate Partnership noted 13 initiatives focused on in the construction and energy industry. Multiple Net-Zero carbon projects are planned for London that is connected with a timber-frame office called The Paradise identified as net-zero carbon and offset other buildings emissions using the carbon sequestered in the timber.

2. WOODEN PREFABRICATED HOUSES MARKET TRENDS

One of the worldwide initiative on the green building recovery strategy is the Platform for Redesign 2020 COVID-19 & Climate Change, that was proposed by Environment Minister KOIZUMI of Japan (at “Petersberg Climate Dialogue” in April in 2020). It is aimed to advance the three transitions (to a decarbonized society, to a circular economy, and to a decentralized society) aimed at RE-DESIGNING socio-economic systems [Platform for Redesign 2020 COVID-19 & Climate Change, 2020].

In 2020, countries were requested by the United Nations Framework Convention on Climate Change to communicate their policies that are under review of the Paris Agreement. Overall, 136 countries mention buildings, 53 countries mention building energy efficiency, and 38 specifically call out building energy codes, indicating the importance of building energy efficiency to our climate future.

European Union has recently announced ‘Renovation Wave’ initiative for public and private buildings that is focused on the increasing the renovation rates across the EU and to provide a framework for renovation to support the green recovery [European Commission 2020].

The prefabricated housing segment seems to be particularly well positioned to meet changing customer demand trends. Scandinavia, Austria and Germany are estimated to have the highest prefabricated shares among focus regions. Low share is assumed in the UK and Poland (focus on solid constructions). The prefabricated housing market volume and price are expected to be favourably driven by a number of trends. Technology acceptance for prefabricated houses is increasing across focus regions – prefabricated houses are increasingly seen to be modern [Roland Berger 2018].

The main characteristic of prefabricated wooden housing is that most parts of the house are produced in the factory and assembled on site. This feature enables construction companies to be focused on the quality of the house and it’s cost efficiency. Demand for wooden housing, is likely to increase even more due an increasing awareness about the impact of climate change [Kuiken & Melander 2019].

Wooden prefabricated houses are known as the energy efficient. There is noted a growing awareness of construction wastage on the environment among consumers who adopt the green building concept. According to Global Prefabricated Building Industry Report 2020-2025: COVID-19 Impact Assessment, the following factors are likely to contribute to the growth of the prefabricated building market during the forecast period: mass township projects, shifting focus on profit, people and planet, increase in demand for branded designers, expansion of prefabricated market, big opportunity in developing countries. Increasing commercial spaces such as shopping malls, trade centres, and office spaces are expected to drive the prefabricated building market.

Dominant factor in the wooden prefabricated houses development is related mainly to energy efficiency regulations that are available in all focus regions are likely to positively impact the prefabricated housing markets.
According to Prefabricated Building Market in Europe - Industry Outlook and Forecast 2021-2026, the COVID-19 pandemic has led several construction companies were compelled to shut down projects owing to lockdown where others have witnessed project postponement from customers. There was noted that in April 2020, approximately 30% of general construction sites were open and productivity in those sites were as low as 20% of planned total work output level per day. However, since a huge workforce is required for traditional construction unlike offsite construction, opting for prefabricated buildings has come become an optimum solution to avoid disease spread.
The residential prefabricated building market in Europe accounted for over 44% share in 2020. Moreover, the ease of preparation and consent procedures are likely to boost the demand for prefabricated houses. The highest numbers in volume of the sold prefabricated wooden houses have been noted in Germany, the Nordics, and the UK that dominate the Europe prefabricated buildings market.

3. ARCHITECTURAL PROJECTS FOR WOODEN PREFABRICATED HOUSING

The pandemic makes most consumers more prudent in their decisions. Customers are more likely to focus on high-quality products because we know that they are the better choice in the long term. This is evident in the construction industry, which is now increasingly choosing wood. It started with its elements in the interiors, now it's time for wooden houses and buildings. It is not only a better choice in terms of the environment and reducing carbon footprint, but also use. Introducing into appropriately designed building with wood get friendly microclimate and savings accounts in the long term. According to the Board of Polish Wooden Houses, this is what the best architects around the world want.

3.1. A self-sufficient and healthy city made of wood

The self-sufficient city in terms of food and energy production is a residential concept developed by Guallart Architects in Xiong'an New Area, China. The architectural studio combined a traditional European city square with modern Chinese apartment buildings. The modern design includes greenhouses where vegetables, fruits and herbs can be grown, roofs covered with solar panels or workshops equipped with 3D printers for creating tools. Additionally, rainwater will be harvested and, to maintain biodiversity, public gardens and orchards will be planted with insect and butterfly friendly flowers. The flats will have birdhouses. The housing estate model did not lack space for offices, shops, a food market, a kindergarten, a swimming pool or rooms for the fire brigade. The goal of Guallart Architects was to create a design with a circular economy with minimal waste and pollution. According to the assumptions, the whole is to be made of cross-laminated timber.

3.2. The wooden school of the future

Italian architect Valentino Gareri presented a modular educational centre project he called the Tree-House School. The project is an energy-balanced, open space surrounded by a forest. The model combines various educational buildings, such as kindergarten, primary and

secondary school, community centre, library and café. According to the architect's assumption, the school of the future is to be a flexible space, open to nature, made of natural materials, in a modular structure.
The educational centre consists of two circular buildings, two courtyards and a usable roof. Modules made of cross-glued wood with an area of 55 m^2 form a classroom that can accommodate up to 25 students. The project assumed, inter alia, rainwater tanks, natural ventilation, photovoltaic panels or devices for generating wind energy, thanks to which the school will be self-sufficient in energy.

3.3. House of Life, a unique temporary hospital

The Danish architectural studio PROTOTYPE presented the project of a temporary infectious disease treatment centre "Vital House". The structure, thanks to the fact that it consists of prefabricated elements, can be created very quickly and anywhere.
The project includes intensive care units and the so-called communication rooms, enabling the sick to receive guests. The large green patio provides more oxygen in the building, helping patients recover faster. On the other hand, separate communication routes and corridors prevent patients from meeting directly with medical staff during their daily activities. The air inside the building is constantly monitored to prevent the spread of viruses.

4. CONCLUSIONS

According to Wolf Haus and Dhw System, who are among the leading manufacturers of prefabricated houses in Italy, respectively of modular structures in wood and steel. For both of them, the coronavirus emergency and the resulting lockdown could represent an opportunity to turn the spotlight on the strengths of these houses: interior comfort, a greater sense of wellbeing, energy efficiency (and therefore tax incentives with the 110% eco bonus). In the opinion of some Italian producers, the emergency due to the coronavirus has helped to give a boost to the modular construction sector. Entrepreneurs observed an important slowdown in terms of sales during the months of March and April in 2020, but this is mainly due to psychological issues linked to uncertainty about the future, which has led most customers to delay the conclusion of contracts [Prefab homes to become more popular after COVID-19].
It was noted that consumers staying locked in the house during lockdown has undeniably led to a reconsideration of the priorities and needs of domestic spaces. Consumers became more aware not only the home space dimensions, but also the quality has become more important for their use (indoor comfort, both bioclimatic and acoustic, but also to the healthiness of the air we breathe inside our houses).
Lockdown cause changes in the consumers awareness since they reached the great importance of the safety and eco - sustainability issues that are crucial for the human health.

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TRADE MARK MANAGEMENT IN THE FURNITURE INDUSTRY

Renata Stasiak - Betlejewska

Abstract: A trademark is not only a designation of a product, service or enterprise, but also an important element of the company's marketing strategy aimed at promoting its key products. Although a trademark does not determine the taste or functionality of a product, it automatically evokes associations with its characteristic features. The author analyses the concept of a trademark and the process of its registration. Examples of registered trademarks in the Polish furniture industry and examples of trademark infringement as acts of unfair competition are presented.
Keywords: trademark, design, management, furniture enterprise

1. INTRODUCTION

Therefore, it is worth considering the mechanism of building a strong brand and the factors that directly affect the value of intellectual resources, e.g. trademarks, and, consequently, the position of companies. Undoubtedly, they include both marketing activities related to the appropriate creation of the image of the company and its brands, as well as legal activities. Among the latter, it is worth mentioning the protection of industrial property rights, including the protection of trademarks, inventions or industrial designs. Importantly, this protection can be implemented with the use of several, completely different procedures, affecting its territorial and material scope.
Intellectual resources have a huge impact on building competitiveness, innovation, as well as the recognition of the company and its products or services. This also applies to the furniture industry. It should be emphasised, that obtaining protection (e.g. a protection right for a trademark) is only the first and basic step on the way to building a strong brand and the value of the company's intellectual resources [Mendonça et al 2004]. The owners of the most popular brands on the market are well aware of this. It can be concluded that effective management of intellectual resources from a legal perspective, in particular, is consistent enforcement of previously obtained protection. These activities lead not only to strengthening the market position, but also to building the value of the brand, intellectual resources and the entire enterprise [Xiaoshu 2019].
Building a brand's position is a business challenge, which will be associated with the need to ensure appropriate legal protection already at the stage of its creation. A brand is directly associated with a trademark that should be properly protected by registering it. However, the brand is the sum of the impressions that consumers have as a result of using it.
A trademark can be any sign that makes it possible to distinguish the goods or services of one entrepreneur from the goods or services of another entrepreneur and can be presented in the trademark register. Trademarks may include graphic, verbal, verbal-graphic, sound, present colours or patterns. In the case of medical facilities, it is recommended to protect verbal markings (especially in terms of treatment names) or word-graphic symbols (especially logotypes of facilities). Not every sign can be a trademark, due to its basic function, i.e. its

distinctive function. A trade mark must be sufficiently distinctive and must not contain generic or descriptive indications.
Article 2 of Directive 2008/95 / EC of the European Parliament and of the Council of 22 October 2008 (hereinafter: the Directive) provides that a trademark may consist of any signs that can be represented graphically, in particular words, including names, drawings , letters, numbers, shape of goods or their packaging, provided that such signs make it possible to distinguish goods or services of one enterprise from goods or services of other enterprises.
Reservation of a protection right to a trademark is territorial. When running a business, it is worth considering whether to reserve the designation of your brand not only in Poland, but also in the European Union, Great Britain or in other countries outside the EU.
It is worth investing in the so-called evaluation of the sign as a result of which trademark databases are searched and analysed. Without a complete assessment, it is impossible to determine whether the use and application of the mark for protection will expose the applicant to additional costs or liability towards third parties. For this purpose, specialized agents use professional tools, such as Corsearch, which detect registrations of signs that may be considered similar or are the same.
A new system for examining trademark applications, the so-called opposition system. On the one hand, it brings very positive effects - signs are registered much faster. On the other hand, the opposition system assumes activity on the part of entrepreneurs who, when they notice the registration of a trademark similar to the one they applied for, should react and file an appropriate objection (within 3 months from the date of announcing the information about the application in the Polish Patent Office Bulletin).
In 2018 Yougov Brandindex recently presented list of the world's strongest trademarks. In seventh place is IKEA, the Swedish trademark for ready to-assemble furniture. In Sweden, IKEA is ranked as No 1 in several trademark searches, such as Evimetrix Swedish Brand Awards –
ranking IKEA as the most popular trademark for Swedish consumers, "Progress with Purpose Summit – PRPS", ranking IKEA as the most meaningful trademark 2018, and the online newspaper Market's consumer research - identifying IKEA as No 1 in the "Trade's hottest chains and shops". The trademark IKEA is well-known to customers around the world, not just because of the word as a trademark, but more as the business concept is a trademark in itself [Rindforth 2019].

2. TRADEMARKS OF FACILITIES

In the case of action related to the creation of visual identification it is necessary to consider the subject of trade mark registration facility. When creating a new entity or taking care of its development, it is worth considering registering a trademark. The right from registration enables monopolization of the designation chosen by the manufacturer. In a situation where another entrepreneur infringes the right to our trademark, e.g. by using the same or a similar trademark, he runs the risk of severe consequences. It is possible to prohibit a competitor from using a designation (which usually involves costly rebranding) or to formulate claims for damages. A trademark may not infringe other provisions either. Many entities therefore decide to introduce into their designations the expression of commonly used commercial terms, combining them with a fanciful name. For my part, however, I do not recommend the use of such markings due to the potential risk of recognizing in the future that consumers are misled (currently there are no such decisions, which, however, does not mean that they will not appear in the future). Fancy terms work much better in practice, and their use is free from additional risks.

If a manufacturer creates a fancy brand that stands out from the competition, he should definitely register a trademark. Experience shows that many entrepreneurs decide to use the reputation of other entities that has been built up over the years.

The registration of trademarks allows an entrepreneur to achieve a monopoly of entrepreneurs for selected designations, but it is worth remembering that the registration itself may not be as simple as it may seem. It is easy to verify the registration databases on your own to check whether an identical designation has not been registered. Worse, if someone has registered a similar designation (e.g. instead of the letter "v", "w" is used, instead of "k" - "c", a domestic cat appears instead of a puma, etc.). Independent research is extremely difficult in such situations, so it is worth using professional software.

If the facility has not registered the trademark and is experiencing unfair market behaviour from competitors, potentially it can be attempted to make claims under the Unfair Competition Act. However, the proceedings conducted on this basis are usually more complicated and multi-threaded, so if possible - it is worth registering sign [Mingook &bSungjoo 2017]

The franchise mark is crucial. A recognizable and positively associated brand is for the franchisor a guarantee of the development of the franchise network, both at home and abroad. For the franchisee, in turn, it is a necessary condition to attract customers and obtain a return on the funds invested in the franchise. Franchise is a system of selling goods, services and technologies, based on close cooperation between independent entrepreneurs, under which the organizer of the system (franchisor) grants the right to use the concept of running a business. On the other hand, the franchisee undertakes to use such a concept, according to the franchisor's guidelines (specified in the franchise agreement), in return for paying the franchisor monthly financial benefits (the so-called license fees). The franchise concept includes the system organizer's know-how, business methods (e.g. merchandising), procedures (e.g. customer service), and industrial and intellectual property rights. And it is the industrial and intellectual property rights, and in particular the right to use the franchisor's trademark (or service mark) that constitute the most important element of the transferred franchise concept. In a franchise, the trademark is crucial. A recognizable and positively associated brand is for the franchisor a guarantee of the development of the franchise network, both at home and abroad. For the franchisee, it is a necessary condition to attract customers and obtain a return on the funds invested in the franchise. A well-known trademark evokes an association in the minds of recipients, linking a given product with a specific franchise system. This makes it possible to distinguish products from a given franchisor from the products of other chains. As a consequence, the competitive advantage of such an entity over other market participants increases. A trademark can be any sign that can be represented graphically (including a word, letter, drawing, colour composition), if it is capable of distinguishing the goods or services of one enterprise from the goods of another.

3. CONTROVERSIAL TRADEMARKS

Contradiction with public order or morality are absolute obstacles to the registration of both national and EU trade marks. Over the past three months, the Court of Justice of the EU delivered two important judgments dealing with these obstacles. Although these judgments only have the EU context, they can also provide a valuable interpretative guide for the application of the relevant provisions of the Industrial Property Law Act.
The jurisprudence indicates that "the prohibition of registration of designations contrary to public order or morality is related to the protection of the public interest, understood as the interest of society, which should be protected against the use of designations that violate applicable legal norms or violate the hierarchy of values professed in a given society". The practice of patent office shows that the filed marks that are contrary to public policy are also often contrary to morality. There are also opposite cases - signs contrary to good practices are also contrary to public order. The literature indicates that the concept of good manners refers to values commonly accepted in society. A universal definition of morality is not possible. Contradiction with good manners may consist in violation of moral norms as well as the violation of existing, established customs [Promińska 2008].
In the English-language text of EU Directive 2015/2436 aimed at approximating the laws of the Member States relating to trade marks in Art. 4 sec. 1 lit. f, there is a direct reference to signs that are contrary to the accepted principles of morality, and therefore perceived in the context of moral principles.
Another group of signs considered to violate good manners and contradict them will be derogatory, obscene, obscene, disgusting, degrading and offensive in their content or form. Such signs include signs containing profanity, vulgar references to sexual acts and human intimacy, curses.
In this context, the ruling of the Court of Justice of the European Union is important, which stated that the use of, for example, vulgar words in literature, art or media is not an argument in favour of recognizing them as admissible. Profanity is used quite commonly in both literature, art and media [see SUE judgment of 14 November 2013, T - 54/13 FICKEN]. The registration of a mark is also not determined by the fact that, in a specific context, the mark also has a different meaning, in addition to a meaning contrary to morality, for example, it is a surname [SUE judgment of 14 November 2013, T-54/13 FICKEN]. However, the Office does not keep any list of marks considered contrary to morality, as it is impossible to indicate them exhaustively.

4. PRACTICES OF POLISH FURNITURE ENTERPRISE AND VIOLATION OF RIGHTS TO THE MARK AS AN ACT OF UNFAIR COMPETITION

One of the largest furniture manufacturers in Poland has found a way to pay taxes. Polish Furniture Factory Forte transferred the licenses for its trademarks to a subsidiary. As a result, the company will increase costs and reduce its tax base.
Forte Furniture Factory has a subsidiary, Antwerp SKA, which signed a license agreement for the use of the company's word and graphic trademarks. The estimated value of the subject of the contract over the period of five years is approximately PLN 120 million net, which exceeds 10 percent of the Issuer's equity. The agreement stipulates that a license fee of 2 percent of the revenue will be charged for using the logo and brand. The company transferring trademarks

to a subsidiary will depreciate them, which will increase costs and reduce the tax base. Thus, Forte will pay less tax. This practice of transferring a trademark allows for the so-called activation of the tax value of a trademark [Rozpędowski 2015].

Antwerp SKA obtained the ownership rights to FORTE trademarks that are protected by trademark registers kept by:

1. The Patent Office of the Republic of Poland under the numbers of protection certificates 144050 and 147680;
2. World Intellectual Property Organization (OMPI / WIPO) at the numbers 810263 and 823025;
3. State Register of Trademarks and Service Marks of the Russian Federation under the numbers 245700,245701 and 245704;
4. German Patent Office under the number 2104299, with a value of PLN 152,104,000.

This solution allows enterprise to increase the value of the trademark, which will then be depreciated. If the depreciation charges are higher, the tax costs will increase, and this will reduce the company's income. As a result, there will also be a reduction in the amount of taxable income and tax itself or even a loss.

Entrepreneurs are obliged to conduct their business with respect to the principles of fair competition. Violation of the entrepreneur's trademark rights, including the violation of the right to designate another entrepreneur, may be considered an act of unfair competition, referred to in the Act on Combating Unfair Competition. An act of unfair competition is generally an activity of an entrepreneur that is against the law or morality, if it threatens or violates the interests of another entrepreneur or customer. The acts of unfair competition include, inter alia, the activity of the entrepreneur, which marks his company, good or service in a way that may mislead customers as to the identity of the entrepreneur or the specific characteristics of the good or service. Determining whether there has been a misrepresentation is made when referring to the assessments of the average customer, whose general impression of the product activates the associations that have arisen so far.

By purchasing the right to his brand, the entrepreneur receives all the tools to effectively enforce his rights. The right to a reserved brand allows enterprise to independently detect an attempt to infringe our property and defend the entrepreneur's interests with the help of tools guaranteed as part of trademark registration. If the entrepreneur/producer does not monitor his brand, he may miss the moment of registration of an identical/similar mark with the Patent Office by competitors, and even lead to degeneration (dilution) of his brand. The example of this kind of situation is as follows. Four years after obtaining the right to the BROTIGA trademark, the furniture manufacturer promoted the brand to such an extent that it won 35% of the furniture market in three provinces. It was connected with huge expenditures on promotion and building brand awareness. Suddenly, the market share and revenues go down. Unhappy buyers of branded products started calling the company, something that had never happened before. As noted later, a competitor appeared on the market, which, seeing the brand's reputation, took the risk and registered the BROTHIGHA trademark in the Office two years earlier. He registered an internet domain and started distributing branded products from China of questionable quality. Slowly, cheaper furniture began to win the market at the expense of the first company. Dissatisfied customers often vented their dissatisfaction in comments on a site not of that company.

Another more recent example is IKEA vs. IKAH in India. The Defendant claimed that there was no risk for confusion, as the IKAH trademark logo was in black/white – compared to IKEA's blue/yellow – and that IKAH is an acronym for "International Kitchen and Hardware", registered for goods in classes 7 and 11. The court, however, ruled in favour of IKEA, noting that the IKEA trademark is distinctive and thereby entitled to the highest protection, and that the Defendants trademark was figurative and therefore did not give any specific protection for the word IKAH as such. The decision was perfectly timed, as the first IKEA store in India recently opened in Hyderabad [Rindforth 2019].

Another example of trademark infringement is one of the Polish companies that illegally used the designs of a well-known supercar manufacturer to produce furniture. Their production used elements that resembled parts of the Italian sports brand Lamborghini. The elements of the furniture were copies of the external parts of the cars. Under current legislation, the production and sale of such items may be considered a criminal offense.

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PERSPECTIVES AND DEVELOPMENT OF QUALITY MANAGEMENT IN THE FORESTRY- TIMBER COMPLEX

Anna Šatanová

Abstract: Current trends and directions of quality management in the world are also focused on other factors, not only on satisfying customer needs with quality products and services. Therefore, at present, all companies are expected to benefit not only from satisfying their customers, but also from all stakeholders (employees, shareholders, owners, banks, suppliers, partners ...) and the environment in which the company is located (citizens, city, state, non-profit organizations). The priority of every organization is focused on mainly sustainable development, and there is a shift from the quality of products to the quality of the organization.

Therefore, the aim of the presented paper is to present how the integrated management system, the comprehensive quality management system TQM, the related responsible entrepreneurship and sustainable development are promoted and applied in the companies of the forestry-timber complex.

Keywords: quality, quality management, quality product, quality management system, quality of the organization.

1. INTEGRATED MANAGEMENT SYSTEM IN THE FORESTRY- TIMBER COMPLEX

In order to improve performance and competitiveness, different methods, tools and approaches that put the organization into a new light are applied. However, we should remember that the basis of all methods used will be effective and functional if the organization is process-driven and applies a procedural approach (Paulová et al., 2018, 2008).There is growing interest in maintaining and improving product quality, the environment and safety at work. Organizations are forced to re-evaluate their status and implement effective management systems - quality, environment and security. For an organization, integrated management systems (IMS) are a very convenient way to create a system that takes into account not only the quality of products and services, but also access to the environment and occupational safety and health. The starting point of almost all of the listed management systems is a process approach that allows process-based integration into one system. IMS may consist of the following management systems: Quality Management System (QMS), Environmental Management System (EMS) at Occupational health and safety management system – OHSAS. If required, the scope of an IMS can be extended to other management systems (see Figure 1), such as the Information Security Management System – ISMS IT service management (ISO 20000), corporate social responsibility (ISO 26000), food safety management system (ISO 22000).

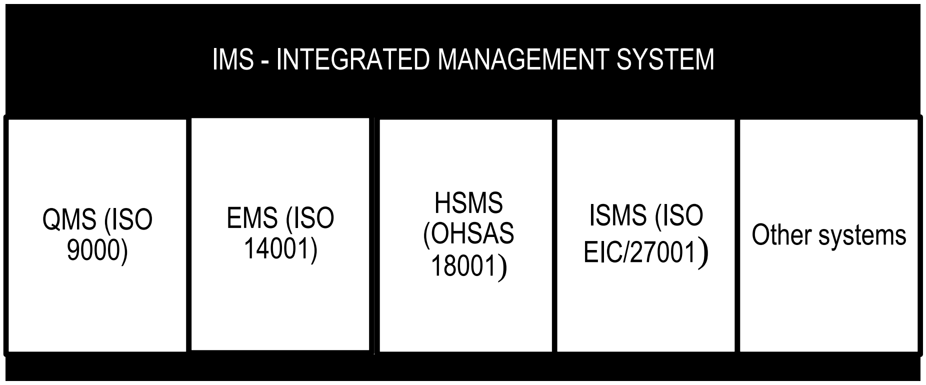

Figure 1: Integrated management system scheme

Source: own source

A major revision of ISO standards in 2000 has opened the way to integrating quality management, environmental and safety management systems. The structure of the newly introduced standard STN EN ISO 9001: 2009 is most closely related to STN EN ISO 14001 standard. As the STN EN ISO 14001 environmental standard is very similar to the OHSAS 18001 safety standard, there is nothing to prevent the use of all 3 management systems together in the form of an integrated module. Each of these management systems defines their specific requirements, but the categorization of the main requirements is the same. The core requirements for integration can be the basis for all three systems. These include the following areas:

- The responsibility of top and middle management
- Systematic structure of documentation
- The goal of continuous improvement
- Conformity with requirements
- Maintenance and operation of systems. (Hrubec et al., 2009).

2. APPLYING A TOTAL QUALITY MANAGEMENT SYSTEM IN THE FORESTRY- TIMBER COMPLEX

Total Quality Management (TQM) is an attitude and philosophy, as well as a process that emphasizes the personal responsibility of all employees who strive for continual improvement, and as such it never ends. At the same time, it is also a system consisting of organizational, administrative and technical procedures, methods, techniques and tools. (Šatanova et al. 2011,2019,2020).The basic concept of TQM is focused on the customer, the organizations own employees on processes, the working environment, the environment and the company. Its essence is to define a strategy on the basis of which objectives are defined and their fulfilment is monitored over the results. TQM is an integrated philosophy that includes strategic, cultural and technical systems. It is characterized by the fact that the whole organization is involved in improving product quality. All business managers are responsible for the enterprise, and in complex quality management they create a management tool based on customer oriented organizations.TQM is an open system that may include everything that can help maximize the satisfaction of all stakeholders and the environment and trust, and minimize funds spent on mistakes and shortcomings. This creates prerequisites for maximizing profits, increasing organizational competitiveness and minimizing costs of poor quality. Total Quality Management applies to the entire organization, and it brings about changes in the following important dimensions:

- Strategic activity is the most important activity of top management in order to formulate the main objectives and planning of all activities related to the efficient management of all processes (using the PDCA cycle)
- An organization's culture is an open system where all suppliers, customers and stakeholders are included in processes.

Experience from the application of total quality management can be summarized as follows:

- Total quality management can only work when leaders understand quality as part of organizational management in all activities
- Teamwork is an important pillar of TQM; management teams that define objectives and create conditions for their fulfilment and teams to improve process quality play an important role
- It is necessary to respond quickly to teamwork outputs and create conditions for change
- Gradual change in the behaviour of an organization's employees is based on leadership, training and motivation of employees
- The company should apply process improvement technology down to the level of production workers
- Practical use with organizational and motivational support must follow as soon as possible after training.

The TQM model is suitable for both large and small businesses to improve existing quality management systems. TQM approaches can be applied using some models. In Europe, the EFQM Excellence Model is the most used in the business sector.

3. RESPONSIBLE ENTREPRENEURSHIP AND SUSTAINABLE DEVELOPMENT

The concept of sustainable development was first used in the book "Limits of Growth" written by Donell and Dennis Meadows and William Behrens in 1972. There are many definitions, and there are many discussions and debates at an international level on sustainable development. The basic aspect of sustainable development is probably best illustrated by the following definitions. The most well-known and also the simplest definition of sustainable development comes from the report "Our Common Future" issued by the United Nations World Commission on the Environment and Development (1987): "*Sustainable development is a way of development that meets the needs of the present without* *compromising the possibilities of future generations to meet their own needs*." (Keeble, 1988).This concept has been developed since 1987 and individual dimensions and principles are identified. It is important to emphasize that the concept of sustainable development is much wider than environmental protection. The European Parliament later defined sustainable development as follows: *"Sustainable development means improving the standard of living and well-being of people within the limits of ecosystem capacity while preserving natural values and biodiversity for present and future generations*." (European Parliament and Council Regulation 2493/2000 2494/2000). However, under current conditions these are statements that overlook the fact that the capacity of some ecosystems has been exceeded for decades. There are a number of other definitions (see Agenda 21[1]: Annex II of the "Report of the UN Conference on Environment and Development", Rio de Janeiro, 1992; Czech Ministry of the Environment issued in 1998).

The following definitions are presented below:

- "*A sustainable way of life – this is a way of life that is closer to the ideals of humanism and the harmony of human-nature relations in a timeless horizon. It is based on a sense of responsibility towards today's generations and future generations, and respect for both living and inanimate nature*. " (Vavroušek, 1994).
- "*Sustainable development is a comprehensive set of strategies that enable the use of economic resources and technologies to meet human material, cultural and spiritual needs, with full respect for environmental limits; it is necessary to redefine the socio-political institutions and processes at a local, regional and global level to make this possible on a global scale today.*" (Rynda, 2000).

At the level of the general principles of sustainable development, there is a broad consensus. It can be said that this is a new value orientation of mankind and direction of the development of human society, where the basic needs of all inhabitants (interpersonal solidarity) are satisfied, when the opportunities and freedoms of the existing generation are not at the expense of the possibilities and freedoms of future generations (intergenerational solidarity), and when the harmony between humanity and nature is promoted (respecting the intrinsic life value of nature and the rights of other living species).

For better understanding, it is also appropriate to define sustainable development negatively. This means briefly describing what sustainable development is not (Rynda, 2000):

- Mere survival.
- The manifestation of prognostic pride or socialist planning
- The megalomaniac concept of bureaucrats.
- Centralist rule, world government.
- Culture as a choice of a particular historical human civilization model
- Equal to ecology
- Ideology

According to Mezřický (2005), these three pillars enviromental, social and economic are often in conflict (e.g. nature protection versus motorway construction, etc.). In the text below, these pillars are dealt with more closely.

The environmental pillar is based on the fact that in a limited system, unlimited growth is not possible. Therefore, the value of ecosystems and their services must be constantly acknowledged and appropriately valued (spiritually or materially) and well guarded.

In the right concept, however, it is absolutely necessary to place the same emphasis on all three pillars (equally). The fundamental prerequisite for the environmental pillar is the protection of biodiversity in all its forms. Rynda (2000) states: *"The highest level is to be understood as cultural diversity that is no less important than biological diversity for the preservation of ecosystems to maintain the dynamic balance and stability of human communities*."

The social pillar activities consist in balancing inequalities between individual social groups or individuals. Rynda (2000) adds: "*Indeed, a higher quality of life that is not based on consumption leading to alienation, but on its own active and creative approach to the world, allows a paradigm of conscious modesty that can deliberately renounce all that is non-essential. The complementary value is selective difficulty, namely the right to use human ingenuity and its products wherever they truly allow and support the fulfilment of the human purpose, namely self-improvement and the fulfilment of good*."

The economic pillar consists of all economic activities, interactions among them and the interaction between the environment and society. For example, the following macroeconomic indicator of gross national or domestic product includes, without distinction, activity contributing to well-being and activities the consequences of which are clearly degrading the quality of life and the environment. These include arms production, ecologically damaging farming, and land devastation by surface mining.

Responsible business - This involves the organization's overall relationship with all stakeholders - customers, owners-investors, employees, public authorities, suppliers, competitors, communities, etc. It includes the organization's commitment to develop its economic activities effectively and responsibly towards society and the environment, considering the interests of all stakeholder entities.

4. CONCLUSION

An Integrated Management System (IMS) is based on the vision of integrating the structure of international standards related to quality management, environmental management, occupational safety and health management, capital management, information security management, etc.

It can be stated that responsible business is not a new concept. This is primarily about the new approach and attitude of leaders and the creation of conditions for the fulfilment of all three pillars – economic, environmental and social, in balance, to the full satisfaction of all stakeholders. The change of approach is in many ways reminiscent of the philosophy of total quality management (TQM), where the primary goal is to compete and be exceptional in business. If small and medium-sized organizations want to prosper, it is not enough to just produce products or provide services that will satisfy customers during their use. If an organization wishes to prosper, it must be perceived positively by its surroundings. This leads to the implementation of responsible business (Młkva et al., 2016).

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REFLEXION OF CIRCULAR ECONOMY AND DIGITIZATION ON A CUSTOMER VALUE PROPOSITION IN SELECTED BUSINESS MODELS OF FURNITURE PRODUCERS

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Abstract: The article presents the literature review of the circular economy, digitization, and customer value proposition reflection on business models in furniture industry. Authors conducted qualitative analysis of Tweets applying the value proposition canvas (Osterwalder et al. 2015). The results have been analysed by text coding and calculation of word frequencies. Results are resented by word cloud and codes categories. We also apply text coding of the selected tweets. The coding system was again based on (Osterwalder et al. 2015). The authors concluded that digitization and circular economy are presented in analysed business models. Nevertheless the emphasis is still put on customer relationship.
Keywords: furniture industry, business model, customer value, circular economy, digitization, qualitative analysis, quantitative analysis.

1. INTRODUCTION

The furniture industry is a labour-intensive and dynamic sector dominated by small and medium-sized enterprises (SMEs) and micro firms. 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 (EC 2016).

The (EC 2016) describes the sector according to different subjects:

Employment - around 1 million workers in 130 thousand companies generate an annual turnover of around EUR 96 billion.

Trends - About 12% of designs registered in the European Union Intellectual Property Office relating to this sector. The sector needs the higher protection of intellectual property rights.

Innovation - the sector depends on innovation and design to increase global trade. It means increasing the financing of the research and ensuring that SMEs have access to the funds.

Workforce - as in other industries, also furniture industry is facing the problem with the ageing workforce. Combined with the gap in the skills and craftsmanship of the young generation, the industry will face severe problems in the future. In relation with the digitization automation will have significant impact on skills requirements. There will be 27% decreased demand for physical and manual skills, but 58% increase in demand for technological skills (Ellingrud et al. 2020). For stable and skilled workforce (Armstrong et al. 2018) recommend to companies to invest strategically in workforce training approach. It is necessary to continue investing in skills, design, creativity, research, innovation, and new technologies to increase productivity and competitiveness with non-EU producers like China and India. It is also necessary to reflect the changing population structure, lifestyles, and trends, and apply new business models and supplier-consumer relationships.

Research - research in advanced manufacturing technologies can result in the creation of high technology and knowledge-intensive jobs, which would give the sector the attractiveness it needs to attract employees from younger generations. This could help rejuvenate the sector while keeping it highly competitive on the world stage.

Access to new markets – EU furniture manufacturers are recognised worldwide for their quality and design. This creates opportunities for the sector to further seize other markets, particularly in high-end segments and emerging economies. (EC 2016)

Many organisations have their environmental management systems certified to ISO 14001 or registered under the EU Eco-Management and Audit Scheme (EMAS). Environmental management systems cover elements of environmental sustainability other than forestry but may include some aspects of it as well.

Based on the Special Eurobarometer 501 report on the Attitude of European Citizens towards the Environment (Eurobarometer 2020), the average EU27 citizen recognises the importance of environment protection: 51% as very important, 43% of fairly important, 5% of not very important and 1% not at all important. When comparing the results from 2007 to 2020, in 2007 it 64% of the citizens saw environmental protection as very important, but in 2020 it was just 51%.

The importance of the sustainable Industry 4.0 was also emphasised in the progress report "Shaping Industrie 4.0 Autonomous, Interoperable and Sustainable" (Platform Industrie 4.0 2019). In this report autonomy, interoperability and sustainability have been recognized as a crucial field of action for a successful implementation of Industry 4.0.

To conclude, EC recognises that the sector needs to foster innovation, digitisation, quality and sustainability to overcome problems with an ageing workforce, shift in customers consumption and significantly lower prices of the non-EU competition.

The first step of the manufacturers facing those challenges is to transfer the shift in customer value perception to strategies and innovative business models. The authors present in this contribution the results of the qualitative research focused on the analysis of business models from three perspectives: sustainability, digitization, and customer value in the furniture industry.

2. RESEARCH

The research was conducted at the Institute of Management, University of Ss. Cyril and Methodius in Trnava. It is a part of over than ten years continual research oriented on CSR and sustainability. Different aspects of the research have been published for example in (Špirková et al. 2009; Relich and Šujanová 2015, Sisková et al. 2017a, Sisková et al. 2017b, Nováková et al. 2018, Pavlendová et al. 2018, Šujanová et al. 2020, Babčanová et al. 2021).

2.1. Research methodology

The core of the research was the QDA analysis of the text collected from Twitter (3578 tweets). The selection criteria were "Furniture".

During the first phase, the tweets have been cleaned, removing the tweets without relevance and duplicity. We also remove tweets that have been not published by the producers or sellers. In the end, we had 2156 tweets for the analysis.

To quantify the content of the tweets, we used the "Word frequencies" function. During the first run of the function, we obtained the list of all the words. We rejected the words that did not relate to the subject. After the second run of the function, the total count of the words was 9395.

The results have been grouped applying the value proposition method published in Osterwalder et al. (2015).

The focus was on the customer (customer jobs, pains and gains) and value proposition (product and services, pain relievers and gain creators). The result is presented in Figure 1. We can see that the group of words presented as a "Style" (vintage, modern, elegant, minimalist, handmade and others) reached the highest frequency. The second highest was represented by the group "Interiordesing" (interior design, decoration, interior styling and others).

We applied text coding of the tweets that contained the words from the word frequencies list during the next step. Here we can apply a more preciously value proposition model (Osterwalder et al. 2015).

We apply the following code structure:

- Business
- CSR
- Customer relationship
- Design
- Digitization
- Ecology
- Emotion
- Function
- Distribution
- Material
- Price
- Quality
- Service
- Style.

Word frequencies obtained by this method are presented in Table 1.

Figure 1. Word cloud of the tweets word frequencies (Authors elaboration based on (Osterwalder et al. 2015) and MaxQDA results)

The highest frequency has the code "Services". Under this code, we put services offered in tweets like courier service, assembly, expert, decoration, interior design, delivery, measure, renovation, repair, support and others.). Our interest was on "Digitization" and "Ecology". The frequency of the code "Digitization" was 189. This code covered marketing on social media, e-commerce, virtual and augmented reality, and digital transformation and cloud technologies. Under the code "Ecology", we integrated eco-furniture, 3Rs, eco-design. However, we experienced also serious concerns on ecology like biodiversity, destruction of the rain forest, environmental impact and sustainability.

Table 1. Code frequencies (Authors elaboration based on (Osterwalder et al. 2015) and MaxQDA results)

Code	Frequency
Service	2369
Design	1254
Style	816
Social	685
Function	348
Quality	252
Digitization	189
Material	165
Ecology	121
Emotion	116
Chanel	35
Price	29
CSR	25
Customer relationship	25
Business	14
Marketing	4

3. CONCLUSION

The research goal was to identify if and how a digitization and circular economy transferred to business models in furniture manufacturing, preferably in customer value proposition and products and services. Digitization was applied in business models in customer relationship management, preferably for communication channels. A significantly smaller group applied digitization in design and logistics.

The circular economy had stronger application in business models starting with design, 3Rs, innovative buying models and environmental impact.

A positive result was also the emphasis on quality in business models.

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WOOD AND WOOD-BASED PRODUCTS AS AN ALL-PURPOSE COMMODITY IN CONDITIONS OF ECONOMIC UNCERTAINTY

Leszek Wanat, Rafał Czarnecki, Katarzyna Dadek, Anna Topczewska

Abstract: The study verified the controversial hypothesis that potential demand for wood and wood-based products is trending sustainably and with adequate consumer interest under conditions of economic uncertainty. During the period covering the year of the pandemic and the year preceding it, data extracted from open Big Data online databases were analyzed. On the example of Poland, an attempt was made to identify the main trends, focused on e-commerce platforms aggregating queries from the wood-based products market. Secondary data were analyzed, based on Google Ads and Google Analytics applications. The paper uses selected open-source analytical tools, including Google Keyword Planner and Data Studio.
Keywords: wood, wood-based products, economic uncertainty, Big Data, e-commerce analysis, Poland

1. INTRODUCTION

Wood is a unique material from the functional, environmental, and aesthetic point of view. It is a renewable resource and can be reused and recycled in certain applications. In other applications it is biodegradable and in various forms a component of many new products [2,17]. It can also be a source of energy. At the same time, wood and wood fiber are used in numerous final products. Popular wood-based products include furniture, wooden construction materials, interior design materials, kitchen accessories, DIY materials, toys, paper products, books, paper hygiene products, tissues, etc. [11,18,19]. Wood-based materials can be found in product packaging (primary packaging, secondary packaging and transport packaging, as well as in information materials. The forest-wood value chain, which further strengthens the value of wood-based products, is informed by the increasingly popular certification [10].

In 2020, the economy, including the wood-based sector, found itself in an emergency situation of economic uncertainty. Initially, it seemed that the equilibrium of economic activity in the wood industry had little chance of success under conditions of permanent pandemic threat [4, 5]. Meanwhile, "lockdown" became an opportunity to activate various symbiosis factors: economic, ecological, industrial, as well as social, behavioral [3,7]. So, is there a compromise that would allow the coexistence of many market participants in the model of integral economy [4,16], which takes into account the specific individual ability to develop even under conditions of uncertainty? What role can wood and wood-based products play in times of crisis?

2. MATERIAL AND METHODS

The starting point of the designed research became an attempt to assess the degree of interest in wood in a particular pandemic period. In the reality of significant restrictions on economic activity, both entrepreneurs and end customers were looking for opportunities to implement plans, stabilization and development primarily in the digital world.

Study Design. The subject scope examined the level of interest of potential consumers in selected wood materials and wood-based products. Specific measures of the "popularity" of wood-based products [6] were sought from a group of Internet users, over a two-year period covering the period from March 1, 2019 to March 31, 2021 (temporal scope). The volume of queries in the spatial scope was limited to the Polish language and the territory of Poland (thus determining the subject scope of the studied Internet users).

Data Sources. The primary source of data has become the open Big Data resources available to users of Google search and its free analytics tools: Google Ads, Google Analytics and Data Studio [13]. This made it possible to avoid the need to maintain the condition of representativeness of the research sample (data made available by Google includes all registered search activities in a given period of time and according to selected keywords) [1,5]. The keyword search conditions were developed using the content-based criterion. Based on the state of the art of forest science, including the wood market science sub-discipline, product groups were purposively selected to reflect the aggregated query patterns for keywords (in Polish of course) from the wood-based sector [21,23,24]. On this basis, the following groups were selected: wood, firewood, construction timber, paneling wood, sawmill wood and exotic wood, analysing 180 related keywords within all groups

Data Acquisition. Data on the number of queries for each group of keywords were collected using a conventional measure (S), corresponding to the average monthly number of search results. A matrix of results (MS) was compiled for each studied keyword and its derivatives (close variants) based on the monthly time range and the search location and network settings (language: Polish, country: Poland). The data were cleaned of outliers and compiled in separate sub-bases (matrices) for each product group.

Tools and scope of analysis. To obtain the data, the Google Keyword Planner tool was used, available as part of the free Google Ads service for registered Google users [22]. Data was collected on the average monthly number of search results (S) for selected keywords and aggregated product groups. The period from March 1, 2019 to March 31, 2021 was analyzed, for queries registered by Google in Poland in the Polish language. Thematic search terms, the most frequent in Google, were selected based on content analysis. Initial trend selection allowed for the selection of aggregated product groups, re-analyzed over the same period.

Research Scenario. The analysis was designed in the following six steps: content analysis and keyword selection (step 1), data acquisition and development of auxiliary IT tools for data aggregation, verification and elimination of outliers (step 2), data aggregation, selection of keywords for product groups and re-analysis of search results (step 3), compilation and discussion of results (step 4), visualization of results using Google Keyword Planner (step 5), formulation of conclusions and recommendations (step 6).

3. RESULTS

Before analyzing the frequency of search for professional keywords related to wood (i.e. demand for wood), the supply perspective of the wood market was evaluated. Thus, the situation of enterprises of the wood-based sector during the pandemic period was verified (Fig. 2 and 3), as well as the average, unified price of wood in comparison with the prices of other valuable commodities (gold, gasoline), during the same period (Fig. 1). A strong upward trend of the average, aggregated wood price was observed, as well as, surprisingly, a relative stabilization of the number of active enterprises in the wood-based sector, especially companies (SMEs) [8]. The behavior of individual entrepreneurs, on the other hand, corresponded to the general sentiment during the pandemic period, but the balance of active companies (taking into account the ratio of companies closing and new ones in the industry) finally shows an optimistic upward trend at the end of the study period.

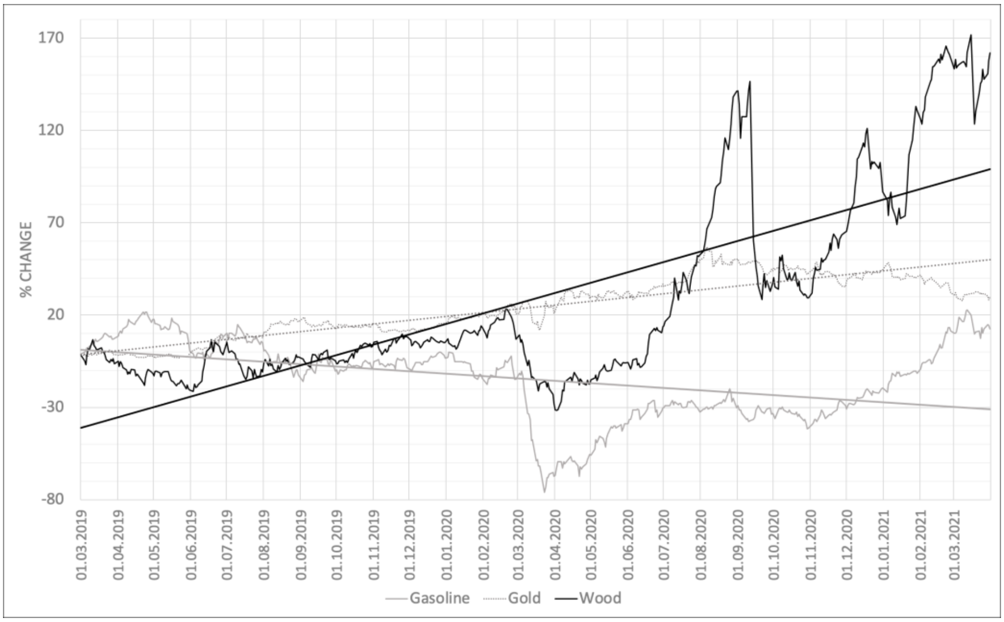

Figure 1. Identification of the trend % change in aggregate indices corresponding to the average price of wood (in USD/1000 board feet) against the price of gold (in USD/unit) and gasoline (in USD/gallon) for the period from 01.03.2019 to 31.03.2021
Source: Own elaboration based on [bankier.pl] [23]

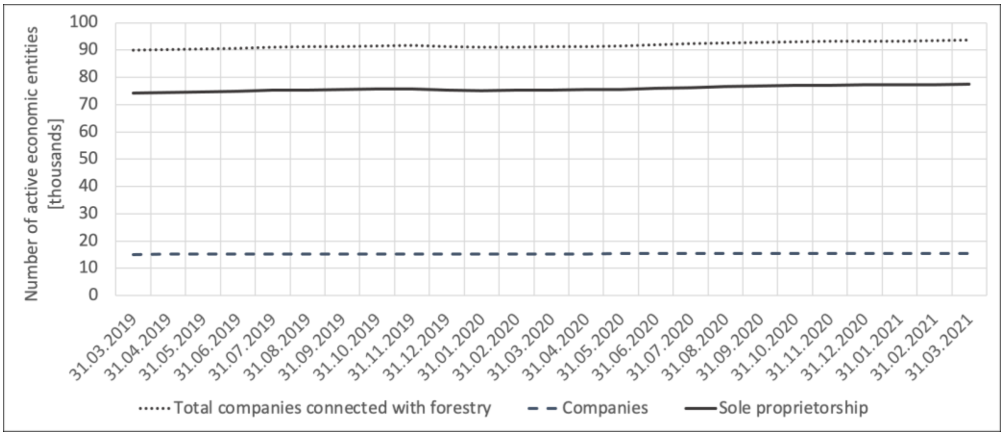

Figure 2 Number of active enterprises related to forestry and wood-based sector from 01/03/2019 to 31/03/2021.
Source: Own elaboration based on [https://stat.gov.pl] [24]

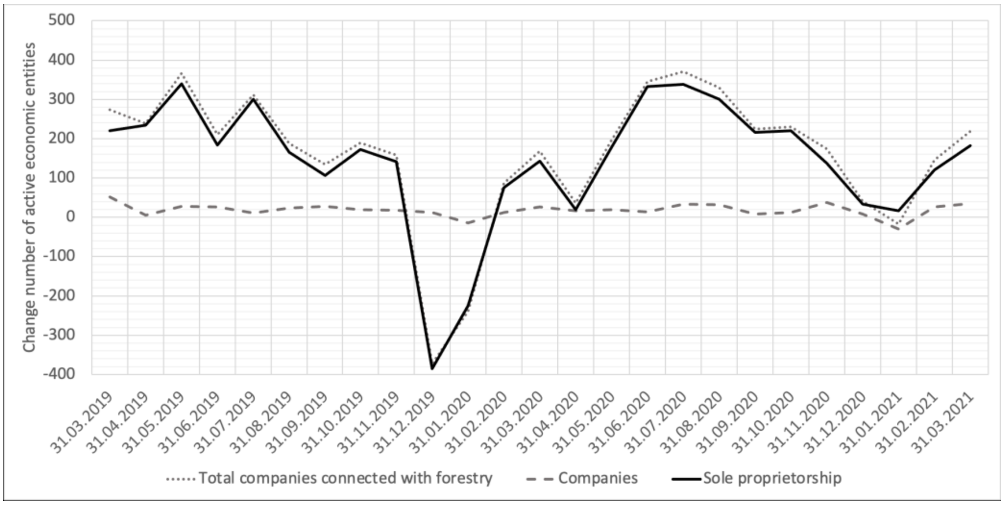

Figure 3. Change in the number of active enterprises (on and off balance sheet) related to the forestry and wood-based sector in Poland, from 01.03.2019 to 31.03.2021.
Source: Own elaboration based on [https://stat.gov.pl] [24]

Analyzing the level of interest in wood and wood-based products against the background of other popular queries on the Internet: about (travelling, production of homemade foods, or following a vegetarian diet, a stable, persistently high average monthly rate of queries was noticed, moreover with an increasing tendency during the pandemic period (Fig. 4). homemade foods, vegetarian diet) from 01.03.2019 to 31.03.2021 [the number of online queries].

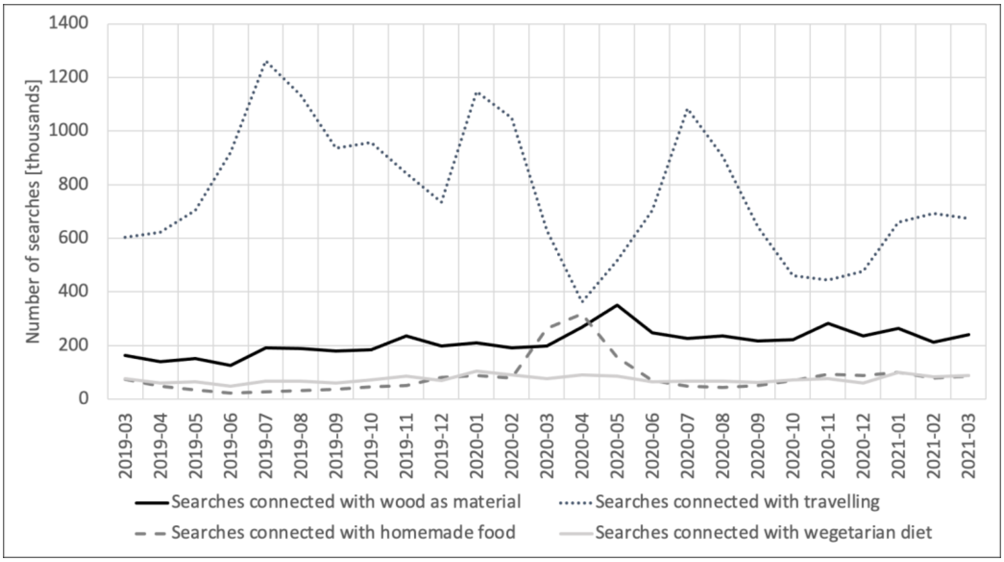

Figure 4. Level of interest in wood and wood-based products compared to other popular online queries (travelling, homemade foods, vegetarian diet) from 01/03/2019 to 31/03/2021 [a measure of the number of online queries].
Source: Own elaboration based on Google Keyword Planner [22]

Verifying in the same range the dynamics of changes (% change), the highest percentage increase of inquiries about wood and wood-based products was noticed in the examined period, moreover, with an increasing tendency (Fig. 5)..

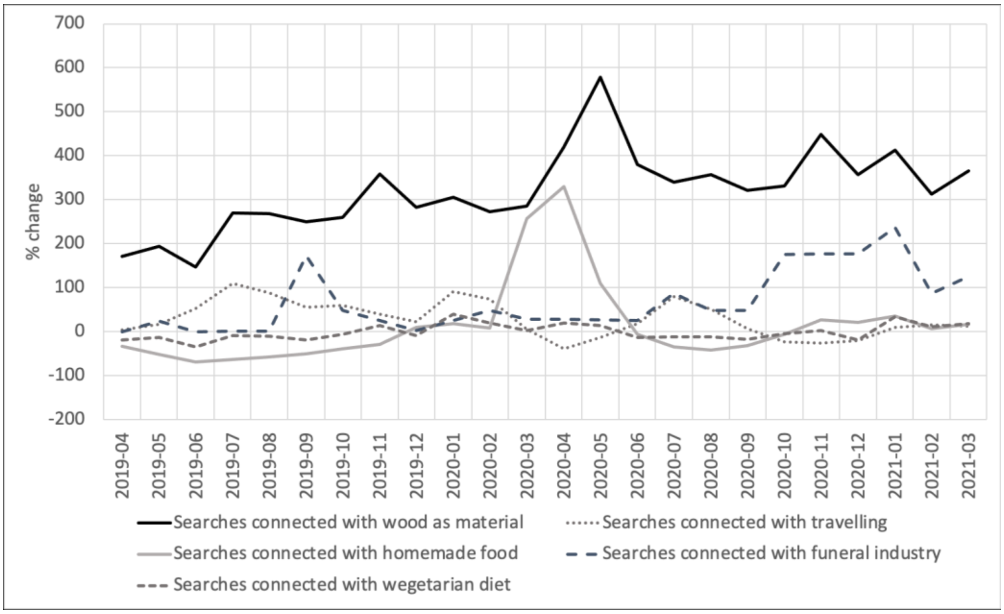

Figure 5. Dynamics of change in online interest in wood-based products (% change for average monthly number of queries) from 01.03.2019 to 31.03.2021.
Source: Own elaboration based on Google Keyword Planner [22]

Analyzing the dynamics of changes in interest in individual wood-based product groups according to the average monthly number of queries on the Internet, in the period from 01.03.2019 to 31.03.2021, a dominant upward trend was noticed. Wood furniture, firewood, wooden kitchens and construction timber were the most popular (Fig.6).

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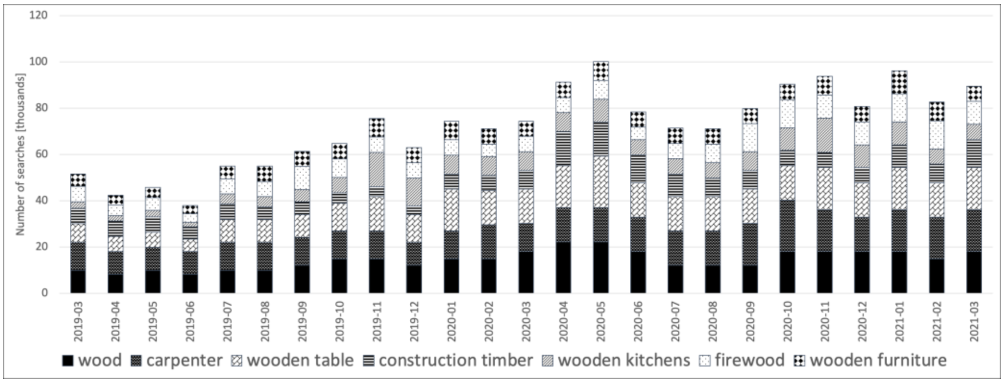

Figure 6.. Change in interest in wood-based product groups by average monthly number of inquiries from 01/03/2019 to 31/03/2021.
Source: Own elaboration based on Google Keyword Planner [22]

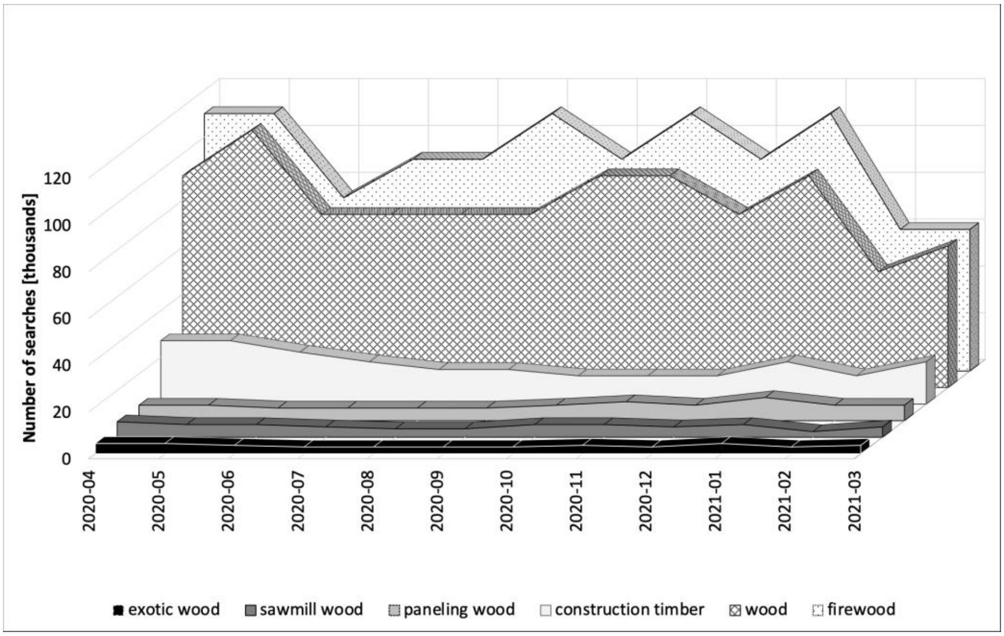

Figure 7. Dynamics of change in consumer interest for aggregated wood-based product groups from 04.2019 to 03.2021 (monthly, in thousands of queries
Source: Own elaboration based on Google Keyword Planner [22]

In the aggregated product groups (Figure 7), we note the dominance of queries for the keywords "wood" (in general) and "firewood". Consumer interest for these groups averaged 100,000 queries per month during the analysis period, with a slight decreasing trend. For the remaining groups, led by 'construction timber', a balanced, relatively stable trend was noted (for 'paneling wood', 'sawmill wood' and 'exotic wood'). Overall, the level of interest in wood and wood products is not declining, and even in the examined period of economic uncertainty (2020-21) shows an upward trend [9,12].

4. CONCLUSIONS

Based on the research carried out, as well as descriptive analysis, the following conclusions and recommendations were formulated:

1) During the studied two-year period, from March 2019 to April 2021, centered on the pandemic and related economic uncertainty, despite initial concerns, no negative trends were observed in the wood-based products market in Poland. Moreover, changes in consumer preferences, greater interest in the home (quality of live at home, including its renovation and furnishing), resulted in a trend of greater interest in wood.

2) The hypothesis formulated at the beginning was essentially verified negatively. It assumed that under conditions of economic uncertainty, potential demand for wood and wood-based products shows a sustainable trend [2]. It was further assumed that this trend is matched by adequate, sustainable consumer interest. It turned out that it did not. Wood has not succumbed to negative trends.

3) There was a certain level of stability (sustainability) in the wood-based business market, although there was a greater tendency for change among individual entrepreneurs, which does not change the situation of the industry as a whole.

Finally, it was noted that in the conditions of economic uncertainty and even signs of crisis in some sectors of the economy, the popularity of wood (raw material, production material and final product) has not decreased at all. What is more, the universal application of wood and wood materials has been "rediscovered" and is always worth reaching for [20]. This kind of economic activity confirms the historical source of economics, hidden in the ancient Greek keyword (*οικονομία*), which enshrines the preservation of laws (*νόμος, nomos*) and principles aimed at taking care of the home (*οἶκος, oikos*) [14,15]. Always, including and perhaps especially in times of uncertainty.

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THE DEVELOPMENT DILEMMAS OF THE FURNITURE INDUSTRY IN THE CONDITIONS OF ECONOMIC UNCERTAINTY. THE CASE OF POLAND

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Abstract: The paper attempts to identify the competitive situation of furniture industry enterprises in Poland in a period of economic uncertainty. The dynamics of changes in the level of economic activity in the furniture industry was identified. The number of active entities in the sector was analyzed (ex post). Moreover, a forecast of its continuation and development in the short term (ex ante) was formulated. The limitation of market functioning during the pandemic prompted the verification of the pessimistic hypothesis. On the basis of the examined econometric models, the hypothesis of a significant limitation of furniture industry development was falsified.
Keywords: furniture industry, enterprise activity, econometric analysis, economic uncertainty, Poland

1. INTRODUCTION

The international competitive position of the Polish furniture industry under conditions of relative prosperity was determined in recent years by top rankings [12]. The uncertainty of pandemic times was to verify these results [13]. A certain surprise was the value index of furniture production sold in Poland, which in October 2020 was the highest ever (PLN 4.75 billion) [17]. Meanwhile, in January 2021, the same indicator amounted to PLN 4.01 billion and was 2.5 percentage points lower compared to December 2020 [17]. What does this mean for the furniture sector? Can pessimistic forecasts be formulated on this basis? The answer was therefore sought based on an analysis of the activity of companies related to the Polish furniture industry, both in the year of the pandemic and in the period preceding it.

2. MATERIAL AND METHODS

The aim of the study was to assess the competitive situation of Polish furniture enterprises. Changes in the number (volume) of active and newly established furniture enterprises were analyzed. It was assumed that the share in the sector is a general measure of companies' ability to be economically active under uncertainty. Secondary data were obtained from the Central Economic Information Office [14], the Local Data Bank of the Central Statistical Office [15] and other government registers [16]. These data were verified and econometric analysis was performed. Significant ex-post trends from 2016 to 2020 (time range) were sought. The created econometric models were statistically verified. On this basis, a short-term forecast of economic activity was developed for the Polish furniture industry (until the end of 2022). A working hypothesis was verified: it was assumed that under conditions of economic uncertainty (pandemic case) furniture enterprises in Poland will reduce their activity, and the supply potential of the sector will decrease by at least 30%.

In terms of entities, all active enterprises of the furniture industry were included, classified according to the Polish Classification of Activities (abbreviated as PKD), viz: Section C, Division 31 (manufacture of furniture) [16]. In terms of subject area, the number (volume) of registered (active and new) furniture industry enterprises in Poland was analyzed (spatial scope), in 2016-2020 (time scope) [2,3,4]. The econometric forecasting covered the years 2021-2022.

Based on the collected data, four econometric models were verified: linear, power, exponential and polynomial. The independent variables (x, explanatory variable) are based on historical data (number of active furniture enterprises in the past years, ex post). The dependent variable (y, explanatory variable) was the forecast sought (number of active furniture enterprises in future periods, *ex ante*).

Starting with a linear model, the validity of the power, exponential and polynomial models was verified successively by referring to the methodology adopted in the literature [5,7,10].

The basic problem in determining polynomial models is to determine the degree of the approximating polynomial. For this purpose, the chi-squared test [7] and the "forward selection" method. In case of failure, alternatively, the "backward elimination" method [7]. In order to determine the mathematical model of an object with one "input" x and one "output" y, i.e. the function y=f(x), it is necessary at least to determine the given input values.

The first step was to assume that the function being sought is a polynomial according to the formula:

$$y = f(x) = a_0+a_1x+ a_2x^2+...+ a_px^p, \qquad (1)$$

where the following symbols mean:

x_i – independent, explanatory variable (vectors of observations of independent variables),

y – dependent, explanatory variable (vector of observations of the dependent variable),

where both the degree of the polynomial "p" and the parameters $a_{0,}\ a_{1,\ ...,}\ a_p$, ap are unknown.

Next, the model was estimated (for the polynomial model: testing the values of the parameters of the polynomial, determining the F-statistic and determining the degree of the polynomial) and verified: substantively and statistically. The key parameter subject to statistical verification was the coefficient of determination R^2. It determines how much of the total variation for the dependent variable y was explained by the model [7]. Based on the comparative analysis, the model was selected and the forecast was discussed.

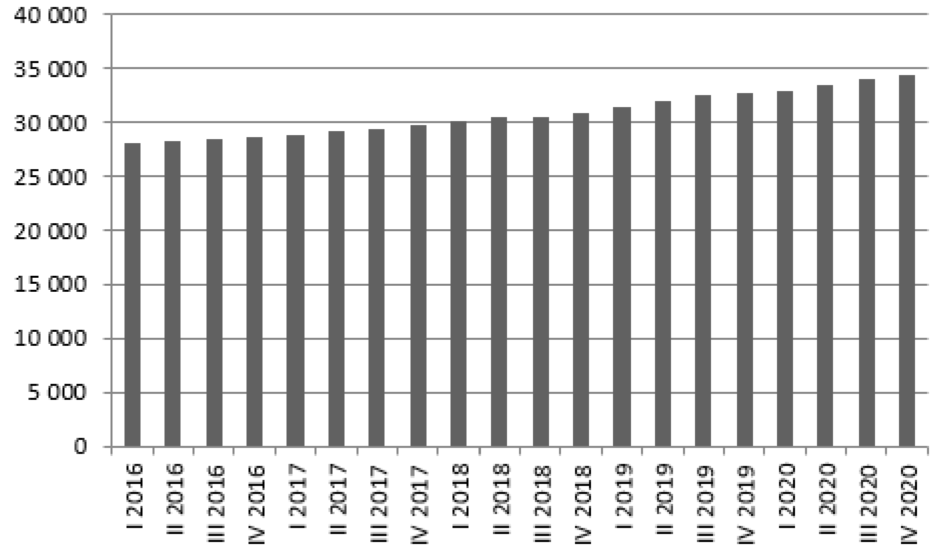
3. RESULTS

In the first step, the activity of enterprises with leading activities defined in Section C, Division 31 (furniture manufacturing), classified according to the Polish Classification of Activities (PKD), was analyzed. In 2016-2020, a matrix of active entities was compiled, and the change in their number (volume) over time was illustrated in the graph (see: Figure 1).

Analyzing the number (volume) of active furniture enterprises in 2016-2020, a weak but stable increasing trend was noted. The surprise was the persistence of a clear increase in the number of active firms during the period of uncertainty (lockdown of pandemic time), studied separately. The change in the number (volume) of active entities is essentially linear in an upward trend.

Then, econometric analysis of the collected secondary data was carried out. Models describing changes in the number of active enterprises in the furniture industry in Poland were constructed and verified. The explanatory variable was the number of active entities ex post (x), while the dependent variable (y) was the number of furniture enterprises forecasted in the future.

Figure 1. Number of active furniture industry enterprises in Poland (by PKD) from 2016 to 2020 (quarterly)



Source: Own elaboration based on [https://stat.gov.pl]

The results of verification and comparison of the degree of correctness of the models based on the value of the coefficient of determination R^2 are summarized in Table 1. The equation that best meets the assumptions was the formula for the polynomial model. Moreover, it was found that all analyzed models obtained the value of coefficient of determination at the level of 0.9 or more (see: Table 1).

Table 1. Construction and validation of selected econometric models describing the size (volume) of the furniture industry in Poland (explanatory variable x: number of active entities ex post)

Econometric model	Equation	Determination coefficient R^2
Linear	$y = 337{,}3x + 27271$	0,897
Power	$y = 26442x^{0{,}071}$	0,902
Exponential	$y = 27425e^{0{,}010x}$	0,901
Polynomial	$y = 7{,}601x^2 + 177{,}7x + 27856$	0,963

Source: Own elaboration

In the next step, a forecast was made for the verified econometric models. It predicts the potential activity of furniture industry enterprises in Poland (defined by the measure of their volume/quantity) in a short-term perspective. The results are summarized in Table 2.

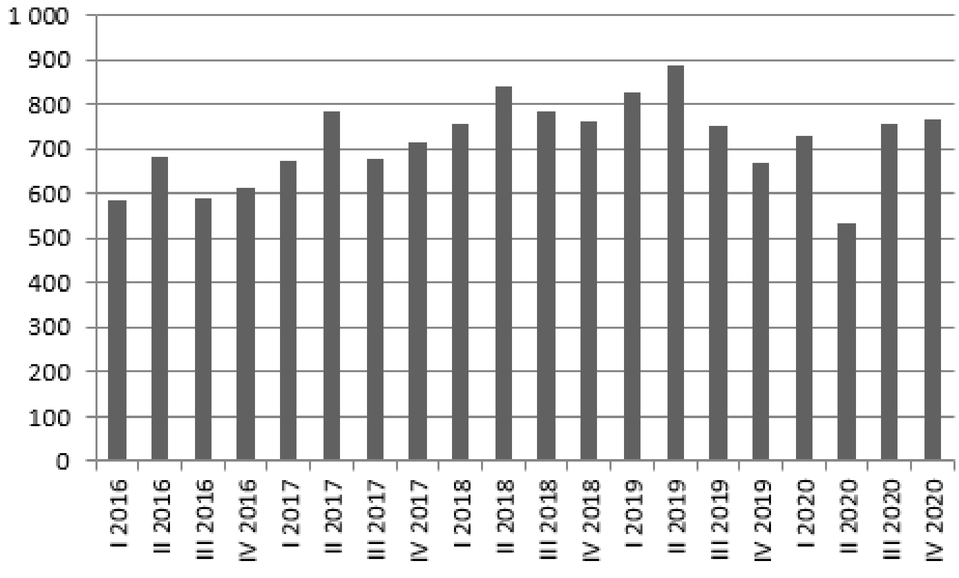
Table 2. Forecast of the number of active furniture industry enterprises based on selected econometric models (variable y: number of firms ex ante) for 2021-2022

Period (quarter/year)	Linear model	Power model	Exponential model	Polynomial model
I 2021	34354	32823	33834	34940
II 2021	34692	32931	34174	35444
III 2021	35029	33035	34517	35964
IV 2021	35366	33135	34864	36499
I 2022	35704	33231	35214	37049
II 2022	36041	33324	35568	37614
III 2022	36378	33413	35926	38195
IV 2022	36715	33500	36287	38791

Source: Own elaboration

Separately, ex-post trend verification was conducted for new furniture industry enterprises entering the sector between 2016 and 2020, quarterly. A periodic variation of the trend was found, a slight decrease during the initial pandemic period (lockdown in the second quarter of 2020), followed by a clear optimistic increase (see Figure 2).

Figure 2. Number of new furniture industry entrants in Poland (sector entry) from 2016 to 2020 (quarterly).



Source: Own elaboration based on [https://stat.gov.pl]

In the end, it turned out that the number (volume) of active furniture enterprises in Poland, despite the pessimism and the freezing of activity at the start of the pandemic time, is constantly growing [9]. Such a trend may be surprising, especially in view of the loss of stability of some other important sectors of the economy [8,10]. The furniture industry remained stable during the pandemic uncertainty, Interestingly, based solely on data from the time of the pandemic, it would have had an optimistic trend (small, steady growth) [1,6]. This is even confirmed by a preliminary verification, based on Big Data analyses (popularity of queries about wood-based furniture, in Poland and in Polish, measured in the first quarter of 2021 [11].

4. CONCLUSIONS

Based on the research carried out, as well as descriptive analysis, the following conclusions and recommendations were formulated:
1) In verifying the change in the number of active furniture businesses, it was noted that even in times of economic uncertainty, the evaluated group not only maintained its previous level, but also grew during the pandemic (linear growth trend).
2) The hypothesis formulated at the beginning of the study was verified negatively. It turned out that under conditions of uncertainty (pandemic), the potential of economic entities active in the furniture industry did not decrease. What is more, the supply potential of the Polish furniture industry recorded an average annual growth of 7%. A similar growth is also forecast in the short term.
3) The furniture industry has avoided the general threat of bankruptcy. New companies are starting up regularly. The trend is relatively stable.

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ECONOMIC CONDITIONS FOR THE PROCESSING OF ROUNDWOOD AS A CONSTRUCTION LUMBER DURING MARKET INSTABILITY

Marek Wieruszewski, Elżbieta Mikołajczak, Leszek Wanat, Rafał Czarnecki

Abstract: Under the conditions of economic uncertainty caused by the pandemic, the situation in the wood market has changed a lot. The study verified changes in prices of wood raw material (roundwood) for sawmill processing. Secondary data (information from world exchanges and Polish Internet auctions) were analyzed. At the same time, the primary data on current market prices of sawnwood and wood-based materials in Poland were obtained. It turned out that irrespective of the time of the pandemic, a strong demand trend prevails both on the domestic and international market The result is a significant increase in wood prices, as well as an imbalance in the global wood market.
Keywords: roundwood prices, construction wood prices, sawnwood, economic uncertainty, Poland

1. INTRODUCTION

Analyzing figures only from the first half of 2020, it was assumed that the wood market in Poland was facing a collapse [7]. The reason for the uncertainty was the temporary reduction in transactions caused by the global pandemic. The ability to execute international wood contracts was also threatened [1,2]. But do pessimistic trends always lead to the results originally forecast?

The initial oversupply of wood raw material on the European market was quickly forgotten. Instead of a decline, there were signs of increased demand for wood on the markets of China and the USA [2, 4]. The internal wood market in Poland, after a temporary decline, responded with an increase in prices. The Polish monopolist in the sale of roundwood, National Forest Holding (Państwowe Gospodarstwo Leśne "Lasy Państwowe"), tried to revise its harvesting plans. The market, balancing between lockdown uncertainty and signs of wood deficit, is looking for an adequate response. Of course, the situation in the sector has also been influenced by government interventions [3, 5, 6], supporting companies in distress [6, 7].

The new perspective looked for a response of the Polish primary wood market to the situation of economic uncertainty.

2. MATERIAL AND METHODS

The starting point of the study was the analysis of the competitive situation on the primary wood market in Poland. Looking for relations between supply and demand, the change in prices of wood and selected wood-based materials in the period determined by the pandemic year was verified. In the forest-wood value chain both the product perspective of round wood (raw wood) and wood-based materials were considered, in particular for sawnwood of general and special purpose.

The question was asked what is the significance of the Polish wood-based sector in specific conditions of uncertainty [12, 13]. The hypothesis was verified which assumed that regardless of the macroeconomic situation, this particular sector of the natural economy can adapt to changing market conditions.

Specifically, the study identified:

- changes in sales volume and average price of roundwood in Poland during a year of economic uncertainty (04-2020 to 03-2021);
- comparison of construction lumber prices in the U.S. and Polish wood markets during the year of economic uncertainty (04-2020 to 04-2021).

The data were aggregated for monthly periods, determining the percentage change in prices relative to previous periods. Considering the special importance of wooden construction developing despite the lockdown, the prices of construction lumber were also analyzed. Prices achieved in Poland were also compared with prices for the same wood materials on the US market.

Moreover, referring to the current competitive situation on the market of wood-based materials, the level of prices for pine wood assortments of particular destination was verified. The results were unified for the average price of a cubic metre of the most popular sawnwood materials. Applying the method of the diagnostic survey, based on the selected group of 30 SME from the sawmill industry in Poland, the average prices of wood were determined as of the end of April 2021.

In the next stage of the study, we performed:

- price comparison of general-purpose sawnwood (untreated and treated) in Poland after the pandemic year (as of 04.2021);
- price comparison of usable (dedicated purpose) sawnwood (pine) in Poland after the pandemic year (as of 04.2021).

Secondary data were obtained from statistical databases available on the Internet, including "e-drewno.pl", "drewno.pl", "bankier.pl" and "stat.gov.pl" [16, 17, 18, 19]. Primary data on current prices of wood materials were collected using an electronic survey questionnaire. A simple opinion polling technique (within the diagnostic survey method) was used by addressing questions to purposively selected respondents, experts in the wood-based sector.

3. RESULTS

First, based on the information provided by "e-drewno.pl" business auction database [18], the sales volume and prices of roundwood in Poland in a period of one year (from April 2020 to March 2021) were compiled. Beside the price matrix in PLN the percentage coefficient of change of wood prices in monthly periods was also determined. The results are presented in Table 1.

Analyzing the results for both classes (lengths) of roundwood, a similar linear upward trend was identified for the price index. Small changes in intermediate values (decreases) do not change the main trend [11, 15].

In the period under review, the average price of pine roundwood of the "Wc" class changed by 12% on an annual basis, and for the "KD" class - by 21%. There was also an upward trend in the volume of wood sales. It is very strong in the months from April to October 2020. Then, after a periodic decrease, the trend repeats itself again from March 2021.

Table 1. Changes in sales volume and average price of roundwood in Poland during a year of economic uncertainty (04-2020 to 03-2021)

Sales volume and price of large-size roundwood (pine) in Poland						
Period (monthly) 2020/2021	Roundwood (Wc/class, 6-14 lm)			Roundwood (KD/class, 3-6 lm)		
	Volume m^3	Price PLN/m^3	% Price change	Volume m^3	Price PLN/m^3	% Price change
04.2020	27899	209	0	30218	210	0
05.2020	32968	214	2,4	25701	206	-1,9
06.2020	48951	212	-0,9	28634	200	-1,0
07.2020	45852	217	2,4	32214	216	8,0
08.2020	36383	220	1,4	23437	223	3,2
09.2020	34753	219	-0,5	32007	222	-0,1
10.2020	52320	221	0,9	74255	215	-3,3
11.2020	14901	223	0,9	11614	235	9,3
12.2020	13065	228	2,2	9538	231	-1,7
01.2021	3527	217	-5,1	4109	236	2,2
02.2021	12753	228	5,1	8479	239	1,3
03.2021	24721	234	2,6	26493	255	6,7

Source: Own elaboration based on [https://e-drewno.pl/, accessed on 03.05.2021] [18].

Price analysis was also conducted for the most popular products in the construction wood group (see Table 2).

Table 2. Comparison of construction lumber prices in the U.S. and Polish wood markets during the year of economic uncertainty (04-2020 to 04-2021)

Prices comparison of construction lumber (pine)				
Period (monthly) 2020/2021	Contract prices on the US market		Prices on the Polish market	
	Price PLN/m^3	% Price change	Price PLN/m^3	% Price Change
04.2020	n.a.	n.a.	1670	0
05.2020	n.a.	n.a.	1700	1,8
06.2020	707	0	1600	-6,3
07.2020	715	1,1	1750	9,4
08.2020	702	-1,9	1800	2,9
09.2020	731	4,1	1760	-2,3
10.2020	739	1,1	1850	5,1
11.2020	765	3,5	1980	7,0
12.2020	892	16,6	1945	-1,8
01.2021	998	11,9	2000	2,8
02.2021	1204	20,6	2000	0
03.2021	1370	13,8	2050	2,5
04.2021	2013	46,9	2100	2,4

Source: Own elaboration based on [https://www.drewno.pl/, accessed on 03.05.2021] [16[.

Table 2 presents results of average prices of construction lumber (pine) in the period from April 2020 to April 2021. At the same time the trend of changes of those prices on the Polish and USA markets was compared (for available data for the period of 11 months). A very large increase in prices was identified. The annual percentage change of prices in the US was almost 285%, while in Poland, in the same period, it was over 31%.It should be emphasized the strong influence of the U.S. market on the global demand for wood (and supply deficit, also in Poland).

Table 3. Price comparison of general-purpose sawnwood (untreated and treated) in Poland after the pandemic year (as of 04.2021)

Dimensions of	Untreated sawnwood (pine) Net price in PLN per m^3 by class					Treated sawnwood (pine) Net price in PLN per m^3 by class				
length (lm)	thickness (mm)	I	II	III	IV	thickness (mm)	I	II	III	IV
2,4 – 6,3	19 – 27	1337	1077	748	413	19 - 27	1198	977	814	452
2,4 – 6,3	28 – 49	1468	1257	961	504	28 - 49	1386	1232	1027	549
2,4 – 6,3	50 – 100	1600	1304	977	509	50 - 100	1419	1257	1034	562
under 2,4	19 – 100	707	602	544	380	19 - 100	718	635	601	402

Source: Own elaboration

Based on our own research, performed with the diagnostic survey method, the average prices of the most popular wooden sawn materials after the pandemic year on the Polish market (April 2021) were verified. A group of 30 purposefully selected Polish woodworking enterprises (SMEs) was invited to participate in the survey. It was noticed that prices of all coniferous sawnwood grades remain high, which is related to a very high demand for wood. Table 3 shows the prices of pine sawnwood (untrimmed and trimmed) of various lengths and quality grades. Similarly, Table 4 presents the prices for special, dedicated purpose sawnwood (pine).

Table 4. Price comparison of usable (dedicated purpose) sawnwood (pine) in Poland after the pandemic year (as of 04.2021)

Dimensions of	Wood materials (sawnwood / pine) Net price in PLN per m^3 by class		
Section (mm)	Length (lm)	I	II
Wood-batten 24×48, 30×50, 40×60	2,4 – 6,3 lm	1174	1029
Wood-batten 24×48, 30×50, 40×60	under 2,4 lm	872	863
Wood-batten cut to size	-	1213	1092
Wood-edge	from 100×100 mm to 140×140 mm	1257	1213
Wood-beam	from140 - 250 mm x 140 - 250 mm	1337	1271
Roof truss	by order	1000	n.a.

Source: Own elaboration

Finally, it should be noted that a natural market reaction to the high demand for wood is very high average prices per cubic meter of sawnwood. These prices exceed, on average, one thousand PLN (this means sometimes, in round numbers, even 300 EUR). This is a situation that could not have been foreseen in conditions of economic uncertainty (pandemic) [15]. Its result is a deficit on the wood supply side, especially the asymmetry on the global market (very high demand for wood on the Chinese and American markets, despite high prices) [1, 10, 14].

4. CONCLUSIONS

Based on the conducted research, obtained results and the descriptive analysis, the hypothesis assumed at the outset was partially confirmed. The Polish wood-based sector (including the primary wood market), despite conditions of economic uncertainty (periodic lockdown), functions in market conditions allowing not only relative stabilization but even development [14].

The following conclusions were formulated:

1) The Polish roundwood market is experiencing a trend of high prices, which combined with the growing demand for wood may result in a supply deficit.
2) During the studied period of economic uncertainty (pandemic year), after a short period of decline in wood prices, a steady increase was recorded. Combined with increasing demand in some international markets (the case of the US market), it can be assumed that the upward trend will continue at least in the short term. This applies in particular to construction lumber.
3) Due to the restrictions on roundwood harvesting in Poland (planned forestry cuttings), a growing deficit in wood supply can be expected. This forecast is also indirectly confirmed by the growing global demand for wood.

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TIMBER FROM PRIVATE FORESTS AS A SOURCE FOR WOOD-PROCESSING INDUSTRY

Karlo Beljan, Ana Bašić, Stjepan Posavec

Abstract: Forestry and wood-processing industry are linked businesses due to the production and respectfully the usage of timber suitable for processing. Looking from wood-processing industry standpoint, the quantities of timber available on the Croatian market do not meet their demand. This paper analyzes the characteristics of the private forest estates advertised for sale (period 2010-2020), and it is an attempt to explore the quantity and quality of timber that could be used for wood-processing industry and by that diminish the supply shortage. The data on the private forests estate's spatial distribution ($\approx$552,000 ha), timber processing plants (416 pcs.), road network ($\approx$44,500 km) and the simulations (period 2018-2048) of private forests management (Beljan et al. (2020) [SmallScaleForestry 19: 19-39]) have been collected and focused just on those estates advertised for sale. In the period of the last 11 years about 740 ads, advertised via on-line platform Njuškalo.hr, have been analysed. The total average surface of estates for sale is about 170 hectares per year, but with the tendency of increasing. Predominant forest types such as beech, sessile oak and beech-fir forests, when performing sustainable and close-to-nature forest management, can produce about 350 m^3 $year^{-1}$ of timber suitable for wood-processing. If we observe all private forest estates which are for sale, the conclusion is that they cannot fill the gap between the national forestry's supply and wood-processing industry demand, but they represent a respectable contribution for reaching that goal.
Keywords: Croatia, supply, demand, natural forests, added-value chain

1. INTRODUCTION

Forestry and wood-processing industry are linked businesses due to the production and respectfully the usage of timber and other forests products suitable for processing. In the production workflow forestry comes first by outputting the timber produced in quite long rotation periods, while the wood-processing industry is second. This mutualistic relationship in necessary to be cognized in order to develop, maintain and upgrade the added-value chain.

The added-value chain by its characteristics and number of segments, as presented by Beljan et al. (2020), encompasses forest management activates (silviculture, road maintenance), truck transport of timber suitable for sawlogs and veneer processing to the timber processing plants. It is crucial to bring out that the term "timber processing plants" refers to sawmills and veneer plants whose total number in Croatia is 418 (MoJ, 2018).

The availability of forest resources is a major issue for the wood-processing industry (Pirc et al., 2010). Due to the fact that about 77% of forests are state-owned (Čavlović, 2010), the wood-processing industry is more dependent on this pool of timber. The essential attribute of timber market is that the Republic of Croatia has a monopoly and keeps the prices unrealistically low. In addition, it needs to be stressed that prices have been more-less constant in the last 20 years (Beljan et al., 2017; Posavec and Beljan, 2013). Looking from a wood-processing industry standpoint, the quantities of timber available on the market do not meet their demand (Pirc et al., 2010). This is precisely why in this paper we have focused on the timber from the private forests estates which could fill the supply shortage to some extent.

Unlike Beljan et al. (2020), where the research frame were all private forests in Croatia, here the determinant is the forest's availability on a market (forest is advertised for sale by its owner(s) or by a real-estate agency). Similar attempts analyzing justification of investing in private forest estates and usage of timber for processing have been published by Beljan et al. (2018), but just on a local scale with a few case studies.

Private forests in many cases are obstructed for active forest management and for being sold on a free market. The reason for this are unsolved property rights and land registry (Krajter et al., 2015), as well as their size. From the literature review it is evident that the average sizes of forest parcels are about 0.34 ha, while forest estates on average amount to 1.28 ha (Berta et al., 2017). Nevertheless, the initial data on all those private forests estates advertised for sale is that all legal and other obstacles have been removed.

The aim of this study arises from the above-elaborated literature review and from the issues which link forestry and the wood-processing industry. The basic characteristics and facts on the private forest estates whose timber could reduce the supply shortage of timber on Croatia's market will be analyzed. The second aim is to analyze the spatial composition of timber processing plants and private forest estates which are on sale.

2. MATERIAL AND METHODS

2.1. The study area

The spatial frame of this research is bounded by Croatia's administrative borders, and respectively by the area of private forests. About 49% of Croatia's land area is covered by forests (including bare forest land which has the potential to become a forest in the future), while 24% of that is represented by privately owned forests (Teslak et al., 2018). On a total area of private forests (551,922 ha), the average length of forest roads is 13.9 m ha^{-1} and 36.3 m ha^{-1} of skid roads. The growing stock equals 156 m^3ha^{-1} where the broadleaved species are predominant (common beech 20.9%, sessile oak 13.3%, European hornbeam 10.3%) (Čavlović, 2010; Teslak et al., 2018). One quarter is damaged mostly by negative insect impacts and forests are featured by poor natural regeneration. By the ad-hoc comparison of private and state-owned forests, which can be made from the results of a Croatian National Forest Inventory (2010), we can say that private forests are inferior in all segments.

The fact is that not all of the private forests are available on a free market (Beljan et al., 2020), so we have focused just on those which are, and which were advertised for sale. The selected study area is characterized by quite small pieces (fragments) of forests (Krajter et al., 2015) whose actual size is yet to be found. Although the wood-processing industry is mainly oriented towards the valuable and prevalent timber coming from the state-owned forests, the spatial entanglement of private and state forests resulted by a more-or-less equal arrangement of timber process plants. This side-effect contributes to the possibility of processing timber from private forests.

To fulfil the aim of this study it was necessary to incorporate all the above-mentioned spatial segments: i) private forests ready to be sold on the free market, ii) timber process plants, iii) forest and public road network.

2.2. Data collection and processing

The data on locations of the timber process plants and the spatial network of forest and public roads suitable for timber transportation (from forest site to a plant) have been taken from a previous study by Beljan et al. (2020) in a QGIS 3.10 format. Concerting the data on the private forests advertised for sale, we encompassed the period from January 2010 to January 2021. The data is provided from Njuškalo.hr which is a leading advertising platform at Croatia's national level. Njuškalo.hr is neither a wholesaler nor a retailer, it simply provides a venue for the seller. In the period of 11 years all ads that offer forest estate have been recorded in the moment of its announcement, and once more when they have been sold or when its owner(s) gave up on selling. The data involves: i) the date when the selling began, ii) forest estate location on a county level, iii) size of an estate. Primary data has been space-time analyzed using descriptive statistics and QGIS 3.10 where the emphasis is put on an interaction between forest estates and timber process plants.

In order to assess the quantity of timber assortments usable for wood-processing, we have used the forest management simulations for private forests in Croatia starting in the year 2018 (Beljan et al., 2020). Due to that, the presented estimate covers 2018, 2019 and the year 2020.

3. RESULTS

In the observed period (Jan 2010-Jan 2021) the total amount of ads is 736. As indicated in Figure 1, the total area of private forest estates available on the market is not constant but varies over time. The average yearly offer is about 170 ha for which it is evident that it tends to increase. For more detailed information, Figure 1 (orange line) shows the yearly average size of forest estates. They vary from 1.17 ha in 2015 to 6.03 ha in 2017, but with an overall average of 2.76 ha per estate.

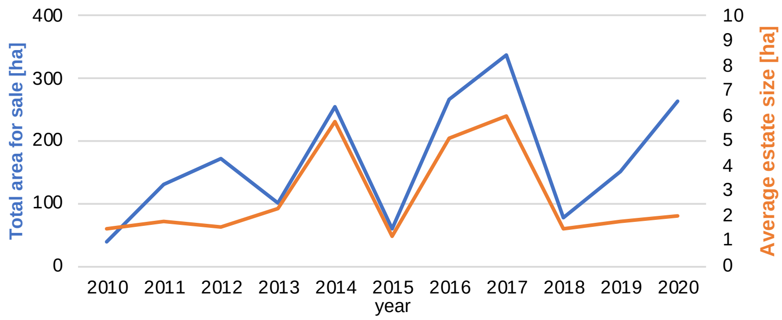

Figure 1. Trends of total (summarized) and average forest estate size advertised for sale.

All private forests (estates) do not have the same potential for the wood-processing industry. Besides forest type, growing stock, increment, quality and quantity of timber planned for felling, a very important variable is the road accessibility apropos the location of plants (sawmills and veneer plants). Figure 2 presents the spatial interaction between forest resources and the wood-processing industry. The spatial distribution of state-owned forests determined the locations on which timber processing plans are established. The timber processing plants almost exclusively depend on timber coming from exactly those resources. However, private forest estates, thanks to their spiral entanglement with state-owned forests, have the potential to offer timber for wood-processing close to the plants (Figure 2). Results indicated that about 91% of private forest estates, in the one-way road range of 15 km, have at least one timber processing plant.

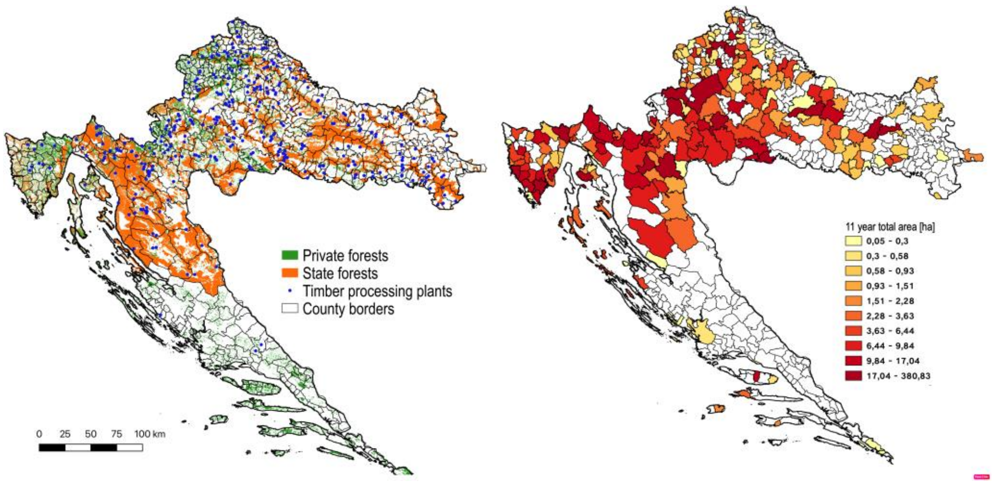

Figure 2. Spatial interaction between forest resources and wood-processing industry (left). The area of estates advertised for sale in the period from 2010 to 2020 per county (right).

The quality and quantity of timber assortments suitable for wood-processing is an outcome of a private forest's management simulations (Beljan et al., 2020) and a collected data on forest estates advertised for sale. The total amount of timber is about 350 m^3 per year where the most valuable assortments, like veneer and peeled veneer, holds just small segments of share (Table 1). According to forest type and the area or private estates, the beech forests stands out by their surface and amount of valuable timber. On the other hand, beech-fir forests are present in minor share by all indicators. Forests in the Mediterranean region (19.7 ha in 2018, 45.0 ha in 2019 and 109.0 ha in 2020) are not included in the analysis (Table 1). In general, those forests with rare exceptions, no not have timber with the proper assortment dimensions for wood-processing, so we have omitted them in this segment.

Table 1. Timber assortments produced in private forest estates advertised for sale (does not include fire-wood).

Timber assortments suitable for wood-processing		year 2018			year 2019			year 2020		
		S[1]	B[2]	B-F[3]	S[1]	B[2]	B-F[3]	S[1]	B[2]	B-F[3]
		area of private estates advertised for sale [ha]								
		27.9	100.2	6.4	38.8	49.2	16.7	44.0	84.4	27.4
m^3	veneer	7.0	21.0	1.8	9.2	10.8	4.6	11.3	18.0	7.6
	peeled veneer	2.3	16.0	2.0	3.8	7.4	5.2	4.8	13.4	8.5
	sawlog 1st class	20.7	82.6	6.9	27.9	40.0	17.9	33.4	69.2	29.4
	sawlog 2nd class	24.1	97.6	4.5	32.5	47.3	11.7	37.1	81.3	19.2
	sawlog 3rd class	11.6	44.6	2.8	16.1	22.0	7.3	18.7	37.6	12.0
	thin roundwood	2.0	8.6	0.7	3.0	4.3	1.9	3.1	7.8	3.2
	Total per *f type	67.7	270.5	18.7	92.4	131.6	48.7	108.5	227.3	79.9
	Total per year	356.9			272.8			415.7		

*sessile oak forests[1], common beech forests [2], common beech-silver fir forests[3], *forest type*

For the results overview, we can say that the total surface of private forest estates advertised for sale is increasing (Figure 1). The fluctuations are present from year to year but with the tendency to rise in the future. The biggest change is happening in the Mediterranean region where the forest's characteristics are not favorable for the wood-processing industry. Forests have low growing stock and respectively smaller DBH (diameter breast height) which in most cases cannot be used in sawmills and veneer plants. Furthermore, the production potential of the estates located on the islands and on the coast is annulled because there are almost none of the timber processing plants (Figure 2). The most valuable forests and timber can be found in the continental part of Croatia. The beech, sessile oak and beech-fir forests are the predominant forests types that are privately possessed and just some of those are advertised for sale.

The timber from private forest estates as a source for the wood-processing industry is limited to a relatively small area (Figure 1) with a modest amount of valuable assortments (Table 1). The share of most demanded assortments like veneer, peeled veneer and sawlogs is directly connected to a growing stock and it is always to be expected that the share of those will not be pretty high. However, in the case of greater growing stocks and increments, like in state-owned forests, the share is the same, but the absolute amount is higher. In other words, the quantity of the most valuable assortments is low because of the low growing stock.

4. DISCUSSION AND CONCLUTION

Private forest estates advertised via Njuškalo.hr present the majority of all of estates that are for sale. Although this online advertising platform is very popular and frequently used in Croatia, it should be considered that some of the estates offered for sale are advertised exclusively via other platforms or by personal advertising. Regarding that, the presented results should be taken with a certain dose of uncertainty.

From the data on the average size of forests estates (in Figure 1 yearly average is 2.74 ha) we cannot express the site of forests parcels. The ads contain information just on the forest estate, but not forest parcel size or its number. Based on previous research by Berta et al. (2017) the site of average forest parcel is 0.48 ha, respectively 0.34 ha, we may try to express just the number of forest parcels from which the advertised estates consist of. However, to get real data on the size and the number of forests parcels, an additional questionnaire for the owners should be conducted. This specific segment could be crucial because the logistical perspective of an estate constituted of more than 2 spatially separated parcels is complicated and more costly.

In the case of this paper, forest management implies sustainable usage of forests where felling is performed just in order to establish and maintain balanced theoretical structure. The yearly felling is more-less equal to the increment which is not much looking from the perspective of the wood processing industry (yearly ranging from 5 to 15 m^3 ha^{-1} (Beljan et al., 2020)). Of course, the quantities of felling could be higher, resulting in greater timber sources for the wood-processing industry, but it would have a negative influence on forestry.

Although the yearly national amount of felling is about 8,412,000 m^3 (1,087,000 m^3 in privately possessed forests) (MoA, 2016) and the wood-processing industry requires about 1,000,000 with a tendency to rise up to 1,450,00 m^3 $year^{-1}$ (CroGov, 2017), from which about 600,000 m^3 is processed by sawmills (Ištvanić et al., 2008), still the supply shortage is present on the market. On one hand, the quantity of felling could satisfy the demand of the national wood-processing industry but that is not the case (Pirc et al., 2010). From Table 1 it is evident that private forest estates advertised for sale, by the timber suitable for processing, are far from reaching that goal. However, the timber processing plants could consider buying private forest estates on a larger scale and using them as an independent source of raw material. In the end we would like to point out that it is obvious how a lot of private forest land is necessary to be possessed and maintained in order to provide enough timber required for wood-processing. At the same time, this paper is a piece of evidence that timber, by its purchase prices, is not appreciated enough by the domestic wood-processing industry.

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PREFERENCES OF COLOUR SHADE OF BIRCH VENEER AT POTENTIAL CUSTOMERS

Roman Dudík

Abstract: By heat treatment of birch veneer, it is also possible to achieve its colour change. In the Czech Republic, a questionnaire survey was conducted on a sample of the population, which examined the preferences of veneer colour shades among potential customers. Based on the evaluation of the results of the survey, an unequivocal preference of customers in the colour shades of heat-treated birch veneer was found. The reference sample without heat treatment was preferred only in about 18% of cases of responses from potential customers. Of the four degrees of heat treatment, the second and third levels were the most preferred. It follows that a low or too high level of colour change was not significantly preferred. Nevertheless, heat treatment of birch veneer can be a way to increase the utilization of relatively cheap birch wood raw material in products with higher value-added.
Keywords: heat treatment, birch, customer preference, questionnaire survey

1. INTRODUCTION

The situation on the wood market in the Czech Republic has been very problematic in the last four years. The volume of harvested timber in the Czech Republic in 2019 reached twice as high value in comparison to the long-term average and that was 32.58 million cubic metres. The wood supply however reached „only“ 30,39 million cubic metres (MZe, 2020), which was caused by overpressure of the supply of wood raw material on the market.

In recent years, Czech forestry has been solving the problem of declining of spruce stands in lower and middle locations, especially in the area of northern Moravia. The result is an increased volume of salvage fellings. Areas heavily infested by bark beetle appeared quickly and are now naturally seeded by pioneer species, very often birch. It is therefore possible to use the "creative forces of nature" in these cases and to direct the development of the birch until the felling age. In the case of the cost side of birch management, lower average costs than for the main commercial species in the Czech Republic (spruce, beech, oak, pine) can be expected. In the case of the revenue side of management, it is necessary to take into account the shorter time of rotation of birch and thus faster yields (Dudík et al. 2018a, Dudík et al. 2018b). Energy from renewable sources is globally a very important issue. In order to reduce pollution and greenhouse gas emissions, many countries enact laws for enhancing the consumption of renewable energy sources (Barčić et al. 2020). In addition to the use of birch wood for energy purposes, where lower monetization can be expected, it is possible to use birch round assortments, especially for furniture purposes etc. Because the demand for wood is a driven demand depending on the situation in other industries, that use wood as a raw material, the development of value added in the wood-processing industry might be affected also by situation in these industries (Palátová, 2019).

There are scientific publications that deal with the topic of heat-treated wood. However, there are very few publications dealing with the heat treatment of birch wood. A side effect of heat treatment of wood is often a colour change of wood, which can be interesting from a customer and marketing point of view. According to Espinoza (2015) existing literature shows that the technical aspects of the thermal modification of wood have received considerable attention in the past, however only limited attention has been paid to market opportunities of thermally modified wood-based products.

Dark colour can be an important benefit of heat treatment, which gives wood a more valuable aspect in some countries. As a result, the modification of wood by heat treatment increases the acceptance of such wood on the market in Europe (Jirouš-Rajković, Miklečić, 2019). The use of new technologies, also related to the heat treatment of wood, is closely connected to innovations in the wood processing industry. And innovations are the basic premise of commercial success in the market (Loučanová et al. 2017), while from a macroeconomic point of view consumption is a key driver of an economy (Parobek, Paluš, 2008). In connection with the topic of this article, consumption is closely related to the preferences of decision-making factors of customers influencing the purchase of furniture. The most relevant purchase decision factors are quality, price and design of furniture (Kaputa, Šupín, 2010). And it is the design that is related to the perception of furniture colours by customers.

According to Bhuiyan (2011), most decisions about launching new products are preceded by marketing research. In our case, the opinion of customers was investigated through a questionnaire survey. The aim of the survey was to determine the degree of attractiveness of heat-treated samples of solid wood and veneers for potential customers with regard to their perception of colour differences of samples and related preferences. The number of respondents was sufficient for the analysis of responses using statistical methods and to determine whether it is possible to apply the results of the questionnaire survey to the entire population - this was confirmed by Dudík et al., 2020. The aim of this paper is a brief introduction to the main results, which concerned the determination of the attractiveness of heat-treated birch veneer samples in terms of their colour shade. The article thematically follows up on the paper published by the author in the proceedings of the WoodEMA conference in 2020.

2. METHODS

The starting point for the analysis of the influence of the colour shade of solid birch wood on the decisions of potential customers is a questionnaire survey on a random sample of 102 people from the population of the Czech Republic. The attractiveness of the colour appearance of selected real samples of birch veneer (1 reference sample and 4 samples with different degrees of thermal treatment) was determined and evaluated. For veneer samples, the letters A to E were used, while the reference sample was marked "A". The methodology of production of solid birch wood samples is published in the article by Borůvka et al. (2019), which also shows a colour representation of the samples.

Designation and nature of samples:

A. Veneer - untreated (BR-REF) – the lightest colour shade
B. Veneer - treated at 170°C/3 h (BR-170-3)
C. Veneer - treated at 190°C/3 h (BR-190-3)
D. Veneer - treated at 190°C/5 h (BR-190-5)
E. Veneer - treated at 200°C/3 h (BR-200-3) – the darkest colour shade.

The attractiveness of the colour appearance was determined in two basic variants. In the first variant, the attractiveness of colour samples was determined in principle in the case of the first furnishing of a new house / flat with furniture (e.g. living room). In the second variant, it was a purchase of a piece of furniture (e.g. into the living room) to the already existing equipment of the house / flat. Another important information obtained was the level of attractiveness of each individual sample of birch veneer, which was evaluated according to the selected point scale (1 point – least preferred; 5 points – most preferred). In this case, the emotional level of attractiveness of individual samples was determined. In addition, each respondent was asked to answer questions of gender, age, level of education and whether the respondent has a forestry/timber related education. The full text of the questionnaire is published in the article by Dudík et al. (2020). The results of the questionnaire survey regarding the attractiveness of heat-treated birch veneer are presented here graphically.

3. RESULTS AND DISCUSSION

The results of potential customer preferences show greater interest in darker shades in both cases - in case of a purchase of an accessory (buying in addition to the present equipment at home) and in case of equipment of a new apartment or house. For the last two darkest shades, a larger share of preferences prevails in the case of a completely new apartment or house furnishings (see Fig. 1).

The lowest value of preferences was found with the darkest sample (BR-200-3) veneer in case of purchase an accessory – 11%. On the other hand, the highest value of preferences of 32% is achieved by a medium-dark sample (BR-190-3) again in the case of purchasing an accessory. Reference samples without heat treatment (BR-REF) are preferred in 18% of cases.

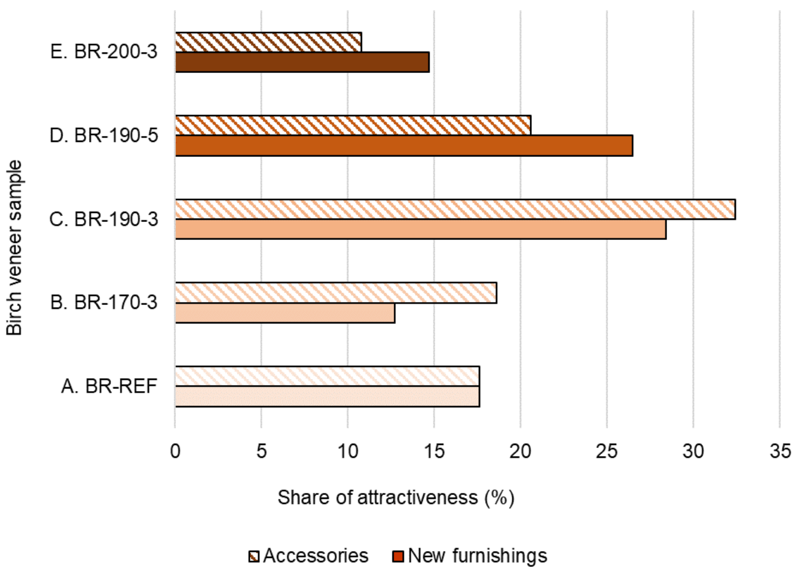

Figure 1. The preference in the samples in the case of purchasing accessories and new furnishings - birch veneer

The level of attractiveness of each individual sample of veneer follows from Figure 2. The maximum number of all possible answers shown in Figure 2 is 510, ie. 5 answers of one respondent (one answer for each sample of veneer) times 102 respondents. Figure 2 shows that for veneer, the degree of preference 3 (medium preference) was used most often, in 151 cases of responses. The second most numerous preference was preference 4 (significant preference), in 148 cases of responses. The least used preference was 1 (insignificant preference - the sample likes the least), in a total of 34 cases. Sample C, BR-190-3, had the highest absolute value of the number of responses in case of preference 4, a total of 48 answers.

At the same time, this sample had the second lowest absolute value of the number of responses, a total of 2 responses in the case of preference 1. It is also interesting to note that in the case of preference 1, the largest number of responses was in the reference sample without heat treatment (A. BR- REF), namely 15 - this means that the lowest level of preference (1 - the sample liked the least) was the most used of all samples for the sample without heat treatment.

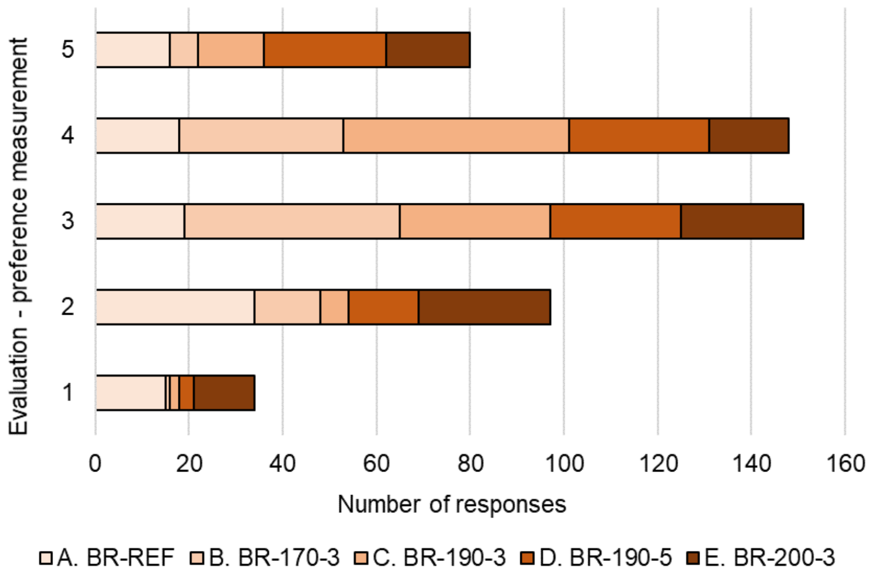

Figure 2. The colour distribution of the samples depending on the preference level - birch veneer

Another view on the distribution of preferences in veneer samples is published in the article by Dudík et al. (2020). When analysing the data obtained from the questionnaire survey, it was also found that statistically significant differences in the preferences of potential customers occur between men and women in the case of new furnishing of the apartment with solid wood furniture. Other significant differences were found between groups with different education, both in the case of new apartment equipment and in the in case of purchase an accessory. The research results are important for wood-processing companies in terms of customer satisfaction. According to Parobek et al. (2015), customer satisfaction is one the most important factor in a successful business.

4. CONCLUSION

The results of the questionnaire survey show more significant preferences for darker birch veneer samples, so for heat-treated samples. This can provide a greater potential in the use of quality birch wood raw material in products with higher added value. This conclusion is also an important signal for forest owners in the Czech Republic, who still perceive birch only as a weed tree species suitable for firewood to be used in the fireplace. The efforts made in the silviculture of birch forests can be returned to forest owners in the form of the possibility of producing quality roundwood assortments. Sale of such assortments could lead to higher sales for forest owners, which is an important motivating factor for them. Wood-processing companies will then have quality birch wood raw material, which they will be able to use in products with higher added value.

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INTERNATIONAL COMPETITIVENESS OF THE VISEGRAD GROUP COUNTRIES ON THE FURNITURE MARKET

Emilia Grzegorzewska, Renata Stasiak-Betlejewska

Abstract: Despite many challenges, furniture industry is still dynamically developing branch of industry in the world. It is also an important element of the EU economy. Some European Union countries are among the leading producers and exporters of furniture. The significant position of furniture is evidenced by the large production and export potential, also of the countries included in the new members of the Community. The paper aims to determine the level of competitiveness of the furniture industry in selected EU countries. Empirical research was conducted on the basis of the Visegrad Group countries (i.e. Poland, Czech Republic, Hungary and Slovakia). The research covered the years from 2009 to 2018. The main source of research material was the International Trade Center database. The trends in the export and import value of furniture were interpreted. The results of the competitiveness analysis, which was carried out with the use of selected result – oriented indicators, were also presented.
Keywords: international trade, competitiveness, furniture industry, Visegrad Group

1. INTRODUCTION

The furniture industry is one of the most dynamically developing sectors of the global economy. The European Union is an important element of the global furniture market. In 2018, the EU countries generated nearly 40% of the value of global furniture export. International competitiveness is an important issue from the economic profitability of economic activity point of view and rationality of decisions taken. This issue can be considered on three levels - macro (country), meso (industry) and micro (enterprise) (Rugman and Oh 2008, Polan 2015, Buturac et al. 2018; Rabar, Cvek 2019). One of the most popular indicators in the literature to assess international competitiveness is the Balassa index (1979). However, so far, many different indicators have been developed, which can be divided into result-oriented and determinant-oriented indicators (Dieter, Englert 2007).

Research on competitiveness was also carried out on the example of the wood-based industry, including the furniture industry. As a rule, these studies referred to the competitiveness of individual countries or a group of countries (Sujová et al. 2015 a,b, Paluš et al. 2015, Parobek et al. 2016, Grzegorzewska et al. 2020). Because the research achievements concerning the international competitiveness of the furniture industry in the countries of the Visegrad Group are small, this topic is discussed in this study.

2. METHODOLOGY

The research on international competitiveness was carried out on the example of the furniture industry in the countries of the Visegrad Group, i.e. Poland, the Czech Republic, Slovakia and Hungary. In total, in 2018, these countries generated almost a quarter of the total value of EU28 export. Considering the availability of statistical data and the assumptions of the project under which the research was carried out, the years 2009-2018 were analyzed. The basic source of research material was the database of the International Trade Center.

The review of the research on the international competitiveness of individual countries in the wood and furniture industries shows that most of these analyzes used results-oriented indicators. Because they should be used together, to minimize the limitations of each individual indicator, three of them were selected for the research: XRCA, MRCA and RTA.

2.1. The Relative Revealed Comparative Export Advantage Index

The Relative Revealed Comparative Export Advantage Index (XRCA) is the relation of two quotients. The first is the ratio of export of a given product in the country k to the export of this product in the country m. The second is the relation of general export of goods in both countries (excluding the analyzed product). The indicator is described by following equation (Pawlak 2013, Frohberg and Hartmann 1997),

$$XRCA_{ik} = \frac{X_{ik}}{X_{im}} : \frac{\sum_{j,j\neq i} X_{jk}}{\sum_{j,j\neq i} X_{jm}}$$

where X is export, i, j are product categories, and k, m are countries.

Values above 1 point to a competitive advantage in the considered product category. The values below 1 suggest a competitive disadvantage (Pawlak 2013).

2.2. The Relative Import Penetration Index

The Relative Import Penetration Index (MRCA) is the relation of two quotients. The first is the ratio of import of a given product in the country k to the import of this product in the country m and the second is the relation of general import of goods in both countries (excluding the analyzed product) (Pawlak 2013, Frohberg and Hartmann1997):

$$MRCA_{ik} = \frac{M_{ik}}{M_{im}} : \frac{\sum_{j,j\neq i} M_{jk}}{\sum_{j,j\neq i} M_{jm}}$$

where M is import, i, j are product categories, and k, m are countries.

The values above 1 means a competitive disadvantage, and values below 1 suggests a competitive advantage.

2.3. The Relative Trade Advantage Index

The Relative Trade Advantage Index (RTA) is the difference between the XRCA and the MRCA (Pawlak 2013, Frohberg and Hartmann 1997):

$$RTA_{ik} = XRCA_{ik} - MRCA_{ik}$$

The values of RTA below 0 means comparative disadvantages in the industry (commodity group). RTA above 0 suggests comparative advantages in the country for export commodities for that industry (or commodity group); and RTA above 1 identifies the industry (commodity) as internationally competitive (Pawlak 2013, Frohberg and Hartmann 1997).

3. RESULTS

The research shows that among the countries of the Visegrad Group, Poland has achieved the highest value of furniture export (figure 1). In addition, in the years 2009-2018 the value of the furniture industry products delivered abroad from this country increased significantly. The Czech Republic was next in the ranking of exporters, while Slovakia and Hungary recorded similar value of furniture export. In addition, in Poland, the value of furniture that hit the domestic market was much lower, which confirms the significant advantage of export over import of furniture.

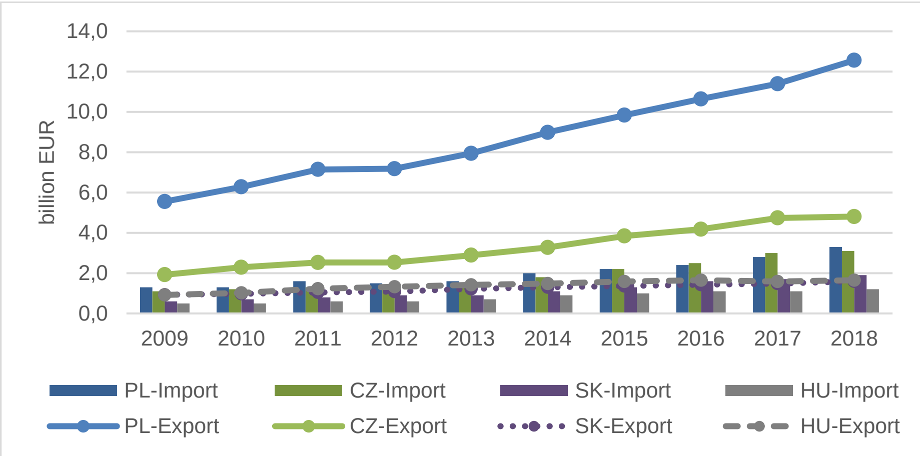

Figure 1. Export and import of the furniture industry in the Visegrad Group countries [billion EUR]

The conducted research shows that in 2009, among the countries of the Visegrad Group, Poland achieved the greatest international competitiveness of the furniture industry. For years, Polish manufacturers, along with Germany and Italy, have been at the forefront of the largest furniture exporters. As shown by the data in Table 1, Poland's high comparative advantage is confirmed by the values of the relative revealed comparative export advantage index (XRCA) and relative trade advantage index (RTA). At the beginning of the analyzed period, the value of revenues from the export of Polish furniture exceeded the import value four times. Among the distinguished countries, Poland gained the greatest competitive advantage in the export. In 2009, the average value of the XRCA index was 6.0, and its maximum value (in relation to Ireland and Malta) was 37.4 and 20.9, respectively. These are small countries, which are characterized by a much low share of the production value of the furniture industry in the total value of the industry and relatively low economic productivity of labor. Additionally, they are net importers of furniture. The favorable competitive situation of the furniture trade was also confirmed by the value of the RTA index, which in 2009 was at the level of 5.3. Only in relation to Lithuania and Estonia, Poland achieved a negative value of this indicator.

The Czech Republic came next in terms of international furniture competitiveness. The relative revealed comparative export advantage index (XRCA) in 2009 reached on average 2.5 and its highest value was 15.1. In addition, the MRCA index amounted to an average of 1.1, which unfortunately confirms the lack of a comparative advantage in furniture import. However, the values of the RTA index, which is the difference of the previous two, were at a favorable level, but significantly lower than in the case of Polish furniture manufacturers (on average 1.4 against 5.3). At the beginning of the analyzed period, a similar level of competitiveness of the furniture industry was reported by Slovakia. The average value of the XRCA indicator was at the level of 2.4. On the other hand, unfavorable tendencies of comparative advantages were noticed in the case of export competitiveness. The MRCA index was higher than one, which confirms the lack of comparative advantages in this area. The total competitiveness of Slovak furniture, measured by the RTA index, was at the same level as in the case of the Czech furniture industry.

Table 1. Selected competitiveness indicators of the furniture industry for the Visegrad Group countries.

Country	Value	XRCA		MRCA		RTA	
		2009	2018	2009	2018	2009	2018
EU28	max	10.0	42.7	1.8	1.8	8.6	41.3
	min	0.2	0.2	0.5	0.6	-1.3	-1.3
	mean	1.6	3.1	1.0	1.1	0.6	2.1
	SD	2.0	8.0	0.3	0.4	2.0	7.9
Poland	max	37.4	150.6	1.5	1.7	36.3	149.4
	min	0.9	0.7	0.4	0.6	-0.1	-0.2
	mean	6.0	11.1	0.8	1.0	5.3	10.1
	SD	7.4	28.2	0.3	0.3	7.6	28.1
Czech Republic	max	15.1	79.0	1.9	2.4	13.7	77.2
	min	0.4	0.4	0.5	0.8	-1.2	-1.3
	mean	2.5	5.8	1.1	1.4	1.4	4.4
	SD	3.1	14.8	0.3	0.5	3.1	14.7
Slovakia	max	14.8	53.0	1.9	2.9	13.4	50.8
	min	0.3	0.3	0.5	1.0	-1.2	-2.2
	mean	2.4	3.9	1.1	1.8	1.4	2.2
	SD	3.0	9.9	0.4	0.6	3.0	9.8
Hungary	max	9.8	42.5	1.1	1.5	9.0	41.4
	min	0.2	0.2	0.3	0.5	-0.6	-0.9
	mean	1.6	3.1	0.6	0.9	0.9	2.2
	SD	2.0	8.0	0.2	0.3	2.0	7.9

Source: own study based on International Trade Centre
*SD - standard deviation

In 2009, Hungary was characterized by the least favorable competitive situation in furniture export. During this period, the value of the XRCA index was on average at the level of 1.6. This means, therefore, that Hungarian furniture manufacturers gained a comparative advantage in export at that time. However, it was lower than in the case of Slovakia or the Czech Republic, and in the case of Polish furniture manufacturers, this advantage was clearly lower (1.6 compared to 5.3 on average). Contrary to Slovakia and the Czech Republic, Hungary showed a comparative advantage in furniture import (0.6 on average). On the other hand, the RTA index was below one, which means that Hungarian producers did not show a comparative advantage in furniture trade at the beginning of the analyzed period.

In the analyzed period, the international competitiveness of the Polish furniture industry increased significantly. In 2018, the relative revealed comparative export advantage index

(XRCA) almost doubled to the value of 11.1. The greatest advantage of Poland in this area was noticed over Malta and Ireland (the XRCA index was 150.6 and 30.6, respectively). Poland was competitive both in export and in the entire international furniture exchange (average RTA = 10.1) in relation to all the countries of the Visegrad Group, and even EU Member States, except Lithuania and Estonia. These countries showed the highest average share of the value of furniture production in relation to the production value of the domestic industry, which confirmed the relevant role of the furniture industry in the total industry of these countries. However, the scale of furniture production and export in countries was clearly smaller than in the Polish furniture industry.

The research showed that Czech furniture manufacturers were characterized by a relatively favorable competitive situation. It should be emphasized that the average value of the RTA index has more than doubled (from 2.5 to 5.8). The average value of the RTA index also increased significantly (from 1.4 to 4.4), which indicates a comparative advantage of the furniture trade. On the other hand, the situation in the area of furniture import deteriorated, which is confirmed by an increase in the MRCA index from 1.1 to 1.4. Similar trends in the international competitiveness of furniture export and trade were noticed in Slovakia. In the Slovak furniture industry, as in the Czech Republic, an improvement was observed in the XRCA (increase from 2.4 to 3.9) and RTA (increase from 1.4 to 2.2) indicators. However, it should be emphasized that the increase in international competitiveness in the Slovak furniture industry was clearly higher. It is also worth emphasizing the almost twofold increase in the revealed comparative advantage of export in the Hungarian furniture industry (from 1.6 to 3.1 on average) and the revealed comparative advantage of RTA trade (from 0.09 to 2.2 on average). Still, the comparative advantage of the furniture trade in Hungary was significantly lower than in Poland or the Czech Republic.

4. CONCLUSIONS

The research results indicate that Poland was the largest furniture exporter among the countries of the Visegrad Group. In addition, the trade balance of the furniture industry in this country was positive and increased significantly in the analyzed period. The Polish furniture industry showed the greatest comparative advantage of export and trade in furniture compared to the EU28 countries (except Estonia and Lithuania). Moreover, in the analyzed period, the XRCA and RTA indicators clearly improved. The Czech Republic showed a relatively significant comparative advantage in the furniture trade compared to most of the EU countries. In the case of Slovakia and Hungary, positive trends were recorded in the area of furniture trade, however, these countries still lagged behind Poland. This means that all countries of the Visegrad Group should take into consideration clear measures to increase the international competitiveness of the furniture industry, i.e. improve work efficiency, increase product and process innovation, including production automation.

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THE IMPACT OF PRODUCTION PLANNING ERRORS ON WOOD FLOOR PRODUCTION EFFICIENCY

Miljan Kalem, Aleksandra Lazarević, Teodora Rajković, Danica Lečić-Cvetković, Branko Glavonjić

Abstract: The subject of research in this paper is the impact of production planning, as the first phase of production management, on productivity in a company for the production of wooden floors. The main goal of this paper is to present the results of research on the impact of errors that occur in the production planning phase on the productivity of wood floor production. The purpose of this paper arise from the need to point out to companies in the wood industry the importance of the impact of production planning on achieving a high level of its productivity. In order to determine the dependence of productivity on the impact of errors in the production planning phase, statistical modeling was performed, using correlation and regression analysis. The results of the conducted research indicate a significant impact of errors in the production planning phase on productivity, which is one of the most important indicators of production efficiency. This is confirmed by the negative value of the correlation coefficient between the length of production interruptions caused by errors in the planning phase, and production productivity.
Keywords: production, planning, productivity, wood industry, statistic, correlation, regression

1. INTRODUCTION

The productivity of a company, as one of the most important indicators of the company's business results, is affected by numerous factors, which can be grouped into internal and external. Internal factors can be managed by the company and thus contribute to increasing the productivity of the production process. Unlike internal factors, external factors cannot be managed by the company or can be managed to a very small extent. In addition to the above, one of the important problems with the affect of external factors on the company is the problem of their quantification. An external factor that significantly affects the productivity of production, and which impact can be indirectly measured, is the impact of end-user demand on production productivity.

Production planning is responsible for transforming customer orders into work orders. On that occasion, a production plan is created, which harmonizes the size of the work order that meets the requirements of the market and the available capacity of the company (Meyr, Wagner and Rohde, 2015). Meeting the needs of customers, in terms of: appearance, quantity, delivery time and price of the product, is the primary goal of every company. In addition, if companies want to remain competitive, they must offer products customized to customer requirements, while reducing costs and minimize product delivery time (Schuh et al, 2017).

One of the solutions in which the impact of customer demands on the productivity and efficiency of the production process can be quantified is the analysis of the demands sent from the production planning service to the production process. As the production planning service is directly related to the sales service and creates production plans based on the data it receives from this service, i.e. market demands, a direct correlation can be noticed between customers demands and productivity of the production process. In accordance with the above, it can be concluded that the productivity of production depends on the efficiency of the production planning service, which has the task to harmonize the requirements of customers with the capabilities of the production plant. According to Mukhopadhyay (2015), the modern concept of production planning is based on three levels of planning: factory planning (the performance of machines and production equipment is identified as the basic performance), process planning (focused on the performance of entire processes or performance of the observed process) and operations planning (strives to achieve the desired performance of work places, time in production and internal transport). In the context of Industry 4.0, production planning and control can be defined as a function that determines the total quantities of products to be produced (production plan), which should meet the commercial plan and profitability, productivity and target delivery times (Chapman et al., 2017).

When creating production plans, various factors should be analyzed which can significantly affect the implementation of the production plan and its efficiency and productivity. Thus, it is necessary to analyze the risks associated with uncertain demand of the product, which can cause a problem in terms of shortage or surplus stock. Also, when planning production, it is necessary to consider the costs and revenues of production, because the prices of raw materials and products vary over time. Other parameters, such as resource availability, machine reliability, and processing time, are also subject to change and can cause various problems in the system (Alem and Morabito, 2012).

Any change in the production plan requires the adjustment of production, in terms of time, materials and capacity in accordance with the new plan, which ultimately results in a reduction in productivity and production efficiency.

2. AIM AND METHODOLOGY

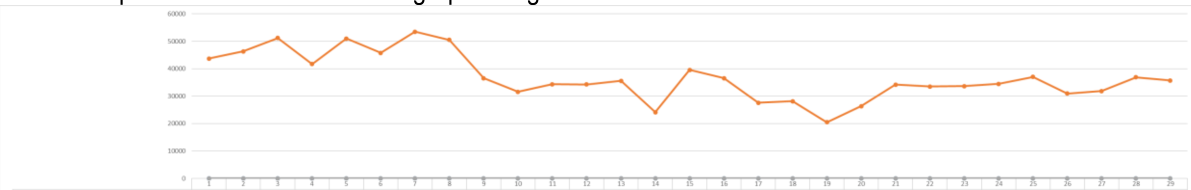
The main goal of this paper is to present the quantitative results of research on the impact of errors in the production planning phase on the productivity of wood floor production in the wood industry. Also, the aim of this paper is to present the results of the analysis of the impact of customer demands on production productivity, observed through the production planning phase. The purpose of this paper is to consider the impact of errors in the production planning phase on production productivity, which are largely caused by changes in customer demands, as well as to draw appropriate conclusions and to give expert recommendations to solve these problems in practice. For the needs of this work, a research was conducted, and a field research technique was used in a selected company from the wood industry. Data on the duration of interruptions in the production process on a weekly basis, caused by errors in the production planning phase, as well as data on actual production, also on a weekly basis, are collected in the field research. Data were collected for a period of 29 weeks. Data collection and processing were performed for the selected machine, which was a key machine in the technological process of wood floor production.

For the purpose of processing the collected data, methods of statistical, correlation and regression analysis were used. By applying the correlation analysis, a research was conducted on the existence of an impact of the duration of interruptions in the technological process of production on the productivity of the selected machine.

Then, after the linear connection of these two parameters was determined, a regression analysis was performed. Regression analysis was performed in order to further determine the strength, direction, intensity and characteristics of the impact between the variables. Also, based on that, a mathematical model was created in order to predict the level of productivity of the selected machine if the duration of production interruption is known, due to errors in the production planning phase.

3. RESULTS AND DISCUSSION

This chapter presents the results of the research on the level of impact of errors in the production planning phase on the level of productivity of the selected machine. Before proceeding with the research, a logical control and analysis of the collected data was performed, aiming to show the impact of the productivity level of the selected machine on the duration of production interruptions on a weekly basis, caused by errors in the production planning phase. A graphical representation of the results of the study of the impact of these two parameters is shown in the graph in Figure 1.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Machine productivity (m2/week)	43722	46300	51205	41716	51030	45739	53509	50541	36545	31579	34312	34293	35564	24127	39543
Duration interruptions planning error (hours per week)	0.17	0.5	0.25	0.33	0.42	1.38	0.29	0.67	0.34	0.25	0.5	17.33	6.75	7.58	5.25

	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Week	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Machine productivity (m2/week)	36531	27603	28162	20520	26311	34205	33480	33668	34476	37011	30977	31873	36914	35693
Duration interruptions planning error (hours per week)	6.34	24	24	47.33	0.2	4.14	1.17	0.58	0.42	1.25	0.33	0.67	0.83	30.53

Figure 1. Impact of the level of productivity of the selected machine on the duration of production interruptions on a weekly basis

In Figure 1 it can be seen that the level of productivity of the selected machine decreases significantly with an increase in the duration of production interruptions, which are caused by errors made in the production planning phase. This conclusion is supported by the data on the lowest level of productivity of the machine, which was achieved in the 19th week, which amounted to 20,520 [m^2] of parquet, while the duration of production interruption in that week was 47.33 hours. Also, in Figure 1 it can be seen that the level of productivity of the selected machine was the highest in the 7th week, and that it amounted to 53 509 [m^2] of parquet, and that in that week production interruptions lasted 0.29 hours. Based on the above, it can be concluded that the level of productivity of the selected machine depends on the duration of production interruptions caused by errors in the production planning phase, and that there is a justified basis for conducting further statistical research.

The first statistical research, conducted for the purposes of this paper, refers to the study of the strength and direction of the impact of the duration of production interruptions caused by errors in the production planning phase on the level of productivity of the selected machine. For the purposes of this research, a correlation analysis was performed. In order to determine the impact of the productivity level of the selected machine and the duration of production interruptions caused by errors in the production planning phase, the achieved level of productivity of the selected machine is put in relation to the duration of production interruptions for that machine, on a weekly basis, expressed in hours. The research was performed on a sample of 29 weeks. The results of the correlation analysis are shown in Table 1.

Table 1. Results of correlation analysis of the impact of production interruptions caused by errors in the production planning phase on the level of productivity of the selected machine

Correlations

		Machine_productivity	Duration_interruptions_planning_error
Pearson Correlation	Machine_productivity	1.000	-.505
	Duration_interruptions_planning_error	-.505	1.000
Sig. (1-tailed)	Machine_productivity	.	.003
	Duration_interruptions_planning_error	.003	.
N	Machine_productivity	131	29
	Duration_interruptions_planning_error	29	29

Based on the data presented in Table 1, it can be concluded that the impact of the duration of production interruptions caused by errors in the production planning phase on the level of productivity of the selected machine is large, negative and statistically significant. The correlation coefficient (*Pearson Correlation*) has a value of -0.505, which indicates that with the increase in the duration of production interruptions due to errors in the production planning phase, there is a significant decrease in the productivity level of the selected machine. Statistical significance *Sig*. is 0.003.

Regression analysis was performed for additional research, which should show how the independent variable (duration of interruptions caused by errors in the production planning phase, i.e. Duration_interruptions_planning_error) describes the dependent variable (Machine_productivity), as well as to create a mathematical model which application can predict the value (level) that the productivity of the selected machine will have, if the duration of production interruption is of a certain size. The results of this part of the research are shown in Tables 2-4.

Table 2. Results of regression analysis - Model Summary[b]

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.505[a]	.255	.227	9040.318

a. Predictors: (Constant), Duration_interruptions_planning_error

b. Dependent Variable: Machine_productivity

Based on the data shown in Table 2, from the *R Square* field, it can be concluded that the coefficient of determination has a value of 0.255, i.e. that the value of the adjusted coefficient of determination (*Adjusted r Square*) has a value of 0.227. This data indicates that the duration of production interruptions, which occurred due to errors in the production planning phase, affects the level of productivity of the selected machine with 22.7 [%]. The obtained value of this variable can be considered extremely high, taking into account a number of factors that affect the level of productivity of the selected machine.

Table 3. Results of regression analysis – *ANOVA method*

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	755600271.046	1	755600271.046	9.245	.005[b]
	Residual	2206638328.259	27	81727345.491		
	Total	2962238599.306	28			

a. Dependent Variable: Machine_productivity
b. Predictors: (Constant), Duration_interruptions_planning_error

Table 3 shows the statistical significance of the linear regression between the observed variables, which has a value of 0.005 (*Sig.* 0.005), which can be considered statistically significant, with 95 [%] confidence levels. This value shows that based on the defined model, it is purposeful to analyze the level of productivity of the machine, caused by the length of production interruptions due to errors in the production planning phase.

Table 4. Results of regression analysis - *Coefficients*

Coefficients[a]

Model		Unstandardized coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	41077.565	1927.745		21.309	.000	37122.16	45032.97					
	Duration_interruptions_planning_error	-454.629	149.518	-.505	-3.041	.005	-761.41	-147.84	-.505	-.505	-.505	1.000	1.000

a. Dependent Variable: Machine_productivity

In Table 4, *the Standardized Coefficients* column shows the value of the *Beta* parameter of -0.505. The stated value shows that the independent variable (duration of interruptions caused by errors in the production planning phase) significantly affect to the prediction of the dependent variable (machine productivity). This value can be considered statistically significant, because the value of the parameter *Sig*. is 0.005.

The linear mathematical model of the impact of production interruptions caused by errors in the production planning phase on the level of productivity of the selected machine, in the observed production system, is presented by equation (1):

$$y = 41\ 077{,}565 - 454{,}63\ x \qquad (1)$$

Interpretation of the obtained values of parameters leads to the following conclusions:

- The duration of production interruptions, caused by errors in the production planning phase, has a negative impact on the level of productivity of the selected machine. This effect is statistically significant (*Sig*. 0.005);
- By increasing the duration of production interruptions caused by errors in the production planning phase by 1 hour per week, one can expect a decrease in the productivity level of the selected machine by 454.63 [m^2/week].

As the selected machine observed in this research is the most important machine in the process of production of wooden floors (parquet) in the selected company, the data obtained by the research indicate that production interruptions caused by errors in the production planning phase significantly reduce productivity level of this machine, and indirectly lead to a significant reduction in the total productivity, not only of the production plant where this machine is located, but also of the overall production of this production company.

4. CONCULUSION

Based on the results of research presented in this paper, it can be concluded that the total productivity of parquet production in the selected company largely depends on the duration of production interruptions due to errors in the production planning phase, which are mostly caused by changes in customer demands. The correlation coefficient between the duration of production interruptions caused by errors in the production planning phase and the productivity level of the selected machine is -0.505 (*Pearson Correlation* - 0.505), and the statistical significance of *Sig*. 0.003. The coefficient of determination, having a value of 0.227, shows that 22.7 [%] of the total productivity of the selected machine can be explained by the impact of errors occurred in the production planning phase.

The main recommendation, based on the results of this research, which can be proposed to the selected production company, is that it would be necessary to strive to reduce errors in the production planning phase, which would significantly contribute to increasing the productivity of the selected machine and production plant as well as the production of this company.

When collecting data for the preparation of this paper, the errors that are observed and that significantly affect production interruptions, which should be eliminated in order to increase productivity in the observed company, are: reducing the addition of new quantities of parquet to already created work orders, following the order of creating work orders and increasing the size of the series.

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THE INFLUENCE OF NATURAL DRYING OF BEECH SAWN WOOD ON LOGISTIC PROCESSES OF SUPPLY AND STORAGE IN ENTERPRISES OF THE WOOD PROCESSING INDUSTRY

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Abstract: The article is focused on the summarization of scientific and practical knowledge from the logistics of supply and storage processes in the enterprises of the wood processing industry. The specifics of wood raw material and the characteristics of its types place increased demands on the logistics processes of wood processing enterprises and on determining the amount of technological stocks of individual wood assortments. The research part presents a more comprehensive view of the process of natural drying of sawn wood, time and volume unevenness of dried sawn wood in individual months of the year and their impact on other processes such as supply, storage and distribution of sawn wood. The process of natural drying of sawn wood is time and economically demanding, influenced by climatic conditions and requirements for its further use.
Keywords: logistics, supply processes, storage processes, sawn wood, natural drying

1. INTRODUCTION

In sawmills, it is very difficult to create the complex corporate logistics needed for optimal coordination of production and non-production operations such as receiving raw materials, detecting the presence of metal objects, shortening stem, debarking log, sorting and dosing specific saw log into the sawmill. The order of processes in the logistics chain is variable depending on whether it is a deciduous or coniferous raw material, on the method of protection of wood raw material and the level of machinery. The overall purpose of the supply chains for logs and sawn wood as well as biomass for energy use is in principle doubled: the costs of raw materials should be kept competitive (Hess et al., 2007) and a continuous supply of secured raw material must be available (Sims and Venturi, 2004). In this respect, problems may arise due to the growth cycles of most wood species, unstable natural conditions such as drought (Mabee et al., 2006) and lack of reliability, willingness and coordination of supply chain actors (Van Belle et al., 2003). According to Ballou (2004) and Rushton et al. (2009) a *logistics system* is composed of several components which can be divided into key activities and support activities. Waters (2009) presents logistics as the function responsible for the flow of materials from suppliers into an organisation. Langley et al. (2008) notes that logistics management is the most widely used term and includes logistics not only in the private business sector but also in the public, government and non-profit sectors. Effective inventory management can bring significant benefits to the entire logistics system. (Bartholdi and Hackman, 2016). Stehlík (2020) defines logistics as the management and organization of material and information flows of goods and all other activities related to the flows of goods and information. According to Li (2014), Supply Chain Management is a set of synchronized decisions and activities used to integrate in a more efficient way the suppliers, the manufactures, the warehouses, all transporters involved, the retailers, and the final customers. The current stocks of logs and sawn wood in sawmills in summer are limited by the seasonal harvesting regime in winter, so it is necessary to ensure a fixed amount of raw material by increasing supplies during winter at monthly intervals or according to a specific situation in forest holdings. Insurance stocks dampen random influences on the input side such as delayed deliveries or reduced delivery size and on the output side such as a higher customer demand (Sixta and Žiška, 2009). The authors Trebuňa and Pekarčíková, (2011) agree that the technological stock consists of materials that require some time to be stored before further processing. The process is completed by the manufacturer, but the product cannot be used for immediate consumption, because it is still undergoing technological processes (e.g., drying, maturation, etc.). For these reasons, this part of the stock must be kept in stock.

2. METHODOLOGY

2.1. Methodology of creating technological stocks of sawn wood in a sawmill

Trebula and Klement (2002) characterize natural drying of wood as a method of drying in open spaces, in which atmospheric air is the drying environment. External drying conditions are characterized by temperature, moisture and flow rate. The average annual temperature in Slovakia is + 8 °C and fluctuates in the range from -10 to 25 °C. The positives of natural drying are in the use of natural energy sources and ease of drying. The main disadvantages are seasonality, long drying time, uneven distribution of moisture in the cage, the need for larger storage areas, connection to the transport network, and other conditions. The results of the research are the use and processing of knowledge about sawn wood drying in the logistics of WPI enterprises. As a part of a comprehensive elaboration of the issue of wood drying, the authors (Trebula, Klement, 2002) present in the form of tables indicative times of natural drying time for woody plants that are most often grown and processed in Slovakia (spruce, beech, oak, poplar). The tables show the average number of days for which the sawn wood is dried from the initial moisture of about 80% to the final moisture, to 20% and to 30. The measured values are given for different intervals of sawn wood thickness, for each wood from 15 to 75 mm, on which the drying time depends (Trebula, Klement, 2002).

2.2 Methodology for determining the length of natural drying of beech sawn wood for the calculation of the technological (seasonal) stock

- Determination of the target moisture and thickness of dried beech sawn wood to determine the length of the drying process.
- List of indicated times for the established criteria according to Trebula and Klement (2002).
- Determination of the day of the month for storage of sawn wood in the warehouse. The 15th day of the month has been set.
- Table 1 shows the length of natural drying of beech sawn wood (in days) for individual months of year, for the selected sawn wood thickness 25 - 34 mm and the required target moisture of 20%.
- Mathematical recalculation of the drying time for each month by adding the drying time to the 15th day of the month and determining the day and month of completion of the drying process.
- Analysis of the determined completion dates of drying and volumes of dried beech sawn wood. .

Table 1. The period of natural drying beech sawn wood in individual months of the year

Month	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
Drying time [days]	165	145	120	105	80	70	75	95	235	220	205	185
Drying completion date	30.6.	10.7.	15.7.	30.7.	5.8.	25.8.	30.9.	20.11.	10.5.	25.5.	10.6.	20.6.

Methodology of calculation of individual types of stocks was according to Rossová et al. (2010) and Kotlínova, Simanová (2011). The insurance stock is an additional stock, and it is calculated according the following formula (1):

$$\boldsymbol{Z_i} = \left[\frac{\sum_{j=1}^{n}[(\boldsymbol{t_{di}} - \overline{\boldsymbol{t_{di}}}) * \boldsymbol{D_i}]\boldsymbol{j}}{\sum_{j=1}^{n}(\boldsymbol{D_i})\boldsymbol{j}}\right] * \overline{\boldsymbol{m}}_{\boldsymbol{j}} \quad (1)$$

Where: $\boldsymbol{Z_i}$ *– insurance stock*
$\boldsymbol{n - j}$ *– number of deliveries*
$\boldsymbol{Di}$ *– amount of delivery t of the i-th material in weight units*
$\overline{\boldsymbol{m_j}}$ *– average daily consumption of the j-th material in weight units*
$\boldsymbol{t_{di}}$ *– delivery cycle in days*
$\overline{\boldsymbol{t_{di}}}$ *– average delivery cycle in days*

In sawmill enterprises, the technological stock may overlap with the insurance or seasonal stock for a certain period of time. The size of this stock is given mainly by the technical parameters of the technological process. Its requirements must be considered when calculating the minimum and maximum stocks, as indicated by the following formulas (2, 3 and 4):

$$\boldsymbol{Z_{min}} = \boldsymbol{S_d} + \boldsymbol{Z_i} \quad (2)$$
$$\boldsymbol{Z_{max}} = \boldsymbol{S_d} * \boldsymbol{DC} + \boldsymbol{Z_i} \quad (3)$$
$$\boldsymbol{Z_{tech}} = \boldsymbol{Z_{min}} - \boldsymbol{Z_i} \quad (4)$$

Where: Z_{min} *– minimum stock*
Z_{max} *– maximum stock*
Z_i *– insurance stock*
Z_{tech} *– technological stock*
S_d *– average daily consumption*
DC – delivery cycle

3. RESULT AND DISCUSSION

3.1 Analysis of the effect of natural drying of beech sawn wood on the amount of technological stock

In the specific case of the sawmill, the impact of an uneven amount of dried beech sawn wood during the year during natural drying and its impact on the volatility of technological stocks is demonstrated. The initial requirements for calculating the natural drying time of beech sawn wood were as follows: required thickness 25-34 mm, initial humidity approximately 80% ± 10%, final required moisture is 20% ± 2%, annual volume of beech sawn wood 36,000 m3 (sawmill capacity), the average monthly cross-section of sawn wood entered for drying is 3,000 m3. Drying times for individual months were determined taking into account the changing climatic conditions and the differences in drying times were taken into account in the amount of insurance stock for a particular month of the year. Table 2 shows the month of entering the sawn wood for drying and the quantities of dried beech sawn wood in a particular month of the year according to the regime of natural drying in Slovak climatic conditions, according to Trebula and Klement (2002). On the 15th day of the month, the storage of beech sawn wood in the warehouse was considered.

Table 2. The quantities of dried beech sawn wood in individual months of the year

Month	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
Quantities of dries beech sawn wood [m^3]	0	0	0	0	6000	9000	9000	6000	3000	0	3000	0

Based on the analysis of the resulting times of completion of natural drying, we can state that the drying of individual batches is not uniformed, which had an impact on the determination of the quantities of individual types of beech sawn wood stocks. These had to be determined individually for each month, considering the size and the date of the completion of natural drying for a specific batch of sawn wood. In addition to the uneven supply, it was necessary to take into account current fluctuations in the amount of precipitation and other climatic conditions, which have an impact on the current dates of dried sawn wood in practice. Figure 1 shows the different length of drying of beech sawn wood depending on the date of the beginning of drying in the respective month of year and according to the climatic conditions of Slovakia.

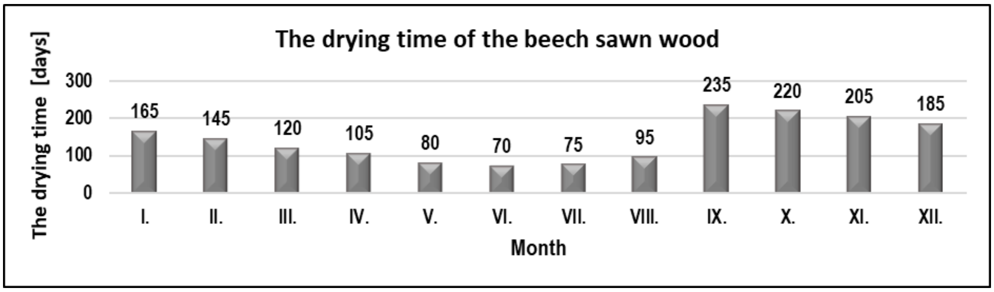
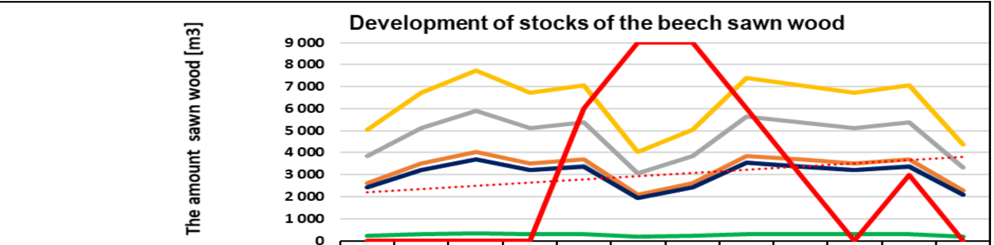


Figure 1. The time of natural drying of beech sawn wood

Figure 1 shows the length of the natural drying process, which is significantly prolonged at the doses given in autumn and winter months, in particular for deciduous trees from September to March. The dried quantities are concentrated in May, June, July and August. Lots of sawn wood stored for drying in September and October can be used only in May of the following year. The sawn wood stored for natural drying in November, December and January may not be used until June of the following year. The batches ending drying in summer months can be transferred to processing gradually for further months, which allows to cover evenly the stocks of production in the months of September to April and create a time reserve for drying in case of worse climatic conditions.

3.2 Determination of the technological stock of beech sawn wood depending on the natural drying regime

The following specifications were considered when calculating the stock height for the natural drying regime: 65% yield of beech sawn wood, thickness 25 - 34 mm, initial moisture approx. 80%, final moisture approx. 20%, and the amount of 3000 m3 beech sawn wood. Klement and Detvaj (2007) state that the dimensional and quality specification of sawn wood has a significant effect on the drying regime and the yield of sawn wood. The development of individual types of beech sawn wood stocks in a sawmill during the year is shown in Figure 2



Month	1	2	3	4	5	6	7	8	9	10	11	12
Seasonal stocks with combined drying regime	2 422	3 229	3 713	3 229	3 390	1 937	2 422	3 552	3 390	3 229	3 390	2 099
Minimum stock	2 632	3 509	4 035	3 509	3 684	2 105	2 632	3 860	3 684	3 509	3 684	2 281
Average stock	3 839	5 119	5 887	5 119	5 375	3 071	3 839	5 631	5 375	5 119	5 375	3 327
Maximum stock	5 047	6 729	7 738	6 729	7 065	4 037	5 047	7 402	7 065	6 729	7 065	4 374
Technological stock	2 415	3 220	3 703	3 220	3 381	1 932	2 415	3 542	3 381	3 220	3 381	2 093
Insurance stock	217	289	332	289	303	173	217	318	303	289	303	188
Seasonal stocks with natural drying regime	0	0	0	0	6000	9000	9000	6000	3000	0	3000	0

Figure 2. Development of stocks of dried beech sawn wood during the year

Minimal, maximal, insurance and technological stocks are calculated according to the formulas 1-4, considering daily consumption, delivery cycles, monthly demand of dried beech sawn wood and recommended stock standards for 20 days. The need for dried sawn wood was determined on the basis of a sales plan and a plan for further processing into furniture components. In these calculations, a combined method of drying beech sawn wood was considered and for this reason it was possible to use standard procedures. The trend line also copies the amount of technological (seasonal) stocks. The regime and conditions of natural drying of beech sawn wood extremely affect the number of seasonal stocks and transfer these stocks to technological or insurance stocks depending on climatic conditions. With a suitable combination of drying regimes, it is possible to use the methodology of calculation of stocks according to 1-4 and to transform seasonal stocks evenly according to the needs of beech sawn wood in individual months.

4. CONCLUSION

When planning stocks, sawmills must take into account the production capacity of the sawmill, the area capacity of the natural drying warehouses, as well as the requirements for subsequent use. Storage areas for extreme volumes of beech sawn wood can be solved either by determining suitable drying regimes, or by stacking sawn wood cages to the height. By harmonizing the capacities of individual technological and non-technological operations, bottlenecks in supply and storage logistics are eliminated. Planning the amount of individual types of stocks in sawmills is demanding from various points of view. From the point of view of logistics, it places high demands on logistics processes in the areas of sawn wood supply, storage, and distribution. From a point of view of time, it is necessary to consider the drying regimes to avoid extreme fluctuations in stocks (Klementová, 2014). At the same time, it is necessary to add that the climatic conditions in the individual months of the year are an attribute that influences the decision-making in the area of determining the drying regime and to a large extent influences the amount of individual types of stocks. The presentation of data on the different time required for drying beech sawn wood and uneven dried volumes in individual months of the year, as well as their impact on the creation of technological and other types of stocks was carried out on a specific example of sawmill conditions.

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ASSESSMENT OF FOREST CERTIFICATION AS A TOOL SUPPORTING SUSTAINABILITY IN FOREST MANAGEMENT

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Abstract: Activities to promote forest certification have evolved in response to the perception of society's shortcomings in the sustainable management of the world's forest resources. Forest certification as one of the voluntary tools recognizes the principles of sustainable practices. Strict adherence to them reduces deforestation and thus halts the loss of biodiversity and the degradation of the natural environment. Therefore, the main objective of this paper is to assess the perception of forest owners and managers of forest certification as a tool for supporting sustainability in forest management. The questionnaire survey targeted 288 PEFC and FSC certified forest owners and managers in Slovakia with the aim to examine whether forest certification helps to support sustainable forest management as defined by the generally accepted international principles. The results of this study indicate that forest certification is perceived as a tool that has a positive impact on individual areas ensuring sustainability in forest management in Slovakia.
Keywords: forest certification, sustainability, forest management,

1. INTRODUCTION

Sustainable forest management (SFM) offers a holistic approach to ensure forest activities deliver social, environmental and economic benefits, balance competing needs and maintain and enhance forest functions now and in the future. As the concept of managing forests, it is closely related to the concept of sustainable development. Under the FOREST EUROPE process this term was defined in 1993 in the Helsinki resolution as “the stewardship and use of forests and forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfil, now and in the future, relevant ecological, economic and social functions, at local, national, and global levels, and that does not cause damage to other ecosystems” (Forest Europe, 2021). Similarly, 6 Pan- European criteria and indicators have been also adopted and continuously revised to promote SFM. They are related to the maintenance and appropriate enhancement of (i) forest resources and their contribution to global carbon cycles; (ii) forest ecosystems’ health and vitality; (iii) productive functions of forests; (iv) biological diversity in forest ecosystems; (v) protective functions in forest management; and other socio-economic functions and conditions. Currently, when forestry faces many sustainability issues that are partly in a conflict of interest, these criteria and indicators serve as a tool to communicate SFM in the sector to policy makers and to the public. Finding the required balance in satisfying ecological, economic and social values, weighing different objectives and seeking a compromise, such as ecosystem services, timber provision, adaptation to climate change or maintaining carbon stocks in forests is required (Köhl et al., 2020). It is also important to have in place a mix of effective public policies and private market initiatives for achieving the goals of SFM (Siry, Cubbage, 2005).

In line with the development of the SFM concept new forest certification systems have emerged to focus on providing evidence of SFM practices applied by forest owners and managers in the forests to demonstrate that these practices are sustainable and that the forests meet both our needs and those of future generations. There are two main internationally recognized forest certification schemes the Programme for the Endorsement of Forest Certification (PEFC) and the Forest Stewardship Council (FSC); both are currently applied across Europe. Forest certification represents a voluntary tool for independently verified SFM (Cashore, et al., 2004), which is in line with specific ecological, economic and social standards (Kurttila et al., 2000). Several studies identified a range of benefits following from certification, such as economic benefits in terms of increased sales, penetration of new markets (Paluš et al., 2018a), biodiversity protection (Kalonga et al., 2016) or conservation of ecosystem services (Ningh et al. 2020). Recent studies on the role of forest certification in Slovakia indicate that the main motivation for certificate holders to enter the certification process was to improve their external image, demonstrate SFM practices and commitment to environmental issues (Paluš et al., 2018b). However, awareness, understanding and perception of forest certification by certified entities and consumers are influenced by a range of other factors among which are e. g. the ownership type or forest area (Paluš et al., 2018a, Paluš et al., 2018b, Paluš et al., 2017, Šupín, 2006).

The main objective of this paper is to assess the perception of forest owners and managers of forest certification as a tool for supporting sustainability in forest management in Slovakia.

2. MATERIALS AND METHODS

The goal of the study was to obtain data to assess how the forest certification tool supports the selected areas of SFM. The survey applied systematic sampling based on the list of certificate holders recorded in the national PEFC database (PEFC, 2020) and international FSC database (FSC, 2020). Google Forms were sent out to the respondents during autumn 2020. Totally 194 responses were suitable for further analysis. The first section of the questionnaire contained questions regarding the demographic profile of respondents in terms of size of their forest area, region, ownership type, implemented certification scheme and the period during which the companies have certified, as well as, the position of respondents in the company. The second section was aimed at the examination of the level of perception of respondents. In order to examine how forest certification helps to support SFM, as defined by the generally accepted international principles, a five-point Likert scale was used, where 1 corresponded to “strongly disagree” and 5 to “strongly agree”. SPSS software was used for statistical analyses of collected data.

To examine the effect of demographic factors on the perception of the role of certification in SFM we focused on the above mentioned factors. As only the region and ownership proved to be statistically significant, further in this study we refer only to these two factors. For these purposes, there were four different regions determined. A Chi-square test was used to identify differences between respondents representing individual regions. Considering the two involved ownership categories in the country the respondents were classified as the state and the non-state owners. Moreover, the nonparametric Mann–Whitney U test was applied to determine differences in the distribution of categorical variables, in particular, differences between the ownership categories.

3. RESULTS

The questionnaire survey focused on the assessment of forest certification as a voluntary tool recognizing the generally accepted sustainable principles. Certified forest owners and managers had the opportunity to assess how this voluntary tool supports the selected areas of SFM.

Based on the collected socio-demographic data, more than a half (57.2%) of respondents from state forests participated in the questionnaire survey and the remaining 42.8% were representing non-state ownership. Another factor examined was the region, where up to 31.4% of respondents were registered in the central region, then the eastern (26.8%), western (23.3%) and northern region (18.6%). The size of the company was determined by the area of the managed forest land owned and managed by the respondents. Based on the answers obtained from the respondents, the largest proportion was with an area of 2,001–10,000 ha (57.7%), followed by forest owners with a mean area of 501–2,000 ha (19.6%), then by a very large area over 10,001 ha (11.3%) and finally, managers with small forest land up to 500 ha (11.4%). Over 77% of respondents were holders of PEFC certificates. Double certified holdings were represented by 16.0% and only 6.20% were FSC certificate holders. The period during which the companies were certified ranged from 1 to 23 years. Out of this time, up to 80.9% of respondents held a certificate from 6 to 15 years. Finally, certified respondents had the opportunity to state their position in the company. More than half of the respondents were in the position of middle management (67.0%), then the top managers (22.7%) and finally first-level workers (10.3%).

The overall assessment of perceptions (mean values of all reported answers) is illustrated in Figure 1. It illustrates that the respondents agree the most in the field, where certification helps to comply with the legal requirements (3.92). A higher level of agreement was also expressed for the statement that certification helps to maintain forest biological diversity and protective functions (soil and water) (3.90). This was followed by the maintenance of productive functions of forests (3.78), forest ecosystem health and vitality (3.77) and socio-economic functions (3.76). The lowest agreement was expressed in the field, where certification helps to the maintenance of forest resources and global carbon cycles (3.74).

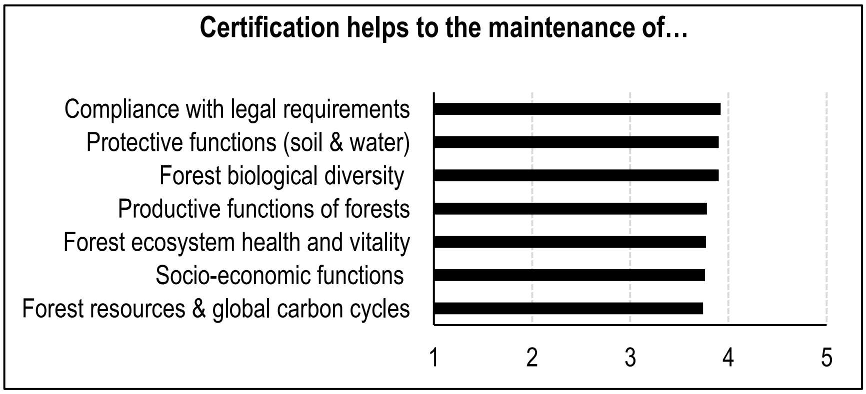

Figure 1. The perception of certification as a tool supporting sustainability in forest management

Based on the distribution of socio-demographic data, differences between the ownership and the represented region were tested. Table 1 describes the level of the respondents' perception of support to sustainability in forest management based on the accepted criteria and indicators of SFM, where the respondents were divided into two ownership categories. Another categorization and testing were based on the division of respondents into four regional categories (west, north, centre and east).

Table 1. The Influence of the forest region and ownership category on the supporting sustainability in forest management

			Ownership			Region				
	Mean	**SD**	**State**	**No State**	**U Test**	**West**	**North**	**Centre**	**East**	**χ2 Test**
Certification helps to…										
Compliance with legal requirements	3.92	1.09	3.99	3.83	4172.5	3.53	4.00	4.18	3.90	9.073
Certification helps to the maintenance of…										
Forest biological diversity	3.90	1.09	3.96	3.81	4440.5	3.49	4.06	4.11	3.88	9.946
Protective functions (soil & water)	3.90	1.13	3.89	3.92	4494.5	3.47	4.08	4.10	3.92	9.551
Productive functions of forests (timber / non-timber products)	3.78	1.14	3.95	3.55	3827.5*	3.33	3.92	4.10	3.71	13.058*
Forest ecosystem health and vitality	3.77	1.16	3.86	3.66	4267.5	3.42	4.08	3.92	3.69	11.308
Socio-economic functions	3.76	1.17	3.82	3.67	4183.5	3.40	3.81	3.95	3.81	1.640
Forest resources & global carbon cycles	3.74	1.13	3.86	3.58	4099.0	3.33	3.92	3.98	3.69	10.150

*Scale of agreement: (1- strongly disagree; 3 - neither disagree nor agree; 5 - strongly agree); *p < 0.05*

Based on non-parametric testing, there was a statistically significant difference found in the ownership factor in one of the identified SFM criteria ($U = 3827.5$, $p = 0.014$). Within this criterion (productive function of forests), the state respondents (3.95) perceive more that certification helps to support and maintain the productive function of forests (timber or non-timber products) than non-state certified respondents (3.55).

A statistically significant difference was also found in the same criterion, where certified respondents manage forest according to individual regions in Slovakia ($\chi2 = 13.058$, $p = 0.042$). Out of this, the highest level of agreement was expressed by the owners from the central region (4.10), followed by respondents from the northern (3.92) and eastern (3.71) region. The lowest agreement was shown by respondents of the western region (3.33) who expressed a neutral opinion on whether forest certification supports and maintains the productive function of the forests.

4. CONCLUSIONS

The latest amendment of the Forest Act no. 326/2005 Coll. adopted a definition of close-to-nature forest management as a concept of the application of more environmentally friendly forest management methods. It states that the forest certification systems can be used in connection with ensuring the professional knowledge-based and sustainable management of the forests. For that reason, a contribution can be also assessed by the certificate holders themselves, as they represent the key stakeholders whose participation in the certification process is critical to the outcome of the certification standard requirements.

Regardless of forest ownership and region of operation the results of this survey indicate that certified forest owners and managers in Slovakia link forest certification mostly with fulfilling legal requirements. The reason is that the forest certification schemes comply with the strict forestry national legislation respecting the SFM principles. All legislative and voluntary requirements can strengthen the role of forest certification in supporting SFM and forest biological diversity, similarly as mentioned by Kalonga et al. (2016).

Báliková et al. (2020) state that a clean and reliable water supply is one of the most important benefits of well-managed forests. Further, the certified respondents agree, that standards of forest certification help to the maintenance of protective functions of the forest, which can be linked to the increased interest in watershed-related ecosystem services.

Despite the adoption and effectiveness of non-state market-driven instruments, such as forest certification, where forestry faces many sustainability issues it is very important to plan and make decisions in the areas of biodiversity, ecosystem protection, restoration, and sustainable development due to the growing intensity of human activities and their associated impacts. Therefore, it is necessary to find the compromise where the vision of SFM will be the management of forests based on the satisfaction of ecological, economic, and social values (Köhl et al., 2020; Randin et al., 2020). According to the expressed agreements by certified respondents, forest certification can help to the maintenance of productive functions of the forest, forest ecosystem health and vitality, and socio-economic functions. On the other hand, the lowest agreement was expressed by respondents in the field, where the forest certification helps to maintain forest resources and global carbon cycles

The overall assessment of the perception of certification by respondents shows, that this voluntary tool is able to meet the individual areas of SFM in Slovakia through compliance with certification criteria.

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ECONOMIC USE OF WOOD RESOURCES IN SELECTED FOREST AREAS, VARIED IN TERMS OF PRODUCTION AND PROTECTION AVAILABILITY - THE CASE OF POLAND

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Abstract: This study attempts to identify and assess the problem of economic use of forest in selected nature-protected areas in Poland. The analysis was conducted on the case of the Promotional Forest Complex "Puszcza Notecka" (PFC Notecka Primeval Forest). Based on secondary statistical data, one of the largest compact forest complexes in Poland was analyzed. In addition, it was verified whether the planned forest use should be more conducive to the tendency towards protection, or rather to the sustainable, integral forest management.
Keywords: forestry, Notecka Primeval Forest, forest-based economics, forest protected areas, Poland

1. INTRODUCTION

The topic of active forest management in areas, part of which are designated natural protected areas, is a sensitive issue, discussed by scientists and forestry practitioners. The problem concerns, among others, the assessment of forest management plans. It is asked to what extent the implementation of these plans has an impact, for example, on forest protected areas? Against this background, Poland is involved in a dispute with the European Commission. The doubts concern a possible breach of the Habitats Directive (92/43/EEC) and the Birds Directive (2009/147/EC). By establishing the "Natura 2000" program, a network of protected areas has been created with the aim of preserving habitats and animal species important for the natural environment [7,14]. In this perspective, key questions have been formulated. What is the scale of the problem? Does rational logging in forests, of which protected nature areas are a part, contradict the model of sustainable forest management? Do the undertaken actions violate the principles of integral economics, whose subject, besides the human world, is the forest?

2. MATERIAL AND METHODS

The aim of the study was an attempt to assess to what extent selected forest areas, diversified in terms of availability of usable and protected areas, are used for economic purposes. The subjective and spatial scope of the analysis was the Notecka Forest area, located in western Poland, between the rivers Warta and Noteć, in the region of Wielkopolska [1,4]. In the subject area, the scope of economic use of forest in the Notecka Forest was verified. Secondary statistical data for the year 2020 (time scope of the study), made available by the Bureau for Forest Management and Geodesy (BFMG), units of the National Forest Holding "State Forests" in Poland, were adopted for verification [17,18,19]. The case study method, comparative and descriptive analysis were used to carry out the tasks.

What is known about the study area? The oldest mention of this huge forest area, dating back to 1296, calls the Notecka Forest "Silva magna" (great forest). On the basis of Regulation No. 62 of the General Director of State Forests of 14.10.2004, the area was included in the established Promotional Forest Complex "Notecka Forest" (marked further in the paper with the abbreviation PFC). It is the largest of the 25 existing forest promotional complexes and covers an area of 137 229 ha (data from the order of appointment). The boundary of PFC "Puszcza Notecka" is marked by administrative ranges of forest districts that are part of it. The inner distance between the most extreme points of this range is 109 km from east to west and 44 km from north to south. The area within the range of the whole PFC is 269 693 ha [1,5].

The actual forest complex forms an area with the shape of an elongated croissant (cornelian) with dimensions of 107 km from east to west and 30 km from north to south. The area of the single compact forest complex is 116 357 ha. PFC "Puszcza Notecka" is located in the area of three Regional Directorates of State Forests in: Piła, Poznań and Szczecin. The initial area of PFC covers 137 229 ha (while according to the 5th revision of the Forest Management Plan it was 137 236 ha). In total, the territorial range of PFC covers 269 693 ha.

A comparison of the area of land used within the Promotional Forest Complex is shown in Table 1.

Table 1. Specification of the land area of PFC "Puszcza Notecka" according to the state of the 5th revision (2020).

Area	Forest area				Non-forest land	All areas
	Forested	Non-forested	Related to forestry production	Total		
	Area measure [ha]					
PFC Puszcza Notecka"	127013,50	2049,40	4343,50	133406,40	3829,23	137235,63

Source: Own elaboration based on [https://www.buligl.pl/, accessed on 03.05.2021] [17].

The PFC consists of six larger forest districts in their entirety: Karwin, Krucz, Oborniki, Potrzebowice, Sieraków and Wronki, as well as partially Międzychód (the so-called Międzychód precinct) and Skwierzyna (forest districts: Chrobotek, Murzynowo, Zawarcie). LKP is located within the territory of three Regional Directorates of State Forests: in Piła, Poznań and Szczecin. Administratively, the Notecka Forest area is divided into two voivodeships (Wielkopolskie and Lubuskie).

The PFC area is definitely dominated by the boreal habitats (share of 86.6% of the forest area), which are among the poorest. The remaining part consists of forest habitats (12,29%) and wet habitats (1,11%).The dominant forest-forming species in Notecka Forest is pine (*Pinus sylvestris L*. share about 93%). According to age classes, older stands prevail ("IVb" and "Va" age classes, that is 36.5% of all forest stands).

The Notecka Primeval Forest is a typical pine monoculture. The existence of a compact area, in the absence of larger enclaves within the complex, creates an environment of a special, large forest.

3. RESULTS

Inclusion of forest areas under the protection of "Natura 2000" is not equivalent to their exclusion from forest management. The idea of "Natura 2000" is based on integration of nature protection with other functions dedicated to this network [3]. At the same time, protection does not mean new, restrictive restrictions on economic activity. Referring to the principle of sustainable development, it is only forbidden to undertake actions which may damage natural habitats [2,6]. Moreover, no negative activities are undertaken for those plants and animals for whose protection the "Natura 2000" enclaves were designated.

The Notecka Forest area is covered by various forms of nature protection such as Sierakowski Landscape Park, several nature reserves, seven areas of protected landscape. Due to the Birds Directive, the whole area of Notecka Forest is included in the “Natura 2000” network. The biggest share of protection forests is in districts of RDSF Szczecin. It results from the assumptions of the new project of protection forests. Share of protection forests in total area of PFC "Puszcza Notecka" is presented in table 2.

Table 2. Division of forest farms in PFC "Puszcza Notecka" according to forested area.

Forestry farm	share [%]	area [ha]
special farms	7,90	10033,78
protected forests	47,50	60329,47
economic (production) forests	40,56	51522,46
forest conversions	4,04	5127,79
Total	100,00	127013,50

Source: Own elaboration based on [https://www.buligl.pl/, accessed 03.05.2021] [17].

The main threats to the forest stands were and still are: fires, insect pests, deer and of course anthropogenic factors. The future will show what effects the planned oil and gas extraction will have on the Notecka Forest. Lack of rivers and watercourses in the forest area, small amounts of precipitation, lowering groundwater level, late frosts, and finally strong winds cause that few forest-forming species can withstand difficult conditions [7,8].

The economic value of the region is the large wood-based production. Approximately 862 000 m^3 of gross roundwood are harvested annually. In terms of area size, the "Va" age class of forest stands dominates. The largest volume of wood, about 9.3 million cubic meters, is also accumulated in "Va" age class, which is more than 30% in relation to all forest stands. Data on forest management in PFC "Puszcza Notecka" are presented in Table 3.

In clearcutting the plan was carried out in 96,2% in terms of area and 98,9% in terms of volume, while in pre-felling - in 100,7% in terms of area and 99.6% in terms of volume. The average pre-felling rate was 25,98 m^3/ha, the lowest in the Potrzebowice Forest District – 22,71 m^3/ha, the highest in the Sieraków Forest District – 32,85 m^3/ha. The average total annual harvest was 4,13 m^3 from 1 ha of forest area. This is less than the average in Poland (5 m^3/ha). The felling forest stands in relation to the total resources in PFC constitute 47.5%. In forest districts of the Forestry Directorate in Szczecin it is only 34.7%.

Table 3. Forest utilization in PFC "Puszcza Notecka" by forest districts (2020)

Forestry District (PFC)	Felling (use) of the forest		Pre-felling (use) of forests			Total
	Plan Final result					
	ha (including clear-cutting)	m^3 netto	ha	m^3 netto	m^3/ha	m^3 netto
Krucz	1969,45 (667,13) 1796,15 (653,60)	299101 304758	13864,53 14348,61	340004 334728	24,52 23,33	639105 639486
Wronki	1916,68 (215,06) 1882,63 (206,45)	369503 369953	13935,19 13941,57	320006 319548	22,96 22,92	689509 689501
Potrzebowice	1556,09 (79,95) 1392,11 (85,80)	294508 295768	12320,33 13209,93	301403 300052	24,46 22,71	595911 595820
Oborniki	2145,81 (639,70) 2161,15 (677,32)	433432 426430	15466,23 15331,75	389722 396723	25,20 26,00	823154 823153
Sieraków	1828,60 (728,91) 1827,58 (720,33)	374197 356402	9733,02 9689,64	300500 318273	30,87 32,85	684697 674675
Karwin	2230,01 n.a. 2142,04 n.a.	464227 455312	17505,05 16873,84	523000 497624	29,88 29,49	987727 952940
Total	11646,64 (2330,75*) 11201,66 (2343,56*)	2234968 2208623	82824,35 83395,34	2174635 2166948	26,26 25,98	4410103 4375573

** without Karwin Forest Inspectorate*

Source: Own elaboration based on [https://www.buligl.pl/, accessed 03.05.2021] [17].

It should be noted that the planned harvest from forest clearcuts (areas) in relation to the total planned volume in the whole PFC constitutes on average 60.7%, while in the forest districts: from 74.2% in Wronki and 70% in Sieraków to 50.7% in Potrzebowice.

4. CONCLUSIONS

Notecka Forest, although it is included in its entirety in the "Natura 2000" program, carries out on its territory the tasks of forest management, resulting from the Polish Forest Act. On the basis of the Birds Directive in the PFC area there is total protection, and on the basis of the Habitats Directive partial protection. Additionally, nature reserves (where no productive forest management is carried out) and other forms of nature protection have been appointed. In this area there are: landscape park, ecological grounds (no forestry is conducted here), natural and landscape complexes, monumental trees. Since 2004, the entire study area is part of the Promotional Forest Complex "Puszcza Notecka". It has been noticed that conducting active forest management does not collide with the tasks of nature protection. At the same time, the applied forms of nature protection do not directly affect forest use (cutting), but the breeding and protection procedures in the forest. Thus, the level of economic use of the forest is high, but at the same time the age of trees is specific – high.

In Poland, forest areas under at least partial and sometimes full nature protection are an integral part of many open forest complexes. Thus, they exist in a kind of symbiosis with the so-called economic forest, which is in current use. Therefore, it seems that forest use should be integral. Then there will be no dilemma: to protect or to use? In economic policy it is worth crossing the barrier of individual interests only [10.11], in favor of the priority of common goods [16]. This tendency, according to the achievements of Elinor Ostrom's research [9], will allow to avoid the tragedy of the commons [12,13]. But it requires a shift from thinking only about "sustainability" to the idea of integral forest use, that is, integral economics.

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ANALYSIS OF PROCEDURES FOR PURCHASING PRIVATE FOREST PROPERTIES IN BULGARIAN FORESTRY – SOUTH-WESTERN FOREST STATE ENTERPRISE EXAMPLE

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Abstract: Two procedures for purchasing private forest properties were carried out in the Bulgarian forestry. In part, the goal was to consolidate forest areas and improve their management. Despite the analyzes made, it is not yet completely clear what the effect of the procedures is. The present study analyses the relationships between the achieved prices, the area of the purchased properties and the extent to which the procedures have led to consolidation. The object of study is the South-western State Enterprise, as the largest in the country and has carried out the most transactions with forest properties..
Keywords: forest properties, purchasing, consolidation, procedure

1. INTRODUCTION

The problems with ownership of forest areas have been among the trivial forest management problems for many years. The land structure determines the resource availability to the forest industries and many other that use wood like raw material. The main goal of forest land consolidation is often to improve the usability of the area for commercial forestry, but depending on the country and the location, environmental issues may also be important (Kolis et al., 2017). The increasing fragmentation of privately-owned forest land represents a main challenge for the future supply of wood raw material in the forest-based sector (Kies & Peter, 2017). Land consolidation means a comprehensive reallocation procedure of a rural area consisting of fragmented agricultural or forest holdings or their parts (Vitikainen, 2004). Land consolidation is an excellent tool to implement rural development projects with multiple purposes and goals in the united land consolidation project (Pašakarnis and Maliene, 2010).

In the Bulgarian forestry have been conducted two procedures of purchasing private forest landholdings by the Forest State Enterprises (FSE). At present, the second stage of consolidation, for which 1000000 Euro has been allocated, has already been finished. The previous stage, conducted in 2016, costed 350000 Euro. For now, the effects are preliminarily examined in previous research (see Neykov et. al., 2020-a, 2020-b). The purpose of the current study is to assess in what extent the procedure given by the Bulgarian Forest Executive Agency (FEA) follow the procedures in other European countries that have conducted forest consolidation. The purpose is supplemented with task to examine the relationship between prices of the purchased landholdings, their areas and the quality of the forests situated on them.

1.1. The aims and the procedures for forest land consolidation

The starting point for land consolidation activities is the existence of economic grounds for the arrangements (Hiironen et. al., 2010). At this point the purposes of the consolidation or procurement of land parcels should be placed. According to (Demetriou, 2014) in 1980s, it was realised that rural space cannot be regarded for agricultural production purposes alone. The aims became broader. According to Hudecová (2015) and Endo (2010) some of the most important benefits include the cadastral map with higher positional accuracy and standardized cadastre base. Today the purposes of the consolidation in forest areas define the consequent process of its implementation. They vary from ownership policy measures in Hungary (Katona et. al., 2017) through forest productivity in Finland and intersection of environmental protection targets with corporate economic land needs in Switzerland (Hiironen et. al., 2010) to climate effects (Kolis et. al., 2017).

According to Kies and Peter (2017) the land consolidation include following steps in the German practice:

- Initiation of the procedure – information campaign
- Valuation procedure – assessment of the forest resources of the landholdings
- Calculation of claims – estimating the total value of the areas claimed to be consolidated or purchased
- Consolidation plan –settlement of all legal relationships that result from the consolidation
- Founding assembly of the new forest cooperative societies
- Closure of the procedure

This procedure is very profound and provide entire change in the ownership type or dislocation of the ownership from one area to another. Despite the analysed procedures are mostly on the agricultural areas, the forest land consolidation follows the same algorithm and logic. Vitikainen (2004) summarized the steps in Finish land consolidation procedures as follows:

Inventory and planning stage:

- Project plan
- Inventory of the rights on the land
- Valuation of the land
- Preparation of the reallocation plan

Implementation stage:

- Registration of the reallocation plan
- Demarcation of the new parcels
- Taking into possession of the new lots
- Payment of compensation
- Division of the cadastral survey costs
- Conclusion of cadastral survey

The common in the procedires are the planning or preliminaty phase: objectives placement, valuation; implementation phase: reallocation of the parcels, payments to landowners and authorities for legalizing the land consolidation; post implementation phase: drainage, road infrastructure and other activities.

2. METHODOLOGY

In order to determine the compliance to the international practices of the procedure of land consolidation in the South Western State Enterprise (SWSE) and forest land consolidation in particular, we have conducted a text analysis of the articles close to the thematic. We summarized the main elements that the procedure should consist. The elements of the procedure are scored as existing - 1, partially existing - 0.5 and missing - 0. They have been compared to the elements described above and the ratio of compliance have been calculated. For this purpose has been created a trivial model, that engaged the main elements, implemented in different countries. The elements of the comparative model – created here (Model Procedure), are numbered as follows:

1. Aims of the consolidation process. Here is assessed the existence of the broader consolidation aims. The narrow purpose like improving the productivity of forests or volumes harvested is scored – 0.
2. Initiation. The information campaign and preliminary communication.
3. Project or allocation plan.
4. Valuation of the proposals, i.e. forest features of each parcel.
5. Calculation of claims.
6. Registration of the reallocation plan
7. Demarcation of the new parcels
8. Taking into possession of the new lots
9. Payment of compensation
10. Division of the cadastral survey costs
11. Conclusion of cadastral survey

All these stages have been included with their numbers in Table 1. Additionally the prices of each purchased parcel have been compared to the area and the quality of the forests. For this purpose have been used regression analysis between prices and characteristics of the parcels.

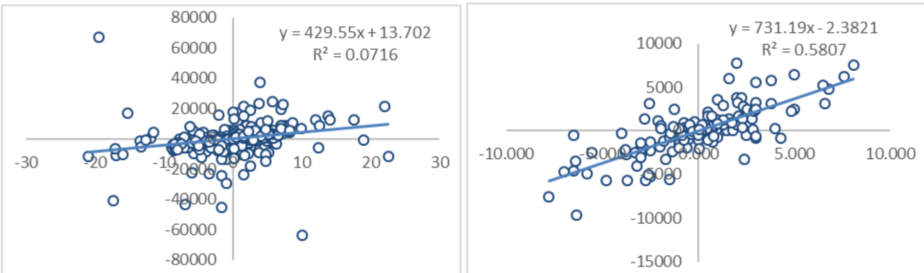
2. COMPARISON AND ESTIMATION

On 26.09.2019 the Minister of Agriculture, Food and Forestry (MAFF) issued an order that constitutes the procedure and the aims of the consolidation. It consists of 25 paragraphs, divided into five sections. SWSE implemented the procedure and purchased private forest properties for 214349.23 € in two pre-screen stages to accept the most compliant to aims parcels (properties). The comparison between the so modelled procedure in Bulgaria and these in Germany and Finland are presented in table 1.

Table 1. Availability of the SWSE procedure to the model elements

	Number of the model procedure element										
Bulgarian procedure paragraphs	1	2	3	4	5	6	7	8	9	10	11
Introduction	1	0	0	0	0	0	0	0	0	0	0
General requirements for the documents and application procedure	0	1	0	0	0	0	0	0	0	0	0
Criteria, evaluation and ranking	0	0	0	1	1	0	0	0	0	0	0
Purchase of forest parcels	0	0	0	0	0	0	0	1	1	0	0
Publicity of purchase and sale transactions	0	1	0	0	0	0	0	0	0	0	0

As can be seen from the analysis, the procedure in SWSE includes the leading stages adopted in world practice. Elements from aiming the process (number 1) to payments to landowners (number 9) are engaged with scores of 1, i.e. they have 100% appearance in the SWSE procedure, but without in (6) - Registration of the reallocation plan and (7) - Demarcation of the new parcels. The emphasis is on the phase of information and selection of properties. Here the appearance is with scores 2 – 200%. The application phase is limited only to the payment of the properties. All other stages are performed outside the procedure, that's why they are scored with 0 – 0% appearance. This is a feature of the Bulgarian forestry. Activities such as marking, road construction and other activities resulting from the consolidation will be performed within the usual activities of the enterprise, but not directly connected to the current procedure. The goals have a wide range. It needs to be clarified to what extent these objectives are focused on the conservation of ecosystems etc. It is apparent that some of the SWSE elements cover more than one elements of the model procedure. Criteria, evaluation and ranking covers Calculation of claims (5) and Valuation of the proposals (4). The same is in Purchase of forest parcels which covers two of the model procedure elements – 8 and 9. The procedure is partially balanced. Some of the modelled procedure, i.e. international practices are more profound and logically follow the algorithm of consolidation. In SWSE procedure some of the model elements are over exposed, like (2.) Initiation, until the others are underestimated.
Supplementing the analysis, we estimated a regression equation between the prices of the claimed parcels and their areas. By this way, the purposes of the consolidation procedure in SWSE have become more obvious.



a) *b)*

Figure 1. Regression analyses between prices – x and areas – y in properties purchased by SWSE in first stage a) and in second – final stage b)

On the Figure 1-a) the prise is connected to the area of the parcels only in 7.16% of the cases. Here the broader contemporary aims of consolidation are achieved. For these parcels the one decare costed on average 429.55 BGN or 219.77 EUR. Maximization of the parcels area being consolidated is obvious aim from the Figure 1-b). It reveals that the aims have been narrowed in the second stage. Despite the wide range of the aims, preliminary declared, the enterprise focused on the areas in 58% of the cases. The procedure can be discussed as partially contemporary in the meaning of the aims range. This is because in the first stage were selected forest sites with various features not connected to their areas. The quality of the forests is connected to the prices in only 42% of the cases. The average price of the decar was 731.19

BGN or 374.01 EUR. The main purpose appeared from the analyses is the improvement of the forest area steered by the enterprise.

3. CONCLUSIONS

The analyses have been made in the research showed that the procedure in the SWSE generally follows the world practices. The emphasis is mainly on the preliminary phase and informing the public and stakeholders. The actual goal was to manage more territories. The understanding of the benefits of forest management as a tool for improving ecosystems and increasing the non-economic benefits of forests has been met at 60%. In the next campaigns for consolidation should be It may be advisable to increase funding for such procedures and to develop it into traditional consolidation objectives, thus preserving high-quality forests. The procedures in Bulgarian enterprises, not only the SWSE should be more balanced and in line with the international practices. By this way the possibility of making mistakes can be reduced.

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HUMAN RESOURCES IN THE WOODWORKING INDUSTRY IN THE CZECH REPUBLIC

Petra Palátová, Roman Dudík

Abstract: The article presents selected data regarding the information on wood-processing industry with an emphasis on human resources. Woodworking industry is represented mostly by CZ NACE 16 - Wood processing, manufacture of wood, cork, wicker and straw products, except furniture. The number of employees is slightly decreasing, the average wage is increasing, however still below national average. Education of the wood-related study programmes refers to high schools and universities (Mendel university in Brno and Czech University of Life Sciences in Prague). Although wood-processing is mostly male-oriented sector, women make around 30 % of graduates at both universities.
Keywords: employees, wage, CZ NACE 16.1, sawmilling, women

1. INTRODUCTION

The article deals with the situation of wood-working industry with an emphasis on the selected economic indicators. In the Czech Republic, wood-working is mostly connected with CZ NACE 16 - Wood processing, manufacture of wood, cork, wicker and straw products, except furniture, and further on also with CZ NACE 17 (Pulp, paper and cardboard production, and their manufacturing); CZ NACE 31 (Manufacturing of furniture) and CZ NACE 32 (Other manufacturing industry). The main attention is devoted to CZ NACE 16 with its two sub-divisions CZ NACE 16.1 - Sawmilling and wood impregnation and 16.2 - Manufacture of wood, cork, straw and plaiting materials except furniture.

2. CURRENT SITUATION IN WOODPROCESSING

Although forestry as well as wood-processing belong to traditional fields in the Czech Republic, there are several issues that both sectors are facing right now – e.g. bark beetle calamity and its consequences like amount of salvage fellings enormously exceeding the average values (Report on forests, 2019). As a result, also conditions for wood-processing have been changing, mostly the decrease of prices of spruce wood, which is the most common raw material to be processed at sawmills. Other issues are also to be concerned (low value added in wood products and low average wage in the sector). This all is a situation to be faced by prospective students and future employees too. Table 1 summarizes the general information on employees and average wage in manufacturing industry in total and in detail for CZ NACE 16 and CZ NACE 16.1.

Table 1: Selected data on C, CZ NACE 16 and CZ NACE 16.1 (2015-2019)

		2015	2016	2017	2018	2019
C Manufacturing industry	number of employees	109794	112269	114964	115620	114652
	average wage (CZK)	26497	27724	29555	31935	33847
	average wage (EUR)	999,9[1]	1046,2	1115,3	1205,1	1277,5
CZ NACE 16	number of employees	31221	30819	29975	29101	28303
	average wage (CZK)	19221	20310	22005	23995	25350
	average wage (EUR)	725,3	766,4	830,4	905,5	956,6
CZ NACE 16.1	number of employees	6380	6450	6369	6175	6022
	average wage (CZK)	19957	21489	23739	25952	28130
	average wage (EUR)	753,1	810,9	895,8	979,3	1061,5

Source: MIT, 2021 and own calculations

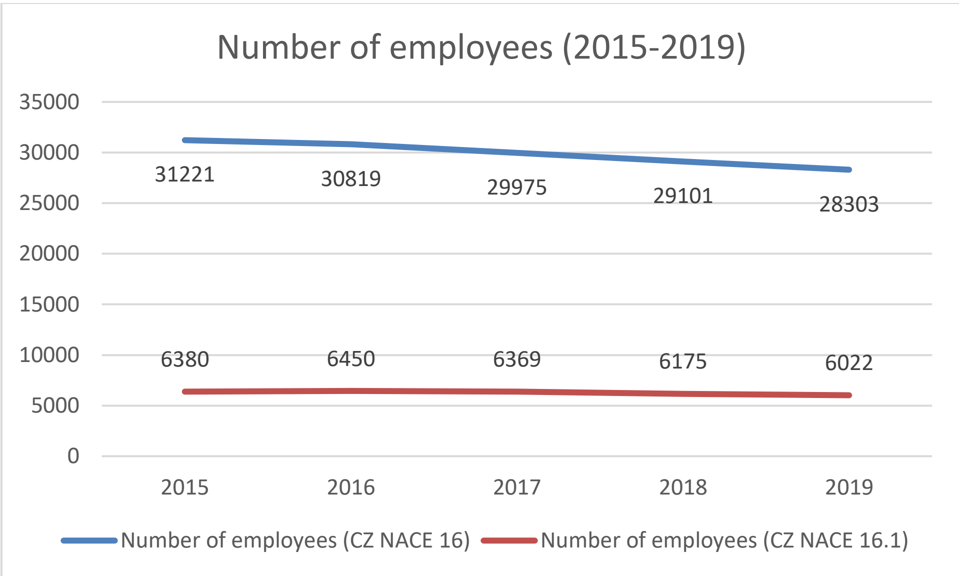

Figure 1: employees in CZ NACE 16 and 16.1 (own processing with data from MIT, 2021)

Looking at the data about employment, the number of employees in CZ NACE 16.1 is significantly lower than in CZ NACE 16.2. However there is a negative trend of decrease of people employed, the share of people employed in CZ NACE 16.1 in comparison to the total CZ NACE 16 is slightly growing (from 20,4 % to 21,3 % in 2019). There are no detailed data on

[1] To be concise, the exchange rate 26,5 Czech crowns for 1 EUR was used for the whole table

division between men and women and their numbers. This is a common thing among majority of the subjects/enterprises, as there is no official obligation to report this data.

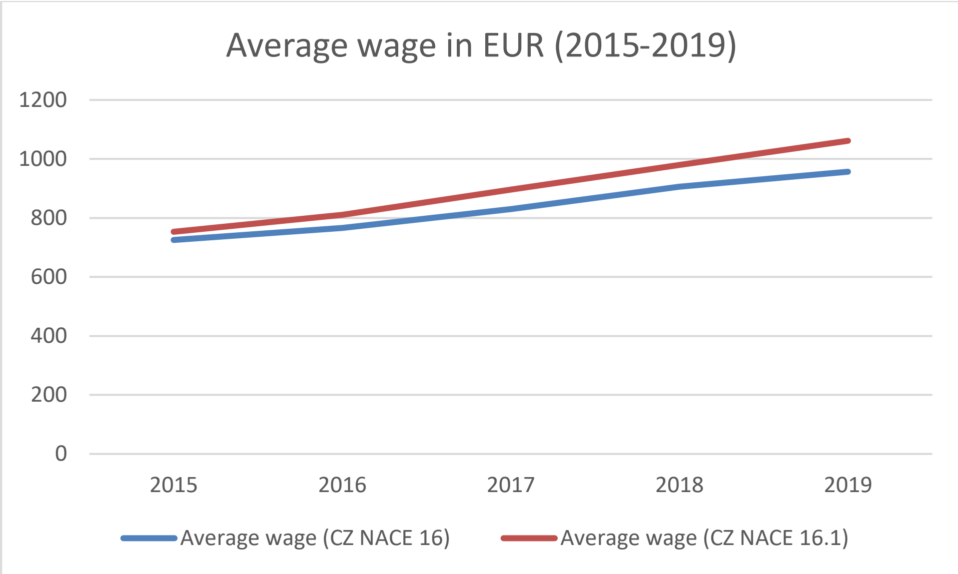

Figure 2: Wage in CZ NACE 16 and 16.1 (own processing with data from MIT, 2021)

Looking at the data on the average wage from 5-years period, it can be confirmed that the average wage has been growing. In CZ NACE 16 as well as in CZ NACE 16.1, the average wage does not reach the average wage of the whole manufacturing industry (see Table 1).

2.1. Education in wood-working

After finishing the high school, students can either start working directly, follow in further education or further continue in studying at university (only fields where students get so-called “maturita” exam/leaving exam after 4 years of study at high school). Number of graduates in the study field *33 Wood processing and production of musical instruments (wood production, joinery, upholstery, musical instruments, natural tissue processing, furniture etc.)* is relatively low in comparison to the other study fields. As latest data from 2018 show, there were 986 graduates, out of which 45 unemployed (Úlovec, Vojtěch, 2018). Two universities provide education in forestry and wood processing.

2.1.1. Mendel University in Brno – FFWT

Mendel University in Brno – Faculty of Forestry and Wood Technology (FFWT) provides bachelor, continuing master and doctoral study programmes. There are no detailed data to directly distinguish the number of students in respective study programmes. Besides forestry-related study programmes, master study programmes are *Technology and management of wood processing, Wood based constructions, Furniture engineering* and *Furniture design.* In bachelor study programmes these are *Creation and production of furniture* and also those entitled in master study programmes (they provide follow-up programmes). In 2019, there were

1414 students (out of which 39,3 % were women) and 332 graduates (38,9 % women). Among employees, women represent 28,9 % and at leading positions only 11% (VZ Mendelu, 2019).

2.1.2. Czech University of Life Sciences Prague – FFWS

At the Czech University of Life Sciences – Faculty of Forestry and Wood Sciences (FFWS), also three-level structure of education (bachelor, master, doctoral) is provided. The development of number of students in the last five years is summarized in table 2. In bachelor study programmes, the students of wood-related programmes amount up to 25 %, which is also true for master study programmes. Among employees, women represent also ¼ of all employees, however at leading positions only 7 %. Women graduates represent 35 % of all graduates (VZ FLD, 2019).

Table 2. Number of students in study programmes at FFWS CZU

Study programme[2]/year	**2015**	**2016**	**2017**	**2018**	**2019[3]**
Wood Technology	158	119	195	210	96+146
Business in the Wood Processing and Furniture	117	130	130	141	73+42
Bachelor students in total	*1321*	*1348*	*1497*	*1382*	*845+580*
Wood Engineering	89	93	109	112	60+47
Masters students in total	*450*	*500*	*462*	*420*	*368+65*
Wooden Structures and Wood-based Constructions					18
Masters students in total					*365+65+18*

Source: VZ FLD (2019)

According to the data from 2019, the unemployment rate of graduates from FFWT and FFWS is relatively low – unemployment rate for FFWT is 1,4 % (1-year average) and 3,1 % (3-year average), whereas at FFWS it is 2,8 % - for both 1 and 3 years average (Zelenka, 2019).

[2] Study programmes taught in Czech language

[3] In 2019 new accreditation started, so the „+“ refers to number of students in the new study programmes

2.2 Information on labour market

Some information about labour market are presented with the data on selected wood-processing companies that are members of Association of forestry and wood processing companies[4] (see Table 3). Some of these companies also belong to the biggest companies in CZ NACE 16.1 according to the data from MIT, 2018 (in italics). The other companies mentioned there are Serafin Campestrini (LLC) and Javořice (PLC).

Table 3: Number of employees in the selected wood-working companies

Company	Number of employees
Biocel Paskov (PLC)	371
Pfeifer Holz (LLC)	450
Kronospan CR (LLC)	448
Mayr-Melnhof Holz Paskov (LLC)	279
Mondi Štětí (PLC)	666
Stora Enso Wood Products Ždírec	*842*
Wotan Forest (PLC)	709
LESS&TIMBER (PLC)	288
Katr (LLC)	186
In total	**4239**

(ALDP, 2021)

These companies provide employment for more than 4 thousand people, important is also their trade with foreign countries, as the lowest share of foreign products placement is 50 %, but on average 71 % (ALDP, 2021).

3. DISCUSSION

Forestry and wood-processing sectors belong to traditional fields and due to the character of work, it has been always male-dominated sector. In addition to that, the economic development does not presuppose to be attractive for future students and workers, because the work is physically demanding and not well paid (average wage is cca 82,5 % of the national average wage in 2019 (CSO, 2020). Data from MIT (2018) inform about the low value added and barriers such as insufficient number of qualified workers. On the other hand, wood-working has always been important also in regions where other working possibilities are rather limited (Kupčák, 2011). Increase in the wood utilization is also in accordance with the principles of bioeconomy. In addition to that, the quality of output from woodworking industry is known not only on the national level, but also in the European area (MIT, 2018). These issues give a potential for future wood-working development. It is also hard to find current data on all wood-working entities in the Czech Republic, and current situation brings new challenges to the

[4] Companies in ALDP process more than ½ of wood harvested in the Czech Republic

sector. Selected economic indicators were investigated e.g. by Palátová (2019), where the emphasis was put mostly on sawmilling operations and its value added. Finding relevant data, such as gender division in respective companies is however rather limited (Palátová et al., 2021).

4. CONCLUSION

The article was devoted to the situation in wood-working industry in the Czech Republic with an emphasis on human resources. Attention was paid on the selected indicators regarding the labour market, such as number of people employed, average wage, education possibilities, unemployment situation of graduates (high school, universities) and gender issue. The average wage in wood-working is below national average (cca 82,5 %). However there are preconditions for further sector development (wood as a renewable source in bioeconomy, good quality and tradition of forestry and wood-working industries). Universities providing education in forestry and wood sciences are two universities in Brno and Prague, where women represent around 30 % of graduates (in 2019).

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IMPACT OF HEATING DEGREE DAYS IN SERBIA, SLOVENIA AND CROATIA'S CAPITALS ON HOUSEHOLD FUELWOOD CONSUMPTION

Slavica Petrović

Abstract: The research presents the results of a study of the functional dependence of fuelwood consumption in households in Serbia, Slovenia and Croatia, on the change in heating degree days in their capitals. The research covers the 2010-2018 period. Simple econometric models were formulated to determine the form of the functional dependency. In addition to being the capitals, Belgrade, Zagreb and Ljubljana are also the largest cities in Serbia, Croatia and Slovenia. Accordingly, it is assumed that they have a significant influence on fuelwood consumption in households in these countries. Additionally, the temperate continental climate prevails in all three cities, January being the coldest and July the warmest month of the year. Similar climatic conditions also served for a comparative analysis of the length and average air temperatures of heating seasons in Belgrade, Zagreb and Ljubljana.
Key words: heating degree-days, fuelwood consumption, households, capitals

1. INTRODUCTION

Belgrade, Ljubljana and Zagreb have a temperate continental climate, characterized by the presence of all four seasons. In Belgrade, autumn has long sunny and warm periods, and as a rule, is longer than spring. Winter is not severe, spring is rainy and lasts for a short time, and summer comes abruptly. The coldest month is January with an average air temperature of 0.1 ^{0}C, and the warmest month is July with an average air temperature of 22.1 ^{0}C (City of Belgrade – official website, 2021). In Zagreb, summers are hot and dry with an average air temperature of 20 °C, while the average air temperature during winter is 1 °C (Wikipedia, 2021). In Ljubljana, the average air temperature ranges from 0 °C in December to 21.9 °C in July (Wikipedia, 2021).

Belgrade, is located in the central part of the Republic Serbia, at Latitude 44.49° N, Longitude 20.27° E and at an average altitude of 117 m. Zagreb is located in the central part of the Republic Croatia, at Latitude 45.81° N, Longitude 15.98° E and at an average altitude of 122 m, while Ljubljana is in the central part of the Republic of Slovenia, at Latitude 46.03° N, Longitude 14.30° E and at an average altitude of 228 m.

Belgrade is the largest of the analysed capitals with 1,659,440 inhabitants and 604,134 households (Statistical Office of the Republic of Serbia, 2011). A 24.28 % share of the total number of households in Serbia are concentrated in the city. In 2018, there were 804,507 inhabitants in Zagreb, ie 19.7 % of the total population (Wikipedia, 2021). It is estimated that with suburbers, the city has over a million inhabitants (Croatian Bureau of Statistics, 2021). Ljubljana is the smallest of the analyzed capitals with 270,000 inhabitants (Wikipedia, 2021).

The climatic characteristics, as well as the geographical position of the three selected capitals, indicate certain similarities between them. Similar climatic characteristics were manifested through the determined values of the annual heating degree days, in the selected capitals. Therefore, the subject of research in this paper is the annual heating degree days in Belgrade, Zagreb and Ljubljana. The main goal of the research was to determine the type and strength of relationship between the annaul heating degree days in Belgrade, Zagreb and Ljubljana and fuelwood consumption in households in the countries where these capitals are located.

2. METHODS AND MATERIAL

The calculation of heating degree days in Ljubljana was carried out on the basis of data from the Ljubljana Bežigrad meteorological station (Latitude 46.06° N, Longitude 14.51° E and at an average altitude of 299 m), for Zagreb the Maksimir meteorological station (Latitude 45.49° N, Longitude 16.02° E and at an average altitude of 123 m) and for Belgrade from the Belgrade meteorological station (Latitude 44.48° N, Longitude 20.28° E and at an average altitude of 132 m).

To calculate heating degree days in selected capitals, a certain methodology was adopted, which is based on the following. The calculation of heating degree days was carried out in accordance with the rule, that heating starts in October of the observed year, when the average daily air temperature is below 12 °C for three consecutive days. The end of heating is in April of the following year, when the average daily air temperature is equal to or higher than 12 °C for three consecutive days. According to Živković et al. (1998), the calculation of heating degree days was carried out using the following formula:

$$\mathrm{HDD} = \mathrm{Z}\left(\mathrm{t_u} - \mathrm{t_{gg}}\right) + \sum(\mathrm{t_{gg}} - \mathrm{t_{sn}}) \quad (1)$$

Where:
- Z – is the number of days in the month when the difference between the limit heating temperature and the average daily outdoor air temperature was lower than 12.0 °C;
- t_u – is the air temperature in heated spaces in residential buildings in the heating season (20.0 °C);
- t_{gg} – is the heating limit temperature (12.0 °C);
- t_{sn} – is the average daily outside temperature over the heating period.

The values of average daily outdoor air temperatures during heating seasons for Belgrade were taken from the database of the Republic Hydrometeorological Service of Serbia, for Ljubljana from the database of the Slovenian Environmental Agency, and for Zagreb from the database of the Croatian Meteorological and Hydrological Service. The data of fuelwood consumption in households in Croatia and Slovenia were taken from the Eurostat database, while the data of fuelwood consumption in households in Serbia were taken from FAO (Food and Agriculture Organization) and the UNDP (United Nations Development Programme) projects implemented in Serbia.

Econometric modeling was done in the "Statistika 7.0." software package and it covered the 2010-2018 period. Simple econometric models were developed to determine the relationship between the annual heating degree days in Belgrade, Zagreb and Ljubljana, and fuelwood consumption in households in Serbia, Croatia and Slovenia. The choice of a simple econometric model that best represents the analyzed dependences was made according to the value of the coefficient of determination.

3. RESULTS AND DISCUSSION

This chapter presents the results of a research of heating degree days at the annual level, as well as in the heating seasons for Belgrade, Ljubljana and Zagreb in the 2010-2018 period, then the lengths and average air temperature of heating seasons in these cities in the analyzed period, and the basic parameters of the simple econometric models.

3.1. Annual heating degree days in Belgrade, Ljubljana and Zagreb in the 2010-2018 period

During all years of the 2010-2018 period, Ljubljana had the highest value of heating degree days, followed by Zagreb and Belgrade (Figure 1). In 2018, all cities had lower values of heating degree days than in 2010. This diference was the highest in Ljubljana and it amounted to 528.2, while in Zagreb it was slightly lower, amounting to 377.8, whereas in Belgrade, it was simbolic, amounting to just 15.73. Only in Belgrade, the highest value of heating degree days in amout of 2579.8 was recorded in 2011, while in Zagreb and Ljubljana it was recorded in the amount of 2712.7, and 3014.8 respectively in 2010. The lowest value of heating degree days was recorded in 2014, and in Belgrade it amounted to 1969.6, in Zagreb to 2020.7, and in Ljubljana to 2144.2. Ljubljana also had the largest number of heating days in a single year. In the 2010-2018 period, the number of heating days in Ljubljana ranged from 154 to 187, in Zagreb from 146 to 168, and in Belgrade from 136 to 164. The largest number of heating days in Ljubljana was registered in 2011, and in Zagreb and Belgrade in 2016.

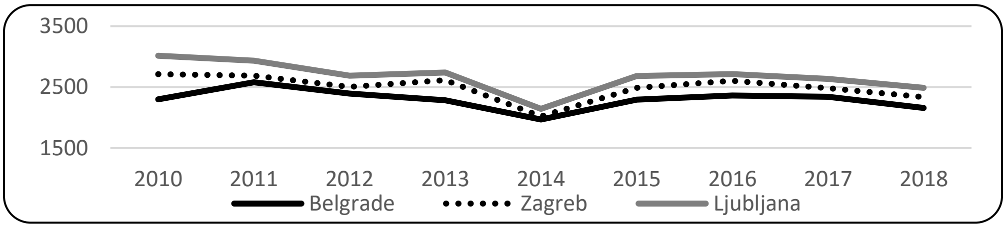

Figure 1. Heating degree days in Belgrade, Ljubljana and Zagreb in the 2010-2018 period

Except in a single year, Ljubljana also had the highest value of heating degree days per heating season during the 2010-2018 period. A record value of heating degree days for this city, in the amount of 3032.4 was registered in the 2011-2012 season, and the lowest one in the amount of 2206.5 in the 2013-2014 season. In Zagreb, the value of this parameter ranged from 2102.6 in the 2013-2014 season, to 2718 in the 2011-2012 season, and in Belgrade from 1939.5 in the 2013-2014 season, to 2640 in the 2011-2012 season (Figure 2). During all the years of the analyzed period, Ljubljana had the longest heating seasons, followed by Zagreb and Belgrade. In Ljubljana, the heating seasons during the analyzed period lasted from 156 days to 185 days, in Zagreb from 149 days to 168 days, and in Belgrade from 140 days to 165 days (Figure 3). The 2010-2011 season was the longest one in Ljubljana, and in Zagreb and Belgrade it was the 2016-2017 season. The 2013-2014 heating season was the shortest in all three cities. The last heating season in the 2017-2018 period was nineteen days shorter than the first one in 2010-2011 in Ljubljana. It was one day shorter in Zagreb, while in Belgrade the last heating season was five days longer than the first season.

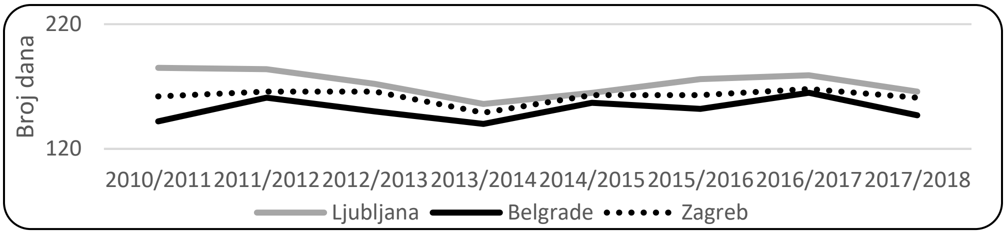

Figure 2 Number of heating degree days by heating seasons in Ljubljana, Zagreb and Belgrade in 2010-2018 period

Throughout the analysed period, the lowest average temperature of the heating season in the amount of 3.44 °C was recorded in Belgrade in the 2010-2011 season, as well as the highest one in the amount of 6.15 °C in the 2013-2014 season. In Ljubljana, the average temperature of heating seasons ranged from 3.70 °C (2012-2013) to 5.86 °C (2013-2014), and in Zagreb from 3.63 °C (2011-2012) to 5.89 °C (2013-/2014).

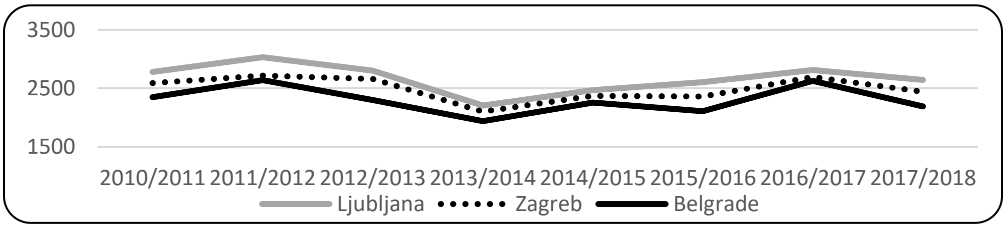

Figure 3. Heating seasons length in Belgrade, Ljubljana and Zagreb in the 2010-2018 period

3.3. Econometric modelling

The influence of heating degree days in Belgrade, Zagreb and Ljubljana, in the 2010-2018 period, on fuelwood consumption in households in Serbia, Croatia and Slovenia, is best represented by simple linear econometric models (the highest value of the coeficient of determination).

The parameters of the simple linear econometric model for heating degree days in Belgrade and fuelwood consumption in households in Serbia are given in Table 1. The calculated value of the correlation coefficient shows that there is a slight correlation of the analyzed variables, and the value of the coefficient of determination shows that the change in heating degree days in Belgrade can explain only 8.2 % of changes in fuelwood consumption of households in Serbia. The value of the Durbin Watson (DW) statistics shows that it cannot be claimed with certainty that the econometric model has no autoccorelation. Parameter b is negative and it is statistically insignificant. The calculated values of the parameters in the model show that if heating degree days in Belgrade increase by 1, fuelwood consumption in households in Serbia will decrease by 0.4TJ.

Table 1. Basic parameters of the simple linear econometric model

Parameter		S	t	|t|	R	R^2	$F_{(1,7)}$	DW test
a	59239.8	4227.20	14.014	$> t_{0.5}$	0.007	0.0823	0.048	1.125
b	-0.40	1.83	- 0.218	$< t_{0.5}$				
Model equation:			**$y = 59239.81 - 0.40 \cdot x_1$**					

The parameters of the simple linear econometric model for heating degree days in Zagreb and fuelwood consumption in households in Croatia are given in Table 2. The correlation coefficient shows that there is a very high correlation of the analyzed variables. The high value of the coefficient of determination shows that 79.77 % of the changes in fuelwood consumption in households in Croatia can be explained by the changes in heating degree days in Zagreb. Based on the DW value, it cannot be stated with certainty that the model has no autocorrelation. Parameter b is positive, statistically significant and shows that if heating degree days in Zagreb increase by 1, fuelwood consumption in households in Croatia will grow by 10.11 TJ.

Table 2. Basic parameters of the simple linear econometric model

Parameter		S	t	|t|	R	R^2	$F_{(1,7)}$	DW test
a	22298.41	5326.27	4.186492	$> t_{0.5}$	0.866	0.751	21.097	1.132
b	10.11	2.20	4.5931	$> t_{0.5}$				
Model equation:			**$y = 22298.41 + 10.11 \cdot x_2$**					

The parameters of the simple linear econometric model for heating degree days in Ljubljana and fuelwood consumption in households in Slovenia are given in Table 3. Due to the existence of autocorrelation, time was introduced into the model as the second independent variable. The correlation coefficient shows that there is a very high correlation of the analzyed variables. The high value of the coefficient of determination shows that 90.12% of the changes in fuelwood consumption in households in Slovenia can be explained by the change in heating degree days in Ljubljana. Parameter b is positive and statistically significant. According to the values of the model parameters, it can be concluded that if heating degree days in Ljubljana increase by 1, fuelwood consumption in households in Slovenia will grow by 4.35 TJ.

Table 3. Basic parameters of the simple linear econometric model

Parameter		S	t	|t|	R	R^2	$F_{(1,7)}$	DW test
a	8276.31	3170.301	2.61058	$> t_{0.5}$	0.949	0.901	27.369	1.549
b	4.353	1.073	4.05807	$> t_{0.5}$				
c	-292.33	98.695	-2.96196	$> t_{0.5}$				
Model equation:			**$y = 8276.317 + 4.353 \cdot x_2 - 292.33 \cdot x_t$**					

4. CONCLUSIONS

Linear simple econometric models best represent the dependence of fuelwood consumption in households in Serbia, Croatia and Slovenia on heating degree days in the capitals of these countries. A comparison of the model parameter values, can lead to the conclusion that the connection between heating degree days in Ljubljana and fuelwood consumption in households in Slovenia is the strongest, while Zagreb and Croatia are in the second place. The increase in heating degree days in Ljubljana and Zagreb has a positive impact on fuelwood consumption in households in Slovenia and Croatia. Unlike in these two countries, the increase in heating degree days in Belgrade causes a decrease in fuelwood consumption in households in Serbia.

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HEATING COST ANALYSIS FOR A TIMBERFRAME HOUSE

Pavol Sedlák, Dominika Búryová, Stanislav Jochim, Patrik Štompf

Abstract: Sustainable energy is the practice of using energy in a way that it meets the needs of the present without compromising the ability of future generations to meet their own needs. Buildings in European Union consume 40 % of final energy, cause 30% of CO2 emissions and produce 40 % of waste. Although only 20% of the world population lives in developed countries, where all the EU countries belong, they use almost 80% of global energy sources.
Well insulated building envelope is part of the solution to reduce heating energy, but it brings new challenges for traditional wood/biomass burning heating systems, and especially for light timberframe houses with minimized energy loss. These systems lack ON/OFF control and can not run under certain designed output power and therefore create risk of overheating in the room where the stove is located. As a result, only small number of stoves/boilers are suitable for space heating and domestic hot water (DHW) preparation in such houses.
This paper analyses different heating and DHW systems for a specific timberframe house, in terms of suitability, initial and running costs, primary energy and related CO2 emissions. The systems would consider wood / wood pellet stoves, electric heating, heat pump, natural gas boiler and possible combinations suitable for the house, with all the advantages and disadvantages.
Keywords: timberframe house, heating cost, heating system, biomass, fuel, CO2 emissions

1. INTRODUCTION

Heating and DHW system selection is essential during design of a building, and directly effects operational CO2 emissions and primary energy, depending on technology used and fuel. There are minimal differences in thermal comfort provided for occupants, especially for well insulated buildings – the location of heating elements is not that important in this case.

The CO2 production is related to so-called Primary Energy Factor of a fuel, which reflects production, transportation and renewability and it weights the different energy carriers, comparing them to the corresponding energy sources. The 2010/31/EU Directive establishes that the building energy performance should be expressed by a primary energy index – if primary energy for a building exceeds strict value 54 kWh/m^2.a (A0 energy class), it should not get building permission in Slovakia from 1.1.2021.

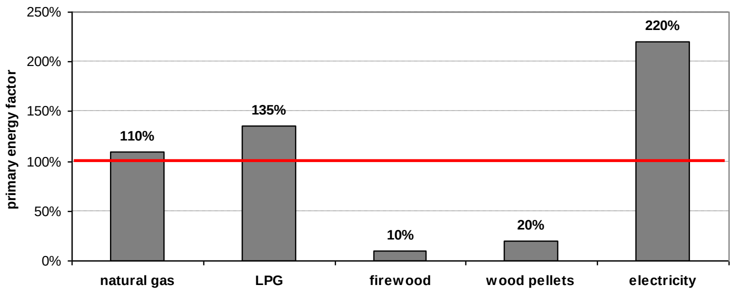

Figure 1. Primary energy factors for fuels [4]

The primary energy factor benchmark is set to 1.0 (or 100%), and shows how much primary fossil energy is used for an energy provided by certain fuel at particular location – in a house. The factor varies from the best 0.1 (10%) for wood (as it consumes CO2 during growth) – to 2.2 (220%) for electricity (as for 1kWh on site there is 2.2kWh of symbolic coal burned in a powerplant). Natural gas value 1.1 (110%) reflects additional 10% for transportation.

The fuel is closely connected to heating system, and usually there are conflicting parameters for each option, e.g. - direct electric heating systems are cheap to install, but the most expensive to run – heat pump is highly effective and good on running costs, but the equipment is complicated and costly – wood stove burns cheap firewood but requires maintenance and can easily overheat a house – etc. The considered options and parameters of heating and DHW systems are described later.

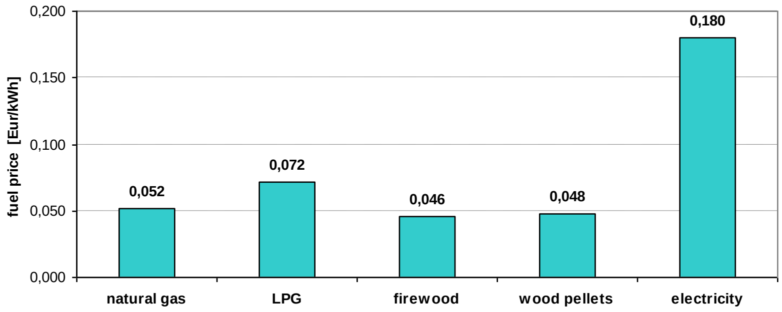

Figure 2. Average prices of fuel types in Slovakia

2. ENERGY CONSUMPTION CALCULATIONS PRINCIPLES

In order to calculate thermal loss by external structures - walls, roof, floor and windows – thermally insulated external envelope is transferred into 3D wire model, providing areas in [m^2], and U-values [W/m^2K] needs to be calculated, to show insulation properties.

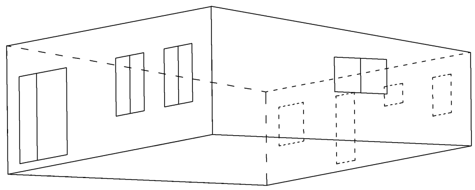

Figure 3. A house - 3D wire model of its external envelope

The energy loss by external envelope and ventilation needs to be balanced by heating system, and separate system heats domestic hot water (DHW) – though it can be provided by single equipment. The energy input to the systems depends mainly on its effectivity, and primary energy and CO2 emissions are further affected solely by the fuel.

The approach is basically equal for all countries, and forms part of all calculation procedures (PHPP calculation, national standards, simulations, etc.). Later calculation used for the analysis were performed in accordance to STN 73 0540 [5] and related codes [4].

3. CASE STUDY HOUSE

The model house is detached single storey building with sloped roof, and is located in central Slovakia. It is 3-bedroom family home suitable for 3 - 5 people.

The timberframe external envelope is designed and built to comply with passive house standard (insulation levels, windows orientation, compact simple shape, window properties [1]), though the house lacks mechanical ventilation with heat recovery. Proposed floorplan is able to accommodate various heating system scenario, including possibility of wood / wood pellet stove in living room – which is usually space demanding.

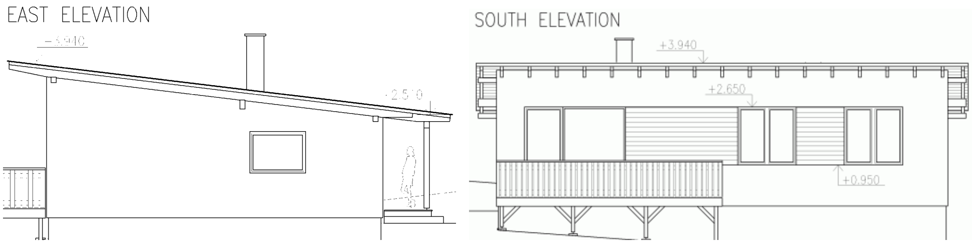

Figure 4. Case study house – proposed elevations at design stage

Table 1. Case study house – basic information, U-values

Building - basic information	
Internal building volume	265 m^3
Net usable floor area	98,1 m^2
External dimensions - floorplan	13,24 x 8,99 m
Building envelope total area	391,8 m^2
Building envelope volume	409,5 m^2
Ratio A/V	0,96 m^2/m^3
Ventilation	natural (by openable windows)
Output of heating system (min.)	4.790 kW

U - values (thermal insulation level)		
external wall	0,14	$W/m^2 \cdot K$
roof / sloped ceiling	0,10	$W/m^2 \cdot K$
floor slab	0,23	$W/m^2 \cdot K$
windows (declared value)	0,80	$W/m^2 \cdot K$
entrance door (declared value)	0,80	$W/m^2 \cdot K$

STN EN 12831 [6] was used for heating elements size calculation, to eliminate unacceptable wood stoves with high output power to internal space in order to reduce risk of overheating.

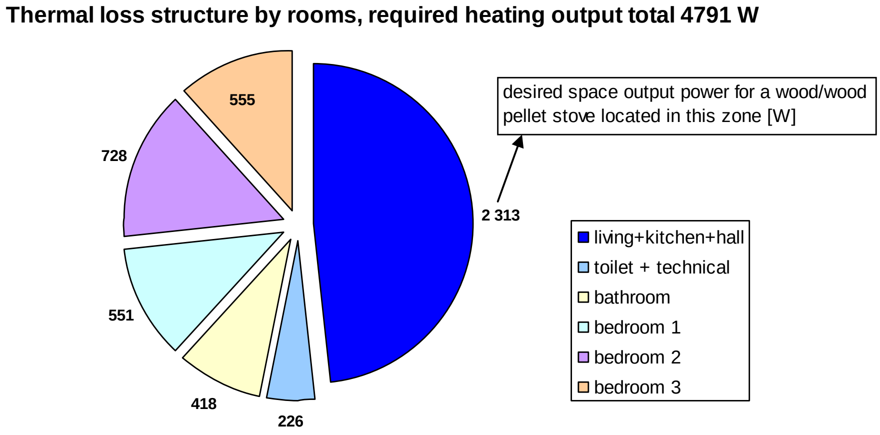

Figure 5. Structure of thermal loss for individual rooms - equal to local heating element required output power, marked value for output power to air of possible wood stove

4. ANALYSED SYSTEMS FOR HEATING AND DOMESTIC HOT WATER (DHW)

There is number of alternative systems for heating and DHW, using different boilers, automatic and manual control, energy carriers, various fuels – and the number of prospective combinations are not limited. We therefore selected small number of the most suitable options only for the house. Solar panels (photovoltaic or hot water) were not incorporated, as the roof does not provide desired slope and orientation.

4.1. Wood / wood pellet stove in living room

4.1.1. Simple small stove, firewood:

Advantages: simple, affordable, warm atmosphere, cheap fuel, easy to install
Disadvantages: heats only single room, dusty and manual operation, risk of overheating, no DHW preparation
Capital costs: the stove... 680 Eur

4.1.2. Stove with water heat exchanger, firewood:

Advantages: warm atmosphere, heats entire house and DHW, cheap fuel
Disadvantages: dusty and manual operation, risk of overheating, no DHW preparation during summer, requires water heating system and heating elements
Capital costs: the stove, installation material, hot water heating system........ 4,774 Eur

Table 2. Example - selection of suitable wood stove with water heat exchanger, based on minimal output to space in order to prevent overheating of the room

name	efficiency	total output power [kW]		H_2O output	space (air) output	space output power [kW]		applicable for the selected room ? (themal loss max. **2,3kW**)	price
		from	to			**from**	to		
HAAS+SOHN KALMAR II/11	83%	3,5	15,0	75%	25%	**0,88**	3,8	**suitable**	1 180 €
HASS+SOHN ALMO	88%	3,3	10,2	71%	29%	**0,96**	3,0	**suitable**	1 160 €
ROMOTOP LUGO 01	81%	4,0	10,4	63%	37%	**1,48**	3,8	**sufficient**	1 230 €
Romotop Espera 01	80%	5,0	13,0	70%	30%	**1,50**	3,9	**sufficient**	1 500 €
HAAS+SOHN Nivala	85%	5,0	15,3	66%	34%	**1,70**	5,2	**sufficient**	1 227 €
Romotop RIANO	83%	6,7	17,4	70%	30%	**2,01**	5,2	**applicable**	1 500 €
EDILKAMIN Aqua	72%	5,0	12,5	56%	44%	**2,20**	5,5	**applicable**	962 €
PLAMEN Marina	79%	8,0	12,0	57%	43%	**3,44**	5,2	**not suitable**	1 280 €
ABX GRUNT	80%	10,0	22,0	50%	50%	**5,00**	11,0	**unacceptable**	1 116 €

4.1.3. Stove with water heat exchanger, wood pellets:

Advantages: cheap fuel, warm atmosphere, automatic operation, heats entire house and DHW
Disadvantages: can be considered noisy, no DHW preparation during summer, requires water heating system
Capital costs: the stove, installation material, hot water heating system.........6,414 Eur

4.2. Natural gas boiler

4.2.1. Gas condensing combi boiler, natural gas:

Advantages: simple automatic operation, DWH preparation, relatively cheap fuel
Disadvantages: needs connection to the grid, requires water heating system
Capital costs: the boiler, connection to grid, hot water heating system......... 6,131 Eur

4.3. Electric systems

4.3.1. Electric convector heaters:

Advantages: cheap to install, automatic operation
Disadvantages: expensive fuel, heating elements on walls, no DHW preparation
Capital costs: heaters (convectors)... 941 Eur

4.3.1. Electric heating foil - underfloor heating:

Advantages: automatic operation
Disadvantages: expensive fuel, no DHW preparation
Capital costs: heating foil, sensors.. 2,817 Eur

4.3.2. Electric tank heater (DHW only):

Advantages: very affordable, automatic operation, only for DHW preparation
Disadvantages: expensive fuel
Capital costs: the tank heater.. 229 Eur

4.3.3. Electric boiler for central heating:

Advantages: relatively cheap boiler, automatic operation, DWH preparation
Disadvantages: expensive fuel, requires water heating system
Capital costs: the boiler, installation material, hot water heating system......... 4,550 Eur

4.3.4. Electric heat pump:

Advantages: high efficiency 290%, automatic operation, DWH preparation
Disadvantages: complicated bulky mechanical equipment with outdoor unit, expensive fuel, requires water heating system
Capital costs: the heat pump, installation material, water heating system.....11,154 Eur

5. HEATING COSTS ANALYSIS

Analysis was made for suitable combinations of individual systems, some of them sharing joint equipment. To determine annual costs, appropriate typical operating life was considered, together with total capital equipment costs and operational energy costs based on system technology and fuel.

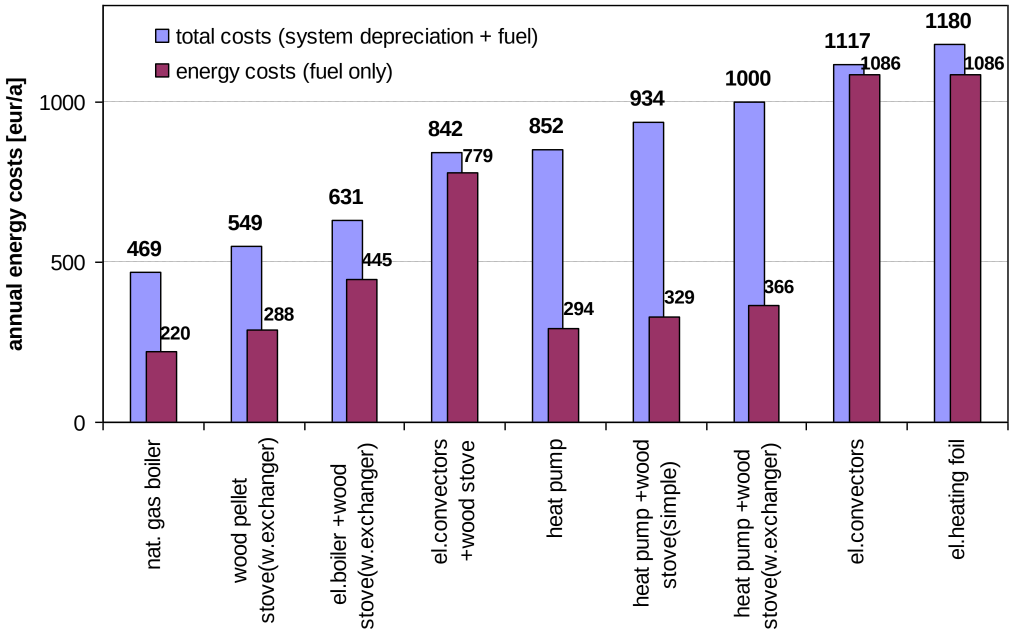

Figure 6. Annual heating costs for considered systems, fuel costs

As could be seen in the graph, the best option seems to be natural gas boiler with the lowest operational and total costs – but it may not be available in some areas, and primary energy needs to be checked. Next options include systems using wood / wood pellets and possible combination with direct simple electric systems. More complicated equipment alternatives with heat pump show high system costs. On the other hand, cheaper simple direct electric systems reflects enormous rates for electricity, and proved to be the most expensive to use.

6. PRIMARY ENERGY ASSESMENT– BUILDING PERMISSION

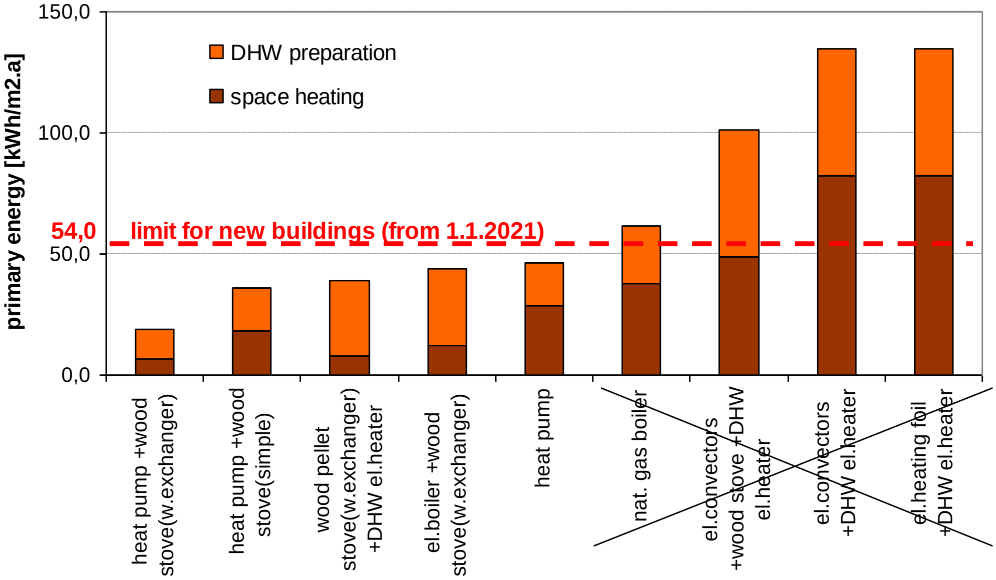

Figure 7. Annual primary energy for the house including heating and DHW

As mentioned earlier, if primary energy for a building exceeds 54 kWh/m^2.a (limit for A0 energy class), it should not get building permission in Slovakia from 1.1.2021.

The best performance is shown for more comlicated systems combined with biomass fuel, particularly for its excellent primary energy factor. The last feasible option is a heat pump only due to high efficiency, providing heating and DHW

Natural gas boiler would not be allowed, probably only with other more acceptable devices – e.g solar panels.

None of the direct electric heating would qualify due to high primary energy of electricity.

7. CONCLUSION

The economic growth requires permanent increasing consumption - that is why it is complicated to find reasonable way how to use resources [3]. The paper showed that initially the most affordable electric heating systems would end up in highest energy bills, and also would not be allowed by the legislation anymore – though often used by developers.

The only allowed sytems would necessarily include wood / wood pellet stove with heat exchanger or a heat pump, when considering primary energy in this case – though appropriate stove selection can be challenging.

Other possible acceptable options would be provided by combination of simple heating systems with additional solar panels – which were excluded from the analysis, as the were not appropriate for this house, and becasue of too complicated demonstration.

But, it must be said, solar panels are ideal in conjuction with biomass stoves for more suitable building arrangement, as the panels provide DHW during summer period, when heating is not in operation, and therefore they save electricity for DHW tank heater or heat pump.

As a result, biomass fired heating systems and DHW can easily comply with current codes and standards for new well insulated timberframe buildings, and are providing the cheapest available alternative for energy use. And, in addition, as a renewable source with reasonable use it seems to be one of only few limited options to the future.

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INDUSTRY 4.0 IN THE FURNITURE INDUSTRY - THE PROBLEMATIC ASPECT IN IMPLEMENTATION

Manuela Ingaldi, Krzysztof Knop, Marta Jagusiak-Kocik, Robert Ulewicz

Abstract: The paper deals with the implementation of Industry 4.0 in the furniture industry enterprises mainly representing the small and medium-sized enterprises sector. The research methods were a survey and an expert interview. 158 representatives of the enterprises from the southern Poland completed the questionnaires. Presenting the research results, the biggest problems related to the implementation of industry 4.0 in the furniture industry in question were discussed. The most important problems in the transformation of enterprises in the furniture industry towards Industry 4.0, which were identified, turned out to be insufficient financial resources and the lack of specialist support in the field of acquiring modern technologies. It has been shown that the production systems of the enterprises are characterized by a low level of robotization and automation, a low level of use of computer-integrated manufacturing systems, or a lack of knowledge of them. The expert interview allowed for the identification of obstacles and problems related to the use of various types of instruments aimed at the modernization of enterprises in the furniture industry, the most important of which were: too old and incompatible production equipment, high cost of obtaining specialists, lack of a pull system and employee resistance. The research results presented in the paper indicate the level of problems encountered during the implementation of Industry 4.0 in the furniture industry and may constitute the basis for research conducted by other research centers.
Keywords: Industry 4.0, implementation problem, furniture industry, SME's

1. INTRODUCTION

For several years, another industrial revolution has been observed all over the world [2]. It has an impact on the functioning of enterprises on the market which, in the face of significant changes, must react to them and adapt to them. This revolution is called Industry 4.0 [8].

Industry 4.0 is a concept that characterizes the coexistence of machines, devices and systems [2, 15] with the Internet and information technologies. It is the digitization of the manufacturing sector [3, 4, 14], aimed at increasing production efficiency and implementing the possibility of flexible changes in the assortment. The essence of Industry 4.0 is the cyber-physical space created by hardware, software, network and people [1, 15]. Industry 4.0 creates many new opportunities for companies, but at the same time several challenges resulting from the progressive automation and digitization [13]. Industry 4.0 seems to be one of the most promising concepts for boosting reindustrialization and industrial competitiveness in the EU countries [7].

Before Industry 4.0, there were already three industrial revolutions, which were called Industry 1.0, Industry 2.0 and Industry 3.0 [8, 10, 12]. Industry 1.0 is associated with the invention and implementation of the steam engine. Industry 2.0 is electrification. Digitization, i.e. efficient computers and data processing systems that enable the control of machines and processes using specialized software, is Industry 3.0.

The term Industry 4.0 was first used in 2011 at the International Fair Hannover Messe, however, the beginning of the 4th industrial revolution is considered to be 2013. It was then that the final report was published, created by a group dealing with the implementation of advanced digital techniques and technologies in traditional industry.

The feature that distinguishes the fourth revolution from the previous ones is that it applies to all areas of life. Within its framework, the industry processes and commercializes the exchange of information between people, between people and objects, as well as between the objects themselves [11].

The pillars of this evolution are 8 different technologies: Internet of Thing (IoT), 3D Printing, Cyber-Physical System (CPS), Internet of Services (IoS), Big Data, Augmented Reality, Autonomous vehicles, Cloud Computing (CM) [6, 10, 16, 17].

2. RESEARCH METHODOLOGY

The research aimed to identify areas and problems in the field of transformation 4.0 in the furniture industry. The research was carried out in manufacturing companies from the furniture industry of the SME sector in southern Poland. The research sample included 200 business entities from the studied area. The questionnaires were completed by 164 entities, and finally, 156 questionnaires were analysed. The conditions for classifying enterprises for research were a minimum 10-year period of running a production activity and the size of employment classifying the enterprise in the SME sector. Based on the survey results, supplemented by an expert interview, the main areas and problems related to the implementation of Industry 4.0 in the furniture industry were defined.

The study consisted of two parts. In the first part, the current state of preparation for the implementation of Industry 4.0 was assessed. The second part of the study concerned the assessment of potential problems related to the implementation of solutions necessary for transformation 4.0. This study was conducted for various industries, hence the universality of the research tool [2]. The first part of the survey, i.e. the assessment of the current state, concerned the identification of the type and form of production, its automation, and the software used. This part was in the form of a questionnaire survey. The questions concerned 19 factors. The product quality assessment scale proposed by Romulad Kolman [5] the precursor of qualitology in Poland, was used to assess the examined factors and standardize the applied assessment scale. One of the transformational methods was selected, i.e. gradual differentiation [5] and then the individual groups of responses were transformed into the range (0.1), where 1 corresponds to the full modernity of the enterprise. In this way, it was possible to compare the responses and assess the general current state of the surveyed enterprises. In the case of area 2, the respondents were to assess the level of automation and robotization of individual operations on a scale of 1-5, where 1 meant manual-machine processes, 5 - full automation and robotization. The following transformation of the ratings was made: 1 - 0.1; 2 - 0.3; 3 - 0.5; 4 - 0.7; 5 - 0.9. In the case of areas 3-19, the respondents could indicate whether this instrument is used in their enterprise by selecting one of the following answers: I do not know, no, sometimes, yes. In this case, the transformation was as follows: I don't know - 0.1; no - 0.3; sometimes - 0.7; yes - 0.9.The second part of the study was to analyse the problems during transformation 4.0 and took the form of an expert interview. The research questions included the identification of obstacles and problems related to the use of various types of solutions aimed at modernizing the enterprise.

The survey was addressed to enterprises from the furniture industry in the SME sector, but due to the lack of precise data and employee turnover, the question about the size of the enterprise also included large enterprises employing over 250 people. In this way, it was possible to eliminate the questionnaires completed by enterprises from outside the SME sector. 32% of the surveyed facilities are enterprises from the furniture industry in which there is a unit type of production, 53% of respondents declared serial production, 15% - mass production.

3. RESULTS

The analysis of the results of pilot surveys in the field of evaluation of enterprises in the furniture industry in terms of preparation for the transformation towards Industry 4.0 allowed for drawing many interesting conclusions. The assessment of the current state of the surveyed enterprises from the furniture industry is shown in Figure 1.

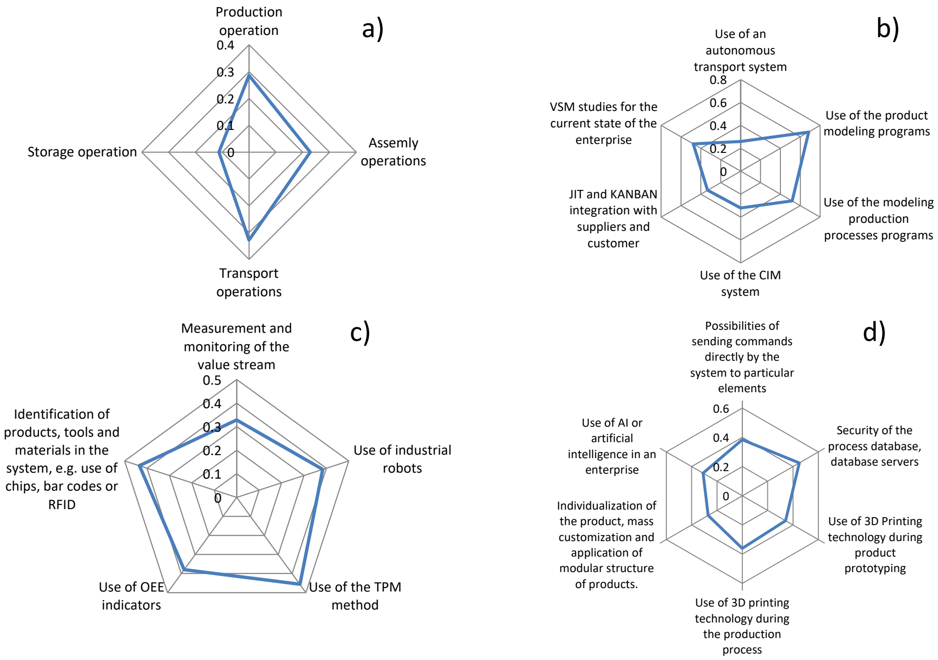

Figure 1. a) The level of automation and robotization of individual operations; (b), (c), (d) Assessment of the current state of the surveyed enterprises from the furniture industry.

The relatively lowest level of automation and robotization among the analysed operations carried out in enterprises from the furniture industry was recorded for warehouse operations (over 0.1); in turn, the highest for transport operations (over 0.3) (Fig. 1a). The surveyed companies are based on proven, older production technology, dominated by machine and machine-manual processes with large human participation. Research has shown that companies in the furniture industry use sporadically programs for modelling products, as well as programs for modelling production processes (Fig. 1b). It was also shown that the surveyed companies do not develop value stream maps (VSM) for the current state, there is no JIT KANBAN integration with suppliers and customers, and the surveyed companies do not use CIM systems (the lowest rating) (Fig. 1b). The respondents rated relatively best such factors as the use of the TPM method and the identification of products, tools, and materials in the system, e.g. using chips, barcodes, or RFID, and these are still rarely used solutions (Fig. 1c). Among the last group of factors (Fig. 1d), the best rated was the security of process databases and database servers, while the degree of use of this solution in the surveyed enterprises is also low. The worst-rated factor is product customization, mass customization, and the use of modular product structures - this is a solution practically not used by the surveyed companies. Equally, poor grades concerned the use of AI, i.e. artificial intelligence, which means that no such solutions are used. The surveyed companies primarily use solutions in the field of mechanization of production, because the solution in the field of advanced automation, robotization, and artificial intelligence determine very high costs of the initial implementation. Many SMEs also had no idea about the existence of such solutions or did not know their names. A low level of system integration, as well as a low level of robotization and automation, characterize production systems in the SME sector of the furniture industry. This is mainly due to the size of these enterprises and the lack of capital for investments. It is more difficult for smaller companies in the furniture industry to obtain favourable loans and they are not able to generate enough profit to buy modern machines or new technology. The next part of the study (expert interview) concerned the identification of obstacles and problems related to the use of various types of instruments aimed at modernizing enterprises in the furniture industry. The most important results are shown in Figures 2-4.

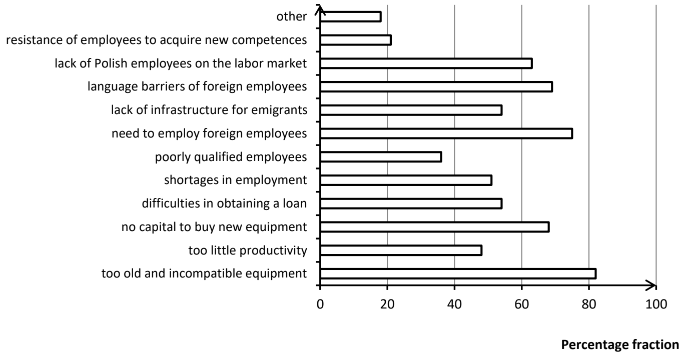

Figure 2. Obstacles in terms of increasing the level of automation and robotization of various processes in the enterprise.

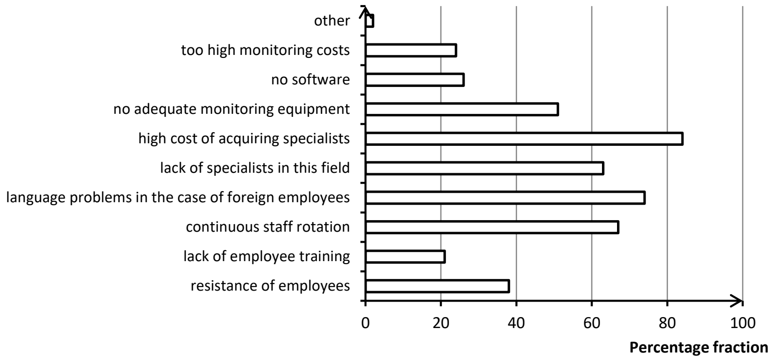

Figure 3. Obstacles in the area of process monitoring, documenting, and selling data and their use in the scope of process improvement and optimization, as well as monitoring and supervision of material, product and tool during the process implementation.

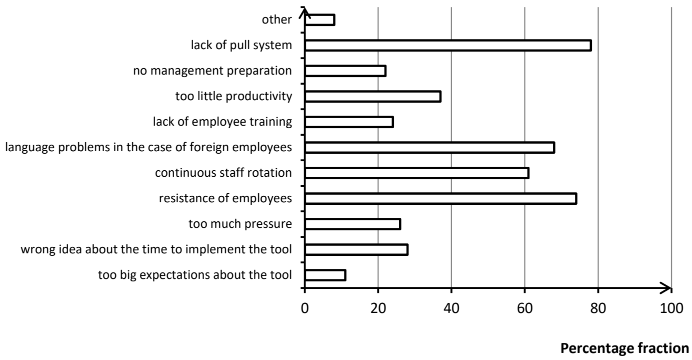

Figure 4. Problems with the implementation of various systems.

The biggest obstacles to increasing the level of automation and robotization of various processes in the SME furniture industry relate to too old and incompatible devices (Fig. 2), which involves the need to purchase new ones, which, in turn, many companies in this industry cannot afford. Other important obstacles are dominant jobs with high human participation and the lack of a workforce in the form of qualified employees from the domestic labour market, which is associated with the need to employ foreign workers (mainly from Ukraine) and causes language barriers in contacts with them. The process of adapting a new non-Polish-speaking employee to a new workplace is often long and tedious. Employees from abroad (mainly from Ukraine) usually treat their work as temporary, hence their lower involvement in the work performed, which poses a threat to the efficiency and quality of production and is a significant barrier to transformation 4.0. The smallest problem, as shown by the research results, is the resistance of employees to acquiring new knowledge, they are not afraid of the challenges posed by progress in production technology. The most important concerns related to the implementation of Industry 4.0 concern the loss of a job and the vision of a "new" order after implementation and the role of the human being in it.

During the survey, the companies indicated a lack of specialists in the field of automation, robotics, and IT (Fig. 3). Employing people from this group is associated with high acquisition and remuneration costs. This factor turned out to be the main obstacle in the field of process monitoring and documentation, data sale and use in the field of process improvement and optimization, as well as material, product, and tool monitoring and supervision during the process implementation. Lack of training is the least frequently indicated factor.

According to the surveyed employees, the most important problem when implementing various systems is the lack of a pull system (JIT, Kanban type) (Fig. 4). Enterprises do not see the need to switch to a pull system. Resistance of employees, constant rotation of employees, and language barriers in contacts with new employees consequently reduce the efficiency and quality of production. These types of factors determine problems in the implementation of new production organization systems in line with industry 4.0.

4. CONCLUSIONS

The article presents the results of research in the field of the analysis of the level of automation and robotization as well as the assessment of the current state of enterprises in the SME sector of the furniture industry in terms of the possibility of implementing Industry 4.0 and related problems. These studies took the form of a survey and expert interview.

Because of the research carried out and the results obtained, it can be concluded that the studied enterprises from the furniture industry in Poland are still unprepared for the implementation of Industry 4.0. This unpreparedness results from the lack of implemented appropriate technical and IT solutions that could function efficiently in the new realities of the fourth industrial revolution. In the implemented production processes, the surveyed companies rely mainly on the mastered technology, based on machine-manual and machine positions with large human participation. The high level of cost of the automation and robotization of production processes is an important factor that hinders the move towards industry 4.0. The problem is also resistance to the changes of the workers themselves (but not the acquisition of new knowledge), as well as of management, which also shows concern about the new industrial revolution. Industry 4.0 requires advanced IT tools, which some furniture industry companies are already quite aware of, but it does not always translate into real implementations and changes. Polish SMEs from the furniture industry is at the beginning of the road to Industry 4.0 - innovation and the degree of advancement of the processes are low.

Summarizing the research results, it is possible to identify three main barriers to the transformation of 4.0 in SMEs in the furniture industry. The first barrier is the narrow product portfolio, which does not guarantee the full use of the efficiency of automated and autonomous manufacturing systems. The second barrier is the limited financial resources available and used by companies for the process and product investments. The third barrier is the resistance of the human factor to changes, connected with the fear for future jobs and the "new" production and organizational reality and the place of the human being in it. Another unfavourable condition is the variability of the environment in terms of micro and macro. A positive aspect that emerges from the research results is the openness of furniture industry employees to acquiring new competencies and skills, which are so important on the road to transformation 4.0.

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INNOVATION AND R&D INVESTMENT TRENDS IN WOOD-PROCESSING SECTORS OF SLOVAKIA

Martina Kánová, Petra Lesníková

Abstract: The aim of the article was to present significant trends in the wood processing industries in Slovakia in relation to the response of the forest-based sector to changes in the global economy. We analyzed selected indicators describing economic performance of wood-processing sectors compared with whole industry in Slovakia, and we link it with Sustainable development goals by The Agenda 2030 as the most comprehensive set of global priorities for achieving sustainable development. Innovation and R&D investments are principal for long-term and sustainable economic development. The paper was focused on innovation activity, structure of gross fixed capital formation and mass of investment in research and development. Source data were obtained from Eurostat and Statistical Office of the Slovak Republic, consequently, we quantified adequate ratio indicators in the study. Hypotheses concerning investment rate indicators were set and tested by appropriate statistical methods. Results describe relevant conclusions of the analysis, they define key areas, trends, challenges and opportunities of forest-based sectors.
Keywords: innovation investment, research and development, economic indicators, wood-processing sector, Slovakia

1. INTRODUCTION

In time of growing globalization and digitization, innovation is becoming an increasingly important factor in determining the success of business. They provide higher growth for companies, increase efficiency, competitiveness and enable for companies to create new markets (SBA, 2020). The Europe 2020 strategy (European Commission, 2010) sees innovation as a driving force for our future growth. The Government of the Slovak Republic consider the sustainable development as one of the basic pillars of the knowledge society and declares this in its strategies and policies (Ministry of Economy SR).

Wood-processing industry (WPI) of Slovakia noted no innovation development focused on increase the competitiveness of production and efficiency increasing, and without solution of the availability of financial resources needed to implement innovative plans can expect a significant decrease in the competitiveness and long-term recession (Merková and Drábek, 2010). In wood-processing industry can positively assess the labour productivity growth, the most significant in pulp and paper, where is recorded long-term growth above average of industrial production, especially in periods with high inflows of FDI into the mentioned sector (Merková, Drábek and Polách, 2011). Foreign capital firms, mostly multinationals, are a special category in the WPI sector. Here, the decisive channel for the transfer of innovations is the parent company of the company, which decides on process innovations and also on their transfer to the given locality. At the same time, systems aimed at continuous improvement and support of innovations are implemented in companies in this way (Balog et al., 2013).

However, most foreign companies investing in Slovakia have their innovative potential organized in home country, so the share of R&D capacities is gradually reduced, and thus it fails to engage the capacities into innovative projects (Merková, Drábek and Jelačić, 2012). Except for some multinational enterprises operating in the Slovak Republic, no significant investments were made in the modernization of processing technologies (Green Report, 2019).

Despite the positive development of economic indicators and the growth in the volume of domestic wood processing, there was no significant increase in the competitiveness of most mechanical wood processing companies and growth in value added. Due to the lower efficiency of wood processing, domestic companies are mostly subcontractors of semi-finished products with a lower degree of finalization for foreign-owned companies in Slovakia (Green Report, 2020).

The ability to obtain key information on current trends as well as the quality of the workforce plays the most important role for the successful technological (process) innovative ability of companies in the wood processing industry. Key information is drawn mainly through the two most common channels - through equipment manufacturers and through memberships in international organizations that facilitate networking and access to modern knowledge. Experience in the sector shows that international organizations have a much more significant positive effect on businesses than membership in domestic organizations such as clusters or associations. The quality of the workforce greatly affects the ability of companies to work with the information obtained. Manufacturers of technological equipment are in this case a sector that is more innovative than the wood processing industry itself, so very often they come up with innovative technologies capable of improving existing production processes or introducing completely new process procedures (Balog et al., 2013).

On the government level it is necessary develop a long-term innovation strategy for this sector with appropriate actions. In order to achieve a high level of innovation performance, countries need a balanced innovation system, public and private investment in education, research and skills development, effective partnerships between industry and academia, as well as an innovation-friendly business environment, including strong digital infrastructure, competition on the markets and efficient allocation of resources (European Commission, 2019).

Sustainable Development Goal SDG 9 Industry and innovation calls for building resilient and sustainable infrastructure, which supports sustainable development and human well-being. Moreover, this goal recognizes the importance of technological progress and innovation for finding lasting solutions to social, economic and environmental challenges. It calls for fostering innovation by enhancing scientific research and technology development, and by upgrading technological capabilities of industrial actors (Eurostat).

The issue of SDGs can be described as phenomenally complex. The fulfillment of SDGs is still a challenge for Slovakia. There are many ways which this issue possible to improve. This also applies the forest and timber sectors which can contribute to fulfillment of SDGs not only by innovations, but at first by striving and adhering to goals related to social area (Lesníková and Kánová, 2020).

The aim of the article was to present significant trends in the wood processing industries in Slovakia in relation to the response of the forest-based sector to changes in the global economy. We analyzed selected indicators describing economic performance of wood-processing sectors compared with whole industry in Slovakia, and we link it with Sustainable development goals by The Agenda 2030 (United Nations, 2015) as the most comprehensive set of global priorities for achieving sustainable development.

2. MATERIAL AND METHODS

Analysis of selected indicators was focused on innovation activity, structure of gross fixed capital formation and mass of investment in research and development. Source data were obtained from Eurostat and Statistical Office of the Slovak Republic, consequently, we quantified adequate ratio indicators in the study.

Industries categorized according to NACE classification were following:
C – Manufacturing
16 – Manufacture of wood and of products of wood and cork (Wood)
17 – Manufacture of paper and paper products (Pulp and Paper)
31 – Manufacture of furniture (Furniture).

Categories of indicator Gross fixed capital formation by industry and by asset (flows) according to Eurostat database analysed in the paper were:
N11G Total fixed assets (gross)
N1171G Research and development, gross
N1173G Computer software and databases (gross)
N117G Intellectual property products (gross)

Hypotheses concerning the investment rate indicators was set as the assumption that R&D investment rate in WPI sectors are on an upward trend and the highest values of the indicator are reached by the pulp and paper sector.

Data were processed using an analytical-synthetic method, mainly descriptive statistics through the Microsoft Excel and software STATISTICA 12.

3. RESULTS AND DISCUSSION

Results of the research describe relevant conclusions of the analysis, they define key areas, trends, challenges and opportunities of forest-based sectors. A general data related to innovation activity of WPI enterprises are presented in Table 1.

Table 1. Innovation activity of WPI enterprises (Source: SOSR, 2018 and 2020)

Enterprises with innovation activity (total, %)		Wood		Pulp, paper		Furniture	
		2016	2018	2016	2018	2016	2018
		38 20.65%	73 28.1%	18 30.00%	24 37.00%	42 31.34%	40 30.80%
Total innovation expenditures	in thous. €	6 397	4 360	1 167	7 034	2 828	15 988
	% of all enterprises	0.94	0.61	0.09	0.50	0.35	1.70
	% of innovation active enterprises	2.35	1.32	0.15	0.82	0.55	3.20
Turnover (thous. €)	innovation activity	272 454	330 876	782 372	855 744	512 281	499 511
Turnover (thous. €)	without innovation activity	406 249	381 093	573 738	559 045	304 424	438 605

Table 2. Gross fixed capital formation (flows) in WPI industries (Source: Eurostat)

Period / mill. €	C - Manufacturing		Wood		Pulp, paper		Furniture, other	
	Total	R&D investment	Total	R&D investment	Total	R&D investment	Total	R&D investment
2004	2 816.1	67.4	60.6	0.0	414.2	0.0	34.1	1.2
2005	3 662.9	74.6	57.8	0.0	181.2	0.0	79.7	1.2
2006	3 564.0	77.3	93.9	0.0	114.4	0.0	114.9	27.1
2007	3 530.6	78.5	192.1	0.0	80.8	0.0	102.2	1.1
2008	4 422.0	108.7	126.4	0.0	148.4	0.0	128.4	0.5
2009	2 829.0	102.8	64.8	4.3	76.0	0.0	-23.8	0.9
2010	2 882.1	165.9	28.6	0.0	61.9	0.0	50.2	1.8
2011	4 712.4	117.0	68.2	0.0	61.8	0.0	71.8	1.0
2012	3 816.0	136.9	70.4	0.0	93.4	0.1	83.0	0.3
2013	3 549.4	225.9	44.3	0.0	82.3	0.0	209.5	3.0
2014	3 486.4	190.0	109.1	0.0	189.0	0.0	97.8	-0.1
2015	4 065.8	187.0	144.0	0.0	61.7	0.0	82.7	0.2
2016	4 025.7	245.7	64.8	0.1	74.4	0.0	131.6	1.9
2017	4 691.8	288.1	71.5	0.0	90.0	0.0	76.6	1.9
2018	4 472.9	284.2	95.8	0.2	127.1	0.0	111.2	2.2
2019	4 245.9	93.7	144.7	0.0	268.9	0.0	89.2	0.7

Structure of gross fixed capital formation and mass of investment in research and development in WPI industries are shown in Table 2. It is necessary to mention the R&D investment is subcategory of Intellectual Property Product, which also contains Investment to computer software and databases; and WPI sectors invest more to these parts of fixed capital. Investment share of WPI sectors in Manufacturing is analysed in Figure 1. All analysed sectors have similar share in total investment in Slovak manufacturing for 15 years (2005 – 2019). The highest average share with increasing trend reached the Pulp and Paper 2.97%, followed by Furniture with average 2.40%. Wood sector has slightly decreasing trend with average of 2.38%.

The assumption concerning the upward trend of R&D investment rate indicators in WPI sectors was not confirmed. As shown the data, wood and pulp and paper branch did not realise R&D investment most of the periods. Furniture sector invested to R&D on average of 2.49% for 16 years (2004-2019) and this course is fluctuating. The biggest share on total investment in manufacturing noted the Pulp and paper sector (Table 3) with slightly increasing trend.

Table 3. Descriptive statistics: Investment share of WPI in Manufacturing (Source: own)

Investment share (%)	Valid N	Mean	Confidence -95,000%	Confidence 95,000%	Median	Minimum	Maximum	Std.Dev.	Standard Error
Wood	15	2.38%	1.73%	3.02%	2.14%	0.99%	5.44%	1.17%	0.30%
Pulp,Paper	15	2.97%	2.15%	3.79%	2.45%	1.31%	6.33%	1.48%	0.38%
Furniture	15	2.40%	1.63%	3.17%	2.18%	-0.84%	5.90%	1.39%	0.36%

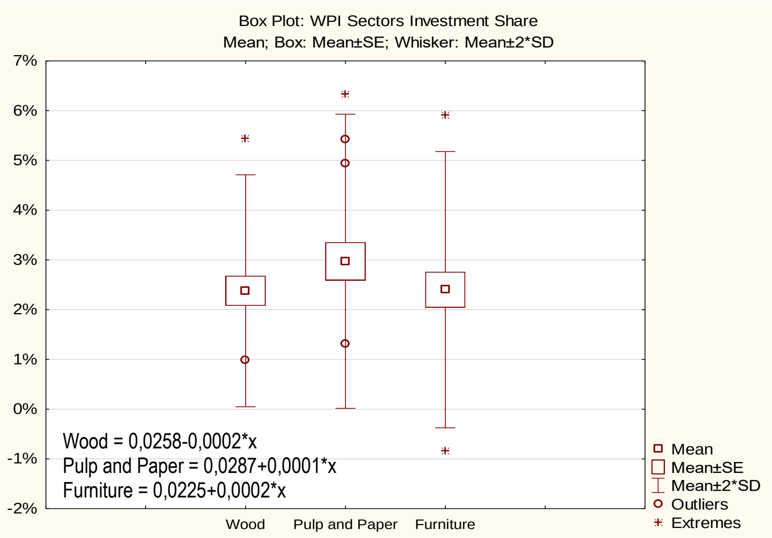

Figure 1. Investment share of WPI sectors in Manufacturing (Source: own)

The main priority for the development of the forestry and timber sector should be the modernization of technology to increase the efficiency of production, and thus increase the competitiveness of wood processing companies. The WPI industries are also forced to respond to changes in demand in the European market, through the implementation of innovations and changes in the structure of production. It is necessary to support the development of sectors with higher value added, especially those with a negative trade balance, including sectors engaged in the production of secondary paper products and the processing of recovered paper (Green Report, 2020).

For wood processing innovation development, an innovation culture appears to be one of key factors. There is a need to promote training not only towards expertise, but especially the ability to specify the innovation strategy, to introduce an innovative corporate culture and to drive innovations. According to Balog et al. (2013), the innovation culture currently also works on a commercial basis, as companies in the sector are increasingly aware of the need to work systematically with innovation. However, due to the status of the sector, they will also dominate especially in small innovations, such as process or marketing innovations. Without the creation of a culture in companies, some measures have been, and will be, unnecessary, because companies are not showing interest in them, as several projects have already done. In this case, investment in basic research is very inefficient and the support of applied research also encounters the problem of the current level of development of the sector. It can therefore be stated that the support of innovation in this sector requires the support of the development of human capital and an innovation culture.

In area of introducing innovations, Slovakia has long been one of the below-average EU countries. Of the 28 EU countries, Slovakia ranked 22nd (Innovation Scoreboard, 2019) and belongs to the group of Average Innovators - the most numerous group of European countries whose innovation performance ranges from 50% to 90% of the European average. The European Commission estimates (Innovation Scoreboard, 2019) that the EU's innovation performance is set to grow in the coming period. In 2020, the EC expected a more than 10%

increase in performance in the areas of financing and supporting innovation, business investment and the innovation environment. According to the EC, the factors that will most influence innovation activity include a more massive broadband penetration, higher use of venture capital and an increase in spending on non-R&D innovations. However, it should be noted that at the date of the estimate, no circumstances related to the outbreak of the COVID-19 pandemic were known, which could significantly slow down the innovation activity of the affected countries.

3. CONCLUSION

Innovation and R&D investments are principal for long-term and sustainable economic development. The innovation activity in wood processing industry of Slovakia is still a challenge. At the national as well as sectoral level the Slovakia and WPI lags behind not only the EU average but also V4 countries, the volume of innovative expenditures and R&D investments are at the low level. There are certain ways how this issue is possible to improve, recommended innovation culture linked with investment to human capital and technological investment.

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THE IMPORTANCE OF INTEGRATED INFORMATION SYSTEMS IN TIME OF COVID-19 CRISIS

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Abstract: Today, in a time when uncertainty rules, knowledge and use of information technologies have proven to be extremely important in business. IT and digital technologies have enabled companies to conduct business and to easily and quickly share information during a crisis. Furthermore, Integrated Information Systems (hereinafter IIS) played an important role in the radical and continuous change of business and production systems, both for, small and large-size companies. In this article, the data of IIS application in the wood industry will be analyzed and the AHP method for ranking IIS factors in today's changing conditions will be applied. IIS platforms provide a broad range of solutions covering many aspects of business organization, so this paper aims to elaborate on how IIS contributes to the implementation outcome.
Keywords: wood industry, the COVID-19 crisis, integrated information systems, AHP

1. INTRODUCTION

In today's market, selling a product or service is extremely demanding work that requires good organization, a large amount of information, and the ability to manage that information well and properly, and above all achieve efficiency. According to Majdandžić (2004), an IIS can be defined as a set of elements (data, personnel, equipment, methods, information) and activities that ensure the transformation of data into information and presentation of information to the user. Majdandžić (2004) also points out that the characteristic of information systems, apart from management information, is that they connect all workplaces on designing, processing, and using the information in the interactive work of each user with databases, and they become an important means of daily work of employees, replacing files, letters, forms, mail delivering and auxiliary computing devices. It is important to note that changing an existing ERP – Enterprise Resource Planning solution or transition to an ERP solution is a strategic decision of the company, and the benefits are: faster responses to customer requirements, availability of information, enhanced monitoring and forecasting of activities, perfectly integrating system that connects all functional areas of the company, increases productivity and efficiency (Kremenjaš, 2019). Considering the wood-processing industry as a predominantly production-oriented industry, but the requirements on information systems go beyond the increased productivity, achieved through better logistical and IT support (CAD/CAPP systems, NC/CNC machines, flexible production lines, etc.) (Perić *et al*., 2019). At the beginning of the lockdown in the Republic of Croatia, most companies had to explore new changes in their businesses, so certain companies managed to improve the existing modules of their information systems. Global trade declined by approx. 13 % during the first six months of the pandemic 2020. This was caused by global lockdown during the first months of the pandemic caused by COVID-19 (Espitia *et al.*, 2020). Many companies had to adjust to working remotely that influenced business outcomes. Espitia *et al*. in their research confirmed that sectorial characteristics such as the feasibility of remote work, durability of goods, and integration into global supply chains played a large role in trade effects.

Stojčić (2020) observed business operations of the manufacturing industry in Croatia in the period after the first wave of the COVID-19 crisis and the results show that the average utilization of production capacity among companies in the manufacturing industry was around two-thirds of capacity. The results also showed research of a large percentage of surveyed companies (85% of them) stated that during and in that period, they maintained a constant number of employees and continued with well-established practices in relations to suppliers and customers (Stojčić, 2020). This research also showed that the decline in sales was more significant among export-oriented companies, to which the wood industry belongs. The wood industry in Croatia exports over 70% of its turnover; during the pandemic, the demand for pellets on the European market decreased significantly, as did the placement of fresh beech wood on the market, which endangered exporters. The conclusions of the 17th Wood Technology Conference held in June 2020 were; the COVID-19 crisis pandemic had caused major problems in the wood sector industry; illiquidity, delays in logistics and world transport, extended payment deadlines, and great uncertainty for the future. The conclusion is that the situation in the sector would be much worse if there were no government support and measures.

2. MATERIAL AND METHODS

The survey method was used to determine the implementation of IIS in the wood industry of the Republic of Croatia. Respondents, companies from the wood industry of the Republic of Croatia were sent a request to fill out a questionnaire by e-mail. This e-mail contained a link to an online survey tool - Survs (www.survs.com). The survey questionnaire contained 18 closed-ended and open-ended questions, of which the chapter related to effects of implementation was used for this paper (Kremenjaš, 2019), which is also used in the AHP method. The effects of implementation are listed in Tables 1. and 2. The questions were formed using five-step Likert scales (1 = 'not important' to 5 = 'extremely important'). The object of the research were small and medium-sized wood processing companies in the Republic of Croatia (Kremenjaš, 2019; Perić *et al.*, 2019). Twenty-three correctly completed surveys were collected and IBM SPSS Statistics Desktop for Trial (IBM, 2017) was used for statistical processing. In this article for establishing the effect of IIS implementation Analytic Hierarchy Process - AHP method is used. This method is one of the most used methods in decision making and it is developed by Thomas I. Saaty (Saaty, 2008). Decision-making is quite complex in most cases, especially in business.

Usually, the decision is based on several criteria that in many cases can be conflicting. The decision requires great responsibility that can finally result positively or negatively on business performance. AHP method can be decomposed into four steps according to Saaty (2008). Ranking effects of IIS implementation was the aim of the AHP method. IIS implementation effects were obtained in previous research conducted by survey method (Perić *et al.,* 2019). As AHP method defines pairwise comparison of IIS implementation factor effects and for this comparison, the survey is designed. Criteria for choosing the experts were experience in integrated information systems as well as experience in wood processing and furniture manufacturing area. On basis of mentioned criteria, seven experts were chosen, however, six of them whose consistency ratio was below 0.15 are taken to account. Surveyed experts were from the academic and business sector of the wood processing and furniture manufacturing area. The task of experts was to determine the degree of preference of each IIS factor through pairwise comparison. For the determination of preference 9-point scale from Saaty (2008) was used, where 9 means extreme preference of one alternative above the other and 1 means equal importance of both compared alternatives. After collection, the data were processed using AHPcalc Version 2018.09.15 (Goepel, 2018).

3. RESULTS

3.1. Results of questionnaire research of IIS

The results of the survey given in Table 1. showed that the most important effect for the participants in the implementation of the information system in the company is financial management (M = 4.70), followed by the availability of information (M = 4.57). Furthermore, respondents rated the effects of IIS implementation with average scores of M = 4.35 information quality and M = 4.26 inventory management (Kremenjaš, 2019). From the results, it can be easily concluded that the effects of the information system are positive for the company, which is shown by very high average ratings of the effects of implementation. The lowest value on the scale of IIS effects (M = 3.91) was given to personnel management, which is not surprising precisely because few companies in Croatia engaged in wood processing decide to allocate a large amount of capital to introduce a personnel management module in their information system. For most companies, the priorities are easier monitoring of finances, sales, procurement, and inventory.

Table 1. IIS implementation effects – survey results

Criterion		$\bar{X}$	σ	Med	Mod	Min	Max	Q1	Q3
1	Finance management	4.70	0.470	5.00	5.00	4.00	5.00	4.00	5.00
2	Information availability	4.57	0.590	5.00	5.00	3.00	5.00	4.00	5.00
3	Quality of information	4.35	0.647	4.00	4.00	3.00	5.00	4.00	5.00
4	Stock management	4.26	0.810	4.00	5.00	3.00	5.00	4.00	5.00
5	Integration of business processes	4.13	0.757	4.00	4.00	2.00	5.00	4.00	5.00
6	Response to customer requests	3.96	0.878	4.00	3.00	3.00	5.00	3.00	5.00
7	Purchase management	3.91	0.848	4.00	4.00	2.00	5.00	3.00	5.00
8	Personnel management	3.91	0.733	4.00	4.00	3.00	5.00	3.00	4.00

Legend: $\bar{X}$ – arithmetic mean; σ – standard deviation; Med – median; Mod – mode; Min – minimum; Max – maximum; Q1 – first quartile; Q3 – third quartile

3.2. Ranking of IIS implementation effects with AHP method

The results of ranking using the AHP method are shown in Table 2. and were collected by six experts that had experience in using the integrated information system in their work before or during the COVID-19 crisis. According to the compromise solution given in the results of the AHP method, IIS implementation affects the most important factor in response to customer requests, it is followed by stock management and purchase management. In the expert's opinion, personnel management is the lowest-ranked IIS implementation effect. The complete ranking of IIS implementation factors with the AHP method is given in Table 2. The results obtained by survey and by AHP method show a different ranking of implementation effects. While for experts the most important effects are customers, stock, and purchase management, for survey respondents as the most important effects of implementation stand out finance management, information ability, and quality.

Table 2. Ranking of IIS implementation effects with AHP method

Criterion	Weights	Ranking
Response to customer requests	21.40%	1
Stock management	18.70%	2
Purchase management	13.00%	3
Quality of information	12.40%	4
Information availability	10.70%	5
Finance management	10.50%	6
Integration of business processes	8.30%	7
Personnel management	4.90%	8

3.3. IIS in time of the COVID-19 crisis – a case study of the wood panel processing company

In this chapter, we will describe how a furniture company has dealt with the crisis caused by COVID-19 disease. The main activity of this company is to supply the market with panel materials, fittings, timber, floors, and additional equipment intended for the production of furniture, equipping facilities for various purposes, and interior design. The company is headquartered in Zagreb, where there are two locations, has six locations in other parts of Croatia and one abroad. Due to the COVID-19 lockdown, major problems arose in the production department, which at that time had major problems with delays in work orders due to a large drop in inventories and long delivery times for customers. In mid-March 2020, all were shaken by the information about closing and preventing daily contact and also customer-buyer contact. Regular customer orders that normally took place in showrooms where the customer had the opportunity to see how particular chipboard in different decors looks, consult on assembling elements, fittings, or design, then replaced paper orders without entering the salon and consulting by salespeople, via the internet, social media, and email.

A major problem arose when European suppliers extended their delivery deadlines. Delivery times for suppliers increased from three to six weeks, which, along with delays at customs, increased the deadline to eight weeks. All this significantly affected the delivery times for customers who mostly accepted such a situation because they knew how big the COVID-19 crisis was in the world and our country. Crisis management was helped by a well-designed and integrated information system that provided the ability to manage inventory at several locations owned by the company - in Zagreb, Pula, Zadar, and others. In this way, the sharing of information and stocks at different locations reduced the possibility of stocks falling to a minimum and reduced the delivery time for the customer. During the crisis, there was a ban on movement from county to county, which prevented the company from being able to deliver and the warehouse was filled with a large number of finished products that were stored for three or more months because customers were not able to pick up their goods due to self-isolation and passes. A considerable number of employees came into contact with COVID-19 infection, and it was necessary to organize remote work, and at that time another advantage of the application of an integrated information system came to light, its accessibility to work from home. From the example of this company and its management during the crisis, it can be concluded that if the company invests enough capital in a good business information system and can upgrade existing modules, then in uncertain situations will have greater ability to keep working, stay available and provide a flow of information to all employees. The company felt the COVID-19 crisis in the financial sense, which was shown by poorer financial results and operations, but despite the crisis and many obstacles, the business did not stop precisely because of the rapid operation and reliable management of the information system.

4. CONCLUSION

Entrepreneurs faced business problems during the crisis caused by the COVID-19 disease. According to the results of Stojčić (2020) and the results from the case study, it can be seen that the COVID-19 pandemic harmed companies in the manufacturing industry in almost all sectors and led to declining revenues, inventory utilization, financial problems, and shook the company's relations both with customers and suppliers. Through various activities, the Croatian Government tried to help entrepreneurs overcome the beginning of the pandemic; by supporting entrepreneurs in preserving jobs, implementing measures for co-financing part-time work, providing new loans with the Bank for Reconstruction and Development, increasing the deadline for payment of income tax for those who saw a decline in income on an annual basis, etc. (HGK, 2020). Regarding the wood industry, a study of the impact of the crisis on the wood sector in 2020 was conducted by the Croatian Wood Cluster. Sector analysis showed that 60% of respondents recorded a significant decline in export orders by more than 20%, while only 7% of companies continued their business despite the crisis (Croatian wood cluster, 2020). Furthermore, all respondents answered that they expected a drop in orders in the coming period, so half of the surveyed companies expected that this decline will be greater than 30%. Precisely because of this, some companies (5%) started laying off workers, a third (33%) suspended planned employment, 17% did not extend their fixed-term contracts, and 39% waited for the termination of contracts until the end of June 2020. At the same time, as many as 31% of respondents (especially in the category of micro-companies) thought about closing down, which is a truly alarming indicator (Croatian wood cluster, 2020). Furthermore, according to research conducted in the manufacturing industry (Stojčić, 2020), the most significant challenges of the pandemic for the industry were those caused by liquidity problems and the companies that managed to solve this type of problem succeeded in reducing the likelihood of declining export revenues.

In this paper, we wanted to show how users of integrated information systems, respectively, companies from the wood industry react to sudden changes in the business world. According to a survey before the COVID-19 crisis, the users of the information system pointed out financial management and the availability and quality of information, or easier and faster communication with each other as the most important effects of implementation. Among other things, the availability of information (M = 4.57) and the quality of information (M = 4.35) that they have and go to customers are important for better communication. The issue of procurement and supplier management was not so significant to the respondents. If we look at the results of research conducted at the time of the pandemic using the AHP multicriteria decision-making method, the preferences of the effects of implementation have changed. In contrast to the survey research, where the most important was financial and information management, according to the AHP method, the priority effects of IIS implementation are responses to customer requirements, inventory management, and procurement. These results can be linked to the crisis caused by the COVID-19 pandemic, customers and procurement have become more important as delivery deadlines have lengthened, companies operated on a lower production volume than usual, waiting, and checking at customs and borders were longer. Furthermore, it is important to mention that in the initial months of the crisis in Croatia, the movement of road transport was banned, and goods were delayed in arrival. In those moments, companies did everything to keep existing and new customers, which coincides with the results of AHP, where the highest priority is given to respond to customer requests, and it also resulted in a high ranking for stock management because each amount of stock is important because delivery delays are possible under current conditions. If we take a closer look at the results on the effects of implementation IIS by experts, we can assume that in this turbulent time, customers, inventories, and procurement are at the top of our priorities. The reason for this may be the struggle for survival in the market, the need for competitiveness, and achieving financial success. It can be assumed that currently, the most important factors for companies are external factors, those that unfortunately cannot be influenced. This research gives a brief insight into the state of IIS implementation before the COVID crisis, gives an overview of the importance of certain factors during the crisis, which opens opportunities for further research in this area.

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CHALLENGES OF THE TRANSITION TO THE ON-LINE EDUCATIONAL PROCESS DURING THE PANDEMIC

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Abstract: Education has changed enormously during the Covid- 19 virus pandemic. It has changed at all levels of education, including the university level. In reorganizing their educational process, educational institutions had to take into account a number of actions and recommendations from the government and the epidemiological profession, as well as their available technological and human resources. During the first wave of the pandemic, when the new situation was solved in an ad hoc manner, improvisation was a normal response, while after this period a more organized response was expected. Educational institutions invested heavily in a technology platform for online teaching, benefiting from numerous government grants, and also used all their existing equipment. Great emphasis was also placed on staff training, particularly on strengthening their digital literacy skills, which are essential for the implementation of online education. However, there were many other challenges, mainly in the sociological and psychological fields, as exclusion could not be solved for all, online work and study segregate us and do not provide real human contact, which learners in particular desperately need, etc. The research was related to higher education in the wood sector in Slovenia.
Keywords: education, on-line, digitalization, higher education, Covid-19, pandemic, Slovenia

1. INTRODUCTION

Education has changed enormously during the Covid-19 virus pandemic beginning in March 2020 with many measures and restrictions taken by many governments around the world for preventing the spread of the virus. From 16th of March 2020, all educational institutions were closed, all public transportation and all "unnecessary" services in the country were suspended (Neck et al., 2021). Education has also faced many changes at all levels, including the university level (Jandrić, 2020; Zhu & Liu, 2020). In reorganizing their educational process, educational institutions had to consider a range of policies and recommendations from the government and the epidemiological profession, as well as their available technological and human resources. During the first wave of the pandemic, when the new situation was resolved in an ad hoc manner, improvisation was a normal response, while after this period a more organized response was expected (Hodges et al., 2020). With appropriate information and communication technologies (ICT), many theoretical subjects could be adapted to enable distance learning, so that the learning process can be carried out using online learning environments or tools.

Besides the advantages, the implementation of online study programs also has many disadvantages (Plevnik, 2021). When implementing and promoting online learning, it is important to ensure sufficient group bonding and community building. Since students communicate with the teacher at a distance, activities need to be planned in details. The teacher has to consider carefully which instructional materials and activities to use in order to achieve the planned educational goals and outcomes. The selection of appropriate working methods and learning materials is crucial because it determines the nature of online student participation supported by online classrooms and ICT (Radovan & Kristl, 2020).

Digitalization of the most educational activities and moving them to cloud platforms that enables distance learning has become one of the priorities of every higher education institutions. A huge rise of e-learning in 2020 is emerging globally (Gonzalez De Villaumbrosia, 2020). The digital transformation of the study process is crucial for the development of the digital society at the European level (European Commission, 2017, 2018, 2021). Therefore, many initiatives have been developed for this purpose, but the practice is still poor. At the level of Biotechnical Faculty, it was found that the state of available ICT and technical support is satisfactory, the general digital literacy of both students and teachers is good and the weaknesses are mainly in the use of online examination tools, lecture videos, social networks, and tools in the clouds (Kropivšek, 2018; Kropivšek et al., 2020).

Students' biggest concern related to their education resolved around whether the upcoming academic year would be online or in-person. Protopsaltis in Baum (2019) show in their study that students were concerned about the quality of online learning, progress in their education, and maintaining interaction with peers and professors, and also some previous research have found that students consistently reported similar concerns before the pandemic. A female student from the Netherlands described "the stress of moving to online learning despite not having skills or equipment to do so, and uncertainty because professors don't submit information until the last minute or change things suddenly with no or late notice". Some students felt that the transition to online learning had a negative impact on their performance and were unsure how it would affect their grades. A female student from the U.S. said, "I have trouble concentrating in my classes because they were never meant to be online, and I just don't get as much out of them in the virtual format (Hawley et al., 2021).

The findings of another study conducted at Wood Science and Technology University in Malaysia clearly showed that the effectiveness of online education is compromised by the existing poor connectivity and limited accessibility to the internet. The problem is further aggravated by the poorly designed content of the online teaching materials, many of which were improvised from the traditional subject centered materials (Ratnasingam et al., 2021).

The research conducted after the first year of "forced" digitization of higher education in the wood sector in Slovenia. After the first wave of the pandemic in spring 2020, when the dramatic changes occurred in a flash and mainly ad-hoc solutions and responses were implemented, the responses to the next waves and the evolution of the pandemic were more organized and goal oriented. This was strongly related to the high investments in technology platforms for online teaching and in strengthening the digital literacy of staff and students, both of which are essential for the implementation of online education.

The aim of the research was to examine the challenges of transitioning to online education during the pandemic of higher education in the wood sector in Slovenia.

2. METHODS

2.1 Survey among students

A survey was conducted among students in Department of Wood Science and Technology at Biotechnical faculty. The purpose of the survey was to gain insight into students' opinion regarding the online study in response to the pandemic Covid-19 situation. It was carried out in the e-classroom Moodle, where all active students at the Department of Wood Science and Technology were invited to answer the questionnaire. The survey was conducted twice: the first time at the end of the first wave of the pandemic on 3rd of July 2020 and the second time at the end of the third wave of pandemic on 16th of April 2021. The first survey was completed by 52 (46,8 % response rate), and the second by 74 students (60,1 % response rate). The survey was anonymous and consisted of 66 questions in the first year, and 86 questions in the second year. Most of the questions were closed type in the form of a five-point Likert scale with one possible answer, and some of them were open-ended.

The application MS Excel was used to compile, conduct and analyze the results. Data were further analyzed based on 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 a percentage frequency distribution, f_j.% :

$$\boldsymbol{f_j}\% = \frac{\boldsymbol{f_j}}{\boldsymbol{N}} * \mathbf{100}$$

Eqation 1

Where is: f_j is the frequency of a class j, and N is the number of observations.

2.2 Analysis of technological infrastructure and support to providers of the pedagogical process

To analyze the technological infrastructure in Department of Wood Science and Technology at Biotechnical faculty, we examined the number and value of investments in various computer equipment, specifically all types of multimedia equipment in classrooms, advanced multimedia equipment for meeting rooms, portable multimedia equipment for laboratories, laptops and multimedia equipment for personal use and licenses for online platform.

In order to analyze the support provided to the providers of the pedagogical process, a qualitative analysis of different trainings to increase the digital literacy of pedagogical staff was conducted, including an analysis of their participation in a specially established helpdesk center at the faculty level.

2.3 Log-in analysis in the e-classroom

In order, to check the actual usage of the e-classroom, in our case the Moodle platform, by the users, we first analyzed the logs of all activities for the recent and the past academic year; data for the previous year were collected on June 16, 2019 and June 17, 2020, for the recent year on 25 April 2021, in all cases for the entire academic year. The sample included 922 subjects taught in the Biotechnical faculty. Special attention was paid to grouping the data into comparable activity groups and frequency calculations (see Equation 1 above), as well as proportion, to compare these data.

3. RESULTS

3.1 Analysis of students' opinion

The way the pedagogical process is carried out has changed significantly with the transition to an online way of working. Figure 1 shows that most of the pedagogical process in Department of Wood Science and Technology at Biotechnical faculty takes place live online. It is encouraging that the proportion of subjects where recording is undertaken has increased and the recordings are then available to students as they learn. About one third of the students have not used this method in any subject, while the other two thirds of the students have used it in several subjects. However, it is pleasing to note that the proportion of students receiving only written materials for subjects has decreased compared to 2019/20, as this method lacks the interactivity that is crucial at the stage of interpreting new material.

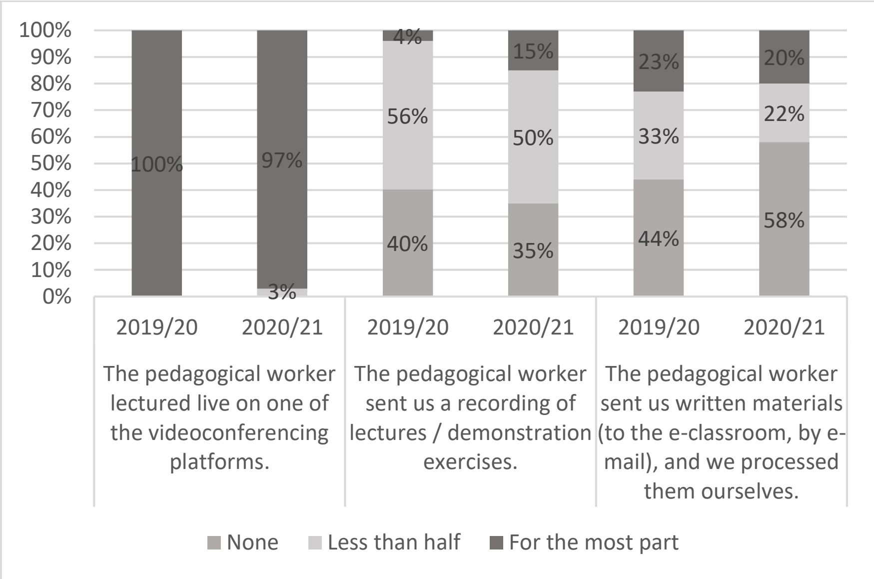

Figure 1: Remote object execution method (2019/20 n=66; 2020/21 n=86)

Among the indicators of the problem of exclusion, two aspects are possible: technological possibilities and digital literacy of students. We evaluate the technological possibilities of students in Department of Wood Science and Technology at Biotechnical faculty as very good. In the survey they answered the question about the barriers that affect their studies from home to a lesser extent they pointed out the unsuitable space and other disruptive factors related to the material conditions for working from home. In the academic year 2020/21, most students invested heavily in purchasing hardware, especially laptops, cameras and headsets, which greatly reduced their technical problems. It is interesting to note that almost half of the respondents had already had all the necessary equipment before the pandemic.

One of the technical factors that greatly affects the quality of distance learning is undoubtedly the speed of the internet connection that students have at home. Figure 2 shows that compared to 2019/20, the proportion of students with an optical connection and fast mobile data connections has increased significantly.

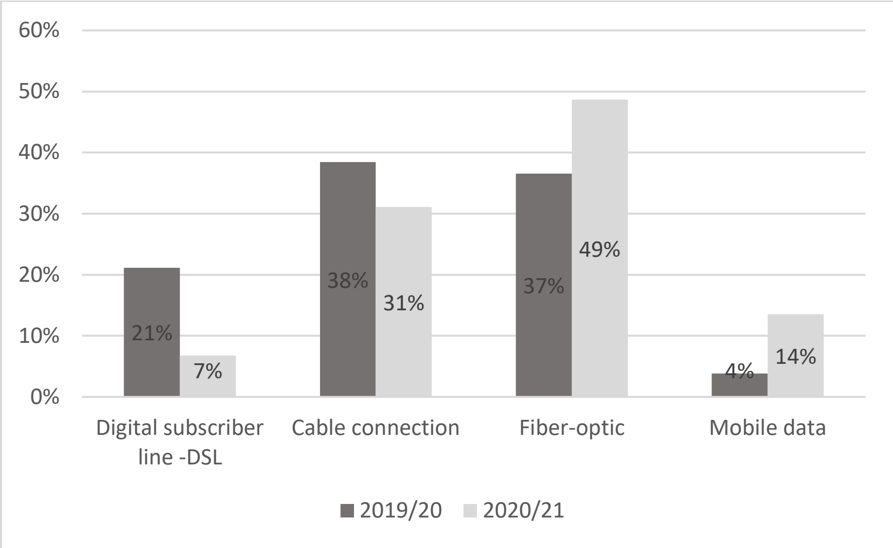

Figure 2: Internet connection mode (2019/20 n=66; 2020/21 n=86)

Another important factor to ensure student engagement is also adequate technical support and their digital literacy. In the research, students confirmed that the distance learning instructions were understandable and simple, and in terms of support, they received most technical support from the faculty and mutual help among students, which indicates their quite high digital literacy, on the other hand, solving (technical) problems together strengthens their mutual relationships and need for communication, which also reduces their sociological problems due to separation by distance learning and distance education.

3.2 Analysis of technological infrastructure and support for providers of the pedagogical process

During the first wave of the pandemic, when the new situation was solved in an ad hoc manner, improvisation was a normal response, whereas after that time more organized responses were expected. Educational institutions invested heavily in a technology platform for online teaching, benefiting from numerous government grants, as well as all their existing equipment. Great emphasis was also placed on staff training, particularly on strengthening their digital literacy skills, which are essential for the implementation of online education.

In summer 2020, in preparation for the very likely second wave of epidemics in Slovenia, in Department of Wood Science and Technology at Biotechnical faculty the equipment of all 7 lecture halls, 2 meeting rooms and 5 laboratories with multimedia was carried out, with an approximate investment value of € 26,000. This equipment enables online-only implementation and hybrid implementation of pedagogical work. In addition, some investments in many hardware upgrades of individuals (purchase of laptops, graphic cards, etc.) has been made. Thus, we estimate that from March 2020 to March 2021 over € 55,000 has been invested in equipment for IT across the department. In preparation for the new academic year in autumn of 2020, licenses of the Cisco Webex platform have been leased for faculty to facilitate the pedagogical process when working online.

In the time since the pandemic began, there have conducted five major and more than 20 smaller internal trainings at the faculty level, with a total of more than 150 enrolments from Department of Wood Science and Technology staff. In addition, employees also participated in other trainings within the University of Ljubljana and beyond.

At the beginning of the new academic year (2020-21), an internal helpdesk service was established to support educators in using Moodle and Webex. In the period from October 2020 to April 2021, the pedagogical staff of the Department of Wood Science and Technology sent more than 60 different requests for support, most of them at the beginning of each semester and before its end (when they started preparing for the distance exams).

3.3 Use of e-classroom

At the end of the second semester of the academic year 2019/2020, at least one activity has been recorded in 565 subjects out of a total of 855 subjects taught in the Faculty, representing approximately two thirds of all subjects (66.1%). However, in the academic year 2020/21, usage has increased significantly: 753 out of 922 subjects (81.7%) has at least one activity recorded, although it should be noted that the vast majority of these subjects are elective or administrative (47) and only 36 subjects (3.9%) are among the Faculty's compulsory subjects (in the Department of Wood Science and Technology, activities were recorded in all 86 subjects offered in that year). Of these subjects, as many as four-fifth also used more advanced modules such as quizzes, questionnaires and assignments. In the year before the pandemic, at the end of 2018/2019 the academic, the proportion of active subjects, as well as the use of advanced modules, was much lower (41% subjects with recorded activity in 2018/2019, including 45% with advanced modules). The number of all pedagogical staff activities in the e-classroom has increased dramatically in the academic year 2019/2020 and even more so in the academic year 2020/2021.

A more detailed analysis of the use of e-classroom shows that in the academic year 2019/2020, compared to the previous academic year 2018/2019, there was a significant increase in the number of subjects using extension modules and even more in the current academic year 2020/2021. Over the period of 3 academic years, we observed an increasing use of the modules "File", intended for pedagogical staff to upload all kinds of study materials (Index = 150) and "Assignment", intended for students to upload documents with final reports, seminars, etc. (Index = 232). There has been particular increase in the use of quizzes in e-classroom, which was the basic platform for online exams during the epidemic (Index = 1147).

In the recent academic year 2020/2021, the »File« module was used in almost two-thirds of all subjects (60,05%), "assignment" was used in about 36%, and quizzes, folders, and URLs were used in a quarter of subjects. Although the use of e-classroom at the faculty level has increased compared to the last two years, it still offers many opportunities for pedagogical staff to explore and use various modules as an extension of the existing study process in the future. These are mainly in the ''assignment'' module, which enables the orderly uploading of various students' protocols and seminars, and in the ''quiz'' module, which allows real-time online examination.

4. DISCUSSION AND CONCLUSION

Educational institutions invested heavily in a technology platform for online teaching, benefiting from numerous government grants and using all their existing equipment. Great emphasis was also placed on staff training, particularly on strengthening their digital literacy skills, which are essential for the implementation of online education. However, there were also many other challenges, especially in the sociological and psychological fields, as exclusion could not be solved for all, online work and study separate us and do not provide real human contact that learners desperately need. One of the technical challenges that greatly affects the quality of distance learning is undoubtedly the speed of internet connection that students have at home. The results of a study in Malaysia clearly showed that the effectiveness of online education is compromised by the existing poor connectivity and limited accessibility to the internet (Ratnasingam et al., 2021). Our research showed that the proportion of students with optical connection and fast mobile data connections has increased significantly over a period of one year, which enables smooth online study, but there are still some users with slower and unstable internet connection.

Extraordinary conditions in the business environment cause many twists and turns and, most importantly, many changes in the business environment and work practice. In such situations, the quick reaction of the management of companies or institutions, the state of the infrastructure and, most importantly, the competencies of employees and their ability to adapt to new conditions are extremely important. The same applies to educational institutions. In fact, the emergency caused by the Covid-19 pandemic and the related measures, especially the closure of institutions, required a quick and dramatic change in the academic year of 2019/2020. During last year's research, the importance of the faculty leadership's quick response and the willingness of staff and students to adapt to the new situation was confirmed. It turned out how important in the context of this transition was a previously established e-classroom with a significant number of active users, a suitable IT infrastructure, a good organization of the IT service in the faculty and a proactive operation, as well as a satisfactory digital literacy of all, pedagogical staff, and students. With this research, we confirmed the successful transition to a new way of teaching and studying, reflected in many formal frameworks established during this period, the successful transition to the implementation of pedagogical distance work, reflected in the increased use of e-classroom and videoconferencing platforms, as well as the student's satisfaction and the responses of students who are "costumers" in the pedagogical process.

During the last academic year, many ad-hoc purchases of small value videoconferencing equipment were made, as well as providing certain services, especially those that enable remote working. A very important role was played by IT support, which also had to move from the physical to the virtual environment, helping all participants and the process with webinars and remote access. In the summer of 2020, in preparation for the new academic year with the very likely second wave of epidemics in Slovenia, The Department of Wood Science and Technology equipped the rooms with multimedia and other devices to enable online-only implementation and hybrid implementation of pedagogical work. They have also invested in many hardware upgrades of individuals and purchased licences of the Cisco Webex platform to facilitate the pedagogical process when working online.

In fact, the pandemic is not over yet. Therefore, it is necessary to find out what was done well and make further improvements to the parts that were not arranged properly and need to be fixed as soon as possible. Based on the research, we can conclude that last year's plans reached the goal, as long-term investments were made in hardware and software for remote work have been made. In this regard the Department of Wood Science and Technology purchased licenses for video-conferencing platforms and hardware to equip their classrooms. We can now say that they are technological well prepared for online lectures. When department was somehow struggling with the ad hoc transition to online studies in the 2019/2020 academic year, they made the same transition smoothly in the 2020/2021 academic year.

We are sure that the transition was smoother as the digital literacy of the educational staff was increased as there were many internally organized trainings and others. The internal helpdesk service was also very helpful in supporting educators in using Moodle, Webex and other IT tools. Technological difficulties were solved relatively quickly and easily, while other problems took a little more time. So far, we are all sure that even after the pandemic is over, the implementation of the pedagogical process will never be quite the same as it was before, while the use of new technologies and procedures based on them is in some cases much more effective than the traditional approach. Thus, good things will remain and complement the traditional implementation of the pedagogical process to be adapted to the demands of the digital age.

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ECOLOGICAL INNOVATIONS IN SERVICES – SERVITIZATION OF FURNITURE

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Abstract: Innovations have become an important tool for managers because of new technologies and various customer requirements and constantly changing conditions on the market. Those are the main reasons why managers should challenge the competition to succeed in the market. This can be achieved by building perspective relationships with current and potential customers. Product innovation is more obvious and quicklier accepted but companies also need to focus on services that are more risky for customers, so they should make more effort to gain customer confidence. One possibility is to innovate in a way that can "materialize" services and at the same time turn them into ecological ones. Such eco-innovations promote sustainable development and are found in a variety of sectors, including the woodworking and furniture industry. This paper will focus on a complete novelty in this area - the rental of furniture as an eco-innovation.
Key words: innovation, ecological innovation, servitization, furniture, IKEA.

1. INTRODUCTION

More and more service companies significantly contribute to the macroeconomic and social development of society. This is also the reason why many countries currently encourage entities that focus primarily on service delivery in their activities. Data, information and knowledge are intangible goods produced and provided mainly by the service sector. Effective distribution and use of knowledge is not an automatic process, but requires support functions. This is one of the reasons why previous years have been characterized by the effort to put the services sector and its specificities in the field of innovation at the centre of economic policy research. The structural change from a technology-oriented economy made up of industrial production to a company providing services is also reflected in the change in innovation processes. In essence, the innovation process is considered to be a learning process that creates or acquires new knowledge and enables its economic use (Miles, 2008).

The importance of innovation processes, widely recognized at both empirical and theoretical levels, and the increasingly important role that service activities play in productive systems, means great importance to innovation in the services sector. However, the analysis of innovation in the service sectors is complex in two aspects. Although, the theory of innovation has evolved mainly on the basis of an analysis of technological innovations in manufacturing, the specific characteristics of services and especially the analytical nature of their output make them particularly difficult to measure using traditional economic methods (productivity) and to reveal room for improvement or change (at a qualitative level) (Gallouj, Weinstein, 1997; Loučanová et al. 2017).

Innovations supported by new technologies are being introduced at an increasing rate (Ringe et al., 2015). Shorter life cycle points to the importance of companies to time their decisions to innovate. Time to embrace innovation is an important marketing decision that can determine the success of innovation. It is all more challenging to succeed with innovation in a market where service companies operate. Service innovation is a challenging concept that is difficult to define unambiguously. With respect to the size and scope of the service sector, this problem is understandable.

Service innovation cannot be one-dimensional. It should be emphasized that different innovations may serve different objectives of the service provider. These goals can take various forms: differentiating from the competition, streamlining the provided services, providing assistance, creating a unique experience or achieving findings. These objectives help to understand the type of development of service innovation, including service package innovation, process innovation, social innovation, experience innovation or business model innovation. Service innovation also causes changes in behaviour (e.g. launching innovation can change customers´ perception of a brand or a brand innovation). Although these categories are not excluded, the catalyst for any innovation project must begin somewhere (Martin et al., 2016; Loučanová, Nosáľová, 2020; Loučanová, Olšiaková, 2020).

Many innovations in the services sector use technological development only as a tool to create new or improve existing products and processes, and not just to offer technological progress itself. Equally important are adequate sales and marketing methods. The organization of the innovation process focuses not only on the research and development departments that are known in manufacturing companies, also including other areas. Thanks to their orientation in the field of data processing and the resulting intensity of information, information and communication technologies play a significant role in the innovation process for service providers.

However, services need to take into account their specific characteristics, which are also taken into account for the implementation of innovation processes. For example, services can often not be specified in advance because they are intangible; and thus their properties are not easily explained to the customer. The specificity of some services obstructs efforts to standardize them. Another important feature of services is integration with customers. Services are characterized either by very close contacts with customers or by the integration of external factors into the production process. In particular, the process orientation of most services requires close contact with customers and can be considered to be a success factor for service companies. Customer integration is based on the current production and consumption of services and is essentially the main characteristic of services. However, information technologies help to reduce the synchronization of time and place between the service provider and the customer, making their specific feature irrelevant in some areas (Hipp, Grupp, 2005).

The diversity of services as one of their typical attributes. It means that service innovation and innovation processes take various forms. The services sector includes economic activities, which are inherently relatively diverse, making it difficult to generalize them.

It follows that what relates to the service sector as a whole does not relate to individual types of services. According to Hertog Day (2000), service innovation can be better understood from several perspectives:

- In terms of the concept of the service, which perceives providing the new service in a particular market or new value for the customer associated with the service. Many innovations present new ways to solve potential problems, or for some types of services, innovations may represent a new arrangement / structure, such as the possibilities of organizing business in different ways (e.g. whether they will be more or less specialized, or more or less focused on quality or cost savings).

- In terms of the client interface, where clients´ requirements are involved in service design, production and consumption of services (e.g. some services offer self-service options for their clients).
- In terms of service delivery system - changing the ways in which service providers distribute their services. Many innovations concern the electronic services providing, but there are also innovations, for example in the field of transport or packaging.
- In terms of technology that allows increased efficiency of information processing, as well as increasing the overall quality and efficiency of provided services.

Many innovations in services represent a combination of four aspects (dimensions) mentioned. Service innovation related primarily to one dimension may necessitate changes in other dimensions. The first aspect mainly concerns the service as such and in particular their main feature - intangibility, while dimensions 2 and 3 mainly relates to the intensity of the client's involvement in the production of services. Dimension 4 has more in common with traditional product innovations, with a particular emphasis on new innovations in information technology. Innovations in any of these respects can be more or less complementary or completely radical, requiring more or less new knowledge and reorganization of production processes (Miles, 2008).

In addition to the above mentioned multidimensional nature of service innovation, there are several ways in which the service innovation process itself can take place. Toivonen and Tuominen (2009) identified five innovation processes with respect to their degree of formality. In the sequence from less to more formal processes, we recognize:

- Internal processes without a specific project (i.e. unintentional and incremental innovations related to an existing service);
- Internal innovation projects (i.e. intentional projects aimed at improving service production systems and their content);
- Innovative projects with pilot customers (i.e. new ideas are tested in cooperation with the customer);
- Innovative projects personalized to the customer (i.e. the service provider seeks to solve a specific problem with the client);
- Innovative projects funded externally (i.e. research collaboration centred on the generation of new service concepts and / or platforms).

According to several authors, the market is dominated by customer orientation associated with innovation. In these times characterized by strong competition in the market, only those who innovate can be successful. The current trend, within the interconnection of innovations and resources, is the implementation of eco-innovations, which are based on the principles of sustainable development in terms of socially responsible business. Therefore, in this paper we will focus on the characteristics of eco-innovation in the field of services - servitization - rental of furniture.

2. ECOLOGICAL INNOVATION OF SERVICES - SERVITIZATION OF FURNITURE

Currently, there is a big trend in servicing. Servitization is one of the business models of the circular economy, focused on providing of services both beyond the product itself, as well as the product providing as a service (e.g. in the form of its rental). Surveys show that almost 70 % of manufacturing companies are already working with some form of servitization and many are just starting to work on service innovations. At the same time, the portfolio of offered services is really diverse and and many are already available in Slovakia (Sumne, 2020). The trend of servitization is gradually beginning to penetrate into areas not traditionally associated with renting.

The Swedish furniture manufacturer IKEA decided to use this model and started offering its products for rent. It is possible to rent a new kitchen unit and return it after a while. The service is currently provided only in selected countries.

Instead of the furniture being discarded over time, the company will refurbish it a bit when it is returned and can sell it to extend its life cycle.

This leasing project is part of the company's efforts to develop a business model that will be based not only on sales, but also on the reuse of furniture parts in the production of new ones.

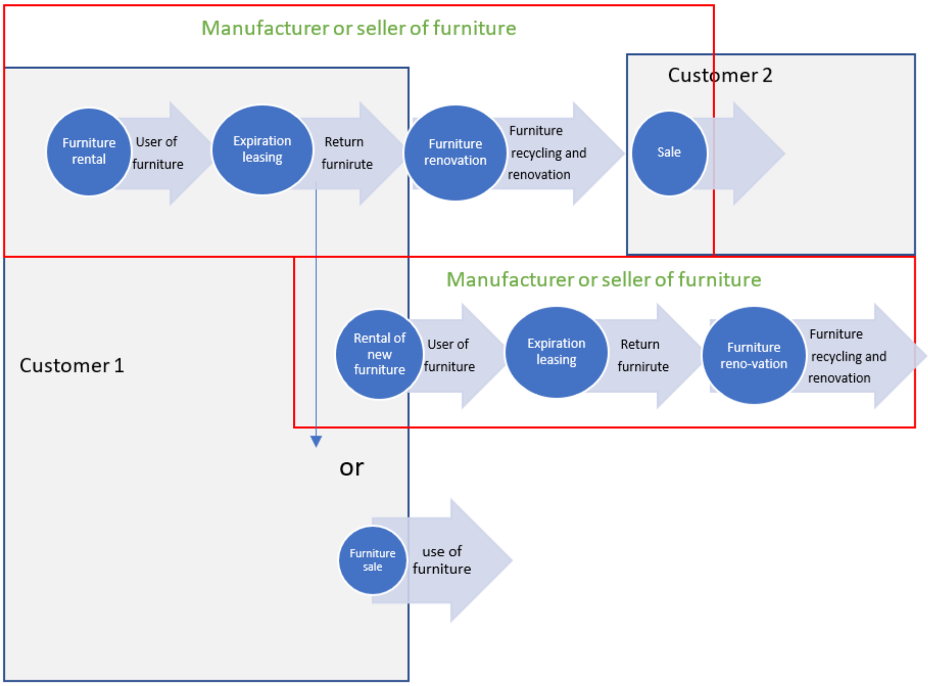

Figure 1. Business model of furniture rental
Source: Loučanová by text Aktuality (2020)

The service is currently provided only in selected countries. In addition to the above, the company also implements other projects of eco-innovation of services in the circular economy support. For example, this is the Recovery project, which is in charge of repairing and repackaging products that have been damaged during transport, display, or handling. Furthermore, there is the ecological service project “Second Life of Furniture”, thanks to which customers can bring their old furniture to the IKEA department store and then sell it to other customers at a reduced price.

The company is also trying to reduce its climate footprint by 15 percent, which would mean a 70 percent reduction in emissions per product due to growth by 2030 (Aktuality, 2020).

3. CONCLUSION

At present, service companies have to constantly renew their processes and service offerings in order to remain competitive. Advanced modern economies are increasingly specializing in services. As the level of services provided in the economy reflects its maturity, society should create the conditions for their further development, including by supporting the innovative activities of service companies. The paper presented by us characterizes ecological innovations of services in a selected company in furniture - furniture rental. The implementation of these and similar projects can not only satisfy their customer needs but also reduce the impact on the environment, by applying business models supporting the circular economy. With this approach, companies can participate very effectively in sustainable development.

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INNOVATIVENESS AND INNOVATION POTENTIAL FUNCTION AT FOREST COMPANIES

Dimitar Blagoev

Abstract: The innovations have always been an important factor for the development and growth of companies' activities. They are particularly important in unstable economic environment and in times of financial and economic crises. Major role, among all types of innovations, have product innovations. Anyway, they are closely related to the other types of innovation in forest companies - technological, organizational, etc. A lot of studies demonstrate that product innovations are perceived by company management as an essential tool for business growth. The report examines the impact of different types of innovations on the overall level of innovation capacity and innovativeness of forest companies. Special and main attention is paid to the methodological aspects of innovativeness and innovation capacity function at company level. The innovations are presented as a part of the so called innovation capacity function. This function determines the forest companies' innovation capacity, and the last strongly affects the production output, described by the production function. We considered basic theoretical approach for the innovations, and applied it to evaluate the innovation index and innovation capacity for companies in forest sector. Our main statement is that in uncertain and unstable economic environment, innovations can be successfully used to ensure economic stability and production growth in forest-based sector. The analysis, however, indicated that the innovation approach for production and technological growth and companies' development is neither fully nor successfully applied in the forest-based sector, yet. There are already some innovations (product, technological, organizational) in the business sector, but they are of low added value. Generally, these innovations are at regional and national level. To ensure the development and growth of companies of Bulgarian industry, they have to develop innovations with higher added values on international level and these addictions can be observed through the innovativeness function.
Keywords: industry, innovations, investments, innovativeness, function

1. FUNDAMENTALS AND PECULIARITIES OF INNOVATIONS AND THEIR ROLE IN INNOVATION ACTIVITIES OF THE COMPANIES.

All kind of innovations, e.g. product innovations, organizational innovations, technological innovations, etc., are all mutually related. Creation of new or modifying of existent products often requires an improvement of already applied or development of entirely new technologies. And vice versa, development of new or improving of known technologies is generally prerequisite for obtaining of new or significantly modified products or services.

The development and marketing of new products, services and technologies, are fundamental factors for improvement in the economic activities of the forest sector companies, and for the rise in their competitive capacity. They are also important factors for balance regulation of current selling positions and profits, and the respective selling, marketing and profitable potential of the companies in the future. All products can be classified as new, according to market conceptions, or definitions of the companies themselves. As a result we have:

- New products for the world market;
- New products for distinct countries or regions;
- New products for a given company.

Based on this classification we could have different cases, which could be distinguished on the basis of the amount of resources needed for their realization and the very enterprise risk evaluation.

Innovations appear to be a challenge not only at a business level, but also on a national level. During the last years they have started to play more and more important role, because of the unstable economic environment on a global scale.

The effective management of the innovation policies give rise to opportunities for successful adaptation of the forest companies, when there are more economic risks and insecurity.

On one hand, realization of the innovations requires a lot of technological and organizational efforts. On the other hand, the innovation policies represent a complex but quite integrated process, that relies on many prerequisites and specific aspects as qualification of the human resources, funding resources, capital value, favorable environment for research and development activities, etc.

Although there are a lot of factors that could influence different stages of the innovation process, of particular importance for the forest company growth and progress is its innovativity strength, which is directly linked to the company competitiveness.

The strong connection between innovations and competitiveness is a subject of investigation in many economic analyses, science forums, university courses, etc. Here, we stress on the widespread conception for the presence of a direct connection between the company innovativity strength, the company competitiveness and the prosperity of the markets via better satisfaction of the consumers' needs. The more efficiently a company succeeds to manage its resources to increase the innovation capacity, the more opportunities for higher competitiveness and market conquering will rise. It should also be noted, that the commercial success of the forest companies would significantly depend on the innovation policies, which are closely related to the capability of resolving issues with respect to the forest company management, production sector and product policies.

Innovativity and competitiveness of a forest company are specific characteristics, which are not intrinsic for all of the market participants. At a company level, of crucial importance are both the innovation capacity and the opportunities of its practical realization. The assessment of innovation capacity spans over several areas and is based on a group of selected indicators. Some authors suggest the following areas for assessment: ability for prediction of the technological development of the branch; ability to predict the innovation strategies of the competitors; company abilities for strategic management of the innovations, etc. B. Twiss (1992) has pointed out, that innovation capacity of an enterprise might be presented as assessment of several areas on a single scale.

In the modern world all of the enterprises have identical access to the new technologies, knowledge and successful strategies. However, not all of them manage to use these advantages in the same manner. The reasons for this could be hidden in their different capacity to adopt the newly appearing technologies. Cohen and Levintal (1990) have performed a practical investigation, which results have shown that the mentioned "adopting capacity" is of crucial importance for the competitiveness of the enterprises and their long-term "survival".

2. METHODICAL NOTES ON THE DEVELOPMENT OF INNOVATION FUNCTION AND INNOVATION INDEX OF THE COMPANIES.

In order to define the elements of forest the companies' innovation capacity, we need to stress on the problems, associated with both innovation and general economic development of the companies. The innovation capacity of forest companies and respectively the innovation potential are result of: **first**, the process of utilization of basic innovation factors, which influence rises proportionally to the expenses for the development of new products and technologies. **Second**, they are result of general development of the forest companies and their overall marketing. On **third** place, they are result of the capacity and potential of the economic system and the environment for innovations at national and international level. In other words, forest companies' innovation capacity and potential are quantities dependable on internal company factors, near external factors, and distant external factors.

An important issue of the forest companies' innovation capacity study is the possibility to practically apply the innovation index, and simultaneously to use it for analysis of the influence of innovation capacity over the rest of basic economic factors, namely: capital, labor, and resources of the company. Such an approach for evaluation of innovations' influence over company efficacy can be represented by the well known production function.

In the investigation of forest companies' innovation capacity and respectively the influence of innovations over the companies' economic growth (based on the approach of production function), of special interest and application is the mathematical modeling. For such kind of analyses and prognoses very popular are the so called "factor models", i.e. those models in which the production increase or its absolute capacity are functions of one or more production factors (Stoyanov, 1992).

"Single factor" model is based on the assumption that the capacities of industrial and overall economic productions are function of the capacity and dynamics of one factor. In this case, the total result from interrelation of different production factors is expressed in only one input quantity. The single factor model is reliable and readily applied in economic analysis and short term prognosis estimation. It, however, does not account for the synergic effects of a series of factors. If we focus particularly on the dependence of production function on innovation factors, it becomes not so readily applicable. According to political economists, most applicable is the "Two factors" model in the form of production function.

$$Y_t = A_t . X_{1t}^{\alpha 1} . X_{2t}^{\alpha 2} \quad (1)$$

Where X_{1t} и X_{2t} are the two factors' quantity inputs (labor and capital), which are time (t) dependent. Empirical parameters α_1 и α_2 indicate the dependence of production output dynamics Y_t on the dynamics of production input factors X_{1t} и X_{2t}

α_1 defines the increase of Y_t, for an increase in X_{1t} at X_{2t} = const.

α_2 defines the increase of Y_t, for an increase in X_{2t} at X_{1t} = const.,

on the condition that $\alpha_1 > 0$ и $\alpha_2 > 0$.

The coefficient A_t in the two factors model has two important properties: on one hand, it adjusts the scale of the factors to the scale of production dynamics Y_t; on the other hand, this coefficient accounts for all production factors not considered in the model.

In accordance with the industrial classification of production factors, the model should be expanded to a “Three factors” one:

$$Y_t = A_t . X_{1t}^{\alpha 1} . X_{2t}^{\alpha 2} . X_{3t}^{\alpha 3} = A_t . \prod_{i=1}^{3} X_{it}^{\alpha i} \quad (2)$$

Now, if we want to account for the influence of innovations and innovation activities of the companies, production function takes the following general form:

$$Y_t = A_t . X_{1t}^{\alpha 1} . X_{2t}^{\alpha 2} . X_{3t}^{\alpha 3} . e^{\pi t} \quad (3)$$

Where $e^{\pi t}$ is a factor accounting for the innovations; e is the Euler's number (e = 2,718); π is a complex index for a total increase of all production factors.

Based on the different modes of the factor model of the **production function** considered above, and accounting for the impact of innovations, we can express it as (Kopeva at al., 2012):

$$P = f(L, \mathrm{C}, R, M) = b_1 . L . \mathrm{C} . R . e^M + b_0 + \varepsilon \quad (4)$$

Where:

L – labor (accounts for production output dependence on labor)

C – capital (accounts for production output dependence on capital)

R – resources (accounts for production output dependence on resources)

M – advances in science and technology (accounts for production output dependence on R&D activities)

$\boldsymbol{b_1}$ – coefficient (adjusts the production output dependence on ***L***, ***C*** and ***R***)

$\boldsymbol{b_0}$ – free parameter (accounts for production output dependence on production incidental factors (not considered in the model))

ε – random variable (accounts for time dependence of the production output)

Production function is expressed as a product of distinct factors, as there is direct correlation between them. In its contemporary form the **Production function** cannot exist without all three main factors – labor, capital and resources.

On the other hand, the advances in science and technology represent complex factor (implicitly, the innovations), which strongly enhance the effects of all three main factors as well. Hence, this factor is expressed in exponential form. On the condition that companies do not have any R&D activities, this will not generally affect their production output as ***M = 0*** and $\boldsymbol{e}^{\mathrm{M}} = \mathbf{1}$.

The exponential function arises whenever a quantity grows or decays at a rate proportional to its current value. The graph of *y* = *e*^*x*^ is upward-sloping, and increases faster as *x* increases. The graph always lies above the *x*-axis but can get arbitrarily close to it for negative *x*; thus, the *x*-axis is a horizontal asymptote. The slope of the tangent to the graph at each point is equal to its *y* coordinate at that point (i. e. d(e^x)/dx=e^x). The inverse function is the natural logarithm ln(*x*). Simple mathematical explanation for a better understanding of the innovation related factor.

From the exponential form of innovation factor it follows that every single rise in innovation related quantity input will result in much greater contribution to the companies' total production output, compared to a single rise in L, C or R.

Taking into account the considerations made above, now we could specify more rigorously the factors in the **production function**, in order to make the model more flexible and suitable to be used with a lot of data:

1) Labor (L) – it can be expressed as a function of the gross value added for the labor process or:

$$L = f(GVA_L) \quad (5)$$

GVA_L **-** gross value added per employee.

2) Capital (C) – it can be expressed as a function of technical and technological renovations, which are a measure of short-term investments (***Inv***)

$$C = f(Inv) \quad (6)$$

3) Resources (R) – An asset expressed as a function of the production process (***C_{gs}***).

$$R = f(C_{gs}) \quad (7)$$

4) Innovations (M) – represents R&D activities as a complex factor, which enhance also the total contribution of all three main factors to the production output. It can be expressed as a function of the expenses for the R&D activities (***Innov***).

$$M = f(Innov) \quad (8)$$

Using equations 5-8, the **production function** (equation 4) can be rewritten in the following form:

$$P = f\left(GVA_L, Inv, C_{gs}, Innov\right) = b_1.GVA_L.Inv.C_{gs}.e^{Innov} + b_0 + \varepsilon \quad (9)$$

In order to focus on the innovation index (*Innov*) and its importance for the companies' development and production growth, we could further process the **production function.** Putting it to logarithmic base results in:

$$lnP = a_0.lnL + a_1.lnC + a_2.lnR + a_3.m + a_4 + \varepsilon \quad (10)$$

or

$$lnP = a_0.lnGVA_L + a_1.lnInv + a_2.lnR_{gs} + a_3.Innov + a_4 + \varepsilon \quad (11)$$

Then, we can extract the innovation index:

$$Innov = \frac{lnP - a_0.lnGVA_L - a_1.lnInv - a_2.lnR_{gs} - a_4 - \varepsilon}{a_3} \quad (12)$$

Where: empirical parameters $a_1, a_2......a_n$ reflect the degree of dependence of L, C and R of a given company on its innovation activities.

The innovation index can be used for evaluation of the innovation capacity (respectively innovation potential) of the forest companies as a direct consequence of the influence of innovation activities over companies' total production output.

3. CONCLUSIONS

Innovation capacities of the forest companies could be classified according to the value of the calculated innovation index as follows:

- Innovation capacity of first degree – innovation index value between 7.6 and 10.0;
- Innovation capacity of second degree – innovation index value between 5.1 and 7.5;
- Innovation capacity of third degree – innovation index value between 2.6 and 5.0;
- Innovation capacity of fourth degree – innovation index value between 0.5 and 2.5

This classification could be used for grouping of forest companies into two main categories:

- Companies of high innovation capacity (first and second degree capacities)
- Companies of medium innovation capacity (third and fourth degree capacities)

Companies with very low innovation index (below 0.5) could be considered as non-innovative.

The evaluation of innovation capacities for forest companies, according to the suggested approach, could be of use in different strategy building in the sphere of innovations and competitiveness at national and international level. The approach could be used also as a prognostic tool, and to serve as a basis for time dependent comparative analyses for a variety of forest companies.

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PRACTICES OF INNOVATIVE MARKETING COMMUNICATION TOOLS IN FURNITURE SECTOR

Miriam Olšiaková, Erika Loučanová

Abstract: The practice confirms that the effect of traditional tools of marketing communication has decreased that is caused not only with the development of Internet technologies but also with increased negative attitudes of customers towards classical tools of marketing communication such as advertising, personal selling, sales promotion or Public Relations. The paper aims to present theoretical and practical information on new forms of marketing communication. They include tools such as guerrilla marketing, content marketing, product placement, etc. Those forms of marketing communication are supposed to be innovative ones and they are known as the part of the inbound marketing The paper is also focused on practical examples of selected innovative forms of marketing communication that furniture companies use not only to succeed on the market but particularly to gain customers´ attention in a less traditional way.
Key words: innovative marketing communication, inbound marketing, guerrilla marketing.

1. INTRODUCTION

The furniture industry is facing various challenges connected with new changes and trends in the market. These challenges are also caused by changes in consumer requirements and expectations. To effectively meet new challenges and remain competitive in an over-saturated market, the furniture business must not only adapt and ensure that the perception of the brand remains positive in the eyes of consumers, but also develop a marketing strategy that is relevant to the current conditions in the market. Marketing plays significant role also in the furniture industry with the aim to reach target market and increase its customer base. This is not possible to achieve without research, planning, and developing and applying the marketing strategy (https://www.cadesignform.com, 2021). The fulfilment of the marketing strategy is also based on the strategies set out in the marketing communication, which can be specifically determined for the economic and communication area.

Marketing communication allows businesses to achieve the set goals that include: the customers' product awareness, confidence building, creating a good relationship with customers, strengthening the market position or the customers' loyalty.

When achieving these objectives companies apply traditional marketing communication tools (also marked as “outbound marketing”), which are primarily based on one-way communication of companies with customers. New experiences show that if the company still uses the same old advertising practices, its business remains invisible to many consumers who are interested in new furniture. The practice shows that if internet, social media and "new media" are not the part of the marketing plan, the company loses incomes resulting from sold furniture.

In the 80s and early 90s of the last century, traditional furniture stores used printed advertisements in commercial newspapers or advertised in yellow pages, radio and television if they could afford it. Larger shops printed circulars and sent direct mails, but most marketing campaigns failed. They aimed to address the most customers as possible. It follows the main feature of traditional marketing communication tools - they are designed to influence and gain the greatest number of people at once. Their probable advantage is that they are supposed to be faithful, because the customer connects the sellers' success on the market with frequency and repeatability of its advertising activity Their main disadvantage is the problem how to determine which of applied tools brought the success. Perhaps they all were successful, maybe it was a coincidence (Root, 2011).

Marketing brings a lot of opportunities to link the company with its environment and customers to meet their needs. In a persistently changing market conditions it is essential to react to changes and customer requirements as quickly as possible. That can be realized through involving customers directly into marketing when using the innovative marketing tools that fall into the open innovation system of businesses and provide two-way communication with customers (Olšiaková, Loučanová, 2017).

Figure 1. The main tools of inbound marketing
Source: Own processing

Marketing communication implements a set of internet communication tools with the aim to achieve the company´s objectives more effectively. Company's internet communication complex uses a branded SEO optimized website, analytical materials, contextual advertising, banner advertising, various thematic internet resources (portals, forums, electronic bulletin boards, etc.). All of them help to adjust analytical and advertising subject content and personal communication (Melnyk, Korinchenko, 2015; Schuurman et al., 2014).

Inbound marketing is aimed at getting individual attention. This can be achieved by social media and content publishing that is attractive and interesting for customers. It includes blogging, educational articles publishing, publishing the troubleshooting guidebooks and contributing to forums. This aim requires producing the content that is valuable provides certain advantages for the target customers. Moreover, it is available free of charge, which also creates a positive brand link with the customer. The probability that so involved customer buys the goods is higher. The whole process is cheaper and has a higher effect (Guadalupe, 2015; Pirnau, 2015; Simionescu, 2015).

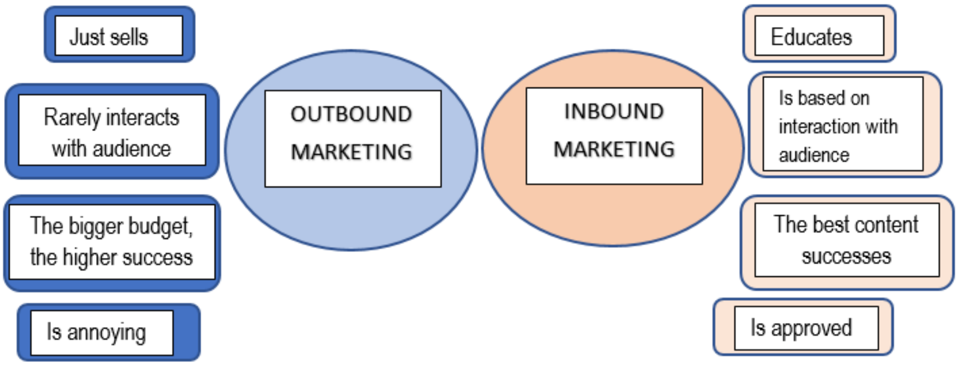

Figure 2. The comparison of outbound and inbound marketing
Source: Own processing

As we have mentioned, inbound marketing is based on two-way, interactive communication with customers using search engines, social networks and different links. The aim and effort of inbound marketing is to entertain or to educate the customer. This way of communication provides the customer an added value and the advantage of the company lies in lower costs spent on marketing communication.

Inbound marketing applies different strategies to effectively address the company´s target audience:

- **Attracting Strategies** are focused on creating and publishing the attractive content for target audience and buyer personas, such as blog articles, content offers, and social media providing specific value for them. They can present guides how to use the products, information about how to solve some problems, customer testimonials, and details about promotions or discounts. To attract the target audience, it is necessary to optimize the whole content with an SEO strategy. It requires you to determine specific keywords and phrases related to provided goods or services. Subsequently, the content and information appear on the search engine results page for those people who are interested in this kind of this information. They are supposed to be the target audience or the right customers for the business.
- **Engaging Strategies** require communicating and dealing with customers in a way that makes them feel that company is interested in building long-term relationships with them by providing special value. Engagement strategies may include specific instructions for employees who are responsible for inbound sales calls.
- **Delighting Strategies** are focused on ensuring customers´ positive feelings such as happiness or satisfaction that persist long time after making a purchase. These strategies involve employees becoming experts and advisors prepared to assist customers any time. It can by realized by incorporating chatterbots (or chatbots) that simulate human-like conversations with users via text messages on chat to assist, support, and request feedback from customers.

- **Social media listening** is another useful strategy with the objective to gratify customers. Social media followers can use the company´s profile to provide feedback, ask questions, or share their experience with goods or services. Respond to these interactions is the sign that company takes care of the customers and is interested in areas they need to be solved (www.hubspot.com, 2021).

Only a suitable combination of inbound and outbound marketing communication tools enables companies to get the instant feedback from customer. The main idea of their usage is to make customer to be the inseparable part of the sales process which results in reducing the communication costs and achieving better communication and marketing objectives (Loučanová, Olšiaková, 2016).

2. GOOD PRACTICIES IN INNOVATIVE MARKETING COMMUNICATION TOOLS IN FURNITURE SECTOR

The furniture industry is also the part of the global market and it also needs to act as an innovator in the area of marketing communication to gain the customer´ attention. Therefore, it is necessary to monitor which innovative communication tools are effective for the active participation of the enterprises of the furniture industry on the market. Besides the above mentioned marketing communication forms there are also other possibilities that can be applied within the communication mix and that have become popular in the furniture industry, too.

This part of the paper presents examples of the good practice that were accepted and preferred by the customers. Those examples can be perceived as the innovative ones and can be used within the furniture industry as a whole.

Guerrilla marketing

Guerrilla marketing is an unconventional marketing strategy that brings maximum results using low costs. This alternative advertising style relies on unconventional marketing policies, high customer involvement and imagination. The purpose of Guerrilla Marketing is to prepare a surprise to the final consumer to gain an unforgettable impression and feeling. Guerrilla marketing is often ideal for small businesses that need to reach a wide audience, but it also has a significant application in large companies (www.digitalmag.sk, 2016).

Guerrilla marketing can be easily applied in the furniture industry. We present some examples how guerrilla marketing could be implemented in the furniture industry. Presented examples are associated with the IKEA Company that is known for a great number of brilliant ideas how to be noticed by as many people as possible in less traditional way.

Figure 3. IKEA ´s idea of guerrilla marketing
Source: www.appnova.com, 2016

Augmented reality

Ikea belongs among the first online furniture stores providing their customers with the added advantage in the form of augmented reality. In 2013 Ikea came out with a catalog app feature called ”Place in Your Room“ that allowed users to try out considered products in their homes. Many people had a bad experince associated with buying the wrong size of furniture, so this handy idea became widely accepted (Binod, 2020).

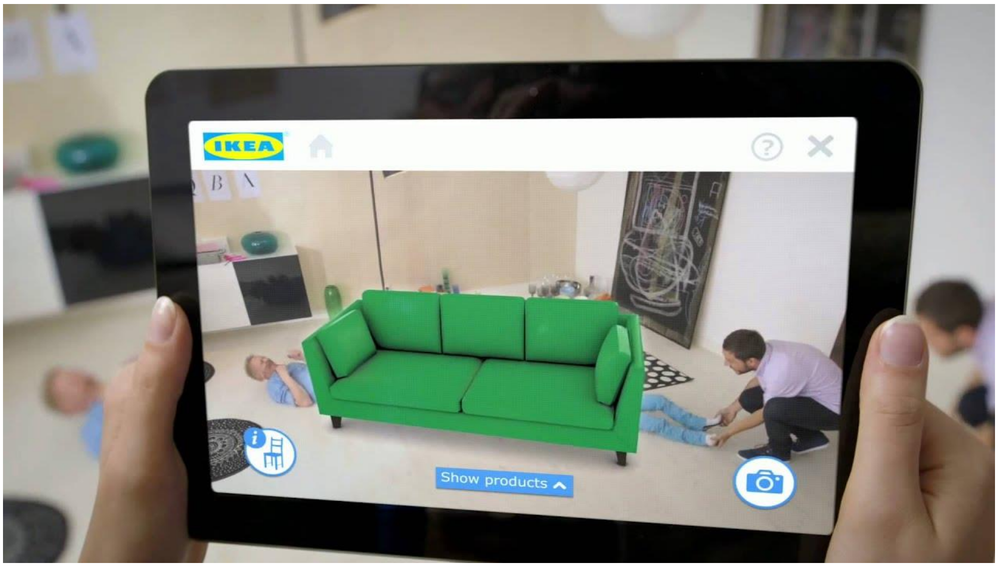

Figure 4. Augmented reality brought by IKEA
Source: Binod, 2020

Viral marketing

Viral marketing is a marketing technique that spreads via the Internet. This special name is based on the principle, as the advertising message circulates. The virus as well as the viral content spreads among people who came into contact with them. Its main objective is the product promotion and advertising as well as strengthening the brand awareness.

Viral marketing is supported by the social networks where people contribute content and share information. Various communication means are used for this purpose (e.g. chain e-mails, chat, SMS are other media that are used for forwarding messages).

Viral marketing is based on creative, funny videos or interesting pictures that are spread naturally among users.

Although furniture industry does not belong among top users of this tool (such as automotive, fashion, cosmetics, food or clothing industry), it is recommended to use it also in the furniture sector, as the positive news spread among trustworthy people can overcome any well-designed campaign and it does not require any special financial resources (Olšiaková, Loučanová, 2015).

IKEA is also a master in creating viral videos and their YouTube videos appeal to a significantly wide audience. But IKEA's marketing teams are not the only creators of videos. They are also a lot of IKEA videos posted by its fans and customers on YouTube too. From useful "How To" videos to a comedian moving into an IKEA store video stories which result in a variety of user-generated content presenting IKEA products on YouTube (www.appnova.com, 2016).

3. CONCLUSION

Business environment also in the furniture industry is constantly facing new challenges that require companies to react as fast as they can. Consumers became more demanding. It is no longer enough to provide them with innovative products of higher-quality, at affordable prices and in advantageous places, but they also demand a more active approach in the field of promotion. This is the reason why furniture companies must focus on using the innovative forms of marketing communication, that seem to be more effective in a relation with their customers (potential and current ones) as well as in keeping the customers´ loyalty. Innovative forms mentioned in the article are also known as inbound marketing consisting of various forms and techniques. They can be well combined with traditional marketing communication tools (advertising, sales promotion, personal sales, Public Relations), which enhances their final effect and minimizes the amount of incorrectly spent money on marketing communication.

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DIGITAL MARKETING INSTRUMENTS AT THE FURNITURE ENTERPRISES IN BULGARIA

Radostina Popova-Terziyska

Abstract: The report presents the trends of the using of modern digital marketing tools in the forest industry. In the beginning of 2021 were studied 48% of the furniture companies, members of Brand Chamber of Woodworking and Furniture Industry in Bulgaria. The research methodology includes questions such as: using of detailed website; using of internet advertisements and campaigns; using of social media (Facebook, Instagram, etc.); making online sales (e-shop); providing augmented reality and virtual tours; publishing photos, videos and content, incl. on social media; using online payment; using blogs; using mobile application of the company. Recommendations for an effective digital marketing strategy of furniture companies in Bulgaria have been formulated.
Keywords: digital marketing; digital strategy; furniture

1. INTRODUCTION

The digital transformation of the organizations is associated with the penetration of digital technologies in all business processes and areas, including their marketing activities.The change from traditional to digital marketing is related to new consumer needs and experiences such as a strong presence and quick reaction in social networks, tracking brands and competitors, researching the best content and time for posting, increasing and decreasing followers on social media. This leads to changes in marketing strategies and requires the use of new digital marketing instruments by companies in the forest industry.

2. CHANGES IN MARKETING DECISIONS RELATED TO DIGITAL TRANSFORMATION

Digital marketing is defined as: achieving marketing goals through the use of electronic communication technologies and the use of different types of electronic media to present products to products and organizations (Chaffey 2015).

Digital marketing has two main components: internet marketing and marketing in non-internet digital channels (Chaffey, 2015; Charlesworth, 2014; Chris, 2015) The different internet channels are websites, search engine marketing, social media and network marketing, mobile marketing , email marketing, online banners. Types of marketing in digital channels other than the Internet are television, radio, SMS, digital billboards (internal and external), which are not based on the Internet.

The transition from traditional to digital marketing combines online and offline interactions between organizations and customers, with digital and traditional marketing working together to win customer support, and connectivity and mobility are the ones that increase customer impact on all marketing decisions of the organization. The main trends are: use of modern tactics to take customers after purchase to support and recommendation; use of multi-channel marketing, which requires mapping of all possible points of contact and channels along the client's path, their improvement and integration; use of own, earned and paid media.[1] (Kotler 2019)

Changes in post-purchase user communication and engagement are related to the use of cloud technologies and digital skills sharing platforms, large databases and analytics tools, mobile communications, social technologies and their applications. Companies can analyze the entire life cycle of consumers through the Internet of Things. (Chaffey, 2015; Kane, Palmer, Phillips, Kiron and Buckley, 2015).

The main trends that affect the interaction between the organization and consumers are: Inbound marketing; Realtime Marketing; Geo-local marketing; Content Marketing; Augmented reality (Steenburgh, Avery, and Dahod, 2011)

The customer's new path in the digital economy is characterized by moving through a series of points of contact with the organization and other users before, both during and after the purchase. Consumers are constantly adding brands or changing their choices, after the purchase they continue to influence the choices of other consumers for a long time, sharing opinions and demanding that companies improve the product. The user's path to the purchase is optimized by automating the payments, quick personalization of the services, purchase management, provision of appropriate additional services, etc. (Edelman and Singer, 2015)

2. TRENDS OF DIGITAL MARKETING OF THE FOREST INDUSTRY

The main goal of all marketing activities is to create a benefit for the consumer, and technology is changing the way it is created, distributed and used. The marketing strategy determines the choice of digital means to maintain lasting relationships with customers. The key characteristics should be: making good use of social media; using Augmented Reality; updates websites; using Content marketing; known the audience; using innovative banners; using easy payment methods. (Kotler P, 2019)

The application of digital technologies in the marketing of organizations will generate many new concepts in the future. Attempts to clarify and systematize them contribute to facilitating the management decision-making process.

More and more companies in Europe used digital marketing instruments but IKEA is a well-known brand since they sell furniture all around the world. The company uses social media marketing effectively by taking full advantage of various social media platforms and has multiple accounts on the same platform for each country like IkeaUSA and IkeaUK. (Digitalagency network 2021)

Bulgaria`s digital infrastructure is very good at all and in some economic activities, the level of digitization is relatively high. (Georgieva D., 2020) The good practices in Bulgarian forest industry companies in production and management are: using CALL customer service center via online orders and sales; using specialized electronic catalogue with full technological

[1] *Their own media are concerning the organization's website, corporate blogs, digital customer service platforms, mobile applications, presence in platforms (Facebook page, LinkedIn accounts, Instagram, Twitter, etc.).*

The media which could be won are related to publicity, which is established through public relations (comments on social networks, blogs and other online or offline communities).

Paid media are concerning to paid online advertising, banners, payment for purchases from customers attracted by another organization (affiliate marketing), as well as the use of traditional media. They contribute to the dissemination of content and the attraction of customers to their own media.

specification, dimensions and materials of wood-based panels, models and schematics of the components; using mobile application, which allows for different combinations of scenery, colours and textures, as well as a choice of interior style; using corporate blogs and B2B business information, incl. franchise opportunities. (Popova, Georgieva 2019)

3. RESEARCH OF USING DIGITAL TOOLS AT FURNITURE ENTERPRISES IN BULGARIA

3.1. Survey methodology

The subject of the study is the degree of digitization of the marketing of furniture enterprises in Bulgaria. The method used is an online interview of 60 companies in the period January – February 2021. The subject of the survey is a small, medium sized and large enterprises, according to the requirements of the law on accounting. The observation methodology is characterized by using modern indicators according to specificity of the marketing 4.0 (Kotler 2019) and selection of the leading furniture enterprises in Bulgaria which are members of the Brand chamber of the Woodworking and Furniture Industry.

The research methodology includes questions such as: using of a detailed website; using of internet advertisements and campaigns; using of social media (Facebook, Instagram, etc.); making online sales (e-shop); providing augmented reality and virtual tours; publishing photos, videos and content, incl. on social media; using online payment; using blogs; using mobile application of the company.

3.1. Survey results

The results of the use of digital tools in furniture companies in Bulgaria shows:

- 100% of the companies have an up-to-date and detailed website;
- 23% of the companies use internet advertisements and campaigns;
- 100% of the companies use social media (Facebook, Instagram, etc.);
- 23% of the companies make online sales;
- 20% of the companies have online payment;
- 2% of the companies provides a virtual tour;
- 100% of the companies publish photos, videos and content, incl. on social media (Facebook, Instagram, etc.);
- 22% of the companies use blogs;
- 2% of the companies have a mobile application.

All the companies have an up-to-date and detailed website, use social media and publish photos, videos and content, incl. on social media (Facebook, Instagram, etc.). Only around 1/5 of the companies use internet advertisements and campaigns, make online sales, have online payment and companies use blogs. But only 1 company provides a virtual tour and has a mobile application.

4. CONCLUSIONS AND RECOMMENDATIONS

For the furniture industry, every year brings new changes and trends in the marketplace, as well as changes in consumer demand and expectations. In order to effectively meet new challenges and remain competitive in an over-saturated market, furniture business must not only adapt and ensure that the brand perception remains positive to consumers, but also develop a marketing strategy that is relevant to the current year. Regardless of what is included in the marketing mix, the ultimate goal is to reach target market and grow the customer base. This simply cannot be achieved without research, planning, and development of a thorough and complete marketing strategy, it will be difficult to connect to the audience and ensure brand recognition or online visibility. The main steps to create a marketing strategy are: understanding customer's demands; mapping customers' buyer's journey; providing an omnichannel experience; leveraging social media platforms; website updates. (Kotler 2019, Cadesignform 2021)

Understanding customer’s demands

The marketing strategy should be specially tailored to create a road map for target market as well — the customer journey map. It doesn’t matter if the business is focusing on furniture shop display ideas, furniture store advertising, creative ways to increase retail sales, or product display strategies — each component of complete marketing strategy should find a way to solve a customer pain point and meet their demands. The marketing strategy needs to discover the answers about customers such as What do they want?, What do they need?, What do they care about?, What can do that will make them happy besides offering them a good product at a good price? How will products solve their problems? It is necessary to build the buyer personas, which is a detailed description of the ideal customer, and all the challenges they face, the problems they need to solve, and what they ultimately desire in a solution. It’s also important to note that the buyer personas from a few years ago or even last year may no longer be relevant today. Consumer demands can shift drastically as a result of environmental, economic, or social changes, or even just due to the emergence of new trends.

That’s why continuous research and data collection is a critical component for the marketing strategy. There are many ways to collect the information that require, but one of the best ways today is via social media channels. By engaging customers on various social media platforms can get a really good idea of what they want, what they need, and even more importantly, how they perceive the brands.

Mapping customers' buyer's journey

The point that the customer first discovers, searches for, or begins to research a product is the beginning of the customer buyer journey. Throughout the buyer journey, the customer will arrive at various touchpoints relevant to the product and the brand. This can consist of the website, a Google review, a social media page, furniture showroom, a chat with a customer service representative, etc. As a whole, these touchpoints form the customer journey map. This map should be designed as part of the marketing strategy, with each touchpoint focusing on providing a positive customer experience and providing information or a solution to a customer main pain point. This is what keeps the customer actively pursuing their product and moving along the map, until at such point they make their purchase decision. If, at any touchpoint, they receive a poor experience, such as not finding the information they seek or having an unsatisfactory conversation with a sales rep, they may leave the customer journey map and instead begin a new journey on a competitor’s map.

Therefore, it is critical to understand fully the purpose of the customer journey map when developing the marketing strategy, but also how each touchpoint will help the customer decide if they need the product. It’s also important to remember that the customer journey map isn’t necessarily 100% online — it may encompass in-store experiences and traditional marketing options as well. The marketing manager need to consider and implement all marketing opportunities, such as furniture shop display ideas, furniture store advertising, creative ways to increase retail sales, and an overall product display strategy, for both in-store and on the website. The buyer journey can be broken down into three stages:

1)The awareness stage

Buyers have identified a problem or challenge, and will need to seek a possible solution. They will need to gather information and find possible sources that can help them solve their problem. At this point, the buyer may not be aware of the brand. When creating awareness, focus on the customer's pain points — a specific problem the customer is experiencing. By focusing on customer pain points, rather than just the product or brand, it is necessary to attract customers to want to actively learn more about the company.

2)The consideration stage

Buyers are actively seeking a solution and they will determine which appropriate method will be best to find the solution such as search online, visiting a store, or contacting a brand directly via social media channels. Many buyers simply just utilize Google to find informational material and reviews. Utilizing marketing methods that increase the search and online visibility is critical to ensure that potential customers will find the company. Also, focus on building a relationship of trust.

3) The decision stage

Buyers have found their solution, but must make a decision. They will do this by evaluating all the criteria they have discovered along the buyer journey. Comparisons will be made, pros and cons will be considered, features and benefits will be appraised, and, ultimately, the overall customer experience will play an instrumental role in their purchase decision.

Providing an omnichannel experience

An important component of the customer buyer journey is being sure that the customer can find the company, wherever they might be looking. While it was mentioned above that the majority of customers will utilize Google to learn about a brand or product, that still leaves a significant portion of the target market that will utilize other methods for gathering research. And the Google crowd, as they near the end of the buyer journey, will also turn to additional methods of collecting information.

Furniture store advertising can be one method of reaching out to customers, while product display strategies can appeal to customers who visit the showroom. 3D models and Image Scripting can also be a worthwhile online product display strategy for consumers who don't visit a showroom but still need a viable solution to the pain point of the need to see a product in great detail. It is important to boost foot traffic to the furniture store. Every opportunity for marketing and communication to make it as easy as possible for the customer to find the company and contact it if they desire. In addition to Google, one of the most feasible ways to accomplish this today is via social media channels.

Leveraging social media platforms

Modern consumers want much more from the brands they choose to do business with aside from good products at good prices. They also want an engaging experience, and the way many of them achieve this goal is via social media platforms. Leveraging social media channels as part of the marketing strategy is not overly difficult — simply first need to discover with social platforms the target audience is using the most.

Once discovering that, it is basically already known where to find the customers, and to meet them there. But it is also needed to engage the audience in a way that helps company to stand out from competitors, improves brand recognition, and to foster a relationship.

Posting relevant industry or product information that is either informative or entertaining, and, even more importantly, solves customer pain points and delivers a solution to their problems or challenges. Posting high-quality images and shareable videos with short lead-in times increases engagement and also enables to spread faster and further throughout the target demographic.

Website updates

The website is one of the first touchpoints a buyer will visit when discovering the brand. It can be easy to navigate and visitors can direct want as quickly as possible. And with so many more furniture businesses realizing the importance of a stunning website, especially now the consumer shopping habits are leaning towards online purchases. It is necessary to present the furniture products in a way that makes them look just as good as if they were being viewed in person on the showroom floor. Using Image Scripting and 3D modelling to produce high-quality, photorealistic images of products that visitors to site can rotate, zoom in and out, and even see hidden components. The presentation of the products in great detail, and in all styles and colours, will greatly serve to help buyers make their purchase decision. It is very important that the website is easily viewable in any format, on any device. Consumers are using mobile devices to search for and purchase products much more than traditional desktop computers, so the website must be optimized for smartphones and tablets.

Trends and technology in the furniture industry may come and go, but a strong marketing strategy will always play a major role in the success of any brand. Developing of the marketing is not a once and done deal, either. The strategy requires constant review to ensure every part is performing to maximum effectiveness and that every touchpoint along the buyer journey is keeping the potential customers on the path to making a purchase. Use analytical tools to see where the marketing is doing well and where it needs improvement. Doing all of the above will help to highlight the brand and instil brand awareness in the audience, maintain an edge over the competitors, and close more sales both in-store and online.

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IMPACT OF THE NEW PANDEMIC COVID-19 ON A WOOD PROCESSING COMPANY AND ADAPTATION TO NEW MARKET NEEDS IN ONLINE SPACE

Andrej Tomić, Mikuláš Šupín

Abstract: Digitization is a priority in many countries, and due to the pandemic of the new coronavirus, the presentation of companies in the online space may seem crucial. The new coronavirus pandemic has had a major impact on businesses in all sectors of the market. If businesses were unable to adapt to the actual situation and provide users with what they demanded, they could lose their position and competitiveness. Many companies set up websites during this period, which could lead to increased competition in the digital space. The researched company offers processed wood products to the general consumer (B2C).
The study deals with the optimization of a website for new and existing trending keywords that are directly related to the wood processing industry and their impact on organic traffic, as well as the turnover of the wood processing company itself during the first wave of the new pandemic COVID-19. In the short term, it was not possible to track long-term data, so various optimization tools had to be used to optimize current search trends. The study uses a year-on-year comparison of periods to avoid the effect of seasonality on monitored metrics.

Keywords: seo, digitization, online marketing, coronavirus, COVID-19

1. INTRODUCTION

The onset of a new coronavirus pandemic has affected the global economy in a gradual way. Therefore, wood processing companies in markets where, at the time, the new coronavirus pandemic has not yet affected demand, could use existing data from other countries where anti-epidemic measures have already been in place. We were unable to detect the increase in demand at the beginning of the pandemic immediately from the tools that track regular searches, because not enough data existed at the time. The research in the document was evaluated on the basis of analytical data from the Google Analytics application before the beginning of the first case of coronavirus in Slovakia and the first lockdown. The analytical application was implemented on the Drevenyprofil.sk website and we compared the data year-on-year to prevent seasonality. Drevenyprofil.sk was a company selling wooden claddings to regular customers (B2C), founded in 2016. All data since the establishment of the website was available, thus year-on-year comparisons could be made in the research. Organic traffic comparison metrics, and primarily, increased turnover from the keywords for which the website was optimized, served as an indicator of proper website optimization.

2. METHODOLOGY

A website can be optimized in a variety of ways, depending on the priorities and shortcomings of the website. According to SRINITHI (2020), the optimization of a website for search engines can be divided into two main areas, which are further subdivided:

- on-site optimization,
- off-site optimization.

On-site optimization consists of adjustments directly on the website. These adjustments can vary from technical improvements to the creation of new content that is effectively designed to be placed on.

To select relevant keywords, it is possible to use the SEE-THINK-DO-CARE shopping cycle model. According to GAJANOVA (2021)., this model helps to distinguish whether we can expect an increase in turnover from a given keyword while gaining a better position. Keywords in the form of SEE are of a general nature, where the visitor does not yet know the answer to his problem. The SEE phase is most often used as the format of a blog article, where we can offer the visitor a relevant solution for his problem. In the THINK phase, the visitor already knows the solution and is looking for additional information about the product. The DO phase is crucial in terms of generating more turnover, because the visitor's intent is to buy a certain product. This is often the name of the category, or a specific product name, such as wooden cladding. In the CARE phase, the visitor has probably bought the product, but is looking for instructions or further help. The choice of relevant keywords, therefore, depends on the defined goal that we need to achieve through optimization. We can use various tools to get keywords, such as Google Ads, KWfinder, Google Search Console, Google Trends, etc.

Off-site website optimization, according to KHALIL and EDLUND (2020), consists of obtaining backlinks. Acquiring backlinks is also called linkbuilding. Backlinks increase the authority of a website. The authority of the website significantly helps to rank higher for existing, as well as new content in the search results. The effect of linkbuilding is not visible until several months later, when the links are already indexed by search engines.

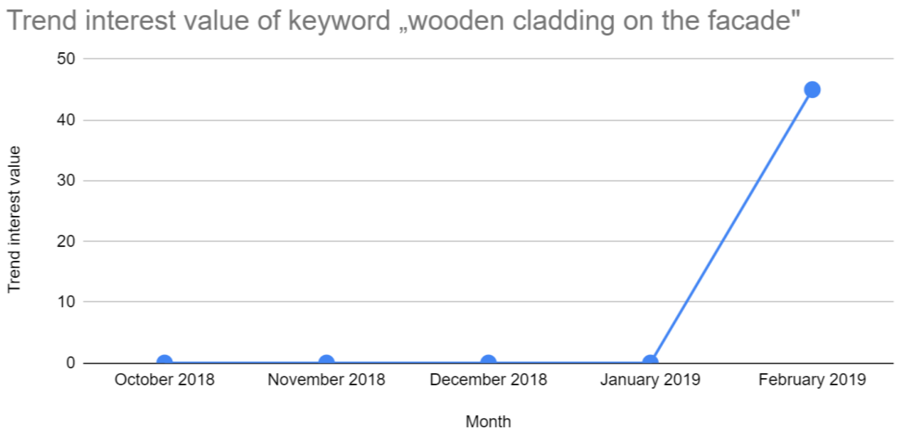
The impact of the new coronavirus pandemic may have led to an increased demand for wood materials and products. As a result, there may be new queries for keywords for which the website has not been optimized. The effect of the pandemic was visible too quickly, so previous pre-pandemic data may not have been sufficient.

3. CASE STUDY OF A B2C WOOD SELLING COMPANY

The Drevenyprofil company sells wooden claddings, OSB boards and other wooden products. The website has been optimized for search engines since its inception in 2016. We have registered a minimum of technical problems on the website that could affect search results, and we have actively acquired backlinks from authoritative sites in an unpaid way. We were, therefore, able to evaluate the website as a suitable subject for content optimization before the outbreak of the new coronavirus pandemic, where the priority was to obtain data on new search queries and create content for the relevant keywords.

3.1. Website optimization based on search trends

We choose keywords based on the increased upward trend abroad, where anti-epidemic measures were already in place and according to trends through the Google Trends application, which were visible only when the measures were introduced in the Slovak market, where Drevenyprofil operates. Keywords that had minimal searchability (0-10) at the time of the research had to be divided according to the SEE-THINK-DO-CARE model. The aim was, in addition to increasing organic traffic, to increase the overall turnover of the Drevenyprofil company.



Graph 1. Trend Interest value for keyword „wooden cladding on the facade”

Table 1.Selection and Distribution

Keyword in the Slovak language	Avg. Search Volume in SR (Before COVID-19)	Avg. Position wood profile (february 2020)	Trend Interest (february 2020) *	STDC
Drevený obklad do obývačky	10	45	75	DO
Ako vyčistiť drevený obklad	0	61+	49	CARE
Drevený obklad do kuchyne	0	32	45	DO
Ako obnovit starý drevený obklad	0	61+	55	THINK
Drevené obklady na fasádu	10	18	45	DO
Drevený obklad na terasu	10	23	58	DO

* Trend Interest min. value = 0, max. value = 100.

According to table no. 1, we selected keywords that had not been searched yet, had an increased upward trend abroad, and subsequently, also an increased positive trend in the Slovak market just before the first COVID-19 positive patient in Slovak Republic, February 2020. The keywords were divided according to the STDC model. Since the aim of the work was to increase the organic traffic, as well as the turnover of the company Drevenyprofil, we chose the keywords in the DO phase of the STDC model:

- drevený obklad do obývačky (wooden cladding in the living room),
- drevený obklad do kuchyne (wooden cladding in the kitchen),
- drevené obklady na fasádu (wooden cladding on the facade),
- drevený obklad na terasu (wooden cladding on the terrace).

3.2. Website optimization based on search trends

Based on the keywords that were available, we started to create content. According to the USP (unique selling proposition), we found that the given keywords appear in the search results for the selected keywords according to table no. 1 product category. Thus, we created a filter that divided the product category of wooden claddings according to their location in the kitchen, living room, facade and terrace. We have enabled the indexing of filtered pages and then optimized them according to the on-site website optimization rules. We added keywords to Titles, H1 Headings, and created descriptions for the new categories. Furthermore, we added keywords to the content naturally, and we did not oversaturate the content with them. We created the description mainly for the users to learn about the benefits that Drevenyprofil products offer.

3.2.1. Evaluation in Google Analytics

After indexing the site in February 2020, we were able to evaluate the activities in the analytics application Google Analytics and compare the results year-on-year for the monitored sites. We were also interested in changing positions for selected keywords to see if content creation had an impact on Drevenyprofil's organic traffic as well as its turnover. As the landing pages were created for the purpose of research and the emergence of a pandemic, there was no data available for the previous year. However, as part of the research, we were able to compare traffic from these sites with previous year's data from the main landing page of wooden claddings. We decided to monitor the results in the period March 2020 - May 2020, when the change in demand for wooden materials was most visible and the created landing pages were fully indexed in search results. We compared the time period year-on-year with 2019.

Table 2. Change in Avg. Positions

Keyword in the Slovak language	Avg. Position wood profile (february 2020)	Avg. Position Wood profile (march 2020)
Drevený obklad do obývačky	45	3
Drevený obklad do kuchyne	32	3
Drevené obklady na fasádu	18	1
Drevený obklad na terasu	23	2

As can be seen from the table no. 2, the creation of content for new keywords had a significant impact on their search position. The website was technically optimized and the linkbuilding has already been in process before the research started, which led to a better competitiveness of the website in search. The created content was placed in the search results in the TOP 3 positions.

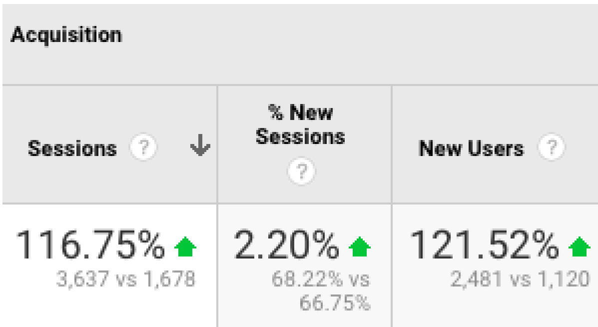


Figure 1. Organic traffic in Google Analytics

We compared the time period from March 2020 to May 2020 year-on-year (March 2019 to May 2019). From figure no. 1, we could observe an increase in organic traffic of newly created categories by 116.75% compared to the main landing page of wood cladding.

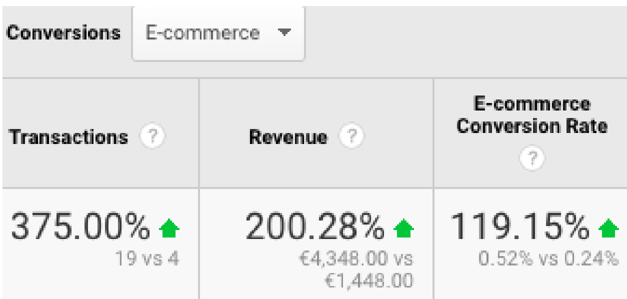


Figure 2. Transactions and Revenue in Google Analytics

In Figure no. 2, we could monitor the increase of transactions of newly created categories compared to the main landing page of wooden claddings by 375% year-on-year. Turnover increased by 200% compared to the mentioned sites. The conversion rate also increased significantly, which may indicate a significant increase in the interest of purchasing wood materials compared to the original period before the COVID-19 pandemic.

4. CONCLUSION

The available data show a positive impact of search engine optimization on Drevenyprofil's organic traffic, as well as its turnover. In the research, we compared the year-on-year newly created landing pages with the existing main page of wooden claddings. Organic traffic of all newly created pages compared to the main existing page of wooden claddings increased by 116.75%, transactions increased by 375% and turnover by 200.28% year-on-year. The general page of wooden claddings also recorded a year-on-year increase of organic traffic by 123.61% and a turnover of 231.21% without changing its position, which proves the significant impact of the pandemic of the new coronavirus COVID-19 on the demand for wood materials. Website optimization based on new trends had a positive impact on organic traffic as well as Drevenyprofil's turnover.

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THE FOREST TOURISM AND MARKETING COMMUNICATION IN POSTCOVID ERA

Jana Černá

Abstract: The forest is a multifunctional environment for tourism activities. Its use for recreational purposes in Slovakia as a landlocked country is already traditional and enjoys a large envelope across all segments of tourism participants. However, in the light of the global pandemic Covid19, its potential is even more significant: it is a territory beneficial to human health, it provides space for social distance, the nature of staying in a forest environment allows a break from massive and everyday use of IT technologies, it is an environment with low light or noise smog, etc.. The aim of the paper is to outline the perspectives of the current marketing communication of the forest as a territory for recreation in the so-called postCovid era. Based on a historical excursion, the author points out the main elements that shaped the tradition of a holiday in a forest environment in Slovakia during the modern era of tourism: the phenomenon of cottage, the phenomenon of marking hiking trails, high rate of afforestation of the country - these are the preconditions that predetermine the use of forest for recreation even in the new conditions in the tourism sector.
Keywords: tourism, forest, marketing communication, COVID 19 pandemic

1. TOURISM AND FOREST PERSPECTIVE DURING COVID 19 PANDEMIC

Tourism is an sector that is increasingly dependent on natural resources, on the other hand, it changes according to fashion trends. Characteristic for this sector is also its fragility and sensitivity to macroeconomic, external influences. For a long time, there has been an increasing demand for products and services that are backward by nature, a quiet and healthy environment (eg Fredman, P., Wall-Reinius, S., Grundén, A., 2012, McGrath, P ., Sharpley, R., 2016 et al.). This trend is most pronounced especially in the urban population. The COVID 19 crisis is accelerating this trend and giving it new dynamism. It is evident that this type of tourism has potential not only in times of crisis, but also in the so-called postCovid era.

The crisis in the tourism sector is affected by the COVID 19 pandemic very large, moreover, it goes far beyond it. Close interconnection with other sectors creates spread to other economic areas such as sports, culture, transport, etc.. The cause of widespread destruction of the industry are restrictions on mobility and social distance. Domestic tourism in particular saves tourism businesses from a complete collapse - although its performance has declined significantly (OECD, 2020). Studies by several international tourism organizations (eg OECD, UNWTO, UN, EU, etc.) point to the recommendation to create tourism products and services according to the macroeconomic changes caused by the pandemic.

The forest represents a significant potential for tourism activities, forest areas are multifunctionally usable for tourism. From the point of view of tourism, coniferous stands are of the greatest importance, especially rhododendrons, which are attached to the alpine relief, which often provides attractive scenery thanks to the vegetation. An important component of the flora that has a positive effect on tourism are forest stands, which are associated with a stay in nature and rest, especially in the hot summer months, but also throughout the year in the form of cottages, often near urban agglomerations (Plesník, 2000, p. 15). Forest livelihoods have the potential for sporting activities such as hunting and fishing.

To define the forest as a recreational area, it is important that the forest environment is part of tourism products and services. Its share in the final product or service can be variable: from a dominant share to a marginal one. According to the UN (2010) in tourism terminology, "... we distinguish between types of tourism products. This typology represents a combination of various aspects (nature of the place visited, mode of transport, type of accommodation, activities in the destination, etc.) around a specific interest such as. nature trips, farm life, visits to historical and cultural monuments, visits to a specific city, etc. ". In the context of the use of the forest for tourism activities, the term "forest tourism" is used (eg Font, Tribe, 2000), but in a broader context these activities include e.g. to ecotourism, agrotourism, summer or winter tourism or even to health tourism. This terminological inconsistency according to the UN (2010) is due to the fact that "tourism products are still not sufficiently measured in a uniform way, there is no international recommendation for the use of this type of classification. It follows from the above that the classification "forest tourism" is increasingly requested and used by tourism stakeholders as a marketing tool. Forest tourism activities can have a passive character, such as sitting, relaxing and enjoying the view, or an active character, e.g. skiing, hiking, mountain biking, horseback riding (Bell et al., 2009) or the increasingly widespread Nordic walking.

2. CREATION OF FOREST TOURISM PRODUCTS AND SERVICES IN NEW CONDITIONS AND THEIR MARKETING COMMUNICATION.

The special challenges arising from the COVID 19 crisis are faced mainly by companies and tourism management organizations (at regional, national and transnational level). A flexible response to changing conditions in the tourism sector appears to be effective in maintaining competitiveness. Empirical experience also shows that tourism destinations that offer a wide range of products and services are the most competitive (Lew, 2020). In times of crisis, there is a need to 1) create products and services that are updated to meet the needs of tourists, while 2) marketing communication plays a key role in this. However, in the case of tourism, the creation of new products or the updating of the existing offer to new conditions depends on the existence and availability of potential and resources for tourism.

2.1 Potential for creation of forest tourism products in the conditions of Slovakia

A positive trend is the fact that according to the State of Europe's Forests 2020 study, Slovakia's forest cover has a growing trend, with the current forest area representing 41% of the territory and an increase of 1.5% compared to 1990. In Slovakia, 63% of the total area of forest land is located in the systems of protected areas. In our conditions, most forests are open to the public, while approximately 6% are primarily designated or managed for the purpose of recreation to the public (FOREST EUROPE, 2020).

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forest land is located in the systems of protected areas. In our conditions, most forests are open to the public, while approximately 6% are primarily designated or managed for the purpose of recreation to the public (FOREST EUROPE, 2020).

The first mention of the use of forests in Slovakia dates back to 1075 - measures aimed at protecting forests and animals. The popularity of hunting as a social past for the upper classes was one of the oldest tourism activities ever. Modern and organized hunting began in Slovakia after 1860. At present, "hunting is considered part of the Slovak cultural heritage based on its rich history" (Ministry of Agriculture and Rural Development of the Slovak Republic, 2018). In terms of active tourism, a more significant increase in foreign hunters was recorded after 2004, when Slovakia joined the European Union. Hunting tourism generally contributes to the improvement of tourism services and thus contributes to the growth of the social and economic potential of the tourism area, as it participates in the improvement of tourism services (Lacina, 2013). However, the benefits associated with it are only possible if the conditions of sustainability are respected.

The first mentions of tourism in the mountain and forest environment in Slovakia come from the 17th century, they are notes and records of tourists who describe the ascents to the alpine peaks. In 1827, the first tourist guide to the High Tatras was published with a description of the usual tours of the time (Chorvát, 2007). The development of mountain tourism in Slovak conditions was delayed in comparison with other European countries, this fact can also be attributed to the more difficult availability of alpine terrain and poorly developed infrastructure. In the field of tourism, it is necessary to point out an important phenomenon which underlines the tradition of tourism in Slovakia, which is realized mainly in forests - and this is a system of tourist signs, which is among the best in European conditions. The marking of the first tourist trails was carried out in 1874. Marked hiking trails in Slovakia represent a complete network and is a rarity rather than the rule compared to other countries. The total length of marked trails in Slovakia is more than 14000 km (Slovak Tourists Club, 2006). In addition to tourist signs, there has been an increase in the number of educational trails in recent years (more than 300 registered). They focus on thematic information about the surroundings and complement the network of marked trails (Kollár, 2015).

The second home phenomenon is another traditional link between the forest environment and man in Slovakia. By this term we mean cottages and country cottages. According to Schindler-Wisten (2018), the cottage is primarily associated with an object intended for recreation mainly in a forest environment (or near a forest, but cottages can also be located near water areas or in garden settlements). Recreation in cottages is primarily considered as an activity of rural tourism, which has an individual character. This form of recreation has a long tradition in the conditions of Slovakia, its origins date back to the period of the second half of the 20th century. This form of recreation has gone through several stages; initially individual ownership of the cottage, later corporate cottage settlements were built for recreation of employees. Such recreational facilities had their significance during the communist era (when travel abroad was restricted). E.g. according to Chorvát (2007) in 1987 almost half of the holidays were provided by the inhabitants of Slovakia themselves in their own recreational facilities such as cottages and country cottages (24.8%) or in cottages owned by family members or friends (23.9%). The importance of these recreational facilities is still intensive, in addition, the pandemic intensifies this demand. In the real estate market, demand prevails over supply, most often these recreational objects are bought into direct ownership, or in the form of shares in the resort, or as shared real estate. In addition to private ownership of cottages, there is also a still existing infrastructure in Slovakia, the so-called corporate leisure facilities. In the past, these buildings were used for the recreation of numerous groups of the urban population, and the urbanization of Slovakia also played a significant role in their development. Today, some buildings are reconstructed, others are falling into disrepair.

2.2 Marketing communication in the context of using the forest for tourism activities

Recreation in forests or in areas that are close to the forest, it is traditionally used for the inhabitants of Slovakia. This is evidenced in particular by the above-mentioned long-term consumer behavior. According to a study focused on the survey of consumer preferences in relation to the environment and bioeconomy (Pichlerová, 2019, p. 141), the inhabitants of Slovakia perceive the forest primarily as a producer of oxygen and a place for relaxation and recreation. A study conducted in an urban context around Bonn (Germany), illustrated the impact that the measures against the spread of COVID-19 have on forest recreation. The main finding is that visitor numbers since the inception of COVID-19 measures in March 2020 have more than doubled. Visitor patterns have drastically shifted, from an even distribution throughout the day with small peaks before and after office hours to a culmination in the late afternoon. Lastly, the interviewed forestry professionals have noted that a new set of visitors, ie young people, families with children and non-locals, has arrived to the forest (Derks et al, 2020). According to Ďaďo et al. (2006), the essence of marketing communication of organizations in tourism is to ensure communication of tourism offer with target markets, facilitate orientation of customers in the tourism market and simplify comparison of evaluation of tourism products. Empirical experience shows that marketing communication cannot be left to individual tourism service providers alone. In economies where tourism accounts for a significant share of the national economy, competences are usually distributed at national and regional level (or even local) through tourism organizations. Their mission is primarily marketing communication, which can: stimulate the demand for tourism, build a brand, raise awareness, etc.

During the Covid19 pandemic, marketing communication is extremely difficult. Tourism management organizations must understand the implications for travel and correctly predict the consequences of a pandemic for the sector: changes in attitudes towards travel, the time horizon for easing mobility restrictions, the desires of tourists. Important communication trends for the conditions of forest tourism can be deduced on the basis of scientific literature as well as empirical studies (eg OECD, UNWTO and others) concerning current trends "covid 19 pandemic": safety (tourists and employees), short - distance travel, even more massive use of IT technologies and social networks and digitization, individual tourism or smaller number of participants in the group, preference for local (local or regional) tourism, virtual and augmented reality, increase in demand for ecological products and services, efforts to minimize IT, light and noise smog during the holidays, etc.

3. CONCLUSION

The economic and ecological significance of forests for the territory of the Slovak Republic cannot be appreciated. From the point of view of tourism, forest is an attractive area that can be used for many recreational activities in several forms of tourism: rural tourism, ecological tourism, sports tourism, or health tourism. Another aspect of forest tourism is its potential for balancing regional disparities, as forest areas are mostly rural. Marketing communication also plays a large role in the planning and regulation of forest tourism and individual recreational areas. During the world's Covid 19 pandemic, the forest environment has great potential for tourism activities due to its contribution to both physical and mental health. Tourism management organizations are under pressure to create new communication messages and communication content in order to help maintain the tourism sector, which is one of the most affected by the global pandemic.

The trends in the coming periods will be short-distance travel, the emphasis on health and social distance, and the current pandemic situation therefore requires an adequate response. Due to the relatively intensive afforestation of Slovakia, the existing infrastructure and the tradition of using the forest for recreation, new possibilities are opening up to respond to the demand for a safe environment, products and services. One of the possibilities for tourism organizations is to update the marketing communication focused on the forest, while its content in Slovakia can be based on the tradition of recreation, which will focus on offering experience, uniqueness and atmosphere, sustainability, etc. The use of new media in the marketing promotion of the forest as a destination for tourism is essential.

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SUSTAINABLE DEVELOPMENT - INTERNATIONAL FRAMEWORK - OVERVIEW AND ANALYSIS IN THE CONTEXT OF FORESTS AND FOREST PRODUCTS - SUSTAINABLE DEVELOPMENT IN THE GLOBAL ECONOMY WITH POLICIES

Annika Hyytiä

Abstract: Policies with sustainable development approach provide new opportunities in the forest sector. Several international and national policies are involved with sustainable development of natural resources of forests. Bioeconomy includes ecosystem services and promotes value chain based on forest ecosystem services.

The European Green Deal is a current new policy. The Corporate Social Responsibility, CSR, can also be seen in the EU FLEGT policy.

Bio-based solutions are important also for the future. Sustainable policies are well recognized in the strive for sustainable development and they have a link to trade, competitiveness, markets and economy. Enhanced innovation constitutes in an important role there.

This is a qualitative research based on academic research databases and policy literature.

Keywords: Sustainable development, Policy, Economy, Forests, Wood

1. INTRODUCTION

2030 Agenda srives for strengthening the social, economic and environmental dimensions of sustainable development (The 2030 Agenda for Sustainable Development 2021).

The concepts of bioeconomy, green economy and circular economy contain the goal of sustainable economy and have great political, academic, social and business interest (Valeria, F. G.; Pié, L; Terceño, A. A. 2018) Materials are circular by nature in bioeconomy. Using circular economy business model saves the use of raw materials. There is a global transition towards cicular economy. (Achillas C.; Bochtis, D. 2020)

Sustainable and circular bioeconomy is a way to the UN SDGs according to the pursued goals (Linser, S.; Lier, M. 2020). COM(2019) 640 final COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE EUROPEAN COUNCIL, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS presents the European Green Deal, a roadmap of the primary policies and measures to achieve the European Green Deal as an essential part of the Commission's strategy to implement the United Nation's 2030 Agenda and the sustainable development goals.

1.1. Concepts

Concepts are presented here for Green Economy, Bioeconomy, Green Growth, Circular Economy and Green Deal policies.

1.1.1. Green Economy means improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities; it is low carbon, resource efficient, and socially inclusive (UNEP 2021).

1.1.2. Bioeconomy means the use of renewable biological resources from land and sea, like crops, forests, fish, animals and micro-organisms to produce food, materials and energy (EC 2021).

1.1.3. Green Growth means enhancing economic growth and development and ensuring that natural assets continue to provide the resources and environmental services on which our well-being is based (OECD 2021). In the Nordic Region, green transition is promoted towards carbon neutrality and a sustainable circular and bio-based economy via Green Growth. The vision 2030 includes: A green Nordic region; a competitive Nordic region and a socially sustainable Region. (Norden 2021)

1.1.4. Circular Economy is a model of production and consumption involving sharing, leasing, reusing, repairing, overhauling and recycling existing materials and products. This is how the life cycle of products is extended. (EU 2021)

1.1.5. Green Deal is an integral part of the Commission's strategy (COM(2019) 640 final). The goals of its Action Plan are advancing the efficient use of resources by moving to a clean, circular economy, restoring biodiversity and preventing pollution. Reaching the target of climate neutral EU in 2050, with the proposition of a European Climate Law to turn the target of climate neutral political commitment into a legal obligation, action by all sectors of the economy is proposed, including investing in environmentally friendly technologies, supporting industry to innovate, rolling out cleaner, cheaper and healthier forms of private and public transport, decarbonising the energy sector, ensuring buildings are more energy efficient, and working with international partners to improve global environmental standards (EC INFO 2021).

2. VALUE FROM FORESTS

2.1. Forest ecosystem services

Direct and indirect benefits from ecosystems are known as ecosystem services the term of which was popularized by the Millennium Ecosystem Assessment (MA) (EC MAES 2021). Ecosystem services can be classified in provisioning of products and material, regulating ecosystem processes and the environment, and cultural for non-material benefits obtained from ecosystems like cultural and spiritual values, and supporting services which include all the underlying structures, processes and functions that characterize ecosystems (FAO 2019). Valuing forest-based ecosystem services include services delivered by forest ecosystems, including also trees that are outside forests and combining the values turned over in policymaking and decision making has resulted an increasing attention in last years, particularly considering threats to the sustainable provision of ecosystem services. (FAO 2019)

Circular economy and ecosystem services are crucial in enhancing bioeconomy with its utilities in pursuing national and international sustainable development (d'Amato, D. 2021). Bioeconomy policy proposes a change in global production and consumption from fossil-based to biomass-based resources. Bioeconomy relies on ecosystems and their related services. Life cycle analysis (LCA) approach has opportunities assessing impacts and dependencies of bioeconomy activities on ecosystem services. (d'Amato, D.; Gaio, M; Semezin, E. 2020)

2.2. Bio-based value chains

Bio-based value chains can be long and intricate and they cover plenty of market participants, producers, suppliers, and users. In a growing economy, tools for tracing information on sustainability characteristics and certificate parameters are necessary. (Majer et al. 2018) Considering the value chain approach, in the biomass value chains, harmonising of the sectors along the core objectives of the European 2018 Bioeconomy Strategy is prospective (Singh, A.; Christensen, T.; Panoutsou, C. 2020). These goals include ensuring food and nutrition security; managing natural resources sustainably; reducing dependence on non-renewable, unsustainable resources; limiting and adapt to climate change, and strengthening European competitiveness and creating jobs. This strategy contributes to the European Green Deal, and industrial, circular economy and clean energy innovation strategies all of which accentuate the importance of a sustainable, circular bioeconomy to achieve their objectives. (A sustainable bioeconomy for Europe: strengthening the connection between economy, society and the environment Updated Bioeconomy Strategy 2018)

Especially considering emerging engineered wood products, wood has been used in the construction of residential and office buildings increasingly. The merge of circularity principles into the construction sector can encourage to a transition further towards a sustainable, low carbon economy, reducing carbon emissions and waste. (UNECE 2021) By different technologies in emerging global value chains, international trade regime particularly at the multilateral level will become more in demand (OECD 2017).

2.3. EU FLEGT for sustainable markets

FLEGT remains essential for current efforts for sustainable use and management of tropical forests. (Tegegne, Y. T.; Cramm, M.; and van Brusselen, J. 2018)

Key success factors include that a pilot project showed the success in carrying out fair trade agreements in Colombia between communities and companies or commercial partners that request legal and sustainable wood for their production processes, and the enabling conditions were significant for this including corporate social responsibility, CSR (FAO REDD+ 2021). The EU FLEGT Action Plan encourages private sector involvement as in adoption of corporate social responsibility, CSR, standards (FLEGT Briefing Notes 2007).

The objective of the 2003 EU FLEGT Action Plan is to ensure a legal trade of timber products within and between countries for a pathway towards global sustainability and good governance. Voluntary Partnership Agreements (VPAs) between the EU and producing countries have turned out as the main tool for achieving these goals. VPAs can be seen as a legality licence in halting illegal harvesting and trade. VPAs can also be seen as a market-based approach. Multi-stakeholder processes aspire to address unclear or contradictory forest related laws and weak community rights which are underlying questions of forest governance. (Lesniewska, F.; McDermott, C. L. 2014) In striving for commendable goals, the FLEGT scheme could enhance human rights more extensively related to forestry usage, harvest and timber processing through the law and the markets. (Buhmann, K; Nathan; I. 2013) Underneath the FLEGT initiative, the EUTR import regime is completed by VPAs between the EU and timber-producing countries. They supply aid to countries in improving their land-use governance and forest regulation, which facilitates greater access to EU markets. (EP 2020)

3. CONCLUSIONS

More and more opportunities exist in the sustainable development in striving for the United Nations Sustainable Development goals and can be reached.

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ESCAPE FROM LOCKDOWN THROUGH THE ECO TRAILS

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Abstract: COVID-19 pandemic changed dramatically people's attitude toward outdoor recreation as a counterpoint to the notorious "stay-at-home" measures. Eco trails, the forest flora and fauna provide multiple opportunities for open-air experience, beautiful landscapes and freedom to move around, yet keeping the necessary physical distancing.
The main goal of this study is to explore the shift in tourists' attitudes to move away from traditional mass types of tourism to forest-based activities like hiking on trails and footpaths. Additionally, the paper focuses on the availability and maintenance of eco trails, and possibilities to further develop their product for weekend breaks to appeal to urban tourists. The empirical research reveals the perceptions of Bulgarian tourists towards the role of eco trails as an escape from the lockdowns.
Keywords: eco trails, eco-tourism, COVID-19, lockdown

1. INTRODUCTION AND BACKGROUND OF THE STUDY

Nature and forest-based experiences are often associated with relaxation, recreation, alleviation of stress and an alternative to the urban lifestyle (Dorwart *et al*, 2010). Besides, people expect positive health effects from their interaction with nature and forests (Nordin & Jamal, 2021). Hiking, walking, trekking, rambling, strolling and bushwalking (Nordin & Jamal, 2021) are all used to describe walking in nature and especially using eco-trails. Hiking is an essential part of ecotourism and involves physical and mental fitness (Nordin & Jamal, 2021). Apart from health value, hiking provides great opportunities to enjoy outer space, with fewer crowds around, appreciating wildlife and learning about the ecosystems. Ecotourism became popular with the accelerating movement towards more sustainable development and lifestyle (Slavova, 2016). As an alternative to mass tourism, but without its undesirable outcomes, ecotourism provides intense and valuable experiences and offers a range of activities in natural landscapes (Ivanov and Ivanova, 2013).

However, in 2020 the Covid-19 measures pressed people to stay at home and even work from home, the so-called "Staycation". Because of the closed borders, international travel stopped. The lack of flights and trips abroad caused considerable trigger in domestic travel, and many people rediscovered their own countries (Ivanova *et al.,* 2021). The pandemic situation imposed different restrictions for most countries, like enhanced personal and public hygiene, protection masks and ensuring physical distance that would prevent the spread of the disease (Hall, Scott & Gössling, 2020). As a result, outdoor spaces appeared as the only and very convenient place for people to relax, because of their higher carrying capacity. In the forests and parks keeping the necessary social distance is much easier, yet even cheaper, and hence, the perceived risk is significantly lower.

Vaishar & Stastna (2020) estimate a significant shift in the tourists' orientation in Czechia, mainly towards higher demand of rural tourism and domestic holiday instead of an international trip. The reasons are closely connected to the lower risk of infection, better access to domestic medical care and greater security. The good public transport network and numerous small towns and villages further enhance this process (Vaishar & Stastna, 2020).

Similarly, in France Covid-19 is stimulating second home tourism as a placebo for people who consider the countryside physically and physiologically safe (Seraphin & Dosquet, 2020). A survey on the impact of Covid-19 on the eco-trails visitation in Pennsylvania identified that the trail use in 2020 was significantly higher than in the previous years (Pennsylvania Environmental Council (PEC), 2020). On the other hand, in Portugal, the significant drop in occupancy and revenues of rural guesthouses was not offset by the domestic tourists (Silva, 2021).

Considering the above, the current study aims to explore tourists' attitudes to move away from traditional mass types of tourism to forest-based activities like hiking on eco-trails and footpaths, as a consequence of the COVID-19 lockdown measures, using Bulgaria as an empirical setting.

Eco-trails are famous forest-based activities and their availability and facilities additionally matter as a factor to their popularity. Texture and width of the trail, maintenance and environmental disturbances are only a few of the features that impact the overall customer experience (Dorwart *et al*., 2010). For short- and medium-length trails the increased tourist number caused mostly positive effects, while for the long-distance eco trails negative impacts prevailed (PEC, 2020). Most reported problems include erosion, widening of the trails, muddy terrains and vegetation loss, overuse and crowding, increased littering and illegal dumping/pollution, illegal parking on adjacent areas, increased vandalism and graffiti. The trails were so busy with tourists that they cannot be maintained, explained one of the eco trails managers from Pennsylvania (PEC, 2020). On the positive side, many new followers appeared and trails became perceived as positive outlets, with a larger demographic pool of users, increased awareness and interest. In this regard, proper management and maintenance of eco-trails appear as another significant issue that needs attention.

Therefore, our paper additionally focuses on the availability and maintenance of eco trails, and possibilities to further develop their product for urban tourists and for weekend breaks in the context of Bulgaria.

2. METHODOLOGY

The research of Bulgarian tourists' attitude towards eco-trails as an escape from the lockdown was designed as a quantitative survey. Data were collected through an online questionnaire developed on Google forms. It was distributed from 01st of March till 10th of April 2021 mainly through social media by sharing the link to it to groups with interests in forest-based and outdoor activities. The participation in the survey targeted all people over 18, living in Bulgaria, and was completely voluntary and anonymous.

Questions were divided into three groups. The first section collected data about the demographic characteristics of the participants; the second section explored tourists' experience with eco trails and dealt with their motives to go hiking in 2020, with an emphasis on the direct comparison between the number of visits in 2019 and 2020. Finally, the last questions examined tourists' perception of the maintenance of eco trails in Bulgaria.

The sample profile (see Table 1) shows clear domination of female respondents, but it is typical for similar studies in Bulgaria (Ivanova *et al*., 2020). The sample includes 203 valid responses, with a majority of single respondents and of "married without children" respondents (79.4% altogether), as well as participants with higher education (70%).

The data were analysed with SPSS 19.0 using descriptive statistics, cross-tabulations and factor analysis.

Table 1. Sample characteristics

Characteristics	Frequency	Share
Age		
18-30 years	69	34.0
31-40 years	39	19.2
41-50 years	66	32.5
51-60 years	17	8.4
Over 60 years	12	5.9
Gender		
Male	53	26.1
Female	149	73.4
Prefer not to say	1	0.5
Education		
Primary	7	3.4
Secondary	54	26.6
University degree	142	70.0
Marital status		
Single	60	29.6
Married without children	101	49.8
Married with children	25	12.3
Widow/Divorced	17	8.4
Personal monthly income		
Up to 1000 BGN	75	36.9
1001-2000 BGN	77	37.9
2001-3000 BGN	27	13.3
Over 3000 BGN	16	7.9
No income	8	3.9
Region		
Sofia	32	15.8
Varna	78	38.4
Bourgas	19	9.4
Dobrich	18	8.9
Other regions	56	27.5
Total	203	100%

3. RESULTS AND DISCUSSION

The 2020 pandemic forced people to stay home and prevented any mass entertainment events. Additionally, the threat of infection restrained people from group meetings and parties. In such a difficult situation going outdoors and walks in a natural environment became one of the few available sources of relaxation and fun. Hiking on eco-trails and going to the forest are among the most popular activities used to alleviate stress and panic. Therefore, our first questions aimed at revealing the frequency of eco-trail visits in 2020 and how it changed, compared to 2019. The results are surprising – although respondents reported having visited eco trails 3-4 times on average (M=3.377, SD=2.058), still the number of visits in 2020 is very slightly above the number of visits in 2019 (M=3.18, SD=1.250). Thus, our initial expectations of a boom in outdoor walks were not entirely met. Obviously, despite the increased opportunities to exchange regular entertainment with hiking eco-trails, only a small share (20.2%) of the respondents preferred the latter. The explanation might come also from the different motives, driving people to visit eco trails (see Table 2). The most cited motives are still closely related to nature – *Relaxation in nature* (M=4.41), *Tranquility and peace* (M=4.39) and *Going outdoors* (M=4.13), while *Keeping physical distance* (M=2.78) as a motive driven by the pandemics remained on the last position, contrary to the initial expectations. Therapeutic benefits of nature have been recognised long ago, but the new social importance of outdoor tourism (Buckley and Westaway, 2020) was not unconditionally identified in our study.

The cross-tabulation analysis did not show any statistically significant differences in the responses, related to any of the demographic characteristics of the participants ($p>0.05$ for all Chi-square test values). Still, the majority of single respondents and of “married without children” respondents implies that those target groups care more about natural relaxation, and do not go hiking only to ensure physical distance and fewer social interactions.

The most intriguing finding came from the factor analysis (see Table 2). Respondents' motives were divided into two factors. The first factor included motives related to the closer interaction with nature, so it was named „Nature-oriented“. The second factor (“Socially-oriented”) reflected the opportunity to socialize or keep physical distancing in a safe environment. The two factors explain 36.986% and 22.189% of the variation of respondents' answers, respectively. While the Cronbach alpha of the second factor is below 0.7, both factors have acceptable composite reliability (around or above 0.8). Although the descriptive statistics did not clearly identify a rise in hiking in 2020, the factor analysis revealed distinguished motives of the eco-trails visit.

Table 2. Factor analysis

Motives for visiting the eco-trails	Mean	Standard Deviation	Factor loading	Cronbach Alpha	Composite reliability	Variance extracted
Nature oriented				*0.839*	*0.897*	*36.986*
Relaxation in the nature	4.41	1.070	0.866			
Tranquility and peace	4.39	1.010	0.789			
Enjoying flora and fauna	3.62	1.353	0.729			
Going outdoors	4.13	1.224	0.640			
Fitness and training	3.97	1.238	0.714			
Socially oriented				*0.541*	*0.782*	*22.189*
Time for myself	3.14	1.536	0.536			
Time for the family	3.75	1.445	0.605			
Keep physical distance	2.78	1.591	0.892			

The next part of the research deals with respondents' perceptions of eco-trails maintenance in the country. Results show that respondents think eco trails maintenance should be improved. Table 3 presents a list of the characteristics of eco-trails that need further development. The pure natural features of eco-trails are pointed as least necessary to be upgraded (*Trail covering*, M=2.94; *Itinerary*, M=3.21; *Adaptation of the terrain to facilitate walking*, M=3.06). Hence, respondents are satisfied with the location and routes for hiking, but they rather insist on better popularization (*Advertising and promotion*, M=3.78), hygiene (*Cleanliness*, M=3.69) and appropriate facilities construction (*Benches, gazebos, bridges, etc.,* M=3.67). The highest result of *Advertising and promotion* reveals respondents' attitude towards eco-trails as a necessary part of everyday life that needs to become more popular as a tourist attraction. On the other side, the results emphasize such characteristics as *Signage and information* (M=3.57), *Marking* (M=3.58), *Safety amenities* (M=3.53), which are mandatory for the full experience of hiking as a forest-based product. Mountain tourism, especially in rural regions often is the main revenue source for the local population (Slavova, 2017). Also, eco-trails and similar facilities for weekend breaks provide a great opportunity for sustainable regional development and employment for local residents. In this regard, results imply that respondents realise the importance of proper eco-trails maintenance, and are ready to go hiking more often, provided eco-trails are kept in good condition.

Table 3. Eco trails maintenance

Characteristics of eco-trails – need of maintenance	Mean	Std Deviation
Trail covering	2.94	1.294
Signage and information	3.57	1.156
Marking	3.58	1.120
Itinerary	3.21	1.231
Facilities (e.g. benches, gazebos, bridges, etc.)	3.67	1.136
Cleanliness	3.69	1.209
Safety amenities (e.g. guardrails, etc.)	3.53	1.279
Adaptation of the terrain to facilitate walking	3.06	1.257
Advertising and promotion	3.78	1.336

Note: Coding – 1- No need of improvement, 5-Great need of improvement

4. CONCLUSION

COVID-19 changed our lives as well as our attitude towards nature and outdoor activities. Many people used hiking as an escape from the lockdown restrictions and an opportunity to relax yet keeping the compulsory physical distance. Our research explored how Bulgarians perceive eco-trails and outdoor visits in 2020, and if the number of their visits changed because of the pandemics. The findings reveal that frequency of hiking has slightly increased but motives remain focused on nature appreciation rather than on overcoming the limits of the pandemics. Still, Bulgarian tourists enjoy eco-trails and think their maintenance should be improved. A special emphasis is drawn to the need for advertising and promotion of eco-trails, because of their significance for the development of forest-based activities.

The small sample is the main limitation of this study. Therefore, the main direction for future research is to survey a larger sample, in order to trace any dynamics in respondents' perceptions and to ensure better reliability of the findings. In addition, the scope might be enlarged to other outdoor activities, not only eco-trails.

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LIVING IN A WOODEN HOUSE – DOES IT MATTER?

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Abstract: The issue of housing is not only a big challenge, but it is one of the most important decisions when starting own life. The preferences for residential housing in Slovakia in the last two decades have been influenced not only by the financial situation of investors but also by the myths tied to the choice of material in building structures. This paper presents the results of an interview carried out on a sample of wooden house owners who expressed their assessment for selected housing attributes and experiences with living in a wooden house. In designing the interview, special attention was paid to the probe of attitudes that reflect current trends: the choice of construction materials, energy efficiency of housing and its environmental suitability.
Keywords: wooden house, owners, interview, preferences, attitudes

1. INTRODUCTION

The shift from a linear towards a circular economy represents the most significant change in the global economy. This is related to persistent social problems (such as graduated disparities between economically poor and rich regions) and undoubtedly also to issues arising from the relationship between man and his environment. The future trends of world housing are strongly affected by the development of globalisation. The globalisation, urbanization, limited amount of natural resources as well as climate change has created societal pressure on housing solutions. As stated by Toivonen et al. (2021) it is necessary to create building solutions which are environmentally, economically and socially better than previous ones. Construction sector represents one of the most carbon emission production sector. Huang (2018) pointed out that the total CO_2 emission of the EU´s construction sector represents 18% of total CO_2 emission produced by the EU. The residential sector has significant role to mitigate global climate change. Nejat (2015) shows that buildings account for almost 40% of global energy consumption. There is also a predicted growth in energy demand for buildings. A change of current construction practices is therefore necessary. Concrete is dominant raw material in the construction industry in Slovakia. As stated by Ryník (2020) 80% of new residential construction is made from concrete. The amount of wood-based construction systems gradually increases. There are 700 – 1000 of wood-based construction systems constructed per year in Slovakia. Wang (2014) argues that using wood in construction can have positive effect on the carbon balance. First of all, using wood can decrease consumption of fossil-based materials in businesses. In addition, it can lead to the decrease of emission from cement processing. Wood-based construction systems are able to accumulate carbon for decades. Wood as building material has an advantage in climate mitigation due to the ability to bond carbon longer (Parobek et al., 2019). The goals of sustainable development could be achieving by increasing the use of wood in construction sector and for other wood products with long lifetime. Wang (2014) further states that wood-based construction systems have small environmental impact on the energy consumption, emissions of greenhouse gas as well as water and air pollution compared to concrete systems. The strength of wood as a building material is not only in its beauty and functionality, but it is also a pure and renewable building material.

On the other hand, wood-based constructions are financially more costly than concrete based constructions. Therefore, the cost of buildings is the key issue that needs to be considered in decision making process. The preferences for residential housing in Slovakia in the last two decades have been influenced not only by the financial situation of investors but also by the myths tied to the choice of material in building structures. Companies which are oriented towards wood-based construction must fight the prejudices against these buildings. As pointed by Ryník (2020) many people believe that wood-based constructions are less resistant to fire, less resistant to sound insulation or the service life of wood-base construction is shorter. Petruch and Wachler (2021) as well as Gold and Rubik (2009) have observed same trends. People highly rated wood-based constructions in terms of aesthetics or eco friendliness, but had doubts regarding their stability, durability, price competitiveness or fire resistance.

2. METHODS

The aim of the survey was to evaluate the attitudes of residents of wood-based buildings, based on the experience they gained during their time of living in such a building. The standardized personal interview was used to find out attitudes and preferences of the wooden house owners. In-depth interviews allows the researcher to produce very precise and specific answers from the respondents, which other forms of qualitative methods (e.g. focus groups) and quantitative methods cannot encompass (Chrysochou, 2017). The interview was carried out on the sample of the owners of six wooden houses in the districts of Detva and Zvolen (Slovakia) in 2019. The owners were married couples who lived in houses with their families. In the evaluation phase, a transcript of the recording of the interview, identification of the decisive characteristics and synthesis of the qualitative features pointed out by the respondents were carried out. Respondents commented on the following areas of questions: years of residence, location, reasons to choose specific type of house, advantages, expectations, and economic efficiency related to wooden houses, duration and circumstances of house construction, satisfaction with construction company, quality of architect's and/or protectant's services and communication. Respondents also assessed the selected attributes of the wooden house on a 5-point scale.

3. RESULTS

The standardized interview was carried out on the sample of the owners of the six wooden houses. Five of houses were bought new – four of which were completed in a stage of „a plain house“ and one house was completed as ready for living. The last one was represented by an old brick house reconstructed with the use of the wood-frame.

Respondents 1

The house (bungalow with a diffusely open structure) has been inhabited for 6 years. Respondents positively assessed the price and the speed of construction of the house. Important advantages were the natural material, the smell of wood and dry construction. The advantages also included heat retention, low heating costs, the fact that wooden house is breathing and release moisture from the inside out and vice versa. Respondents moved into a house from a two-room flat and recorded twice lower operating costs with a twice as large area. The amount of fuel wood that was scheduled for one heating season finally lasted for up to three years. Compared to buildings with a concrete structure, wood has much better properties for eliminating moisture. From their own experience, the problems with breathing dry air were eliminated after moving to a wooden house. They were satisfied with the company that carried out the construction. They gained confidence in the construction of a wooden house structure based on information from their friends who had experience with such construction from the Scandinavian countries.

Respondents 2

The family has been using wooden house (bungalow) for seven years. Respondents did not initially consider building a wooden house. They decided on this type of house after studying the materials, finding out the insulating properties of the wooden house and inspecting the buildings. The advantage was the price (lower than a brick house), as well as the speed of construction (in their case only three months). Operating costs are much lower than the three-room apartment from which they moved. Owners see no reason why wood should insulate less than other materials. During summer, the inside temperature is 25 degrees while outside is 10 degrees more (also thanks to the blinds). In winter, when house is heated, it is warm within an hour without using underfloor heating. The construction was carried out by a company, the construction design was consulted with a designer. They did not seek the help of an architect.

Respondents 3

They have been using the house (bungalow) for four years. The reasons for choosing a wooden house were short construction time (the possibility of earlier living) and dry construction process. Among the advantages they pointed out were the cost of housing, which are lower compared to the apartment owned before. The house is equipped by a heat pump, thanks to which the total cost of living is low. Based on the references, they selected a building company that implemented the owners-selected project of a brick house, which was modified by the designer. The house actually enlarged as the initially projected brick walls were wider. They did not seek the help of an architect. Consultations and overall communication with the company and the designer went smoothly. The process of building a house (to the stage without finished interior) took 5 months. The owners did not have high expectations, they wanted to become independent and have peace at home, which was fulfilled.

Respondents 4

The family has been using the house (bungalow) for 4 years. Initially, they were not looking for a wooden house, but there was an opportunity to buy it for a good price. They were fascinated by the location of the house and the fact that the wooden house was built in a low-energy standard. Also, these owners experienced that the expenses for the operation of the house are very low compared to the three-room flat from which they moved here. There are no problems with pests and fungi. They had problems with moisture in the panel construction, while in the wooden house they are completely satisfied with the condition.

Respondents 5

The wooden house has been inhabited by the family for one year. The reason for choosing a wooden house was the speed of construction, which they consider a great advantage. Another advantage was the more pleasant living highlighted by the realized wooden cladding and visible wooden pillars and trusses. From an economic point of view, the wooden house is incomparable compared to the flat where they lived before. For the overall operation of the household, electricity, water, etc. they pay less than half of the previous costs. It is a catalogue type of bungalow, which was adapted to the requirements of the respondent. Communication with the contractor went smoothly, the construction lasted 5 months. They did not look for an architect. They are satisfied with the insulation. Before choosing a wooden house, they studied information about the flammability of wood and how to prevent a possibility of fire. Respondents think that fungi and pests are less of a threat in a wood-based house than in a silicate-based house.

Respondents 6

This is a reconstruction of an old house on which a wooden building was constructed. It has been inhabited for three years. The owners appreciate the scent and aesthetic properties. Another advantage is the fast heating of the whole house. It has no problem with humidity. Breathing in the house cannot be compared to a prefabricated house. When moving into the house, the costs were expected to be lower than before, which was also reality. The house is heated by a gasification boiler connected to a storage tank to maintain heat. There are solar collectors for water heating on the roof. Input costs were higher, but the investment returned.

Table 1. Assessment of wooden house attributes by the owners (scale of assessment: 1 – the best, 5 – the worst)

Attributes	*Owner number*					
	1	*2*	*3*	*4*	*5*	*6*
Fire safety	2	1	3	2	1	3
Weather resistance	1	1	1	2	2	3
Lifespan/Durability	2	1	1	2	2	2
Energy efficiency	1	1	1	1	1	1
Thermo-insulating attributes	1	1	1	1	1	1
Value for money	1	1	1	1	1	1
Maintenance	1	1	2	1	1	1
Sustainability	1	1	1	1	1	1
Acoustic attributes	2	2	1	2	1	2
Speed of construction	1	1	1	-	1	2
Health and safety	1	1	1	1	1	1
Ease of renovation	1	1	2	1	1	1
Aesthetics	1	1	1	1	1	1

Table 1 contains the respondents' assessment of the requirements for wood. The best rating has the energy efficiency, thermal insulation, value for money, environmental suitability, health and safety and aesthetic properties. The speed of the construction is also well evaluated, except for one respondent, who had a more complex construction process due to the reconstruction of an older building. Fire safety / fire resistance was rated worse. The overall evaluation of respondents for the attributes of a wooden house is positive. All respondents are satisfied with their wooden houses and it would be their choice for housing again.

4. COCLUSIONS

Considering the answers of the respondents, we can state that families choose wooden houses mainly due to the quick construction, an acceptable price, and lower operating costs. Most of them retained the wooden elements of construction visible, emphasizing the aesthetic properties and smell of the wood. The addressed respondents did not use the help of an architect in designing the building. They either prefer to choose a catalogue house or look for the type of house whose construction they consult with an authorised designer. According to the respondents, none of the wooden houses had a problem with pests, fungi, moisture, or poor insulation. Respondents expressed satisfaction with the companies that carried out the constructions. They appreciated the skills and helpfulness of the employees of the companies, as well as the effort to find a suitable solution. Communication with authorised designers or structural engineers was also positively evaluated. The mentioned problems were non-compliance with the set deadlines, which happened at several companies. Despite the extension of deadlines, the speed of construction was above the expectations of respondents.

To summarize, our survey did not reveal any significant negatively perceived attributes of wooden-based houses. It means that for the companies in this segment that want to successfully promote their products, it can be recommended to emphasize features that have been positively perceived by the respondents. On the other hand, for the future research, it would be useful to focus also on negatives, myths and prejudices in more details so that they can be addressed and eliminated by appropriate communication strategy. Further research should also incorporate these findings into the questionnaire and realize quantitative survey to get statistically representative results.

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PERCEPTIONS OF ENVIRONMENTAL SUSTAINABILITY OF WOOD PRODUCTS

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Abstract: Sufficient knowledge of the consumer perception of the environmental sustainability of wood products is a prerequisite for adoption of any policy (either at corporate or national level) supporting development of this market. Through questioning, we obtained profile data of the consumers and their preferences when buying products, in the context of sustainability. A total of 311 respondents participated in completing the questionnaire. In addition to the perceptions of environmental sustainability of wood products, the design of the survey includes the following areas: the negative impact of consumer behaviour and the formation of pro-environmental attitudes. The findings show that the vast majority of respondents consider wood products to be environmentally friendly, recyclable, harmless in disposal, aesthetic, and products that create mental well-being. Most respondents perceive the association of wood products with renewable resources. The most negative attitudes were expressed when claiming that wood products are safe to dispose of.
Keywords: perceptions of users, sustainability, wood products, environment

1. INTRODUCTION

Forest-based sector has a unique opportunity to attract meaningful global attention on the wave of recently adapted of bio and circular-economy concepts. It is not sufficiently utilised in spite of fact that consumers are becoming more conscious about environmental issues thanks to fast development of various information platforms. They want to live in healthy environment, buy healthy products. This need should be reflected in their behaviour, and their cautious and conscious choices of products. If this is only a narrative of green policies and company marketers who willing to utilise this wave is still the question.

Since the sources of economy are limited, economic development base on green growth is needed (Lis and Wanat, 2014). Over the years emerged different solutions and concepts to protect environment (Velenturf, 2021). One of them is to move from linear, to circular economy (Kirchherr et al., 2017) which might lead to sustainable development. The other one is concept of circular economy (Suarez-Eiroa et al., 2019) which include active participation of companies and consumers. The part of global and social wellbeing can be rooted in good green marketing strategy implementation made by companies (Maignan et al., 2005; Haanes et al., 2011). On the other side of the global market are consumers acting environmentally consciously (Stern, 2000), and responsibly participate on sustainable economy (Kaplan, 2000; Barr, 2003). Their pro-environmental behaviour has positive impact on availability of sources (Stern, 2000).

Consumer responsible behaviour is affected by different determinants: demographic, psychological, sociological, economic, cultural, geographical, and environmental (Gupta, 2017; Lee, 2014; Alibeli (2011; Lee, 2017; Kim and Seock, 2019). The inner values and deep individual beliefs about environment affect consumers environmental attitude (Alibeli and Johnson, 2009). If it is enriched by personal experience – knowledge from school – we talk about consumer environmental knowledge (Gupta, 2017). It involves knowledge about core environmental issues and its solutions. If consumers act consciously on solution of environmental problems, we talk about environmental concern (Apaydin, 2017). Those consumer perceptions can be reflected by two behavioural areas. Frist one is non-monetary way of acting and includes green activism (Stern, 2000) and green habit (Apaydin, 2017). They are opposed to second area which includes monetary exchange: green buying behaviour. It takes into consideration the outcome, that will have the purchase of the product on environment (Moisander, 2007). Consumers intentional buying patterns of less environmentally harmful products are changing (Williams et al., 2012; Zoric and Hrovatin, 2012; Maťová and Kaputa, 2018; Burton, 2014). Some studies declare that consumers prefer to buy green products (Sony and Ferguson, 2017; Majerova, 2015). Other studies indicate gap between consumers environmental values, attitudes, and pro-environmental/sustainable buying behaviour (Papista, 2017).

To overcome gap between attitudes and real buying behaviour, sustainable marketing concepts developed over time. Companies developed different marketing concepts: from embryo marketing, ecological, marketing, green marketing to sustainable marketing (Katrandjiev, 2016). Otto et. al. (2021) who aimed on consumer perceiving of sustainable packaging, indicates, that consumers evaluate and perceive packaging sustainability based on: i) natural look, ii) design, and iii) possible recyclability. Another study was evaluating aiming on attitudes and willingness to pay for bio-textiles in wood fibres. More than 95% of consumers are willing to pay a premium price for bio-textiles in wood-based fibres (Notaro, 2021). Core prerequisite for effective marketing, product development is to know consumer perceptions of the product. That is why we aimed this paper on perception of wood products in Slovakia.

2. METHODS

A form of questionnaire survey was applied to find out users' attitudes towards wood products. If the aim is more to get an overview and not explore in-depth the phenomenon, then survey methods should be preferred (Chrysochou, 2017). Users were asked if they perceived wood products to be environmentally suitable, recyclable, safe to dispose of, aesthetically pleasing and psychologically valuable, and that they come from renewable resources. The electronic form of the questionnaire was distributed by e-mail and contacts on social networks through university students. Closed and semi-closed questions have been used. Likert's type scale was used for answers construction where "1" means marginal positive expression and "5" means marginal negative expression ("3" means indifferent attitude – neither yes/neither no). For evaluation of the collected data, a frequency analysis and cross-tabulations were used to find out relations between the demographics of the respondents and their answers to the selected questions. 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. We took into consideration only those contingency tables where the following assumptions were met: all expected counts E_{ij} are > 1 and, at the same time, more than 80% of expected counts E_{ij} are > 5 (Luha, 2007). Since the above assumptions were not met during analysis, we merged respondents' answers into the three groups of responses – positive, indifferent, and negative.

3. RESULTS

A total of 311 respondents took part in the survey. More than half were university educated young adults (and almost ¾ up to 40 years). As follows from the attitudes of the respondents, most evaluated wood products positively in all the examined characteristics. Specifically, more than 96% of respondents perceived wood products as environmentally friendly, 91% as aesthetic, 85% as recyclable, 80% as creating mental well-being, 65% as safe for disposal, and 80% of respondents agree that the products from wood come from renewable sources.

Table 1. Statistically significant differences in answers

Questions	Pearson chi-square			Pearson contigency	Cramer's V	Effect size*
	Chi-square	df	p			
Gender versus recyclability	7.585860	df=2	p=.02253	.1538262	.1556791	small
Gender versus mental well-being	6.551295	df=2	p=.03779	.1431836	.1446743	small
Residence versus recyclability	9.949314	df=2	p=.00691	.1755211	.1782889	small
Residence versus mental well-being	16.69462	df=2	p=.00024	.2250258	.2309490	medium
Residence versus origin from renewable resources	8.244474	df=2	p=.01621	.1602004	.1622966	small

*Effect size for chi-square test, Cramers's V and its interpretation is based on Cohen (1988).

Table 1 shows the statistically significant results that were found in the analysis of the dependence between the demographic data of the respondents and the options offered in the analysed question. Based on the results of the contingency coefficient and Cramer V, we can say that the found dependencies are statistically significant at the level of $p < 0.05$, but they are weak with one exception. Significant differences are between men and women. Here, higher share of men perceive wood as a recyclable material and claimed that wood contribute to better mental well-being. Significant differences were also identified between respondents of different residence. Higher share of residents from an urban areas perceived wood products as recyclable compared to those from rural areas (alsmost 17% do not perceived wood products as recyclable). Conversely, almost 22% of urban residents do not perceive wood as a material that creates mental well-being - compared to 6.4% of rural respondents. Also, almost 21% (!) of the respondents from the urban areas disagreed with the statement that wood products come from renewable resources. We are aware of the fact that the survey was not representative hence it would be necessary in further research to employ the sample representing overall population to get a full picture on the studied issue. Nevertheless, our study provides interesting insight into the field, revealing overally prevailing positive perception of consumers on wood products together with identification of negative perceptions that should be further eliminated.

4. COCLUSIONS

Most respondents evaluated wood products positively in all the examined characteristics. The largest share of negative attitudes (25%) was reported by respondents when claiming whether wood products are safe to dispose of. Up to 14% of respondents think that wood products do not come from renewable sources and at the same time 12% do not consider them recyclable. In the current information society, this is a relatively high share also considering the demographic composition of the sample. It is obvious that in this direction it is necessary to set up awareness and educate the public from the position of all stakeholders who care about the development of the wood products market. The renewable nature of the source (wood as a material) from which such products come must be clearly declared since wood products are not perceived positively in the minds of part of the public in terms of disposal and recyclability. It is appropriate to fully develop this topic in connection with the development of the concept of circular economy, in which the forest-based sector, given the uniqueness of the processed material, has the appropriate prerequisites to excel. Regarding sustainability, paper products and furniture are positively perceived by public. Kaputa et al. (2017) pointed to paper products as preferred in the portfolio of substitute products for their highly perceived environment-friendly properties. Jošt et al. (2020) compared changes in time in users' preferences for furniture in Slovenia and stated that significance of environmental attributes increased considerably. It is noteworthy that in the case of wooden houses, despite their undeniable uniqueness, the public does not perceive their environmental properties as a significant positive (Kaputa et al., 2019, Olšiaková et al., 2018).

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POSITIVE EFFECTS OF THE FOREST ON THE HUMAN ORGANISM IN THE CONTEXT OF ECOLOGICAL INNOVATIONS AND MODERN MEDICINE

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Abstract: Forests produce and excrete biologically active substances into their surroundings, which can have a beneficial effect on humans. Recently, much attention has also been paid to the management of innovations that are close to nature (so-called eco-innovations). Within this issue, innovation management focuses not only on business models, but also on segmentation models of consumers, in which it identifies consumers who have a positive attitude towards nature and natural products and lifestyle associated with nature. Recreational use of forests significantly helps to regenerate the physical and mental strength of a man and thus begins to play an important role in modern medicine. Active forms of movement in the forest reduce the risk of various diseases of civilization. Therefore, in this article we will focus on the positive effects of the forest on the human body from the point of view of ecological innovation and medicine.
Key words: effects of the forest, ecological innovation, nursing.

1. INTRODUCTION

"Sometimes a simple walk in woodlands, where you're surrounded by the echoes of calling birds, and that satisfying crunch of fallen leaves and twigs underfoot, is the perfect remedy for reducing stress."

Patrick Begg

In many countries of the world, original inhabitants still use forests to provide for basic livelihood needs, including food and medicine. Experiences livelihood during centuries of experience make people to be able to find everything they need for their lives in the forest. It is estimated that there are about 7,000 different species of plants on the Earth that directly serve as a food source, not to mention thousands more, which have demonstrable healing effects and are widely used in modern medicine, not only in traditional folk healing. Various parts of trees and plants such as bark, roots, leaves are used in remedies or medicinal products production. Many of the medicinal species of plants and trees can be found in forests.

Forests also produce and excrete biologically active substances into their surroundings, the so-called Phytoncides that can have a beneficial effect on humans and negatively on germs (microorganisms) because they support - inhibit the growth of bacteria and protozoa. While urban air in summer contains an average of 36,000 pathogenic bacteria in 1 m3 of air, only about 500 bacteria are present in the same volume in the forest. One hectare of deciduous forests gives off an average of 2 kg of volatile organic compounds in 24 hours. One hectare of coniferous forest in the same time gives off about 5 kg of these substances, but juniper forest up to 30 kg.

The hygienic impact of forests is also conditioned by the healing of the air (forests "trap" pollutants from the air and thus reduce the level of air contamination) and the impact on other physical factors favourable to humans. Any forest generally affects the movement of air in its surroundings and thus also affects the movement of impurities. Solid pollutants (dust, ash, etc.) sediment by damping the air flow and are trapped on vegetation organs. Aerosol and gaseous impurities are partially absorbed by vegetation or raised by turbulence into the upper layers of the atmosphere, where their concentration decreases or is completely eliminated.

Forests also have a positive effect on the horizontal spread of noise. Woods have very good sound insulation properties, which depend on the intensity of noise, the composition of the forest vegetation, its height, width and density. Forests create strong absorbing barriers that convert noise into kinetic energy by resonance of thin plant parts (leaves, needles). Forest stands, by being high, reflect and disperse annoying frequencies better than deep ones, they act as an effective filter. In addition to the sound-insulating ability, the noise of the leaves, the singing of birds and a variegated mosaic of colours and shapes, which are typical for the forest and which change depending on the season and the forest composition (deciduous, coniferous, mixed) also have a very positive effect on the human psyche.

Of course, forests are also a major producer of oxygen. A hundred-year-old beech with a leaf area of 1,600 m2 produces 17 kg of oxygen per hour, thus ensuring the annual consumption of ten people. One hectare of vegetation, depending on the type of vegetation, habitat conditions and other environmental factors, produces an average of 900 kg of CO_2 and 650 kg of O_2 in 24 hours.

Recreational use of forests significantly helps to regenerate the physical and mental strength of a man. Active forms of movement in the forest reduce the risk of various diseases of civilization (FP, 2021; Bartošovičová, 2016). Therefore, in this article we focus on the positive effects of the forest on the human body in terms of eco-innovation and medicine.

2. ECOLOGICAL INNOVATION IN THE CONTEXT OF ENVIRONMENTAL SEGMENTATION MODELS AND HEALTH LIFESTYLE

In recent years, from the point of view of management, a great attention is paid to innovations and their ecological variants with respect to the various segmentation models. Lešková (2009) presents that ecological innovations reduce the demands on materials, use closed material flows and create or use new materials. At the same time, they focus on reducing energy intensity and create or alternative energy sources. They also reduce overall emissions or existing environmental burdens and health risks, while supporting the whole idea of a healthy lifestyle and sustainable consumption (Kollár, Brokeš, 2005; Loučanová, 2016; Zuraidah, et al. 2012; Loučanová, Nosáľová, 2020). In 2010, Harvard Business Press organization when monitoring ecological consumers over the last twenty years has found that companies can classify consumers into four groups. Of course, there is some overlap among these groups (figure 1).

Figure 1. Segment green consumers
Source: Ottman, 2010

“Resource Conservators“ hate waste. They wear classic or old-style clothing, recycled material and try to avoid wasting resources. They read news online to save the trees. They install low-flow shower heads and compact fluorescent lamps marked EPA Energy Star and WaterSense. They avoid over-packaged products, they turn on the lights only when they are needed, they connect appliances to the distribution boards so that they can be easily switched off.

“Animal Lovers“ are probably vegetarians or vegans, they belong to the group of People for the Ethical Treatment of Animals (PETA). They look for products marked as "without cruelty". They look for synthetic handbags and faux furs and prefer faux meat options in restaurants. They avoid plastic bags to protect marine life.

“Health Fanatics“ they are afraid of excessive sun exposure, they are afraid of pesticide residues on the products, they look for products marked as "USDA Organic" (in the USA) or with the EPA logo. They are willing to pay more money for organic food and safe products.

“Outdoor Enthusiasts“ they spend their free time camping, climbing, skiing and hiking. They plan holidays in national parks with tips from Outdoors Magazine. When shopping they look for FSC products (from sustainable sources), they are also likely to buy outdoor equipment made from recycled materials (Ottman, 2010; Loučanová et al., 2015; 2021). They try to minimize the impact of their recreational activities.

In Slovakia, there have been created several ecological innovation projects linking forest, nature and recreation in nature, such as apihouses (Figure 2). Peace, relaxation and contact with nature in its most natural form, which is offered in the kind of bee families. Apihouses are non-traditional accommodation where you can enjoy peace of mind and touch the life of nature and ourselves. Wooden apihouse - apiary is intended for everyone who is interested in alternative ways to health.

The air in the apiary contains high temperature, essential oils, liquid waxes, aerosols of flavonoids and propolis, trace elements, enzymes, choline, plant hormones produced by bees and a temperature of around 36°C. Breathing is the simplest and most natural way to get effective substance into blood circulation very quickly. Good results are achieved in the treatment of various diseases, such as weakened immune system, problems with blood pressure, allergies or asthma, eczema, but especially in diseases caused by stress (O.Z.Štiavnické vrchy, 2021; Loučanová, Olšiaková, 2020).

Figure 2. Apihouses – Uhliská - Slovakia
Source: O.Z. Štiavnica Mountains, 2021

Apihouses present one of many ecological innovative projects connecting forest, nature and a healthy lifestyle, which improves people's health by staying in the forest.

3. POSITIVE EFFECTS OF THE FOREST ON THE HUMAN ORGANISM AND MODERN MEDICINE

Scientists have recently studied the positive effects of the forest on the human body. Forest sounds, such as birds singing or leaf rustling, have positive effects on people's psyches.

In Japan, a stay in nature is also called a "forest bath" and it is considered to be a type of preventive health care. Forest wellness, which is essentially time spent among the trees, became part of Japan's national public health program in 1982. Japan is a world leader in "forest medicine" medical research, which has been applying for over 20 years and the state is investing a lot of money in it. During that time, they tested hundreds of volunteers. They provide some interesting findings, e. g. forest wellness significantly increases activity and number of NK cells („natural killer" cells, which increase the ability to recognize and destroy especially tumour cells and virus-infected cells) in the human body. The subjects also had increased numbers of intracellular antitumor proteins, and there were lower levels of stress-related adrenaline and noradrenaline in their urine.

Half an hour in the forest:

- increases innate immunity,
- reduces the level of stress hormones,
- lowers blood pressure, slows the pulse,
- has an antidepressant effect, reduces anxiety,
- charges with energy.

As Japanese research shows, trees decrease the anxiety, anger, fatigue, and confusion scores and they increase the mental energy score. According to experts, this indicates the preventive effect of the forest bath not only against civilization diseases caused mainly by stress, but also against depression.

In California, the private Association of Natural and Forest Therapy was founded five years ago. It has branches with certified forest spa therapists in Europe and Australia. Some Australian and New Zealand doctors, who appreciate the healing power of nature, have already begun to prescribe "green prescriptions" instead of traditional medicines and send people more outside (Paľovčíková, 2017, Loučanová et al., 2017).

A walk in the forest is an ideal solution to relieve stress and forget about everyday problems.

The study participants found themselves in three situations. They found themselves in the forest with a woman leading a meditation exercise, and in a room where there was complete silence. They came to the conclusion that relaxation in the forest is the most ideal solution. People felt 30 % more relaxed, they felt lower stress and anxiety. Similarly, research by the National Trust found that birdsong and rustling leaves increase relaxation by 30 %.

When people were asked to listen to forest sounds for one minute, people felt 30 % more relaxed while stress and anxiety subsided. Nothing has changed in the field of relaxation that people felt after listening to meditation or silence.

We constantly spend time at work, at the computer, on social networks, but somehow, we forget about exercise and our health. According to a study by the National Trust, up to one-fifth of people have never gone for a walk in the forest.

The aim of the National Trust's research was to find out the impact of the forest on people and to point out that people go more into nature because we live in a hectic time. "In the forest you can hear the noise of leaves, the singing of birds or the crackling twigs underfoot. A walk is the best solution to relieve stress."

Much of this research has focused on visual experiences, but recent work has shown that outdoor sounds, such as birdsong, wind and water, can also improve mood and reduce stress. These sounds offer a way to connect with nature no matter where you are (e.g. Nature around the lake in Uhliská in Slovakia presented in Figure 3).

Figure 3. Nature around the lake – Uhliská - Slovakia
Source: Haraba, Loučanová, 2020

Much of this research has focused on visual experiences, but recent work has shown that outdoor sounds, such as birdsong, wind and water, can also improve mood and reduce stress. These sounds offer a way to connect with nature no matter where you are.

To measure the impact of the forest on humans, they used a system called mental chronometry, in which reaction times are used to assess how strongly people respond to various stimuli. When they were asked to relax with the sound of forests for one minute, people said they felt 30 % more relaxed, 25 % less stressed and 20 % less anxious.

However, the study warns of various explanations of the results:

- Some results are psycho-evolutionary. It means we are adapted to be in a natural environment such as forests.
- It can also be a cultural association, so we combine the journey into nature with the opportunity to relax. If we can hear these sounds, it reminds us that we are in a relaxing place, even when we are in the laboratory.
- In addition, people may associate similar sounds with active self-help.

Psychologist Eleanor Ratcliffe explains that time spent in nature is beneficial for health and recovery from everyday stress, noting that she does not want to give the impression that time in the forest solves all problems.

Forestry England has collected data and pointed out that a visit to the forest can improve people's mood or attention, it is also beneficial in mental recovery (Figure 4). The walk also reduces the level of cortisol, a hormone that is associated with stress (Pacigová, 2019; Olšiaková et al, 2017).

Figure 4. A walk in the woods of the participants of the 7th International Scientific Conference Position and Role of the Forest Based Sector in the Green Economy WOODEMA 2014 – Lesnícky skanzem – Čierny balog - Vydrova dolina – Slovakia
Source: Woodema, 2014

However, it is important to realize that when we go into nature, our mood improves, we reduce stress, but it will does not solve all our problems.

4. CONCLUSION

The article based on the applied researches, describes the positive impact of the forest on the human body used in modern medicine. We also explained segmentation models of customers who have a positive attitude towards a healthy lifestyle and living in nature. In addition to the above facts, the connection of this knowledge of the positive effects of the forest on the human body and modern medicine creates new potentially ecological innovative business projects such as Apihouses applied in Slovakia. At the same time, it creates great potential for other business models that combine this knowledge and create promising eco-innovation projects that take into account a healthy lifestyle in harmony with nature and forest.

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SOCIO-ECONOMIC CHARACTERISTICS OF POTENTIAL CUSTOMERS OF WOODEN BUILDINGS IN SLOVAKIA

Marek Potkány, Monika Škultétyová, Lucia Krajčírová

Abstract: The paper presents the results of primary survey on the sample of 802 respondents. The aim of the survey is to determine the Slovak customers´ level of awareness and user preferences of wooden buildings in relation to family houses construction based on wood. The results point not only to the basic socio-economic characteristics of customers but also to the identification of disadvantages that cause lower share of wood-based buildings construction in the market.
Keywords: wood-base building, advantages of wood-base buildings, disadvantages of wood-base buildings, preferences

1. INTRODUCTION

From earliest recorded time wood has made it possible to create values that satisfy basic human needs. One of them is the need for housing. In the meantime, wood, has become secondary building material and has been replaced by new, more progressive technologies (Potkány et al., 2019). Reduction of energy consumption, together with reduction of greenhouse gas emissions and efficient resource management has become the focus of environmental protection. Construction industry is the key area for achievement of energy and environmental goals which the European Union is determined to fulfil by 2050. The largest consumers of energy are buildings, by their energy performance. Directive of the European Parliament and of the Council (2010) declares that buildings are responsible for almost 40% of total energy consumption in the European Union and for more than one third (36%) of greenhouse gas emissions. From 1st January 2021 all new buildings will have to meet the conditions of energy class A0, according to requirements of the Directive. This regulation also applies to households sector, which has a great potential for reduction of energy consumption, as the Vögele et al. (2017) states. Besides the energy efficiency, we should also focus our attention to increasing the number of buildings that meet the condition of using sustainable and easily recyclable materials. State activities should be aimed at support of wood-based constructions, which shift construction sector closer to the green buildings. Wooden buildings have undergone long development and now are truly an equal partners of classic brick buildings. In many ways they show even better performance. Such arguments were presented in studies focused on LCA analysis (Mitterpach and Štefko, 2016; Hafner and Schäfer, 2017). Wood-based products are in comparison with other materials produced in low-energy production process with minimal emissions. The use of wood in various industries, especially in construction sector, appears to be very interesting and perspective solution in terms of both design and environmental performance. Following the current energy efficiency trends of buildings, the effort of environmental impact minimization of buildings also occurs in construction sector (Sedlák et al., 2019). The main aim of this contribution is to present the results of primary survey about awareness level and user preferences of wood-based buildings of Slovak customers.

2. MATERIAL AND METHODS

The demand technique has been used for the purpose of primary quantitative survey. The "online" questionnaire was chosen as the survey tool. This survey was conducted in the period from February 2019 to April 2019. Its aim was to ascertain the awareness of wood-based buildings and customer preferences in the field of family houses constructions based on wood. Slovak citizens older than 18 years were the target group.

On the basis of selected socio-demographic data a specific group of respondents in the age of 26 – 50 years (802 respondents) was analysed. This is the most productive group, so it can be logically assumed to have the greatest interest in construction of a family house, and it can also be anticipated to fulfil this idea. In addition to basic demographic and economic-social characteristics of respondents, the survey also looked at the interest in wood-based buildings constructions and at the level of awareness in combination with the perception's identification of potential advantages and disadvantages of wood-based buildings. A specifically focused question tried to asses 7 potential benefits of wood-based building for its user (Which of the following advantages would you consider to be the most important?). Other question tried to asses 7 myths forming the negative attitude toward wood-based buildings (Which of the myths would invoke your greatest concerns?). The possible options were selected on the basis of information analysis published on various websites of Slovak and also foreign producers. In questionnaire respondents were asked to rank the offered options at preference level from 1 to 7. In order to fulfil the purpose of the research and the aim of the work, following research question and related working hypotheses were defined:

Research question (RQ1): What is the interest and the awareness of wood-based buildings constructions possibilities and of their benefits to potential Slovak customers?

Working hypothesis (WH1): The most perceived benefits according to potential customers of wood-based buildings include healthy indoor climate and short construction time.

Working hypothesis (WH2): The most perceived disadvantages according to potential customers of wood-based buildings include low fire resistance and low resistance to natural disasters.

The reasonings were the results of the authors' studies (Maťová and Kaputa, 2018; Lenoch and Hlaváčková, 2015) and also the short pre-survey of the most common arguments in favour of wood-based buildings and their risks reported by Slovak wood-based buildings producers through published information on their web portals. The evaluation of individual data was carried out through the STATISTICA program 12. For the presentation of data, the quartile box chart was used, in which it is possible to observe the layout of measured data in the selection file indicating certain trends.

3. RESULTS

For the specific target group of respondents in the age of 26 – 50 years, the total of 802 responses were analysed. Out of this number, 546 respondents (68%) chose the option of classic brick building and 256 respondents (32%) chose the alternative of wood-based building. This share is point, but unreliable, estimation of potential customers fraction in the analysed target group population. Therefore, we further focused on the calculation of a 95% confidence interval (Tab. 1). Based on interval estimation we can conclude that from 55% to 81% of the analysed population would prefer the construction of classic brick building.

Table 1. The absolute and relative frequencies summary according to the construction type

	Absolute frequency	Relative frequency (Point estimation)	Interval estimation 95%	
			Lower limit	Upper limit
Wood-based house	256	31.92%	19.07%	44.93%
Brick house	546	68.08%	55.07%	80.93%
Total	802	100.00%	-	-

Source: Own study

The test results confirm the assumption of lower interest in wood-based buildings compared to brick buildings from the point of view of potential investors. However, if we compare the fact that current share of realized wood-based buildings in Slovakia is at the level of 7 – 10% of the total number of building constructions, we get to an interesting finding. With the usage of 95% confidence interval, the construction of a family house as wood-based building would be preferred by the range of 19% to 45% of potential interestors. For this segment this is still very interesting value, as it represents huge potential to reach Slovak customers in the target group of 26 – 50 years. Although potential interest in the realization of wood-based buildings is considerable, it is still necessary to focus on identifying the reasons for the current dominance of classical masonry buildings constructions. One of these is low general awareness level of the possibilities of wood-based housing (Fig. 1).

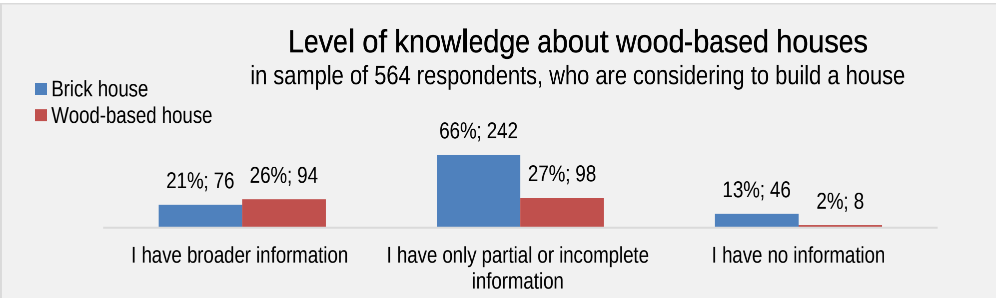
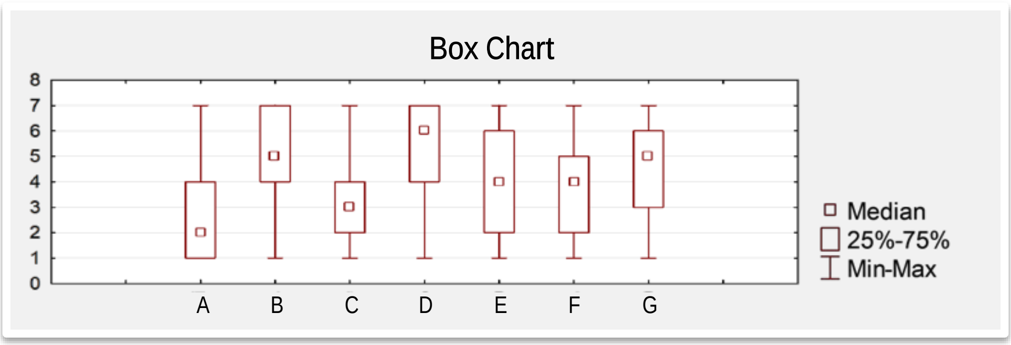


Figure 1. Level of knowledge about wood-based houses of respondents, who showed interest in house building
Source: Own study

Up to 79% of those respondents, who are really considering the construction of classic brick family house (364 respondents), have no or only partial information about wood-based buildings (Fig. 1). The probable reason is low information level about benefits and potential effects of wood-based houses offered by producers of wood-based houses alone. Only 76 of our respondents have broader information about wood-based houses, and nonetheless they took a negative stance and still prefer brick building. The causes of this negative stance might be mainly still persistent concerns about the wood-based houses building risks. These were presented in work of Östman et al. (2017), Draghici and Maican (2018).

The question about the possible wood-based houses benefits was connected with working hypothesis (WH1). Based on the analyzed responses regarding the preferences in perception of the advantages of wood-based buildings, we observe that the distribution of measured data in selection file (Fig. 2) indicates certain trends onwards. Basically, 50% of respondents attributed the first or second place in the hypothetical ranking of benefits to the excellent thermal insulation properties. The half of the respondents identified lower operating costs by ranking place 1 – 3. In both cases (as opposed to the other options), up to 75% of respondents placed these two benefits at ranking place 4 or below. In contrast, 50% of respondents placed considered healthy inner microclimate and short construction time at ranking place 4 or below. The test results confirmed significant differences (p = 0.000) in how potential customers perceive these options associated with benefits of wood-based buildings. Excellent thermal insulation properties are considered by respondents as the greatest advantage. Lower operating costs for heating were identified as the second best advantage and the third was healthy microclimate. The WH1 has not been confirmed.



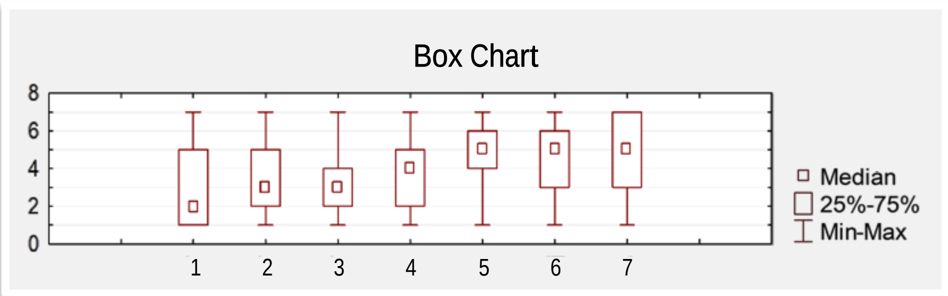
*Excellent thermal insulation properties (A), Acoustic comfort (B), Lower operating costs for heating (C), Useful floor area larger by 10% (D), Short construction time (approx. 3 – 4 months) (E), Healthy indoor microclimate (F), Ecology (Usage of natural materials) (G)

Figure 2. Box chart of preferences in potential advantages of wood-based house
Source: Own study

In previous statements we answered the individual parts of the defined research question RQ1. For more comprehensive understanding of the awareness, we will complement the research question with data on knowledge of Slovak wood-based houses producers.

The results of our survey on total sample of 1,228 respondents of all ages show that awareness of producers operating in wood-based construction industry is in Slovak business environment relatively low. When asked, if the respondent knows and could name certain producer, only 20% of respondents answered positively. Up to 80% respondents were unable to name any of them.

In accordance with the working hypothesis (PH2) the survey focused also at the ascertaining of the most significant disadvantages. Based on the data distribution (Fig. 3) we observed that up to half of all respondents attributed the short service life to the 1st or 2nd place in the individual disadvantages ranking. Up to 75% of respondents chose the rank 4 or lower because of the low fire resistance reason. The analysis carried out by level of significance of 0.05 revealed statistically significant differences (p = 0.000) in how potential customers perceive the possibilities associated with wood-based buildings disadvantages. The respondents expressed the greatest concern of the short service life. By the construction of a family house, the investor intends to invest in some future value. So it is only natural that he requires some guarantee of return of capital in case the house will be later sold. As the second most seriously perceived potential risk of wood-based houses the low fire resistance was evaluated as we also expected, with the second smallest value in the average rankingThe other identified perceptions of disadvantages showed the order of concerns of maintenance demand and increased demand for care, as well as low resistance to natural disasters. The risk of damage by rodents and wood-destroying insects, together with the possible high humidity causing the spread of wet rot, dry rot and bacteria, are the challenge for wood-based building producers. Producers themselves are the ones who should focus on presenting the clear arguments that negate mentioned concerns. The results presented by us in the search for answers has not confirmed WH2, corresponding to the conclusions of Maťová and Kaputa (2018), who in their study confirmed the persistent distrust of wood-based structures in Slovakia. They consider low fire resistance, short service life and low weather resistance as the worst perceived characteristics of wood.



* Short service life (1), Maintenance demand and increased demand for care (2), Low fire resistance (3), Low resistance to natural disasters (4), Extreme overheating in summer/rapid cooling in winter (5), Risk of damage from rodents and wood-destroying insects (6), High humidity (spread of wet rot, dry rot and bacteria) (7)

Figure 3. Box chart of preferences in potential disadvantages of wood-based house
Source: Own study

4. SUMMARY

The paper presents the results of primary research about the level of awareness and user preferences in wood-based houses on the sample of 802 respondents. The test results confirmed our assumption, that the interest in wood-based houses from the perspective of potential investors is lower than in the case of brick houses. One of the reasons is the low level of general awareness of the possibilities of wood-based houses construction, as well as still prevalent concerns associated with their construction. Excellent thermal insulation properties, associated with lower operating costs and healthy internal microclimate, are considered by respondents to be the greatest wood-based house advantage. The biggest concerns expressed by the respondents were of the short service life of the wood-based houses and their low fire resistance. Identified disadvantages are typical concerns encountered by most producers of wood-based houses in communication with potential customers and are often part of the discussion forums dealing with the topic. These concerns are relatively easily technically rebuttable by various executed studies, experience and already done research (Štefko, 2014; Bedon and Fragiacomo, 2019; Wang et al., 2018). The problem however remains in the form of their presentation to the general public. In order to increase the share of wood-based houses in the market, the producers themselves of such structures should be particularly proactive.

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GREEN CONSUMPTION BEHAVIOUR WITH EMPHASIS ON WOOD-BASED PRODUCTS IN SLOVAKIA

Alena Rokonalová, Marek Hlodák, Katarína Slašťanová, Nikola Slašťanová, Ján Parobek, Hubert Paluš

Abstract The recent years have witnessed a phenomenal change in quantum and pattern of consumption all over the world. Ever increasing consumption leads to the increasing pressure on the environment. Forests are considered to be renewable natural resource capable of providing several major and minor forest products. Using wood-based items rather than non-wood alternatives reduce an environmental footprint. This study investigates into understanding the relationship between the environmental concerns and consumer choice behaviour. The aim of the research is to evaluate the consumer shopping preferences in terms of the principles of the green economy. The survey was carried out using an online questionnaire. The first part focused on examination how demographic data, such as income and education, determine the impact on purchasing decisions. Results identified that young people are more willing to pay more when buying environmentally friendly products. Finally, it can be concluded that the principles of the green economy as a tool for sustainable development are increasingly influencing the shopping behaviour of final consumers.
Keywords: green economy, green consumption behaviour, sustainable development

1. INTRODUCTION

In the last decades, production and consumption of goods and services has increased rapidly. The associated destruction of the environment and the large amount of waste have become a serious issue. However, a healthy lifestyle, increased interest in environmentally friendly products and sustainable consumption are one of the major trends nowadays. We are living in a society where ethical values, social responsibility and their financial results play an important role in image of the company. As people's awareness about global warming and climate change grows, consumers expect companies to act on their understanding towards the environment (Kasliwal and Agarwal, 2017).

Many individuals and companies have identified with the concept of a green economy, which reflects strong interconnections with the economic growth and protection of the environment. UNEP (2012) defines a green economy as “one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities. In its simplest expression, a green economy can be thought of as one which is low carbon, resource efficient and socially inclusive”.

More and more companies are focused on changing their production strategies to actively respond to environmental issues and changes in consumer attitudes to the environment. On the other hand, although manufacturers produce environmentally friendly products, there are still barriers to their sales. Many consumers are not interested in such production due to higher prices, lack of awareness or reluctance to change their consumer behaviour (Jung et al., 2020). Therefore, it is of great practical importance to evaluate the consumer shopping preferences in terms of the green economy principles. Consumer behaviour means choosing a product with characteristics that meet the consumer's needs. The change in consumer behaviour from egocentrism to eco-centrism is linked to growing environmental awareness and a willingness to put emphasis on the environment, quality and health (Bryła, 2019). The forest industry can

make a significant contribution to the concept of a green economy in context of tackling global environmental challenges such as rising carbon dioxide concentrations and related climate changes. Therefore, it has the potential to become a leader in the production of environmentally friendly "green" products.
The main aim of this study is to evaluate the consumer shopping preferences in terms of the principles of a green economy.

2. METHODOLOGY

The research was carried out using the questionnaire survey as the most common tool for data collection. The questionnaire consists of a series of questions where the goal is to get an opinion from the respondents. The preparatory phase of each questionnaire survey is crucial, it is necessary to define the statistical unit as the object of the survey, determine the size and structure of the research sample, scope and exact definition of monitored characteristics, decide on the form and data collection technique (Terek, 2019). The specific aim of this research was is to examine the relationship between the respondent's age as one of the demographic factors, and purchasing decisions in green economy context.
The methodological approach of the research was as follows:

- Compilation of the questionnaire: The questionnaire consisted of 3 parts – the first was focused on demographic data, the second examined how the respondent understands the concept of the green economy and environmentally friendly products and the last part was focused on short-term consumption patterns and long-term investments.
- Collecting the data: Setting a minimum sample of respondents. The questions were closed-ended and using the Likert scale respondent had the opportunity to express their agreement or disagreement with the statement on a five-point scale where 1 means agreement and 5 disagreement.
- Processing the data: The database of answers were processed in the statistical software SPSS. Using the descriptive statistics; namely frequency analysis, the percentages of responses to individual questions were evaluated.
- Analysing the impact of age: The statistical significance of the influence of age as independent demographic factor on individual responses was tested using statistical method X^2 (Chi square), where a 95% confidence level and at the level of significance alpha (p) = 0.05 were applied. The Chi Square statistic is commonly used for testing relationships between categorical variables (Hui et al., 2008). Selected interdependencies between variables were tested and the extent to which they interacted was determined. In order to comply with all conditions for the application of the test, it was necessary to adjust the Likert five-point scale to a three-point scale, where 2 means neutral, 1 agree and 3 disagreement. Data obtained were incorporated into contingency tables.
- Evaluating of the influence of the respondent's age on individual attitudes of respondents.

3. RESULTS AND DISCUSSION

The growing environmental awareness has influenced shopping behaviour and led to an increase in the consumption of environmentally friendly products (Darnall, 2008; Perrini et al., 2009). According to Peattlie (1999), consumers' purchasing decisions can either be interconnected and linked to common values or are the result of specific situations and are not interrelated. The identification of the increasing awareness about environmental protection, as well as the principles that create well-being from a global perspective, was carried out through a questionnaire survey on a research sample. Consumer shopping preferences in terms of the principles of a green economy were evaluated using descriptive statistics. Through frequency analysis, we obtained data on the percentage of answers to individual questions. In the survey there were 102 respondents participating, the majority were men (70.60%). The age distribution of surveyed respondents is shown in Figure 1 below.

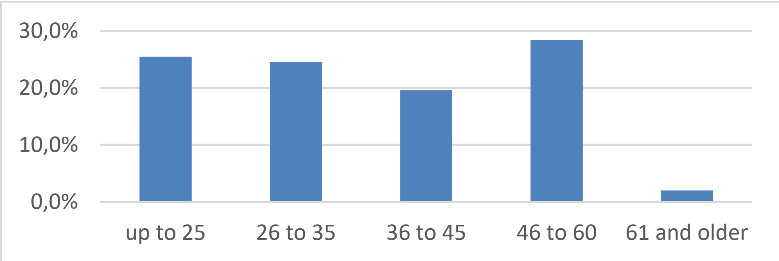

Figure 1. Age distribution of respondents (%)

In relation with green purchase behaviour, it is important to point out the education level. The higher education level is usually connected with higher knowledge, which is consequently reflected into shopping behaviour (Witek and Kuzniar, 2021). Several studies have confirmed the positive impact of education on green shopping behaviour (Leonard-Barton, 1981; Chan, 1996; do Paco et al., 2009; Akehurst et al., 2012; Wang, 2014; Chekima et al., 2016). In our research, more than half of the respondents were university graduates.

Respondents' knowledge of specific principles of green economy were identified using the Likert 5-point scale. Based on the data obtained, it can be stated that the addressed respondents have average to higher knowledge in this area and especially young generation is familiar with the concept of green economy. Only about 10% of respondents do not understand the term of green economy. The term environmentally friendly product is understood by just over 40% of respondents.

The analysis of the respondents' short-term shopping behaviour trends was focused mainly on food, recycling of goods and packaging and transport. At average, approached respondents place less importance on the price, quality of products and services than on their environmental impact. An example is the opinion of almost 60% of respondents accepting the charge for plastic bags. The opposite of green behaviour is the preference of cars over public transport or bicycle, which represent 50% of respondents' agreement. Preferences for long-term investments, such as housing and furniture, are represented by 60% of respondents preferring sustainable solutions. Therefore, it can be stated that the concept of green economy affects consumers' shopping behaviour.

After identifying general awareness of the green economy concept, short-term and long-term green consumption behaviour, the research focused on analysing the impact of respondents' age on their purchasing decisions. As stated in the methodology, data were analysed by applying chi square test and were incorporated into contingency table. Revealed statistically significant responses are shown in Table 1. All other questions were tested but either did not meet the significance level condition or more than 20% of the cells had a frequency of less than 5 answers. Therefore, they were not considered statistically significant.

In accordance with the average replies to the individual questions in Table 1, it is clear that positive replies were recorded the most to the statement "I am willing to pay 10% more for the use of energy from renewable sources". According to the data, respondents under 25 years are more willing to pay extra 10% for long-term consumption than the other age groups. Simultaneously, the largest number of positive replies was recorded among respondents under 25 years when asked whether they focus only on price and quality in long-term investments. We can conclude that among young people there are also responses that are in conflict with the principles of environmental behaviour. This contradiction can be justified by the fact that respondents under the age of 25 usually do not have their own source of income and therefore pay more attention to the costs, quality and characteristics of products (Zhang and Dong, 2020).

Tab 1. The effect of age on cumulative responses

	Average	Chi^2	df	p
Green economy affects resource efficiency	2.392	11.549	4	0.021
I am influenced by the factor of possibility to contribute to the protection of the environment	2.333	16.793	4	0.002
I invests in renewable materials in housing	2.323	11.985	4	0.017
I prefer wooden windows	2.362	10.464	4	0.033
I focus only on price and quality	2.598	10.280	4	0.036
I prefer green furniture	2.460	9.663	4	0.047
I am willing to pay 10% more for the use of energy from renewable sources	2.264	12.063	4	0.017

df – degree of freedom, p = 0.05

Older people were rather neutral or disagreed with the issues related to the extra charge for environmentally friendly solutions. Also, respondents aged over 60 did not agree with the charging of plastic bags. However, when considering short-term consumption of environmentally friendly products, the factor of the possibility to contribute to the environment protection influences the most respondents in the age category from 41 to 60 years.

Likewise, Akehurst et al. (2012) point out that younger people are more sensitive to sustainable development issues. However, the positive attitude towards the green purchase and the willingness to pay higher prices will not be reflected in a higher frequency of purchases (Witek and Kuzniar, 2021). The results of our research contradict the study of Xu el al. (2020) who points out that age does not affect the consumer's intention to buy green furniture. Young people are aware of the environmental issues, have sufficient information in this area and positive perception and preferences for sustainable shopping. On the other hand, regarding to willingness to pay, the consumers tend to back down and prefer to meet other than environmental needs (Kasliwal and Agarwal, 2017; Chan and Lau, 2000; Park et al., 1994). Hence, in green purchases business, companies should be oriented on targeting the segment of consumers that includes working-age people who have considerable purchasing power. Better understanding of green purchase behaviour may support effective promotional campaign of green products in the future.

4. CONCLUSION

The green economy principles as a tool for sustainable development are increasingly influencing the purchasing behaviour of final consumers. The research identified an increase in environmental awareness, which is focused on the field of environmental protection as well as on the principles that create prosperity and well-being from a global perspective. The purchasing behaviour of Slovak consumers, with an emphasis on the green economy principles, is focused on the possibility of recycling the product or its packaging, the country of origin and the health of the population. Compared to other age groups, respondents under the age of 25 are willing to pay more especially for long-term consumption related to investment in green furniture and renewable resources in housing. In green consumption patterns, an important role is played by the wood as a renewable natural resource. Using wood can lead to reducing or completely avoiding of non-renewable materials in consumption.

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A STUDY OF HOTELS' MANAGERS AND TOURISTS' ATTITUDES REGARDING THE USE OF FURNITURE WITH HIDDEN COMPARTMENTS BY HOTELS IN BULGARIAN BLACK SEA AND MOUNTAIN RESORTS

Daniela Ventsislavova Georgieva

Abstract: Among the main threats facing the tourism sector are crimes, terrorism, and robberies. Researchers in the field state that hotel managers and even tourists themselves are refraining from submitting crime signals. In this respect, one of the main goals of the hotel's management is to assure enough conditions to the guests to make them feel safe and secure in the hotel facilities. For that purpose, except the commonly used security devices, it is possible specially designed furniture with hidden compartments, where the guests to hide their valuables, to be placed in the hotel rooms. Such furniture are already used in the USA but there is no data or previous researches in the field regarding their use in Bulgaria. The main goal of the study is to present data from survey results of the opinions of hotel managers and tourists regarding the effectiveness and the future use of such furniture. The collection of data among hotel managers is based on the case study method. The survey among tourists is based on the questionnaires distributed on the spot. The study of statistical relationships and dependencies is based on the Chi-square test. The findings of the study show mixed reactions by the tourists even though the majority would use furniture with hidden compartments. Managers however do not see any benefits (financial or marketing) from it. The presented results are part of wider questionaries' and data collected under the project "Model Development and Testing for Monitoring and Evaluation of Sustainable Tourism Development in Bulgaria (after the example of national resorts)" financed by the National Science Fund, contract No КП06-Н25/3 from 13.12.2018.
Keywords: hotels' furniture, hidden compartments, case study, questionnaires.

1. INTRODUCTION AND STATE OF THE PROBLEM

One of the main strengths of Bulgaria as a tourist destination is the relatively high level of security (NSSDTRB 2014-2030, p.75). According to data from the National Statistical Institute (NSI) the total number of crimes under the Criminal Code in 2019 is 30,276 (24,962 of which have ended with a sentence). Nearly 17% of the registered cases are crimes against property, and nearly 43% are general dangerous crimes (Penal code, chapter 11). Due to their specific activities, hotels are part of the stakeholders involved in the process of ensuring the safety of tourists and their belongings. The main security risks in hotels' rooms, hotels' restaurants, and bars, that may be associated with crimes against property and general dangerous crimes are (but not only): robberies, bomb explosions, money laundering, trafficking and distribution of drugs, robberies during prostitution, bookmarkers, loan sharks, assault and murder, rape, fire risk, guest poisoning, etc. (Hughes, 1984, p. 35; Buzby II and Paine, 1976, p. 205; Burstein, 1994; Barth, 2006, p. 275; Beaudry, 1996; Wood, 2013, p. 78; Zhao and Brown, 2009, pp. 21–33; Nadel, 2009). Hotels use proactive measures which primarily include: installation of different security devices like alarm systems and surveillance systems, hiring internal or external security guards, appropriate architecture design of the building, parking lot and premises, electronic hotel locks, safes, etc. (Handbook, Part I, 2020; Hayes and Ninemeier, 2006, p. 410). A study of hotels in Bulgarian Black Sea resorts is indicative of the fact that thefts are predominant among the mentioned crimes. Therefore, monitoring and alarm systems are the main devices and equipment used for ensuring guests' safety (Georgieva and Bankova, 2021). Based on the theory of Crime prevention through environmental design (CPTED), it is believed that security must be embedded in the architectural design or physical changes in the hotel environment (Atlas, 2008, p. 53). Protection should be based not only on the use of security equipment, devices, policies and procedures but also on appropriate design solutions. Although architectural changes to the building and the environment are a focus of the CPTED, the use of appropriate furniture should not be neglected. Furniture enterprises produce a diversity of furniture for public spaces in the form of sofas, tables, chairs, and furniture parts, which defers in styles and models, colors, and sizes (Popova, 2018; Popova 2019). This could be used by hotels for securing guests' belongings.

To keep jewelry, passports, money, and small valuables safe from third parties, people handmade or buy custom-designed furniture with hidden compartments in them. Although the design of such furniture is not a new phenomenon, they are mainly for home use purposes. Thieves are also aware of the possibility that people may have hidden valuables in various places around the room. Therefore, the furniture with hidden compartments does not provide full protection but makes people feel more secure for their belongings. The **main goal** of the study is to analyze the possibility for using furniture with hidden compartments by Bulgarian hotels to protect the valuables of their guests. The main **research tasks** are (1) to be studied the attitude of hotel managers towards the installment of furniture with hidden compartments in hotel rooms; and (2) to be outlined the tourists' opinions and the factors affecting their willingness to use such furniture. The adopted **research methods** are based on - logical, deductive, and comparative methods, as well as on the methods of analysis and synthesis. For the empirical study, the case study method and questionnaires distributed on the spot are used. The study of statistical relationships and dependencies is based on the Chi-square test. The results of the study **support the literature** by presenting more data on different views for the future use of furniture with hidden compartments in hotel rooms. The **main research hypothesis** is that hotels primarily rely on the commonly used protection measures and devices. Hotels' furniture is not considered to provide security and safety of money and small belongings of the guests.

2. METHODOLOGY OF THE STUDY AND RESULTS OF THE ANALYZES

2.1. A case study investigating the introduction of the furniture with hidden compartments in hotels

The study examined 10 hotels in the sea resorts of national importance in Bulgaria, covering Albena, Golden Sands, Dunes, St. Constantine and Helena, and Sunny Beach. It is based on the case study method and was conducted during the period 18.02.2021-15.03.2021. The survey involved managers of hotels with three (30%) and four stars (70%). The data was collected by the use of telephone interviews, social media discussions, and questionnaires. The main key findings are:

- In more than half (60%) of the hotels, the most common crimes are theft of money and belongings of guests.
- To ensure the safety of guests and to prevent thefts the hotels use: alarm systems (70%), surveillance systems (90%), external security companies (60%), electronic hotel locks that open the door by the use of a card (80%), panic buttons at the reception (70%) and hotel rooms (50%), safes at the reception (90%) and personal safes in hotel rooms (50%). However, more surveillance devices and guards are considered to be needed in terms of securing the safety of the guests.
- The hotels do not use furniture with hidden compartments, and it is not considered to be used as a good practice in the future.
- The majority of hotel managers would not buy such furniture (70%), and it is not considered that their guests would use them or that this would provide real protection of their valuables.

The main limitation of the study is that it was conducted during unstable economic and health situations, which is why the focus of hotel managers is on ensuring health safety measures to the guests and not so much security for their valuables. Also, the actions taken by the managers, are related to pursuing a stabilization policy, which is why the marketing effect of the use of furniture with hidden compartments is not perceived as a priority.

2.2. A study of the use of furniture with hidden compartments by tourists

The survey among tourists is based on the questionnaires distributed on the spot in the mountain resort – Borovets during the months March-April 2021. It is a part of wider questionaries' and data collected to identify the current needs for tourism development in Bulgaria. The study of statistical relationships and dependencies is based on the Chi-square test, and the measure of association is done by the use of Cramer (V) with the program IBM – SPSS Statistics. 102 tourists were surveyed, from which nearly 93% are Bulgarian and 7% from abroad. The majority of the tourists (93.1%) are between 25 and 65 years old. Most of the respondents visit the resort together with their family (71.6%) and mainly for rest and recovery. For 78.4% the preferred duration of the stay in the resort is between one and three days. Nearly 61% of the people who spend up to 3 days in Borovets indicate that they have spent between 10-25 EUR per person per day (excluding their accommodation and food costs). For nearly 59% of the respondents who stay only for a day those expenses are between 25-50 EUR. For 17.6% this is the first visit to the resort, for 37.3% between the second and fifth, and for 45.1% over the fifth visit.

The respondents were asked questions related to their opinions regarding the use of specially designed hotels' furniture with hidden compartments. The highest percentage of respondents (55.9%) believe that such furniture would protect their valuables from theft. Based on the collected and analyzed data, there are no statistical relationships and dependencies between the age of the tourists and their opinion that the furniture with hidden compartments would protect their belongings. There is no statistically significant relationship as well between (1) the number of current visits to the resort by the respondents, (2) the duration of their stay, (3) the funds that the respondents spend daily, and the opinion that the furniture with secret compartments would protect the respondents' valuables. The collected data analysis provides evidence for an average statistical relationship between the nationality of the respondents and the opinion that the furniture with hidden compartments would protect their valuables (Cramer's V: 0.480, $p < 0.05$). Although in this case the null hypothesis is rejected not all conditions for the Chi-square test application are fulfilled. This is a prerequisite for being skeptical when accepting such a statistical relationship. Despite the relatively high percentage of respondents who believe that the use of hotel safes does the same job as the furniture with hidden compartments (26.5%) and that hotels are currently safe enough (22.5%), nearly 18% share the opinion that such furniture in the hotel rooms creates an additional sense of security (see Fig. 1). Individual cases believe that the specially designed furniture with hidden compartments is going to be used only for advertising purposes by hotels. Almost 4% do not see any sense in their use.

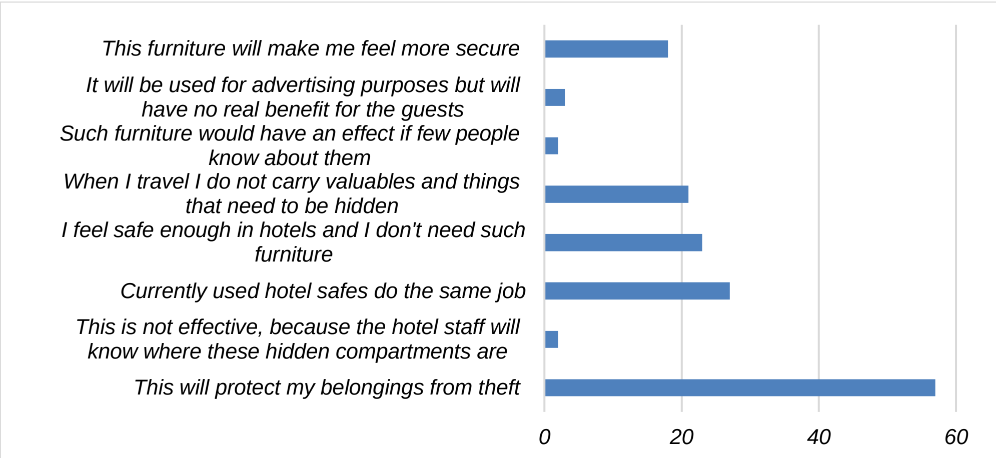

Figure 1. Answers to the question "What is your opinion regarding the use of specially designed furniture in the hotel rooms with hidden compartments in which to hide your valuables?", N = 102
Explanation note: Respondents have the opportunity to give more than one answer

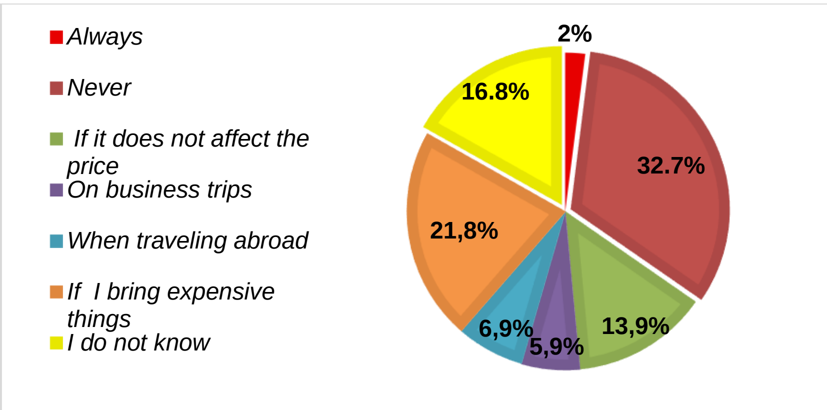

Figure 2. Answers to the question "At what occasions would you use furniture with hidden compartments in which to hide your valuables and belongings when you are a hotel guest?", N = 102

When asked "At what occasions would you use furniture with hidden compartments in which to hide your valuables and belongings when you are a hotel guest?" nearly 1/3 of the respondents would not use them at all (see fig. 2). However, for 21.8% their use is determined by whether the respondents will carry valuables with them during their trips. Although such situations may be associated with business trips (when carrying a laptop, flash drives, jewelry, watches, etc.) and when traveling abroad (when carrying passports, more cash, etc.), the percentage of people who would use hidden furniture compartments is relatively low. The percentage of the respondents (13.9%) who state that the price of the hotel service is a factor for the use of such furniture is also low. The collected data analysis once again provides evidence for no statistical relationships between (1) the age of the respondents, (2) the number of current visits to the resort by the respondents, (3) the duration of their stay, and the tourists' opinion on when they would use furniture with hidden compartments. There is a strong statistically significant relationship between the nationality of the respondents and their opinion on when they would use such kind of furniture (Cramer's V: 0.801, $p < 0.05$). However, not all conditions for the Chi-square test application are fulfilled. There is also an average statistical relationship between the funds that respondents spend daily and the use of furniture with hidden compartments (Cramer's V: 0.364, $p < 0.05$). Again, not all conditions for the application of the Chi-square analysis ($\chi 2$) are met, so it is a reason to be skeptical when accepting such a statistical relationship.

3. CONCLUSIONS

Although the use of hidden compartments in people's home furniture is seen as an alternative form of protection of money and valuables, this approach is still insufficiently studied in the hotel industry. Despite the possibility of such furniture to be used for marketing purposes, managers of hotels in the Bulgarian Black Sea coast, do not consider that it would be of interest to their guests and they will not use the compartments for hiding stuff. In this case, the investment is not considered to bring the expected financial return. However, managers do not pay attention to other forms of benefit for the hotel. For example, the hidden compartments can be used by hotels as a way of innovative interaction with guests, by placing in them complimentary gifts, funny notes, etc.

The analyzed data from the interviews, conducted among tourists in Borovets, show that 50.5% would use furniture with hidden compartments (always or under certain conditions, especially when carrying valuables, when this will not affect the price of the hotel services, during business or when traveling abroad). However, the percentage of respondents who would not use such furniture is relatively high (32.7%). Although a large percentage of respondents state that this type of furniture can protect their belongings and prevent possible theft, a significant proportion of tourists would prefer not to carry valuables with them when traveling. This lowers the functionality and the efficiency of the use of such furniture. In addition, around 1/4 of the respondents believe that the hotels are safe enough and that the hotel's safes have the same effect as the hidden compartments in the furniture. The willingness to use furniture with hidden compartments by tourists is influenced by the nationality of the respondents and the funds they spend daily during their visit to the resort.

As a limitation of the study and possibilities for future researches in the field is the fact that the paper does not focus on the positive and negative sides of the use of furniture with hidden compartment in places often visited by different people (such as hotels). Despite the psychological attitude of having guests' valuables secured by the use of such furniture, the paper does not take into account the need for frequent changes in the places of the compartments (in order not to be known by potential thieves). The research does not analyze the possibility of thefts committed by hotel staff members (who are aware of the locations of the secret compartments). The author of the present study does not underestimate the possibility of such furniture to be used for hiding objects, which are for committing crimes. However, this is not a subject of research in the current paper as well.

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STRENGTH AND STIFFNESS OF REINFORCED L-SHAPED AND T-SHAPED MORTISE AND TENON JOINT

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Abstract: This paper investigated the strength and stiffness of L-shaped and T-shaped mortise and tenon joints with rounded shape of tenon. PVA-c glue was utilized to assemble the beech wood joints with interference fit. The strength was carried out by measuring maximal applied load and by calculating ultimate bending moment. Stiffness evaluation was conducted by measuring displacement and by calculating the ratio of applied force and displacement along the force line and the ratio of bending moment and rotation angle of the joint. The results were compared for common mortise and tenon joints and reinforced mortise and tenon joints. The joints were reinforced with round beech wood pegs *i.e.*, standard dowels. The round peg passed perpendicular through the geometric center of the tenon cheeks. The results showed that, for the same tenon geometry but different shape of joints and test configurations, the maximum force of L-shape joints was higher than the force value of T-shape joints. However, the results showed small difference among the calculated bending moments of the analyzed type of tenon joints. The values of stiffness of L-shape joints and T-shape joints were notably different. A significant difference was not detected between the bending moment (strength) and stiffness of non-reinforced joints and reinforced joints for both L-shape and T shape joints. The investigation showed that the joints reinforced in this way could not be successfully used to improve mechanical properties of loaded mortise and tenon joints.
Keywords: mortise and tenon joint, strength, stiffness, reinforced joint, wood peg

1. INTRODUCTION

Mortise and tenon joints are still the most common way of connecting wood elements of furniture construction. Strength and stiffness are the main indicators of mechanical properties of mortise and tenon joints. Numerous factors that affect the above properties of joints are widely researched in order to improve the quality of tenon joints and wood constructions.

Tenon geometry affects the mechanical properties of mortise and tenon joints. The strength and stiffness of mortise and tenon furniture joints became greater as either tenon width or length increased. Tenon length had more effect on moment resistance, while tenon width had more effect on stiffness (Kasal et al. 2015; Hajdarevic et al. 2020; Hu and Liu 2020). Also, mortise and tenon joint are adhesive-based joints and glue and bonding are important factors that affect mechanical properties of joints (Horvatin et al. 2013). Analysis of T-joints strength, which are reinforced by using glass-fiber composite laminate, shows that mechanical properties of the joints could be affected by the reinforcement (Yerlikaya and Atkas 2013).

This paper investigated the strength stiffness of reinforced L-shape and T-shape mortise and tenon joints. The objectives were to determine the difference between the basic mechanical properties of reinforced and unreinforced joint and, in particular, to determine the effect of reinforcement on the joint bending moment that is the main joint strength indicator. The aim of the study was to explore the strength and stiffness that reinforcement contribute, and also capabilities and limitations of use of reinforced tenon joints.

2. MATERIALS AND METHODS

Twenty (20) L-shape mortise and tenon joints and eighteen (18) T-shape mortise and tenon joints supplied from furniture manufacturers were analyzed (Fig. 1). All joints were made from beech wood (*Fagus sylvatica* L.), with round peg shape and mortise and tenon interference fit and tenon length and width of 30 mm. PVAc glue was utilized to assemble the joint specimens. The first sets of L-shape and T- shape joints included standard mortise and tenon joints (Fig. 1), while the second set of L-shape and T- shape joints included reinforced (pegged) mortise and tenon joints (Fig. 2). The joints were reinforced with round beech wood pegs (single pin) i.e., standard dowels 6x25 mm. The round peg passed perpendicularly through the geometric center of the tenon cheeks.

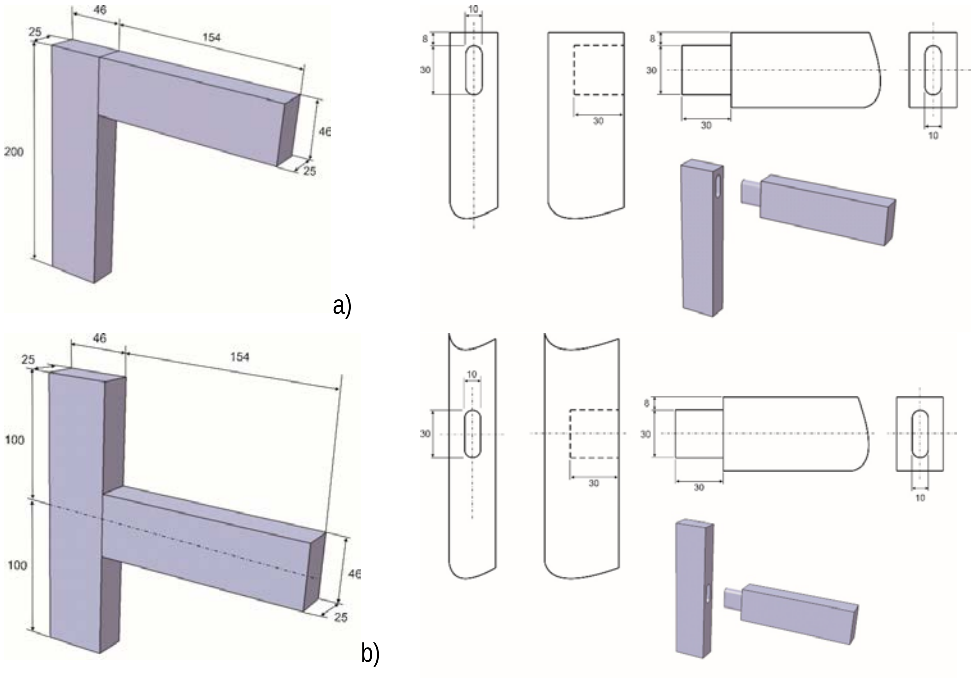
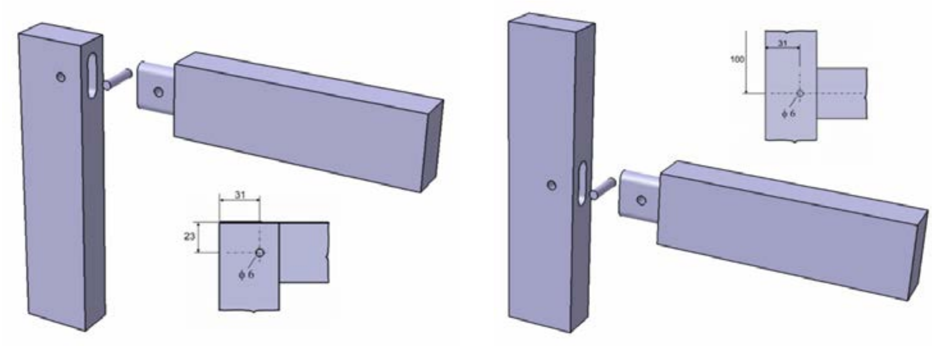


Figure 1. Mortise and tenon joints: a) L-shaped, b) T-shaped

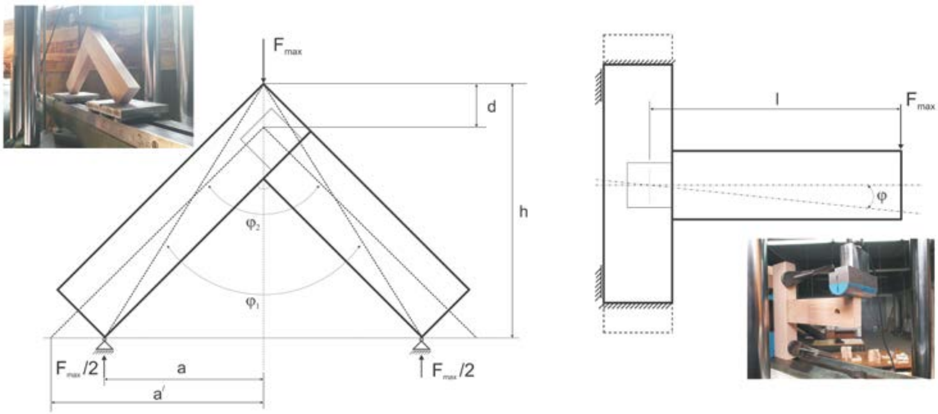
The loading diagram of specimens of L-shape and T-shape joints and tests setup is shown in Fig. 3. Roller supports were set up on the lower joint edges while the load was applied to the L-shape joint in a manner that corresponded to the tension of specimen. Maximal bending moment of the joint was calculated as $M_{max}=(F_{max}/2)\cdot a$. The post of T-shape joint was fixed at the upper and lower end and maximal bending moment of the joint was calculated as $M_{max}=F_{max}\cdot l$. Distances a=108.9 mm and l=169 mm are moment arms *i.e.*, perpendicular distance from the support reaction line to the force line. The values of displacements at the ultimate applied load (d_{max}) were used for calculation of stiffness coefficient that was defined by ratios F_{max}/d_{max} in N/mm for all types of joints (Hu and Liu 2020). Stiffness coefficients of the joints shown in Nm/rad were calculated by ratios $M_{max}/(\varphi_2-\varphi_1)$ and M_{max}/φ for L-shape joints and T-shape joints, respectively (Smardzewski et al. 2016). The angles were obtained based on the trigonometric analysis of right triangle.



a) b)

Figure 2. Pegged (reinforced) mortise and tenon joints: a) L-shaped, b) T-shaped

The test was carried out on a universal testing machine with load cell and inductive displacement transducer. Force and displacement along the force line were measured simultaneously until a joint failure. The moisture content (MC) was evaluated in accordance with procedures described in ISO 13061-1 (2014) after testing. The average MC value was 11.2%.



a) b)

Figure 3. Diagram of joint loading: a) L-shape joints, b) T-shape joints

3. RESULTS AND DISCUSSION

The curves of force-displacement diagrams of the tested type of joints are shown in Fig. 4. The diagrams show noticeable differences among the ultimate applied load values (maximal force) and displacements of L-shape joints and T-shape joints. The differences among the ultimate applied load values and displacements of the L-shape joints or T-shape joints without and with reinforcement were not apparent. The basic results of descriptive statistics of maximal force (F_{max}) and displacement (d_{max}) of the L-shape and T-shape joints (unreinforced and reinforced) are given in Table 1. The maximal force mean values of L-shape joints were higher than the mean values of T-shape joints. Also, the results show relatively small differences among the bending moment and noticeable differences among the stiffness coefficients of L-shape and T-shape joint. The differences are the results of different configurations of test specimens of the joints and tests setup. Consequently, the experimental results were not comparable due to noticeable differences of these two types of joint.

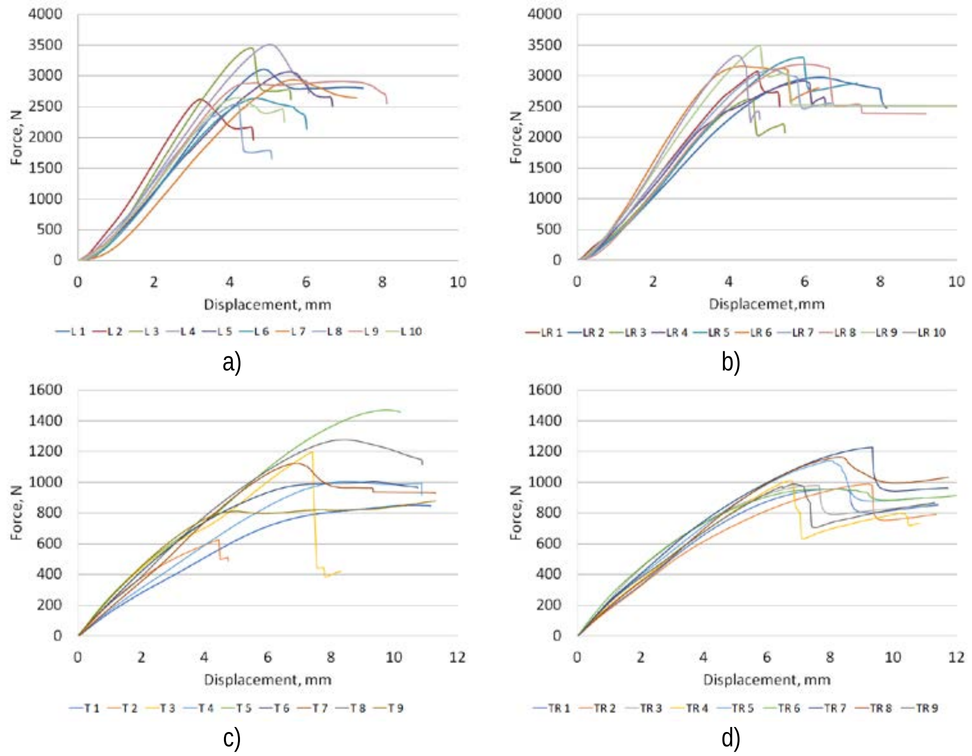
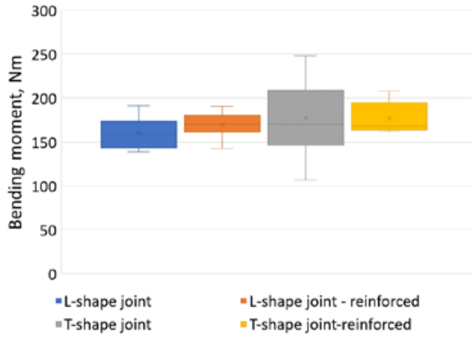


Figure 4. Working diagram of joint testing: L-shape joints - a) unreinforced, b) reinforced and T-shape joints - b) unreinforced, d) reinforced

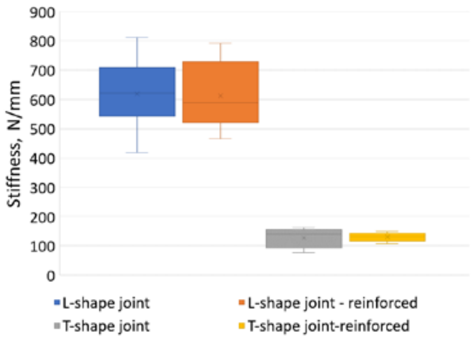
Table 1. Descriptive statistics of L-shape and T-shape joints

L-shape joint	Unreinforced L-shape joint				Reinforced L-shape joint			
	Mean	Median	Standard Deviation	Coeff. of Variation	Mean	Median	Standard Deviation	Coeff. of Variation
Force, N	2942.92	2925.23	345.47	11.74 %	3117.20	3128.16	243.64	7.82 %
Bending moment, Nm	160.24	159.28	18.81		169.73	170.33	13.27	
Displacement, mm	4.89	4.78	1.02	20.78 %	5.20	4.96	0.79	15.20 %
Stiffness coeff., N/mm	619.57	622.26	115.69	18.67 %	612.38	589.77	109.66	17.91 %
Stiffness coeff., Nm/rad	1898.18	1899.20	344.83	18.17 %	1880.36	1808.17	328.36	17.46 %
T-shape joint	Unreinforced T-shape joint				Reinforced T-shape joint			
	Mean	Median	Standard Deviation	Coeff. of Variation	Mean	Median	Standard Deviation	Coeff. of Variation
Force, N	1048.95	1006.14	251.73	24.00 %	1046.70	991.44	102.44	9.79 %
Bending moment, Nm	177.27	170.04	42.54		176.89	167.55	17.31	
Displacement, mm	8.54	8.49	2.10	24.63 %	8.06	8.16	0.90	11.20 %
Stiffness coeff., N/mm	127.81	140.87	33.63	26.31 %	130.91	131.52	14.74	11.26 %
Stiffness coeff., Nm/rad	3653.44	4024.40	960.50	26.29 %	3741.65	3760.30	420.94	11.25 %

The results show small differences among the mean values of bending moment and stiffness coefficients of unreinforced and reinforced joints. The mean values of maximal force increased by 5.9% as L-shape joint reinforced with round wood peg. Other differences between mean values of unreinforced and reinforced joints are less than 2.5%. Comparative distributions of bending moment results and stiffness coefficients results of all the tested groups of joints *i.e.*, the unreinforced and reinforced L-shape and T-shape joints, are shown on the Box and Whisker plot, Fig 5. The median lines of reinforced joint lie inside appropriate comparison boxes of unreinforced joints, which indicates that there is no difference between this group of joints both for L-shape and T-shape joints.



a)



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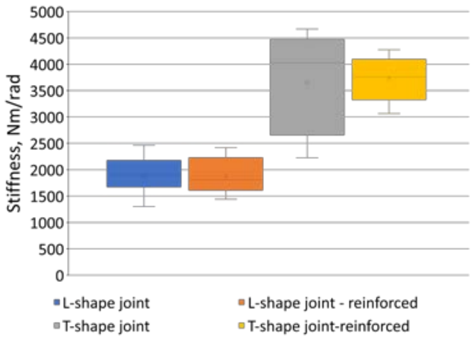

c)

Figure 5. Box and whisker plot - distribution of the results: a) bending moment, b) stiffness (N/mm) and c) stiffness (N/rad)

A significant difference, *p*-values are shown in Table 2, was not demonstrated with a 95 percent level of confidence (α=0.05) between bending moments for the unreinforced and reinforced L-shape joints, and between bending moments for the unreinforced and reinforced T-shape joints. Also, a significant difference between the stiffness (both coefficient) for unreinforced and reinforced L-shape joints or unreinforced and reinforced T-shape joints was not demonstrated. These results tend to indicate that the effect of joint reinforcement with round wood peg (standard dowel) on strength and stiffness of both types of joint has not been determined.

Table 2. P-value – analysis of significant difference between the bending moments and stiffness for the L and T shape joints without and with reinforcement

Data source	Variable 1	Variable 2	*p*-value
Bending moment, Nm	L-shape joints	Reinforced L-shape joints	0.2087
	T-shape joints	Reinforced T-shape joints	0.9805
Stiffness – N/mm	L-shape joints	Reinforced L-shape joints	0.8882
	T-shape joints	Reinforced T-shape joints	0,8035
Stiffness – Nm/rad	L-shape joints	Reinforced L-shape joints	0.9070
	T-shape joints	Reinforced T-shape joints	0.8039

4. CONCLUSION

Bending moment and stiffness coefficients of unreinforced and reinforced L-shape and T-shape joints were investigated. The joints were reinforced with standard dowels that passed perpendicularly through the geometric center of the tenon cheeks. Due to different configurations of test specimens and tests setup, the testing results of the L-shape and T-shape joint were not comparable. A significant difference was not detected between the bending moments and stiffness coefficients of unreinforced joints and the bending moments and stiffness coefficients of reinforced joints for all investigated type of joints. The result showed that the reinforced joints did not have higher mechanical properties than unreinforced ones.

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STRENGTH AND DEFORMATION OF END CORNER JOINTS BY STAPLES WITH DETAILS FROM SCOTS PINE UNDER COMPRESSION BENDING

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Abstract: The staples joints with PVA glue made of Scots pine (Pinus Sylvestris L.) were common using in upholstered furniture wood frames. The main objective of these tests was to research the influence of availability of the PVA glue, reinforcing corner wood block and type of corner joints (case or end to-face) on the bending strength and stiffness coefficient of end corner joints by staples under compression bending.
As results the bending strength and stiffness coefficients were established. Results of the tests showed that the bending strength was increasing with 3,7 to 5,3 times after gluing and 2,9 to 3,9 times than the corner joints with fitting a reinforcing wood block. The results indicated that the stiffness coefficients of corner joints with glue were 1,5 to 3,4 times higher than the joints without glue. Experimental results also indicated that the stiffness coefficients were increasing with 1,5 to 2,4 times after fitting reinforcing wood block. It was established that the end to-face corner joints by staples have higher strength and stiffness than the case corner joints by staples.
The results for bending strength and stiffness coefficients are useful for design and modeling of skeletons of upholstered furniture..
Keywords: staples corner joints, Pinus sylvestris L., stiffness coefficients, bending strenght

1. INTRODUCTION

In the manufacture of skeletons of upholstered seating furniture, butt joints by metal clips (staples) are increasingly being used. This is dictated by the high productivity and less labor intensity in the technological operations compared to the other non-detachable joints used in the constructions of upholstered furniture (skeletons). In practice, when produce the skeletons of upholstered furniture, butt joints by staples and reinforcing members are successfully applied.

The first person who researched this type of joints is Eckelman, whose publications date back to 1971. In them the author determines the bending strength and stiffness of middle corner joints of plywood members from Douglas fir (Pceudotsuga). It has been found that in the presence of a single-sided reinforcing member a satisfactory strength is provided for that can be improved by increasing the size of the reinforcing member. It is also concluded that the strength depends directly on the shear strength of the adhesive joint of the individual veneer sheets of the plywood rather than on the number and density of the staples (Eckelman, 1971). The reinforcing members can also be made of High Density Fibreboard (HDF). Such joints are subjected to a study by Erdil et al. They determined the maximum bending moment of middle corner joints by staples, means of OSB members and HDF reinforcing member with and without the presence of adhesive. The results indicate that the application of glue results in a double increase in the strength of the joints (Erdil et al., 2003).

In the specialised literature, there are publications whose subject of study is middle corner joints of staples by means on OSB members with reinforcing members with or without application of glue with polyvinyl acetate adhesive. The joints are subjected to static bending. In consequence of the results obtained, the authors conclude that, in the presence of application of glue on the reinforcing members, the strength is increased by 27%. It is also concluded that a reinforcing member with a length of 102 mm is insufficient and such one with a length of 305 mm is resized for such a type of joints. It has been found that increasing the width of the reinforcing member in the range from 102 mm to 203 mm, in the presence and absence of adhesive, is not a prerequisite for greater strength of the joint. The authors conclude that changing the position of the staple does not affect the strength of the joint (Wang et al., 2007a). In the second part of his study, Wang et al. examine the behaviour of the same type of joints under dynamic load. The results show that even in the presence of different types of destruction in both types of joints, with or without adhesive, the ratio between static to dynamic maximum load force is preserved. In the case of staple joints, the high value of the ratio is due to the pulling of the staple. In the case of adhesive joints, the low value of the ratio results from a shear along the thickness of the board and the high due to breaking of the member of the joint. In conclusion of their study, the authors conclude that such type of joints should not be subjected to load with more than 48% of the breaking force obtained under a static load (Wang et.al., 2007b).

In the literature, data has been found to determine bending and tensile strength of corner joints by staples by means on wood members of beech (Fagus sylvatica) and poplar (Populus sp.). The joints are reinforced with a member in the form of a triangular block or two-sided member of HDF (Kamperidou et al., 2010). The values determined for the maximum bending moments are the lowest for joints with double reinforcing member. Based on the results obtained, the authors conclude that the type of wood does not significantly affect the values of the maximum strength of the joint.

Bulgarian scientists determine the maximum bending moments under bending load with bringing together and opening of the arms of the end corner joints by smoothing and joints at 90-degree angle and at 45-degree angle of the wood members of spruce (Picea abies Karst.). The authors recommend that the standard values of the maximum bending moments be used as the control in determining the quality of the furniture constructions (Kyuchukov et.al, 2015).

2. EXPERIMENTAL METOD

For the purposes of the study, test samples were made of wood members from Scots pine (*Pinus sylvestris* L.) with following physical and mechanical properties: density of $\rho_{12\%}$ = 430 kg/m^3, modulus of elasticity – $E_{L12\%}$ = 9000.10^6 N/m^2, $E_{R12\%}$ = 593.10^6 N/m^2 and bending strength $\sigma_{bend.12\%}$ = 64,84.10^6 N/m^2.

Eight series of test samples with cross-section 50x25 mm were made. The members were assembled with two staples M1 with or without PVA adhesive. For this were used staples of the company “OMER” series 100, type M1 with a length of 40 mm and a wire cross-section of 1,3x1,5 mm and a water-soluble polyvinyl acetate adhesive of the company HENKEL – „Moment Wood Standard“, water resistance class D2, consumption 100÷200 g/m², viscosity η = 8000÷15000 m.Pas and open time t = 8 min.

The type and sizes of test samples is listed in table 1, respectively, of the form and dimensions shown in Fig. 1.

Table 1. Type of end corner butt joint with two staples M1/40 of parts of Scots pine (*Pinus sylvestris* L.)

Nomber	Type of end corner butt joints with 2 staples $M_{1/40}$	Series
1	Case butt joint with 2 staples	$C_{1M1/40PVA}$
2	Case butt joint with 2 staples and PVA	$C_{1M1/40PVA}$
3	Case butt joint with 2 staples and corner block	$C_{1M1/40\Delta}$
4	Case butt joint with 2 staples, PVA and corner block	$C_{1M1/40\Delta PVA}$
5	End-to-face butt joint with 2 staples	$C_{2M1/40PVA}$
6	End-to-face butt joint with 2 staples and PVA	$C_{2M1/40PVA}$
7	End-to-face butt joint with 2 staples and corner block	$C_{2M1/40\Delta}$
8	End-to-face butt joint with 2 staples, PVA and corner block	$C_{2M1/40\Delta PVA}$

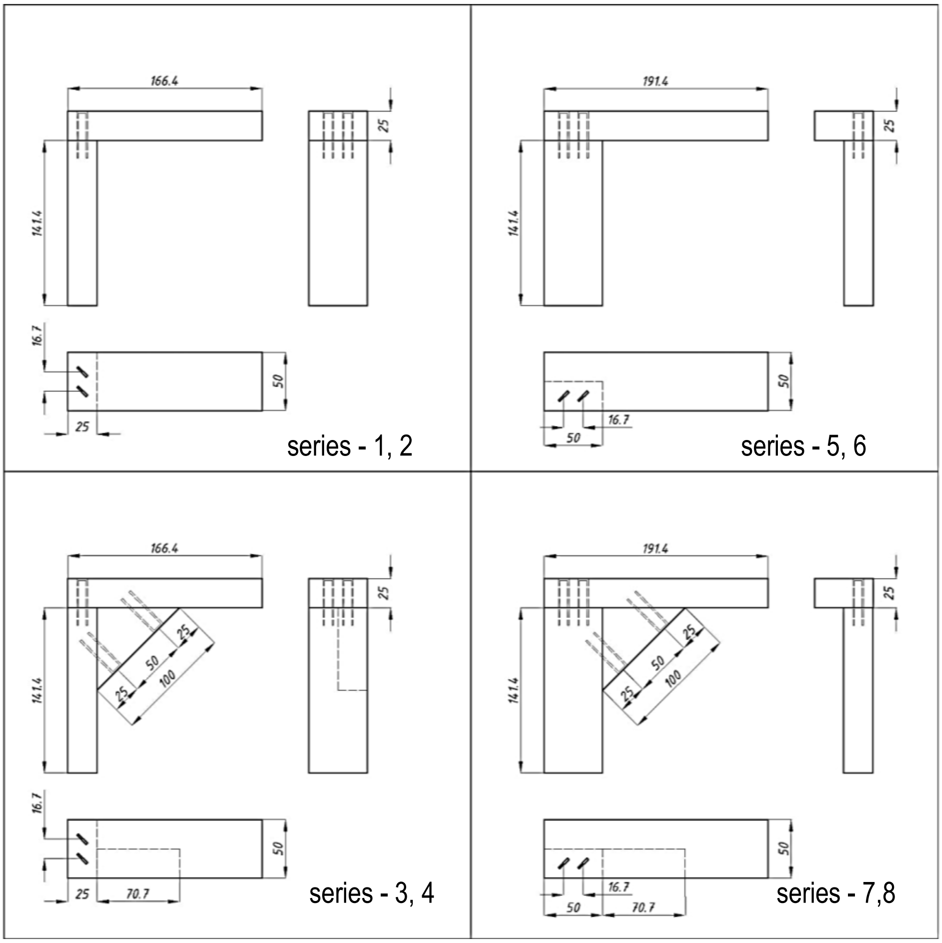

Figure 1. Form and dimension of the tested samples series

For determining the maximum bending moments and stiffness coefficients, the test samples were subjected to a bending load by collecting arms, using a simultaneous testing method of the strength and deformation characteristics, of the fixed corner joints of members under bending load (Kyuchukov et.al, 2016).The scheme of loading and deformation as shown in Fig.2.

For certain values of the loading force Fi the bending moment under bending stress by collecting arms in N.m is determined with the formula

$$M_i = F_i l_i \quad (1)$$

Where Fi is loading force, N.m;
li – bending arm , m, according to Fig.2.

The stiffness coefficient c_i was determined according to formula 2 in N.m/rad.

$$c_i = \frac{\Delta M_i}{\Delta \alpha_i} \quad (2)$$

$$\Delta M_i = M_i - M_0 \quad (3)$$

$$\Delta \alpha_i = \alpha_i - \alpha_0 \quad (4)$$

Where c_i is rotational stiffness, N.m/rad;
$M_i,\ M_0$ – bending moment for F_{40} and F_{10}, N.m;
α_i, α_0 – angle of semi-rigid rotation of the arms of the joint at F_{40} and F_{10}, rad.

All the data are statistically processed and Student t-distribution was established.

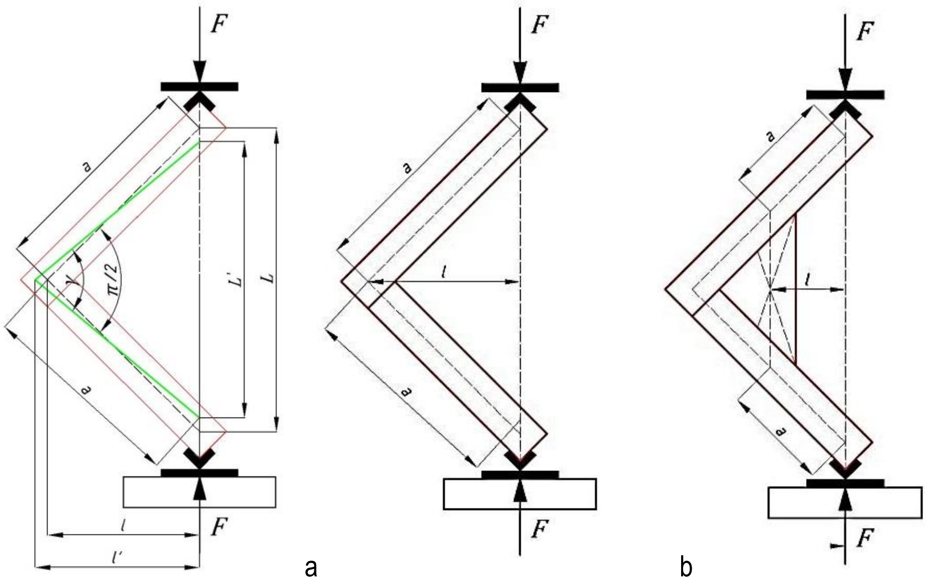

Figure 2. Scheme of loading and deformation (a) and sizing of bending arm l (b)

3. RESULTS AND DISCUSSION

The main indicator, characterizing the strength of the corner joints, made of wood is the bending strength and in particular the average values of the ultimate bending moments $M_{max.bend}$. The results from the experiments are processed by variation-statistics, and the data are presented in Table 2.

Table 2. Variation statistics parameters from ultimate bending moments of end corner butt joints with 2 staples M1/40 of parts from Scots pine (Pinus sylvestris L.)

№	Series	Ultimate bending moments, $M_{max\ bend}$, N.m							
		Variation statistics parameters							
		$\overline{\chi}$, [N.m]	M_{max}, [N.m]	M_{min}, [N.m]	med., [N.m]	s, [N.m]	v, [%]	p, [%]	n, [pc]
1	$C_{1M1/40}$	6,76	8,88	5,87	6,72	1,01	14,89	4,71	10
2	$C_{1M1/40\ PVA}$	25,30	31,81	20,43	25,10	3,69	14,59	4,62	10
3	$C_{1M1/40\Delta}$	19,48	23,25	18,41	18,95	1,74	8,94	2,83	10
4	$C_{1M1/40\Delta\ PVA}$	98,11	113,37	71,78	92,28	13,27	13,53	4,28	10
5	$C_{2M1/40}$	7,68	9,42	5,65	7,47	1,18	15,31	4,84	10
6	$C_{2M1/40PVA}$	38,52	50,24	31,55	38,74	5,63	14,48	4,58	10
7	$C_{2M1/40\Delta}$	22,44	26,59	18,80	21,72	2,51	11,17	3,53	10
8	$C_{2M1/40\Delta\ PVA}$	118,10	139,69	95,82	120,09	14,13	11,97	3,98	10

The largest value of tested series of joints is 118 N.m, found in in end-to-face butt joints with PVA and reinforcing member of pine ($C_{2M1/40\Delta PVA}$).

The values for the maximum bending moments, an increase after gluing the parts, with the following percentage differences, in the compared group respectively: 73.28% ($t_{calc.}$ 2.22< $t_{tabl.}$15.31) at case butt joints (series 1,2); 80.27% ($t_{calc.}$ 2.23<$t_{tabl.}$17.16) end-to-face butt joints (series 5,6); 80.15% ($t_{calc.}$2,26<$t_{tabl.}$18,57) case butt joints with reinforcing part (series 3,4) and 81% ($t_{calc.}$2.26<$t_{tab.}$18.21) at series end-to-face butt with reinforcing part (series 7,8). The percentages show that the gluing of the details of the staples joints increases their strength significantly.

The results about ultimate bending moments show that the corner block improves the strength characteristics of the joints, as the significant percentage difference between the values for $M_{max.\ bend.}$ before and after strengthening from joints in different groups, as follows: 65,29% ($t_{calc.}$2,14<$t_{tabl.}$20,02) at case butt joints (series 1, 3); 74,21% ($t_{calc.}$2,28<$t_{tabl.}$16,71) case butt joint with PVA (series 2,4); 65,78% ($t_{calc.}$2,16<$t_{tabl.}$16,87) at end-to-face butt joints (series 5,7); 67,38% ($t_{calc.}$2,20<$t_{tabl.}$14,53) at end-to-face butt joints with PVA (series 6,8).

The differences between case joints ant end-to-face are established, as follows: 11,98% ($t_{calc.}$2,10>$t_{tabl.}$1,37) at series only with staples (series 1,5); 34,32% ($t_{calc.}$2,12<$t_{tabl.}$6,38) at joints with staples and PVA (series 2,6); 13,19% ($t_{calc.}$2,12<$t_{tabl.}$3,07) joints with corner block (series 3,7); 16,93% ($t_{calc.}$2,11<$t_{tabl.}$3,31) at the joints with corner block and PVA (series 4,8). From the percent dependencies can be derived that series of type end-to-face have higher values of maximum bending moment than case butt joints, except for a group of joints with staples (series 1,4), where statistically difference were insignificantly.

In Table 3 are presented the average values of the stiffness coefficients. Greatest value was achieved at the end-to-face butt joints with PVA and reinforcing member ($C_{2M1/40\Delta PVA}$).

Table 3. Variation statistics parameters from stiffness coefficients of end corner butt joints with 2 staples M1/40 of parts of Scots pine (Pinus sylvestris L.)

№	Series	Stiffness coefficients, c [N.m.rad-1]							
		Variation statistics parameters							
		$\overline{X}$, [N.m.rad^{-1}]	c_{max}, [N.m.rad^{-1}]	c_{min}, [N.m.rad^{-1}]	med., [N.m.rad^{-1}]	s, [N.m.rad^{-1}]	v, [%]	p, [%]	n, [pc]
1	$C_{1M1/40}$	609,21	736,72	519,42	603,79	66,27	10,88	3,44	10
2	$C_{1M1/40\ PVA}$	2068,57	2676,54	1627,94	1999,44	300,71	14,54	4,60	10
3	$C_{1M1/40\Delta}$	1461,04	2094,37	1359,75	1378,14	231,02	15,81	5,00	10
4	$C_{1M1/40\Delta\ PVA}$	4410,62	5241,49	3576,30	4780,04	598,98	13,58	4,29	10
5	$C_{2M1/40}$	1649,07	1946,21	1225,55	1628,70	186,27	11,30	3,57	10
6	$C_{2M1/40PVA}$	2392,59	3086,51	1875,24	2403,94	330,80	13,83	4,37	10
7	$C_{2M1/40\Delta}$	2407,95	2864,81	1549,26	2507,74	314,45	13,06	4,13	10
8	$C_{2M1/40\Delta\ PVA}$	5610,74	6665,85	4211,34	5730,07	843,73	15,04	4,76	10

After gluing the joints with staples increase their stiffness, with significant percentage differences: 70.55% ($t_{calc.}$2,23<$t_{tabl.}$14.95) at case butt joints (series 1,2); 66.87% ($t_{calc.}$ 2.18<$t_{tab.}$14.90) at case butt joints with corner block (series 3,4); 31.08% ($t_{calc.}$ 2.1<$t_{tabl.}$6.34) at end-to-face joints (series 5,6); 57.08% ($t_{calc.}$2.15<$t_{tab.}$10.76) at end-to-face joints with corner block (series 7,8).

The presence of a reinforcing wood block also leads to an increase the values for the stiffness coefficients. The determined percentage differences, between the series with and without corner block are established: case butt joints with staples (series 1,3) - 58.30% (t_{calc}.2.20<$t_{tabl.}$11.16); case butt joints with PVA (series 2,4) - 53.10% ($t_{calc.}$2,16<$t_{tab.}$11,40); end-to-face joints (series 5,7) - 31.52% ($t_{calc.}$2.18<$t_{tabl.}$5.41); end-to-face joints with PVA (series 6,8) - 57.35% ($t_{calc.}$2.18 <$t_{tabl.}$11.40).

In all tested series, higher values for the stiffness coefficients were found at end-to-face than those case butt joints by staples, with percentage differences: 63.06% ($t_{calc.}$ 2.20<$t_{tab.}$16.53) at joints by staples (series 1,5); 13.54% ($t_{calc.}$2.10<$t_{tab.}$2.41) at joints by staples with PVA (series 2,6); 39.32% ($t_{calc.}$2.15<$t_{tabl.}$6.42) for series with corner block (series 3,7); 21.39% ($t_{calc.}$2.11<$t_{tabl.}$ 3.26) for series with corner block and PVA (series 4,8).

3. CONCLUSIONS

From the results of this study on the bending strength and stiffness of the corner joints by staples made of Scots pine, several conclusions can be derived.

The bending strength was increasing with 3,7 to 5,3 times after gluing and 2,9 to 3,9 times than the corner joints with fitting a reinforcing wood block.

The results indicated that the stiffness coefficients of corner joints with glue were 1,5 to 3,4 times higher than the joints without glue.

Experimental results also indicated that the stiffness coefficients were increasing with 1,5 to 2,4 times after fitting reinforcing wood block.

It was established that the end to-face corner joints by staples have higher strength and stiffness than the case corner joints by staples.

It is recommended that the comparative data of bending strength and stiffness coefficients of corner joints by staples made of Scots pine has to be taken into consideration when selecting the type of joints in the skeleton upholstered construction made of pine wood.

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USE OF WOOD-PLASTIC COMPOSITES AS MATERIAL FOR 3D PRINTED BILAYER ACTUATORS

Daša Krapež Tomec, Aleš Straže, Andreas Haider, Mirko Kariž

Abstract: The use of additive manufacturing is increasing and so is the search for nature based materials for 3D printing. Wood is one of the possible solutions and can be used in FDM filaments as a filler or as a reinforcing component. Wood particles for 3D printing filaments can be made from wood waste from other woodworking industries, adding value to low-cost waste materials. The disadvantage of wood - dimensional changes due to water adsorption and desorption - could also be used as its strength. Wood retains some of these properties after incorporation into polymers and WPC composites also show dimensional changes, induced by changing climate conditions, that could be used in shape changing materials.
In this research, FDM printing materials with or without wood particles were used to design shape-changing bilayer actuators that could serve as active façade or ventilation valves. The initial research shows that the wood content in the WPC causes dimensional changes and thus shape changes in the designed actuator, but further research is needed to determine the behaviour of the 3D printed elements over a longer period of time with changing climatic conditions.

Keywords: 3D printing, 4D printing, actuators, wood, dimensional changes, shape-changing materials

1. INTRODUCTION

Natural fibres/particles are used as composite reinforcement to replace glass fibres due to their mechanical, acoustic or even morphing properties (Le Duigou et al., 2017) in combination with their low density, reduced environmental footprint and alternative end-of-life management (Faruk et al., 2012). Natural fibres are anisotropic and sensitive to moisture, and this is one of their main disadvantages when used for structural applications (Faruk et al., 2012), but could also be used as positive attribute when shape change is desirable-like in 4D printing.

4D printing aims to achieve a predictable and predefined time-dependent change in functionality (shape, property, self-assembly, or self-repair) that the 3D-printed structure undergoes when it encounters an external stimulus - e.g., temperature, ultraviolet light, humidity, electric and magnetic field (Miao et. al., 2017). Actuation in response to a stimulus by pre-programmed hierarchical structures, can provide a bio-inspired model useful for functional gradation of natural fibres to evolve hygroscopically induced morphing, i.e. hygromorphing. The difference in volumetric expansion, bending stiffness, and modulus of elasticity of each layer form the basis for the responsive deformation behaviour (Correa et al., 2015).

Hygromorphic or shape-changing materials work differently because it is the external stimulus that triggers the transformation from their original shape; the transformation is reversed when the stimulus is removed. Therefore, the material can be considered to oscillate between two equilibrium states without the need for an external force, allowing for multiple cycles of transformation. However, the direction and amplitude of the motion are pre-programmed into the material structure (Zhou et Sheiko, 2016).

The addition of wood to PLA makes hygroscopically active composite that is capable of deformation while adsorption/desorption in changing climate. When the specimen is thin enough, the material responds by relieving the stress through an elastic deformation, that is, by shrinking and expansion of the material.

In this research we studied the behaviour of samples 3D-printed from three different filaments (pure PLA, PLA with 15 % wood particles, PLA with 25 % wood particles) during exposure to different climate conditions (relative humidity). Bimaterial actuators were designed and their behaviour in changing environment was monitored.

2. MATERIALS AND METHODS

Three different filaments were used - one commercially available: PLA (Plastika Trcek, Slovenia; abbreviated as PT) and two Wood-PLA filaments; one with 15 % and other with 25 % of wood share, manufactured by Kompetenzzentrum Holz GmbH (Linz, Austria; abbreviated as WPL15 and WPL25).

All samples were 3D-printed using a Creality CR10-V3 (Creality 3D Technology Co., Ltd, Shenzhen, China) with a direct extruder. The printing layer thickness was set to 0.3 mm, the nozzle diameter was 0.4 mm, printing temperature 200 °C, bed temperature 50 °C. Samples were printed with solid layers in a 45° raster angle.

The research was made in two steps: first we determined the dimensional stability of the printed samples in changing conditions. In this part samples were printed with just one material in sample. The second step was determination of behaviour of bimaterial actuators-samples were prepared from two materials: PLA and one of the Wood-PLA composites.

2.1 Dimensional stability of the materials

Samples for first step - dimensional stability - moist/drying tests were modelled in SolidWorks software (SolidWorks Corp., Massachusetts, USA) and exported to STL format. The STL models were sliced and prepared for 3D printing in Cura software (Ultimaker, Utrecht, Netherlands). The dimensions of these samples were 120 × 15 × 4 mm^3 (length × width × thickness).

The dimensional stability tests were carried out in the laboratory drying tunnel TLS-01 (Kambič, Semič, Slovenia). In the test chamber of the drying tunnel with dimensions 700 × 400 × 610 mm^3 (length × height × width), a supporting grid floor was placed in the middle, on which 3 series of 7 samples were positioned. The moisturizing and drying processes were controlled by a central microprocessor controller DPC-420, which allowed the adjustment of air temperature, relative air humidity and air speed (accuracy of regulation of air temperature to 1 ºC, regulation of relative humidity to 1 % and regulation of air speed to 0.1 m/s).

The moisturizing kinetics of 3D-printed samples were monitored at relative humidity of 80 % or 20 %, temperature 20 ºC, air velocity 1 m/s. Measurements of moisturizing and de-moisturizing kinetics were made on seven samples of each variation at predetermined time intervals. The results were arithmetically averaged in Microsoft Excel.

The moisturizing process of the 3D-printed samples was monitored by interval weighing of each sample on an Exacta 300 EB laboratory balance with an accuracy of 0.01 g and by measuring three dimensions of samples with digital calliper with a precision of 0.01 mm.

2.2 Bending properties of selected materials

Modulus of elasticity (MOE) of 3D-printed samples from selected materials was determined on the same samples that were used for determination of dimensional stability.

Prior bending test, samples were conditioned in standard climate (20 °C, 65 % RH). Samples were tested in a 3-point bending test on universal testing machine Zwick Z005 universal testing machine (ZwickRoell GmbH, Ulm, Germany). The support span was 80 mm, and the loading speed was 10 mm/min. Samples were loaded to approximately 50 % maximum loading force (for each material one sample was loaded until a failure occurred) and MOE was determined accordingly. The values given for each material were calculated as the average values of seven samples.

2.3 Shape change of bimaterial actuators

The samples for the second step of research were made as bi-material samples, where first layer (0.3 mm) was printed with pure PLA, and the other 5 layers (5 x 0.3 mm) with wood PLA composite (either WPL15 or WPL25). 3D models with the dimensions 200 × 12 × 1.8 mm^3 (length × width × thickness) were modelled in SolidWorks software (SolidWorks Corp., Massachusetts, USA) and exported to STL format.

STL models were sliced and prepared for 3D printing in Cura software (Ultimaker, Utrecht, Netherlands). Samples were immediately after printing clamped on one end for approx. 10 mm on specially designed template (Figure 1). Firstly, they were conditioned in 20 % relative humidity and 20 °C in a thermostatic climatic chamber with saturated salt solution of potassium acetate (CH_3COOK) for at least 72 hours. After that, the samples were weighted together with clamping template and initial deformation was measured and marked on a template with millimetre grid.

The samples were then placed in a humid thermostatic climatic chamber with saturated salt solutions – with 80 % relative humidity and 20 °C. In predetermined time intervals the deformation of samples was monitored with markers (dots in the upper right corner of the sample) and in parallel, weighing of samples was done on an Exacta 300 EB laboratory balance with an accuracy of 0.01 g. After one week the samples were placed in a dry thermostatic climatic chamber (with 20 % relative humidity and 20 °C) and the measurement of deformations were monitored the same way.

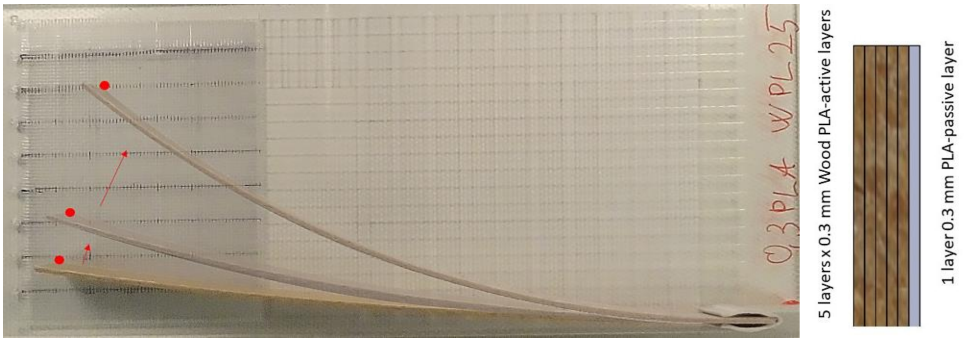

Figure 1. Curvature of sample 0,3PLA WPL25 at initial position (after conditioning in 20% RH), after 6 hours and after 168 hours in 80 % RH and 20 °C (left) and composition of the actuator (right)

3. RESULTS AND DISUSSION

3.1 Dimensional stability of the materials

The results show that the dimensional stability of 3D-printed parts depends on the material used (Table 1). The lowest longitudinal swelling was observed in samples made of PLA and was 0.09 % when samples were exposed from climate with 20 % RH to 80 % RH. Samples from Wood-PLA exhibited higher longitudinal expansion (0.3 and 0.47 %). Samples made from Wood-PLA with highest wood content (WPL 25) exhibited highest length expansion. These results were expected and reported in previous studies (Adhikary et al., 2008; Stark N., 2001). Moisture adsorption increases with wood content in composites because of the free hydroxyl groups (OH) of hemicelluloses and amorphous cellulose within the cell wall of wood fiber (Neagu et al., 2006). Therefore, wood-plastic composites with higher wood share adsorb more moisture when exposed to higher humidity.

Certain biopolymers, including PLA, are said to have a notable hygroexpansion, but as can be seen from our results, the values are considerably lower compared to Wood-PLA.

The relationship between wood content and moisture uptake applies correspondingly to mass change (Table 1).

Table 1. ***Mass*** *change* ***and length expansion*** *during* ***moisturizing and drying*** *- according to the material*

Specimens	Mass change during moisturizing in %	Mass change during drying in %	Length expansion in %
PT	0.61	- 0.45	0.09
WPL 15	1.91	-1.50	0.30
WPL 25	2.82	-2.15	0.47

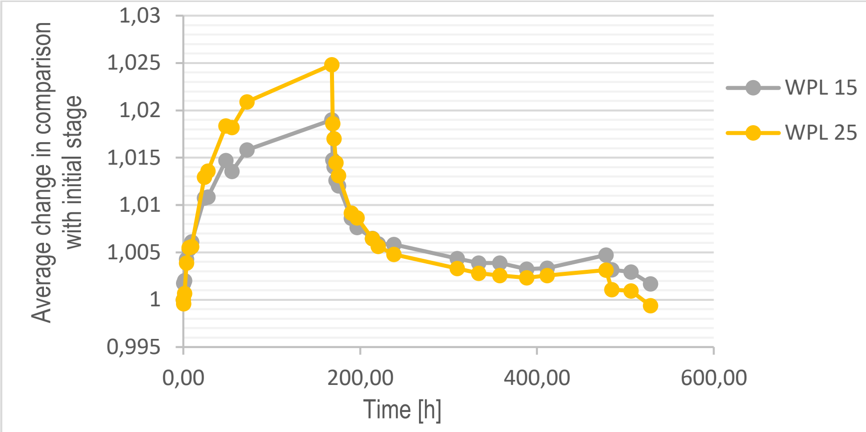

Figure 2. Adsorption and desorption curve of WPL 15 and WPL 25 specimens

In hygromorphic biocomposites based on natural fibres manufactured by thermocompression, the adsorption and desorption behaviour tends to be slightly asymmetric. The actuation rate is temporally non-linear with a rapid increase for a short time and a subsequent deceleration effect before reaching the saturation regime (Le Duigou et al., 2016). For multi-materials, the mechanisms induced by desorption tend to be slower than those occurring during adsorption. As stated by Le Duigou and co-authors (2020) this is due to the very low sensitivity of the passive layer, which can protect the active layer from convective drying by air.

The causes of sorption hysteresis are equilibration time, energy losses due to plastic deformations, formation of hydrogen bonds, contact angle of capillary condensation and internal stresses (Gorišek, 2009).

3.2. Bending properties of selected materials

In Table 2 modulus of elasticity (MOE) values for samples conditioned at 65 % RH are presented. Values of material with 25 % wood content were higher than those of material with 15 % wood share. The results are expected and are consistent with previously reported studies. Kariž and co-authors (2018) identified small increases in MOE and tensile strength values measured at lower wood additions, but these decreased at higher loads. At low wood additions, the wood particles can act as reinforcement, but at higher loads, the polymer cannot fully encapsulate the particles, resulting in poor bonding and limited load transfer.

As described by Martikka and co-workers (2018) parts made of wood-plastic composites have notably lower MOE, tensile strength and impact bending strength than those made of pure polylactic acid. This was also the case in our study as presented in Table 2.

*Table 2. **MOE** for samples conditioned at **65 % RH***

Specimens	Average MOE in [N/mm^2] at 65 % RH	St. dev.
PT	3107	222
WPL 15	2168	139
WPL 25	2238	237

3.3 Shape change of bimaterial actuators in changing climate

The idea of shape-changing bimaterial actuators is based on bimetal actuators. Bimetal actuators use two metals with different coefficient of thermal expansion. However, in our research we used materials with different swelling / shrinkage coefficient. The change in shape of bilayer actuators depends on selected material properties (dimensional stability and MOE) and its thickness ratio in the composite (Timoshenko S., 1925).

The samples in our research were made of PLA (with higher MOE, but dimensionally stable) and wood-plastic composites (lower MOE, and higher dimensional changes under changing climate). Thinner samples react quicker and the longer the piece, the greater is the deformation and change of curvature.

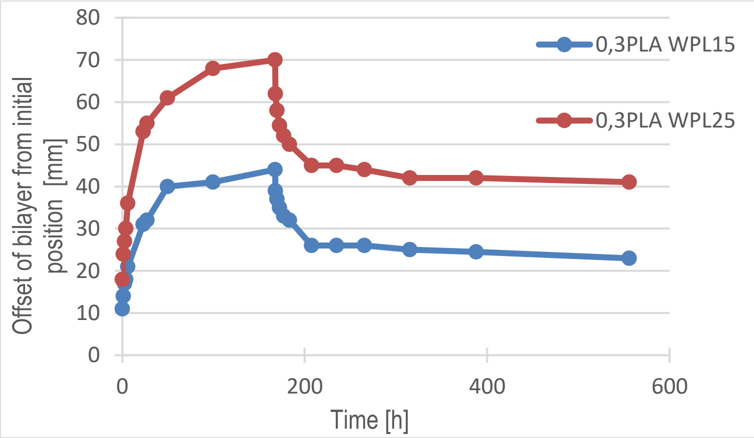

Figure 3. Curvature offset from initial position of two bilayer actuators (0.3 PLA WPL15 and 0.3 PLA WPL25) during moisturizing and drying

Natural fibres act as an actuator in swelling, therefore hygromorphic biocomposites should be developed with as high a volume fraction as possible. A high natural fibre content promotes faster and stronger swelling, thus improving both reactivity and response of the actuator, which is also evident in the presented results (Figure 3).

As noted in previous research by Le Duigou and co-authors (2017), the hygroscopic properties (sorption and swelling coefficients) of biocomposites are influenced by the nature of the fibres involved, i.e., their microstructure (cellulose MFA and lumen size) and biochemical composition (pectins, hemicelluloses and lignin).

The higher the fiber content, the greater the difference between wetting and drying rates, reflecting a hysteretic behaviour typical of the sorption mechanism of natural fibers (Hill et al., 2009). The reactivity of the composites is directly linked to the rate of water sorption and transport in wood.

4. CONSLUSION

To conclude, Wood-PLA composites with different wood content could be used as materials for shape-changing actuators/products.

It was observed that strains and mass change are bigger for material with higher wood content (WPL 25). Research has shown that PLA and Wood-PLA materials can be used to 3D-printed shape changing actuators, that change in alternating climate conditions. Further research is needed to evaluate long-term behaviour and potential application in products.

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THE QUALITY OF WOOD-PLASTIC COMPOSITES AND THEIR IMPORTANCE FOR THE CIRCULAR ECONOMY

Renata Novakova, Jana Šujanová, Viera Horváthová

Abstract The wood-plastic composite material produced by a combination of wood and plastic uses the good properties of both materials and remains an environmentally friendly and recyclable material. However, this is not a complete novelty. Such materials have been known since the early 20th century. The content of our contribution will point out the qualitative attributes of the so-called wood of the future and its importance for the circular economy.
Keywords: quality, wood-plastic composite, circular economy

1. INTRODUCTION

The environment we live in is changing very quickly. We are talking about global changes that have a major impact on society as a whole, on industries, on products and services. Organizations have two options. They will either adapt to these changes or their future will not be rosy. The topic that is the subject of this paper concerns megatrends focused on resource scarcity and the growing environmental crisis. The lack of resources is linked to population growth, growing demand for energy, food, water, minerals and fossil fuels, and the need for a circular economy. The ecological crisis, in turn, is associated with irreversible changes in the environment and industrial disasters. One of the acute problems is deforestation. At present, about 30% of our land is covered by forests, but thanks to deforestation, we lose an area of forests every day that is equal to 2 times the size of High Tatras.
There is no need to talk about the importance of forests. There are known facts such as that more than 80% of the world's biodiversity on earth is found in forests, tropical rainforests give us 20% of total oxygen, 1.6 billion people worldwide find livelihoods, drinking water, shelter and traditional forms of medicine in forests. Forests are allies against global warming, they absorb 2.4 billion tonnes of carbon dioxide every year and we could continue. Agriculture, livestock, illegal logging, paper production, construction, etc. have a negative impact on deforestation in particular.

The use of wood in the construction industry has a history. The first technically significant wooden buildings were built in the Neolithic period, but wood occurs in virtually all architectural styles (earch.cz/cs/stavitelstvi/potencial-vyuzitia-dreva-v-udrzatelnej-vystavbe).
Wood is also of great importance in terms of quality properties for sustainable construction.
Increased use of wood as a substitute for other raw materials has an impact on effective thermal protection, the total amount of accumulated carbon, energy intensity, but also on pricing in the sector. An important trend is the use of modern wood-based materials. Such materials have excellent mechanical and technological properties, excellent diffusion and insulation properties, high homogeneity, low thermal conductivity and the like. (Forintek Canada Corporation - 1991: Building Materials in the Context of Sustainable Development - An Analytical Framework, Forintek Canada Corporation and Wayne B. Trusty & Associates Limited) These include the

so-called wood plastic composites. It is a combination of wood, most often in the form of wood fibers, or fine wood dust and polymer with various additives.

Composites that combine wood and plastics have been known since about the beginning of the 20th century. The first composite consisted of wood flour and phenol formaldehyde resin. The American company Strandex is considered to be a pioneer in the development of a new material based on wood flour and polymer. In Europe, the Czech company WPC-Woodplastic is one of the most important producers of quality wood composite. It owns a Strandex license for a unique production process, which it further improves in cooperation with research centers. Products of the company that combine wood flour, or. other natural fibrous material as thermoplastic matrix fillers are called, as already mentioned, wood-plastic composites (Wood-Thermoplastic Composites or Wood-Polymer Composite - WPC). Lignocellulose is used in the production of thermoplastics to reduce costs and at the same time improve mechanical properties. Interest in the use of these materials has been aroused by the rising price of plastics and the emphasis on renewables. (Novák, P.: istavebnictvo.sk) (Smith, PM - Walcot, MP: Opportunities for wood / natural fiber-plastic composites in residential and industrial applications. Forest Prod., J. 56 (3), 2006, s. 4 -11)

2. WOOD-PLASTIC COMPOSITES

The material for the production of wood-plastic composite can be divided into three groups: i) Wooden part, ii) Polymer and iii) Additives.

Wood flour is produced from sawdust, dust and wood chips produced during wood processing from hard and soft wood waste. It is also possible to use other cellulose sources such as e.g. straw, flax, rice husks, peanut husks, coconut fibers, jute, bamboo dust. The most commonly used polymers are polyethylene (PE - 80% on the market), polypropylene (PP - 10% on the market) and polyvinyl chloride (PVC), or lactic acid polymer (PLLA). By additives are meant various binders, UV stabilizers, pigments, flame retardants, lubricants, fungicides and foaming agents. (Novak, P .: istavebnictvo.sk)

The mechanical properties of wood-plastic composites depend on the material used and the technology of its production, specifically on the ratio of individual components in the total volume and on the size of the wood particles. Compared to wood, wood-plastic composites are characterized by better mechanical and chemical properties. They have better dimensional stability at different degrees of humidity and resistance to wood-destroying fungi.

The production of WPC - Woodplastic boards is based on extrusion with the help of laser-controlled technology, which guarantees maximum accuracy of the entire production. The composition of the mixture is patented. However, it approximately contains the following composition: about 60% wood flour and 40% polymer. To this must be added the necessary amount of binder, glue, UV stabilizers and dyes. The production uses wood from European forests and in most cases, it is wood from PEFC-certified suppliers.

3. PEFC - QUALITY BRAND

PEFC is the world's most widely used forest certification system. Forest management standards under the PEFC system seek to change the way forests are managed locally and globally. The aim is to preserve and expand forests while maintaining a responsible approach to the forest ecosystem and respect for nature.

PEFC, through the promotion of sustainable forest management, ensures that timber and forest products are produced throughout the supply chain in compliance with the highest environmental, social and ethical standards. Thanks to the PEFC brand, customers and consumers can identify forest products that are managed in a sustainable way. The PEFC criteria are regularly reviewed through a process of global consultation involving the public, businesses, governments, employers and research organizations. At present, PEFC has 49 members based on national forest certification schemes. (pefc.sk/files/documetns/materialy-a-zdroje/propagacne-materialy/pefc_znacka_kvality.pdf)

Just for the sake of interest, in Slovakia more than 60% of forest areas are currently certified in the PEFC scheme and more than 130 companies are proving their social responsibility by participating in the PEFC certification of the consumer chain.

In practice, there is a similar certification scheme Forest Stewardship Council (FSC), which is preferred in Slovakia in the program statement of the Government of the Slovak Republic.

What does the PEFC brand offer entrepreneurs?

- Demonstrating social responsibility policy
- Improving the image of a responsible company using wood and paper from renewable sources

What does the PEFC brand offer consumers?

- A guarantee that wood, fiber and non-wood products marked with a tree green logo PEFC come from sustainably managed forests.

4. ADVANTAGES OF USING WPC BOARDS IN THE CIRCULAR ECONOMY

One of the advantages of wood-plastic composites is that their processing does not require special procedures and they can be machined on conventional woodworking machines. The big advantage is the long service life with minimal maintenance. A very important consideration is the elimination of insects, load, grease, dust, solar radiation, as well as resistance to mildew, wear, or swimming pool chemicals. *A big advantage is also 100% recyclability. None of the substances used is toxic and the final products are suitable even for the youngest children.*

Woodplastic is based in Bukovany, Czech Republic. In 24 hours, it produces more than 20 tons of wood composite of the highest quality. That's practically six kilometers of boards a day. The quality and originality of the products is guaranteed by the so-called birth certificate with a unique numerical code, which is part of every product or every invoice for goods leaving the factory gates. The company exports its products to more than 40 countries around the world. The business model of WPC - Woodplastic is based on three basic pillars and that is: quality product, fully equipped customer-oriented terrace centers and a network of dealers and a base of stable partners - architects and designers and certified experts for terrace installation and assembly in Slovakia, Czech Republic and abroad. . (istavebnictvo.sk/clanky/kvalitne-drevoplastove-kompozitne-materialy-wpc-ponukajú-viac-nez-len-alternativu, published 8.1. 2020). The boards are colorfast, do not change their shape or turn gray. No chips or grafts are formed on quality boards. They have a full profile, so unlike some hollow plates, they do not twist or crack. They are easy and fast to mount without the need for anchoring to a solid base. The boards have a non-slip surface which, thanks to the hidden anchorage, remains smooth and compact without the risk of injury.

5. CUSTOMER PREFERENCES WHEN BUYING WPC BOARDS – RESULTS

WPC products appear to be a material that is gaining more and more satisfied users on the market. Therefore, we were interested in which quality criteria customers prefer. The analysis of customer preferences was carried out through a structured interview on a sample of 25 respondents. All respondents were potential customers interested in purchasing WPC boards for outdoor use.

The structured interview consisted of 5 questions and a choice of predetermined answers. In question no. 4, respondents were asked to prioritize their preferences and number them in ascending order from no. 1 to no. 11. The aim was to find out which of the qualitative criteria respondents put in the first, second and third place as the most important for their decision to buy a composite product. In this question was summarized criteria on this issue, which are also related to sustainable management.

It goes without saying that it will be necessary to abstract from some facts such as reason and purpose of using the composite material. Other preferences may have customers who want to use the material as a wall covering, other customers who want to use the material as a pool area, others for customers who are dealing with covering the terrace. It also depends on whether the customer will solve the project independently or assign it to the company for implementation. It also depends on the amount of material used. If only a smaller amount is used, it is not necessary to prioritize the price, but if it is a larger area and added structures, then the price can play a more important role. There are several such factors that can significantly affect the survey. Therefore, we have only taken into account the properties that are declared for the product. Specific samples of the composite material were used so that the respondents could look at them, touch them and imagine their specific use.

Table 1. Respondents' answers to a structured interview in qualitative and quantitative terms (own processing)

1. Where did you learn about the product?	Frequency of respondents' answers
- Social networks	8
- References from the satisfied customer	2
- Recommendation of a specialized dealer	2
- From advertising in print media	9
- Accidentally	4
2. What is your reason for choosing a WPC product? (you can mark more than one answer)	
- I prefer a modern materials	6
- I am a supporter of ecological materials	12
- the product must be recyclable	17
- the product don´t must to be overpriced	21
- the product must be readily available on the market	11
- I have not special reason	2
3. Is it important for you to have a quality mark?	
- yes I prefer products that have a quality mark	15
- it is not my priority	4
- I never thought about it	6
4. 1. Which of the properties of the WPC product do you prefer? Determine the order of properties	
- Multicolor combinations	3.
- The appearance of wood	2.
- Health-friendly material	1.
- Low price	4.
- Easy accessibility	6.
- Resistance to UV radiation	9.
- Resistance to wood-destroying fungi	
- Resistance to bending	10.
- Recyclable material	
- Easy installation	5.
- Anti-slip properties	11.
- Long material life	12.
5. How do you want to use WPC wood-based panels?	
- Terrace floor - Around the pool - Fencing - Wall cladding	12 4 6 3

Interesting information emerges from the above. Most of the respondents learned about WPC boards from print media, followed by social networks in second place. After a more detailed survey, we learned that it was mainly the catalogs that focus on construction. It is possible to present in more detail the product, its various variations, properties and even finished designs.
The second question, which concerned the reasons for choosing a product, was answered by most respondents that it should not be overpriced. Customers are looking for materials that are affordable. To some extent, this also follows from the economic situation. We are pleased that customers are also becoming interested in the issue of recyclability.
The third question was about quality awareness through quality brands. Here it was confirmed that customers are interested in whether the product has a quality certificate, or more precisely whether it includes any of the awarded brands, which inspires confidence in the qualitative characteristics focused on the product, but also on the production itself and the social responsibility of the producer.

The fourth question was more complicated, as we asked the respondents to rank the quality criteria from the most preferred to the less preferred, respectively. Customers had to determine the order from 1 to 12. Here, the different requirements and preferences of customers were demonstrated in relation to the use of the product. Where a large number of customers agreed on the order, it was entered into the table. The answers of customers can be found in table no. 3. It must be said that the transcendent perception of quality has been confirmed here, which means that what the customer does is his individual view of product quality. Most responses to Rank 1 related to the requirement - Material harmless to health. In second place was the preference for demand - the appearance of wood. It was interesting to note that the criteria of UV resistance and anti-slip properties were placed in 11 places at the same time. Although we have abstracted from the specific use of WPC material, what has been confirmed here is the main reason for choosing such a product - exterior use and safety. The low price request is located in the 4th place. This fact only confirmed the answer from question no. 2, that customers are not interested in overpriced products.

6. CONCLUSION

Manufacturers strive to adapt to customer expectations and preferences. Customer requirements change following changes within megatrends. While in the past there was a greater emphasis on quantity, now quality attributes are important. Many companies try to declare to their customers that they behave in an environmentally and socially responsible manner and transfer this evidence to the properties of products and quality labels that are part of their marketing strategies. The above survey only confirmed that customers are looking for products that are not harmful to health, are safe, are similar to natural materials, but at the same time are not as expensive as traditional wood materials. Of course, we must take into account what we want to use composite materials for and what their strong point is compared to traditional materials. Our assumption that customers' preferences for quality are beginning to change, and although wood as a traditional material will always find its customers, there will be an increasing portfolio of those who will focus on recycling, safety, health and affordability. Wood products are also relatively difficult to maintain, which is another reason why customers will look for a replacement product that is very similar to wood, but the demands for additional maintenance will be minimal.

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DETERMINATION OF SUCCESS SAWMILL PROCESSING OF PEDUNCULATE OAK (*Quercus robur* L.) LOGS BY LIVE SAWING METHOD

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Abstract: This paper theoretically and through experimentally researches the performance indicators of sawmill processing of Pedunculate oak (*Quercus robur* L.) logs in sawn boards. The research covered the sawmilling logs of the oak classified according to the Croatian standards HRN D.B4.028 into two qualitative classes: second and third class. Diameter of processed logs were in range between 30 to 39 cm and 4 m long. Logs were sawn up in the 25 and 50 mm nominal thickness of sawn boards. Automatized line based on vertical log band saw with hydraulic carriage was used for primary sawing up. Secondary sawing was carried out by the classical cross-rip sawing process on machines with individual sawing. Smaller products were made on a band saw and a cross cut circular saw. Quantity yield in live sawing of the oak logs observed in this research was around 57,29 %, quality yield 87,89 % and value yield 50,35 %.

Keywords: pedunculate oak (*Quercus robur* L.), sawmilling logs, sawmilling production, sawn board, log quantity yield, quality yield, value yield.

1. INTRODUCTION

The most used and most value and important wood species in Europe is Oak. Croatian sawmill processing is mainly based on the tradaditional processing of Slavonian oak (Prka, 1978). Quantitative yield significantly depends of diameter and quality of oak logs. Value yield of logs increase with increasing quality and diameter of the logs (Prka, 1988). The yield of raw material, as well as the quality and dimensional structure of sawn products, depends on the method of sawing. Also the quality of raw material is the most important factor for yield of logs (Petutschnigg and Katz, 2005). The dimensions of the log (Tanušev et al., 2009) also is important for yield. With increasing log length the volume yield decreases, however, less, when the top end diameter is less. While analysing the impact of top end diameter it is obvious, that the intensity of changes in volume yield increases with greater log length and taper (Baltrušaitis et. al., 2001). Processing of the Oak logs by live method is usually carried out on log band saws. In general the yield of raw material, as well as the quality and dimensional structure of sawn products, depends on method of sawing (Skakić, 1985). Main aim of this research was to show theoretically and through experimentally researches the performance indicators of sawmill processing of Oak logs in sawn boards.

2. MATERIAL AND METHODS

The oak sawlogs, 30–39 cm in diameter and 4 m long, were used in this research (Figure 1). Twenty logs were prepared for live methods of sawing (Figure 2). Sawlogs were made with almost the same quality and dimensions acording HRN D.B4.028. Sawing pattern was not predefined but it was adapted according to quality, dimensions and shapes of logs. The main goal of processing was to make products of the highest quality and highest possible value.

Measurements taken were: length of log (l), diameters without bark (top end - d, mid length – d_m, butt end – D).

Figure.1. Oak logs processed in research *Figure.2. Sawing patterns for Oak logs-live sawing*

Volume of logs without bark (V_l) was calculated according to the formula 1. (Šoškić et al. 2010).

$$V_l = \frac{\left(\frac{d + d_m + D}{3}\right)^2 \pi}{4} \cdot l \qquad (1)$$

Values of diameters were calculated as the mean value of two crossmeasurements. All dimensions were rounded to the nearest centimeter whitout bark. The thickness of bark was measured with a precision of 0.2 mm, and the mean value of four sample measurements on each log was used. The volume of bark was calculated as the difference between volumes of each log with and without bark. Primary sawing was carried out on a log band saw (Primultini SHF, flywheels diameter 1400 mm). Logs were sawn into 25 and 50 mm thick sawn boards, parallel to the central log axis. Blade parameters were: width - 206 mm (band saw), thickness – 1.47 mm (band saw), and breadth of swage set on one side – 0.3 mm. Secondary sawing was carried out by the classical cross-rip sawing process on machines with individual cuts, and smaller products were made on a band saw and a cross cut circular saw (Figure 3).

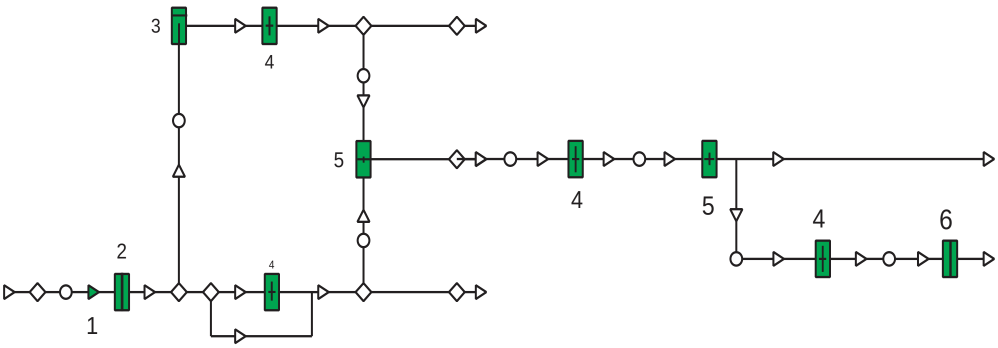

Figure.3. Technological flow of log sawing (1 - transporter for sawlogs, 2 - log band saw, 3 - resawing band saw, 4 - circular saw for cross sawing, 5- circular saw for rip sawing, 6- band saw for making small sawn products).

Long and short edged sawn boards, half edged and un-edged sawn boards, as well as small products, elements for flooring strips and squares were produced. Standard applied in this process were HRN EN 975-1. Different kind of products, which were produced are presented by Figure 4. The quantitative yield was calculated by dividing the volume of sawmil products by the volume of logs without bark. Analysis of the sawmil product structure was done for each group of products (unedged and edged sawn boards and small sawn wood products), calculated as the share in the total volume of products. Due to its irregular shape, the total volume of large wood waste (slabs, edgings and trimmings) was calculated as a ratio of waste wood mass and wood density. Based on five randomly chosen products from each log, by measuring their mass and dimensions average wood density was calculated. The difference between the log volume, sum of product volume and large wood waste volume obtained as the volume of sawdust.

A B C

Figure 4. A - Un-edged and half edged sawn boards, B - Edged and half edged sawn boards C - Small wood products (elements for flooring strips and squares)

Quantitative yield is a very important indicator of sawmill processing success. The objective assessment of the effects of production is often made by the value yield. This is often calculated by using the value of production, expressed in a currency per unit of the area or volume (Shepley et al., 2004).

This is a simple and practical method and it was used as one of the indicators of value yield in this research. Factors that can be included in the calculation of quantity, quality and value yield and which in this research used were:

$Y_{Quantity}$ – quantity yield in form of sawn board and small sawn wood products
$\sum V_{sawn\ board}$ – total sawn board and small sawn wood products volume, m³
V_{log} – total log volume, m³
$V_{sawn\ board\ 1 \dots n}$ – single sawn board and small sawn wood products volume, m³
$N_{sawn\ board\ 1 \dots n}$ – number of sawn boards and small sawn wood products of the same volume
$Y_{Quality}$ – sawn board and small sawn wood products quality yield
$k_{sawn\ board\ 1 \dots n}$ – quality index of sawn board and small sawn wood products of the same quality group
$Y_{Quality\ €/m3\ sawn\ board}$ – monetary value of the sawn board and small sawn wood products quality yield, €/m³
cp – price of sawn board and small sawn wood products whose quality index is selected as 1, €/m³

Y_{Value} – log value yield in the form of sawn board and small sawn wood products
$Y_{Value\ €/m3\ log}$ – monetary value of the log value yield in the form of sawn board and small sawn wood products, €/m^3.

Calculation was done according to the formula 2 to 6. (Brežnjak, 1997):

$$Y_{Quantity} = \frac{\sum V_{sawn\ board}}{V_{log}} \quad (2)$$

$$Y_{Quality} = \frac{V_{sawn\ board_1} \cdot k_{sawn\ board_1} + V_{sawn\ board_2} \cdot k_{sawn\ board_2} + \ldots + V_{sawn\ board_n} \cdot k_{sawn\ board_n}}{V_{sawn\ board_1} + V_{sawn\ board_2} + \ldots + V_{sawn\ board_n}} \quad (3)$$

$$Y_{Quality\ €/m3\ sawn\ board} = Y_{Quality} \cdot c_p \quad (4)$$

$$Y_{Value} = Y_{Quantity} \cdot Y_{Quality} \quad (5)$$

$$Y_{Value\ €/m3\ log} = Y_{Value} \cdot c_p \quad (6)$$

3. RESULTS

The values of calculated yield are shown in Table 1 and structures of sawmill products made of oak saw logs are shown in Table 2. The data show quantitative yield of live sawing. The structure of quantity yield (%) is shown also graphically (Figure 5). However, in this research differences were not statistically confirmed due to high variation within the groups. Anylysis of variance and descriptive statistics showed that there is stastistically significant difference between sawed logs, different dimensions and quality only between volume of the groups of logs.

Table 1 Calculated yield based on the used method of sawing

Yield	Method of sawing	
	Live	
	Value	Unit
$Y_{quantity}$	57,29	%
$Y_{quality}$	87,89	%
$Y_{quality€/m^3}$	428,89	€
Y_{value}	50,35	%
$Y_{quality€/m^3\ log}$	245,73	€

Table 2 Structure of quantitative yield (%) based on the used method of sawing

Wood products	Live [%]
Total, un-edged and half-edged wood	19,47
Total, edged wood	12,92
Small wood products elements, strips, squares	24,71
Raw material yield	57,29
Large waste	17,43
Sawdust	15,16
Total Waste	32,59
Oversize	10,12
Total	100,00

The cause for this can be in the fact that the logs had irregular shape and they had lower diameter. Descriptive statistics and anylysis of variance every category and variables (mid length diameter, top end log diameter, butt end log diameter and length of log) which were compared over statistics analyse are shown in Table 3 and 4, which show that there isn't any stastistically significant difference between sawlogs. Another cause of this also may be in a really heterogeneous structure of sawn products, which results in different secondary processing. Based on the product structure, live sawing clearly differed from some other tangential methods, especially in the number of small sawn products.

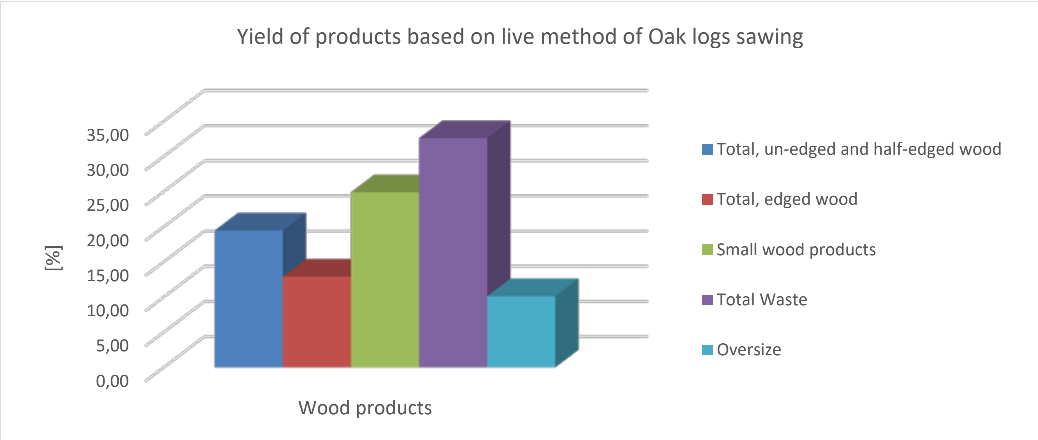

Figure.5. Yield of products for live method of Oak logs sawing

Table 3. Descriptive statistics of dimensions and average values of processed sawlogs

Variable	Breakdown Table of Descriptive Statistics – Logs; N=20								
Method of sawing	N	Mid length diameter, cm		Top end log diameter, cm		Butt end log diameter, cm		Length of log, m	
		Means	Std.Dev	Means	Std.Dev	Means	Std.Dev	Means	Std.Dev
Live	20	30,85	1,52	27,89	1,81	33,82	1,84	4,10	0,13

Table 4. Results of an ANOVA

Variable	Analysis of Variance - Logs Marked effects are significant at p < ,05000							
	SS Effect	df Effect	MS Effect	SS Error	df Error	MS Error	F	p
Mid length diameter, cm	7,5163	2,0000	3,7581	237,434	117	2,0293	1,8519	0,1615
Top end log diameter, cm	9,6542	2,0000	4,8271	368,613	117	3,1505	1,5321	0,2204
Butt end log diameter, cm	7,2060	2,0000	3,6030	262,107	117	2,2402	1,6083	0,2046
Length of log, m	0,1084	2,0000	0,0542	2,107	117	0,0180	3,0086	0,0532
Log volume, m3	0,0127	2,0000	0,0064	0,195	117	0,0017	3,8061	0,2140

A considerable amount of small products in live sawing caused the smallest average product. Radial sawn boards were dominantly obtained by live sawing.

4. CONCLUSION

Methods of sawing have a strong influence on the final quantity of small sawn products. Quantitative yield in live sawing of the oak logs observed in this research was around 57,29 %, quality yield 87,89 % (428,89 €/m^3) and value yield 50,35 % (245,73 €/m^3). Structure of the sawn products was strongly depended by method of sawing. It can be concluded that live sawing yielded the least favorable results comparing with some previous research works. Reason for this is why those products were produced by more precise secondary machines. Considering the market status of oak sawmill products, more attention should be given to economic indicators of success of sawmill processing of this form of sawmill raw material.

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THE DEVELOPMENT OF BIO-BASED ADHESIVES ENABLES A HIGH ADDED VALUE OF RESIDUAL MATERIALS FROM THE WOOD AND PAPER INDUSTRY

Milan Šernek and Jaša Saražin

Abstract: The wood and paper industry produce large quantities of residues and by-products (bark, wood residues and technical lignins), most of which are burned to produce energy. This consumption represents the low added value of this raw material. An alternative is to use these residues for the development of environmentally friendly bio-based adhesives, which could partially replace synthetic formaldehyde-based adhesives. As the demand for adhesives increases, the development of new bio-based adhesives will significantly increase the value of these residues. In the completed study, it was determined that there are sufficient quantities of tannin and lignin from residues for large-scale production of bio-based adhesives. Different types of novel bio-based adhesives (tannin and lignin-based) were developed and tested. The pure tannin-based adhesives were suitable for bonding wood and wood-based composites to be used in dry conditions and showed similar performance as commercial urea-formaldehyde adhesive. With further optimization of the lignin-based adhesives, it was suggested that adhesives containing lignin could also meet the threshold value for bonding of wood to be used in dry conditions.
Keywords: bio adhesives, biomass, wood industry side products

1. INTRODUCTION

The wood and paper industry produces large quantities of residual materials and by-products, most of which are burned to produce energy. These materials are bark and wood residues from the wood industry and technical lignins from the paper industry (we will refer to them collectively as wood biomass).

Wood is the oldest known energy source and also one of the oldest building materials. Even in the Stone Age, the best pieces of wood were used to make various products, and the rest (when dried) was usually good enough for burning. To this day, this has not changed much. The use of wood and wood biomass is now being expanded to several new products, but energy production is still considered one of the lowest added values. Although wood and wood biomass is considered a CO_2-neutral fuel, its combustion is not among the cleanest and, surprisingly, its stocks are not among the most abundant.

Global consumption of fossil fuels is increasing every year and so is the drive to replace them with renewable sources. If all the wood, which was removed worldwide in a year, would be used for energy production, it would represent less than 7% of the total global annual energy consumption (Saražin et al., 2020a), shown on Figure 1. This is further evidence that burning wood and wood biomass should be the last way of use. On the other hand, the same wood biomass can be used as a raw material for the production of various products and new materials. In the production of special chemicals, biomass is usually the only alternative to fossil fuels. This is also the case in the field of wood adhesives.

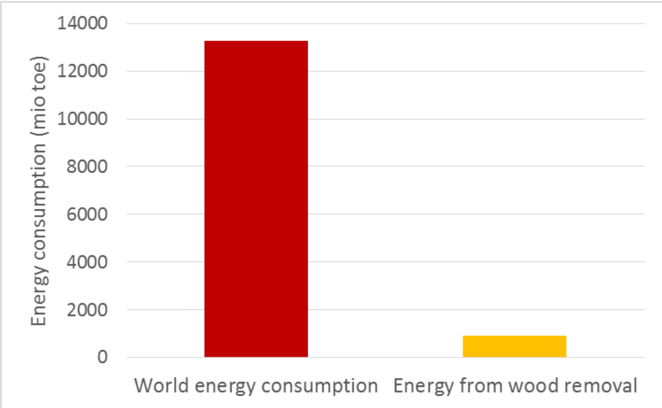

Figure 1. Presentation of energy share, which could be obtained from the global wood felling in 2017 (Saražin et al., 2020a)

2. WOOD ADHESIVES STATE AND PERSPECTIVE

The demand and consumption of wood panels is increasing year by year. In recent years, it exceeded 400 million m^3 per year worldwide (FAO, 2020). It has been assumed that this amount of wood panels requires about 24 million tons of adhesives (Saražin et al., 2020a). 90% of these adhesives are synthetic adhesives. The most commonly used among them may contain up to 50% formaldehyde in the adhesive resin. This methanol derivative is problematic due to environmental and health concerns. For this reason, bio-based adhesives from natural sources have attracted considerable interest since the 1990s.

Various bio components such as tannins, technical lignins, proteins, carbohydrates, unsaturated oils and some others, can be used to produce adhesives (Pizzi, 2006). Due to their phenolic origin and wide natural abundance, tannins and lignins (from wood biomass) are considered to be the most promising solutions among those listed to replace synthetic adhesives in wood panels (Saražin et al., 2020a). Several attempts to prepare different tannin or/and lignin adhesive formulations have been successful at laboratory scale, some of them also in industrial applications. Tannin-hexamine adhesive (Pizzi et al., 1997), tannin-lignin adhesive (Mansouri et al., 2011) and lignin non-isocyanate polyurethane adhesives (Saražin et al., 2021) are some of these perspective formulations for further investigation.

3. TANNIN AND LIGNIN WOOD ADHESIVES

To obtain the optimum tannin-lignin adhesive, the shear strength of different tannin-lignin adhesive mixtures was tested according to the standard EN 205 (2016). Prepared lap joint test specimens were conditioned at standard atmospheric conditions (20/65) before being tested on a Zwick Z005 universal testing machine. For all tannin-lignin adhesive mixtures, the hardener was hexamine (6%) and the pH value was maintained between 11 and 12. The ratio of tannin to lignin varied from 0% to 100% as shown in Table 1. The tannin was extracted from pine bark, while the lignin was obtained from the kraft pulping process (Saražin et al., 2020b). A commercial urea-formaldehyde adhesive (UF) from Dynea and a successful formulation of a tannin-hexamine adhesive (T100R) developed by Pizzi et al. (1997) were used as references.

Table 1. List of tested adhesive mixtures

Adhesive Name	Tannin : Lignin : Hexamine	pH Value
UF	-	6.4
T100R	100 : 0 : 6	6.5
T0-L100	0 : 100 : 6	11.6
T20-L80	20 : 80 : 6	11.7
T40-L60	40 : 60 : 6	11.3
T60-L40	60 : 40 : 6	11.4
T80-L20	80 : 20 : 6	11.4
T100-L0	100 : 0 : 6	11.0

All the specimens bonded with the adhesive mixture containing lignin did not reach the threshold value of 10 N/mm^2 (Figure 2). Only two pure tannin adhesives (T100R and T100-L0) and one commercial UF adhesive passed this requirement, and they were significantly different from all other lignin-containing mixtures. Surprisingly, no significant differences or trend line were found between the adhesive mixtures with the presence of lignins.

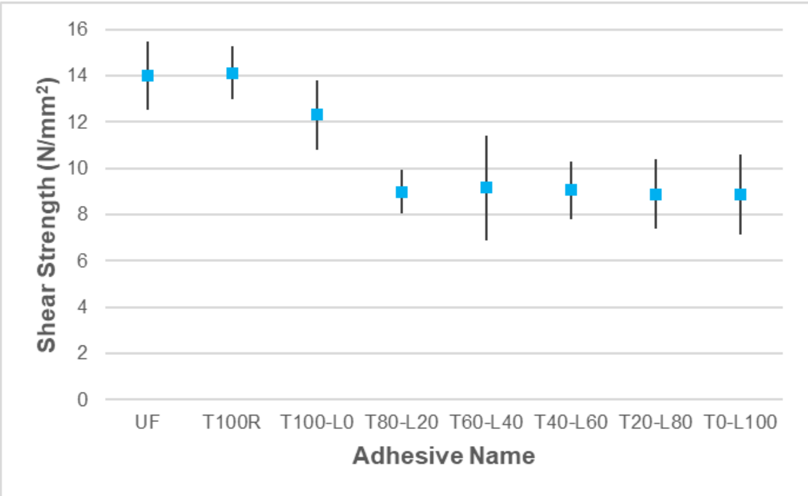

Figure 2. Shear strength results

4. CONCLUSION

However, the deficiency in shear strength of these adhesives to reach the threshold was approximately 10%, and it is assumed that with further optimization of the mixtures (water content and pH value adjustment) and pressing at higher temperatures, tannin-lignin adhesives have a potential for further development and application. Utilization of tannin and lignin in bio-based adhesives has a great potential to result in higher added value to residual wood biomass, comparing to traditional energy production.

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EVALUATION OF THE SURFACE QUALITY DURING LONGITUDINAL FLAT MILLING OF SPECIMENS FROM LINDEN WOOD (*TILIA* SP.)

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Abstract: The current study evaluates the quality of the processed surface during a milling process, performed with knife shaft with spirally arranged flat blades. The influence of the feed rate (V_f) and the thickness of the cutout layer (*h*) on the change of the roughness parameter R_z is investigated. The roughness of the processed surface was measured with a roughness tester, type „Surftest SJ-210“ (Mitutoyo, Japan). As expected, the results confirmed that the feed rate has greater influence on the surface quality, i.e. by increasing of the feed rate, the roughness of the processed surface increases. Based on the performed experiments, graphical dependencies, presenting the influence of the individual factors on the quality of the processed surface were derived.
Keywords: surface roughens, cutting mode, wood milling, Linden wood, *Tilia*

1. INTRODUCTION

Milling is one of the main technological processes involved in the processing of solid wood and wood-based materials, which aims to give a certain shape of the processed details and at the same time to ensure a higher surface quality (higher roughness class). It is well-known that the quality of the processed surfaces may be influenced by different factors, related to the characteristics of the processed material (Sandac et al., 2004), of the cutting tool and at last but not least, to the cutting mode during the material's processing (Keturakis, 2007; Gochev, 2014[b]). When determining the roughness of the wood surfaces, the direction of the wood fibers in which the measurements will be carried out is also important. Due to the anisotropic structure of the wood, the roughness of the surface is different and depends on the orientation of the fibers (Sandac et al., 2004). Some of the influencing factors can be controlled during processing, therefore they should be given more attention and become subject to wider and more comprehensive study in order to be managed in a more adequate way. In the recent years, a number of studies have been focused on investigating the processes related to the longitudinal plane milling and the resulted surface (Costes et al., 2002; Keturakis, 2007; Barcik et al., 2009; Prakasvudhisarn et al., 2009; Rousek et al., 2010; Gonzalez-Adrados et al., 2012; Pinkowski et al., 2013; Wilkowski et al., 2013; Gochev, 2014[a]; Gochev, 2014[b]; Durkovic et al., 2017; Kminiak et al. 2017; Kminiak et al. 2018; Vitchev et al. 2018a; Vitchev et al. 2018b; Vitchev et al. 2018c). Their common goal was to assess and determine the optimal parameters and conditions, assuring higher surface quality.

In relation to this, the aim of the current experimental study was to investigate the influence of the following factors: the feed speed (V_f) and the thickness of the cut-out layer (*h*) on the surface quality of details from Linden wood (*Tilia* Sp.) during longitudinal plane milling with knife shaft with spirally arranged flat blades.

2. METHODOLOGY

The experiments have been performed using woodworking planer machine, type Hammer A3-41 (Felder Group, Austria) (Fig. 1) with the following technical characteristics: power N = 4 kW; rotation frequency of the knife shaft n = 5000 min^{-1}; diameter and length of the knife shaft D = 72 mm and L = 400 mm, respectively.

Figure 1. Planer machine, type Hammer A3-41 (Felder Group, Austria) – general view

The cutting head consists of 62 segment knives with a side length of 13.8 mm, arranged spirally versus the axis of rotation of the shaft (Fig. 2).

Figure 2. Cuter head with segment knives

The machine is equipped with a roller feeder (Fig. 3) with a two-speed motor with power N_1 = 0.75 kW. Thanks to the two engine speeds and the exchange of gears in the gear, the feeder provides four possible feed rates (V_f), namely: 4, 8, 11 and 22 m.min^{-1}.

A *B*

Figure 3. Roller Feeder: A – general wiue; B – gear

In the course of the study, details from Linden wood (*Tilia* Sp.), with the following characteristics: density ρ = 530 kg.m^{-3} and moisture content W = 11,5 %, determined respectively in accordance with BDS ISO 3131 and BDS ISO 3130, have been processed. The processed details were with the following dimensions: longitude (l) 1000 mm and milling width (b) 60 mm. The details were fed automatically by a roller feeder.

In order to evaluate the influence of the factors: feed speed (V_f) and thickness of the cut-out layer (h) on the roughness of the processed surface, they were changes, as follows:

- Feed speed V_f – 4, 8, 11 and 22 m.min^{-1};
- Thickness of the cut-out layer h – 1, 2 and 3 mm.

In order to assess the quality of the treated surfaces, depending on the variables, the roughness parameter R_z, µm, was used. It has been determined separately for five base lengths in the longitudinal direction of the wood fibers of each part. For each base length R_z is determined by the mathematical equation:

$$R_z = \frac{\sum_{i=1}^{5}\left|y_{p_i}\right| + \sum_{i=1}^{5}\left|y_{V_i}\right|}{5}, \mu m \quad (1)$$

where:
y_{pi} is the height of the biggest roughness of the profile, µm;
y_{vi} is the depth of the greatest slot of the profile, µm.

The surface roughness of each detail was determined using the mean average value $\overline{R_z}$ from the five measurement. The applied methodology is in accordance with BDS EN ISO 4287 and is described in detail (Gochev, 2005; Gochev, 2018). The measurements were performed with the digital roughness tester, model „Surftest SJ-210“ (Mitutoyo, Japan) (Fig. 4).

Figure 4. Roughness tester, model Surftest SJ-210 – general view

3. RESULTS AND DISCUSSION

Based on the performed experiments, the roughness of the surfaces, processed by longitudinal plane milling of linden (*Tilia* Sp.) wood was evaluated depending on the feed speed (V_f) and the thickness of the cut-out layer (h). The assessment was made based on the roughness parameter R_z (µm).

3.1. Influence of the feed speed

The change of the roughness of the processed surface depending on the feed rate is presented in Fig. 5.

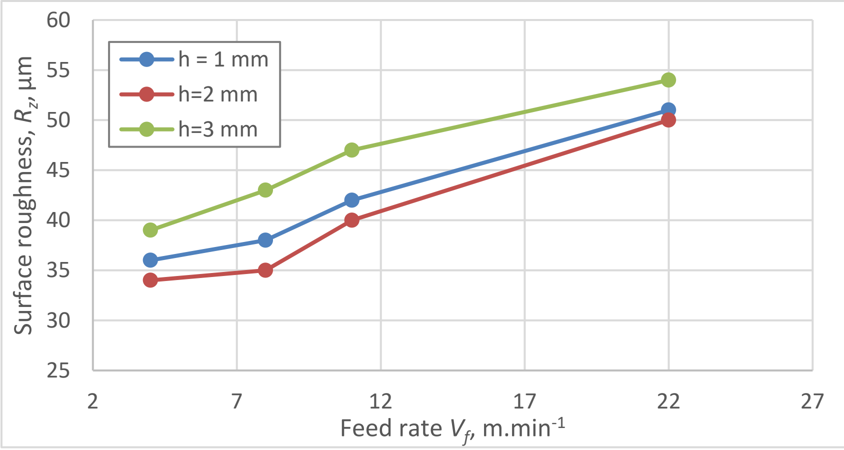

Figure 5. Changes in the roughness of the processed surface (R_z) depending on the feed speed (V_f)

The obtained results clearly confirm the influence of the feed rate on the surface roughness. As the feed rate increases, the value of the roughness parameter R_z also increases. This relationship between the two parameters is confirmed by other studies, performed in our laboratory (Vitchev et al. 2018a; Vitchev et al. 2018c; Vitchev, 2019). From the graphs on Fig. 5 it can be seen that the tendency of the roughness to change with increasing feed rate (V_f) is the same for all three thicknesses of the removed layer. Despite the small differences in the values of the parameter R_z, at different thicknesses of the cut-out layer, it has to be noted that the highest quality is achieved at the thickness of the cut-out layer h = 2 mm. More specifically, at h = 2 mm, the value of the roughness parameter R_z varies from 34 µm at feed rate V_f = 4 m.min^{-1} to 50 µm at feed rate V_f = 22 m.min^{-1}, which is equivalent to a 32% reduction in roughness at the highest feed rate (V_f = 22 m.min^{-1}) compared to the lowest V_f = 4 m.min^{-1}). However, despite the large difference, both groups of specimens, processed at the lowest and highest feed rates belong to the roughness class VIII with limit values of the roughness parameter R_z from 32 µm to 60 µm (Gochev, 2005; Gochev, 2018).

3.2. Influence of the thickness of the cut-out layer

Figure 6 depicts the changes in the quality of the processed surfaces, presented by the roughness parameter R_z, depending on the thickness of the cut-out layer at the four different feed rates.

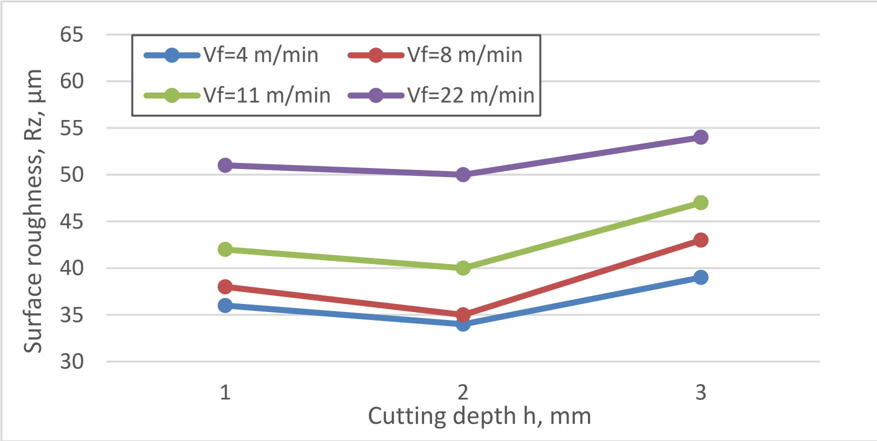

Figure 6. Change in the roughness of the processed surfaces (R_z) depending on the thickness of the cut-out layer (h)

The obtained results show some influence of the thickness of the cut-out layer (*h)* on the quality of the processed surfaces, but it is significantly less compared to the influence of the feed rate (V_f). For all four feed rates, the changes in the roughness curves influenced by the change in the thickness of the removed layer show the same tendancy. From the graphs it is visible that the highest quality is achieved at the thickness of the cut-out layer h = 2 mm and feed speed V_f = 4 m.min^{-1}. In this experiment the value of the roughness parameter R_z varies from 36 µm at h = 1 mm to 39 µm at h = 3 mm.

4. CONCLUSION

The following conclusions can be drown, based on the performed experiments to assess the surface quality of specimens from linden (*Tilia* Sp.) wood during milling, performed with knife shaft with spirally arranged flat blades.

- It was confirmed that the feed rate (V_f) has higher influence on the surface roughness compared to the thickness of the removed layer (h) (Fig. 5).
- Depending on the specific parameters of the variable factors (V_f and h) the values of the roughness parameter R_z vary from 36 µm to 54 µm, which qualifies the treated surfaces to roughness class VIII.
- When compare the roughness curve at the feed rate V_f = 4 m.min^{-1} vs V_f = 8 m.min^{-1} (Fig. 6) it is visible that the values of the parameter R_z are almost equivalent. In relation to these results, the feed rate value of V_f = 8 m.min^{-1} and the thickness of the cut-out layer value of h = 2 mm can be recommended as optimal to ensure a high process productivity.

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RESEARCH OF TRADITIONAL CONSTRUCTION AND HERITAGE OF ZAGORJE REGION AS A BASIS FOR DESIGN REQUIREMENTS OF A MODERN PREFABRICATED OBJECT FOR PUBLIC EVENTS

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Abstract: The article seeks to determine the features of traditional architecture in Croatia as a continuation of the last year's research of the same title in the Posavina region (Lozančić et al., 2020). This research is focused on Zagorje region and defines the aesthetic characteristics of traditionally built houses. An analysis of building features of traditional structures in the Kumrovec area was carried out with the help of various literature and collected photographs. The data and answers of several interviewed experts in the field of traditional heritage, construction and interior design were obtained. The presented data will serve as the main and continuous inspiration for the design of a small and movable contemporary public facility (stand) based on stylistic, aesthetic and structural wooden components of Croatian traditional buildings.

Keywords: traditional wooden construction and design, heritage, small houses, contemporary displays

1. INTRODUCTION

This article is a continuation of last year's research project CROSTAND that dealt with the characteristics of traditional houses in the Posavina region (Lozančić et al, 2020) and in which basic characteristics of houses in Posavina from villages Krapje and Čigoč were analysed.

This article brings out research results of the first phase of continued research project CROSTAND2, and will analyse the characteristics of traditional houses in Hrvatsko Zagorje, village Kumrovec.

Hrvatsko Zagorje is part of the peripheral area of the Pannonian cultural zone and influenced by the Alpine cultural circle in the western part of the zone. Every traditional construction reflects the circumstances of the region (including Zagorje), such as overpopulation and poverty. Those circumstances arise from events such as deforestation that have caused earth erosion that carried away the fertile land from that hill area, leaving an infertile and loamy soil (Živković, 2013).

1.1. The aim of the research

The aim of the paper is to collect and present visual, aesthetic and specific details on wooden structures and construction processes used in traditional building in Hrvatsko Zagorje region as the main inspirations for the next step in design concepts of contemporary public spaces.

2. MATERIALS AND METHODS

The research was conducted in March 2021 in Kumrovec village in Hrvatsko Zagorje, Croatia. Museum exposition in "Staro selo Kumrovec" (Old Kumrovec village) under the name "Život zagorske obitelji" (eng. Life of a Zagorje family) presents an ambiance of a Zagorje collective of the Sutla region (Sutla is a river in Zagorje).
Two main methods used in this research were photography and interview. Photographic documentation has the aim of its later analysis and interview with the curators of the exhibition in Kumrovec. The interview has helped to explain the details and history of traditional design and constructions of objects situated at the observed location.

3. RESULTS AND DISCUSSION

A typical Zagorje house, the so-called "hiža", has is known for four basic types: wooden single-story houses, "mazanka" houses, multi-storey brick houses and single-storey brick houses or "zidanice" (Demonja and Baćac, 2013.). Brick houses used to be made out of stone called "lomljenca" (Figure 1), and "mazanka" houses (Figure 2) were made out of wood.
The outer walls of houses with wooden structures (mazankas) were often coated with a mixture of white or gray loam, chaff and dung as binder materials, while interior walls were covered with a mixture of loam and chaff. Limewash and copper(II)sulfate or iron(II)sulfate were applied when the first coat had dried out (Šarić, 2011). Houses were often coated due to aesthetic reasons, but mostly to protect their wooden structures from being affected by atmospheric conditions (temperature, moisture, rain and other) and pests (insects, fungi and bacteria). The visible part of the foundation was made out of stone called "lomljenca". "Coklin" or the foundation wall bound with lime was painted in black by mixing soot (the so-called "saje") with slaked lime.
Foundation walls of brick houses were coated in the same manner and painted in black or gray colour, depending on the ratio of soot and lime. An interesting fact is that in Hrvatsko Zagorje coating of houses was done by women who managed to take care of this very strenuous work, a job which was usually done by male family members in other regions (Ištok, 2009).

Figure 1. Brick house. Photo by: Authors

Figure 2. Coated wooden house (the so-called "mazanka"). Photo by: Authors

Observing the floor plan of the most common house type (Figure 3), it can be seen that it is a house with a three-room ground floor consisting of an entrance area in the central part from which one enters the kitchen on the left, while on the right there are two bedrooms and a living room. The one in the front (facing the road) is bigger and is called "hiža" or "družinska hiža" (family house) and the smaller one is called "komora" (storeroom). There are also other variations such as houses with a porch (the so-called "ganjak"), or with a basement under the part of the house. There are also examples of houses, either single-storey or two-storey, with a ground floor wall built out of stone.

In cases of simpler floor plans, an example being traditional houses in Hrvatsko Zagorje, a gabled roof structure is used in which the load-bearing structure consists of the so-called double king post (Čizmar and Volarić, 2017).

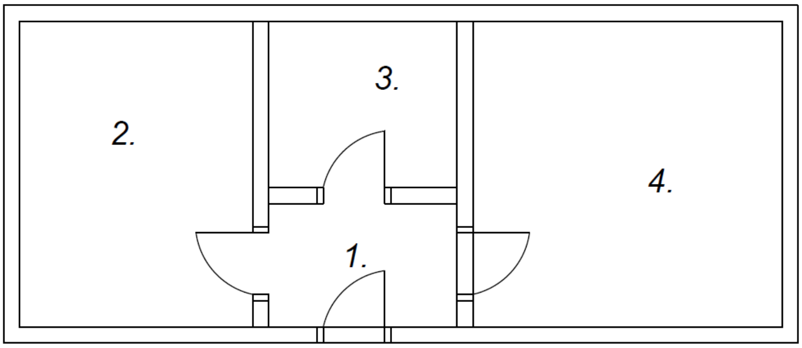

Figure 3. Ground plan of the traditional house in Zagorje. Drawing by: Authors

Roofs of residential houses and outbuildings were built by master roofers. Older roofs were covered with straw, and the roof structure was called "roženična", or "krovišta na škare" (pitched roof structure). The name of the structure comes from angled beams that are called "roženice" (rafters). The rafzers are laid on a supporting horizontal beam that is laid along the length of the building. The ends of the the rafters ("roženice") intersect at the right angle at the ridge of the roof. In that way they support the ridge beam, and therefore the whole roof.

The strongest main beam, also called "pocek", was laid along the length of the house. Hewn beams were laid across the main one and most often connected in corners by notch joints, the so-called "hrvaški vuger" (or "Croatian zagvozda"). Beams were assembled in a way in which parts of them extended beyond the corner of the house. That type of corner joint is called "Hrvatski sjek" (Croatian joint) (Figure 4). In traditional construction of this region, a newer German corner joint (Figure 5) has also often been used in cases where the main beams were cut straight at the corners and leveled with the front of the wall.

Figure 4. Croatian joint. Photo by: Authors

Figure 5. German joint. Photo by: Authors

What is especially interesting are the outbuildings. Buildings that were used as stables or barns were not coated with a mixture of loam like the houses, but rather the wood was exposed without exterior coating (Figure 6). Outbuildings often had canopies constructed on the longer part of the building. Their main feature was that their roof extended over the buidling and rested on longitudinal beams lined up next to a wall. Places under the canopies served as a store away area for tools and trailers It should be noted that some of the information presented in this article about the life and customs of their village were obtained during a conversation with the . We will also note that we acquired some information used to write this article during our discussions with the “kustos” (museum curatos (so called “kustos”).

Picture 6. Outbuilding in Kumrovec. Photo by: Authors

4. CONCLUSION

This article focuses on traditional houses in the village of Kumrovec, region of Hrvatsko Zagorje. “Staro selo Kumrovec” (Old village Kumrovec) is a unique locality containing extraordinary preserved examples of traditional Croatian buildings.

The interior of each house in the village contains a small exhibit with different thematic content, including traditional crafts and customs. Last year's research in which traditional construction in the area of Lonjsko polje had been analysed (Lozančić et al, 2020) represents together with this article a corpus of information that will be used for the next phase. The next phase is to design a modern prefabricated public building for the purpose of socializing and exercising that will be aligned with the requirements in the context of the current situation and the limitations of COVID-19 pandemic which we face on a daily basis.

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THE ENGINEERED WOOD PRODUCTS APPLICATION IN VERNACULAR AND CONTEMPORARY ARCHITECTURE IN MACEDONIA

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Abstract: In the distant past, wood was intensely used in Macedonia as one of the most important structural materials, available locally since ancient times. Therefore, the wood application in Macedonian vernacular architecture was inevitable, and with a wide range in the building construction, roofing, façade as cladding material, stairs, doors, window frames, and for different elements in the interior design.
Despite this wide usage of wood in the past, nowadays, in Macedonia, wood is mostly used in mountain regions for massive timber buildings, in the interior design, or as an external façade decoration due to its appealing aesthetics. Some new companies that manufacture single-family timber housing are arising.
In the last two decades, a new class of structural wood products was developed to form the basis for a range of building solutions that were increasingly functional, based on a combination of performance and sustainability characteristics. This has been possible because of new industrial processes that provide increased dimensions and superior engineering properties for structural products that can use manufacturing residues, lower-grade and smaller diameter trees as feedstock. The result is a category of products broadly known as engineered wood products (EWPs) which are increasingly being adopted in architectural design and building applications in Macedonia also.

Keywords: EWPs, application, vernacular architecture, contemporary architecture, Macedonia

1. INTRODUCTION

Vernacular architecture reflects local traditions and cultural practices and can be defined as a type of local or regional construction based upon local needs, using traditional materials and resources from the area where the building is located and is becoming even a means of reaffirming an identity [4]. Vernacular architecture represents the majority of buildings and settlements created in pre-industrial societies and includes a very wide range of buildings, building traditions, and methods of construction. It has also strong influence on Macedonian contemporary architecture using EWPs since people awareness for sustainable materials is growing. The traditional architectural elements will transform residential housing typology into the best solution for low-energy building requirements.

2. VERNACULAR ARCHITECTURE IN MACEDONIA - THE TRADITION OF WOOD CONSTRUCTION

The architecture in Macedonia arose in several basic developmental periods when political and social changes influenced the creation and development of specific cultural and architectural traditions. Each period affected the overall picture of Macedonian architecture and contributed to the development of cultural diversity and specific architectural expression in the country. In the distant past, wood was intensely used as one of the most important structural materials, available locally since ancient times [2]. The traditional Macedonian house had both a high technical quality, as well a high living quality at the same time. Selected examples of vernacular housing in Macedonia in different regions are presented in Figure 1. This architecture is closely related to its context and is aware of the specific geographic features and cultural aspects of its surroundings, being strongly influenced by them.

Figure 1. Examples of vernacular housing in Macedonia reflecting local traditions and cultural practices: 1 - Refik Selja House in Debar; 2 - House in Janche; 3 - House in Galichnik; 4 - Symmetrical Krusevo house; 5 - House in Ohrid; 6 - Residence building (konak) in the monastery of Sveti Jovan Bigorski; 7 - House in Shtip; 8 - Arabati Baba Tekke in Tetovo; 9 - House of Koco Racin in Veles; 10 - House in Skopska Crna Gora; 11 - House in Krushevo.

3. CASE STUDY: ANALASYS OF WOOD APPLICATION IN VERNACULAR ARCHITECTURE IN MACEDONIA

The aim of this research was to analyze the presence of wood in vernacular buildings, in order to transmit Macedonian cultural heritage to the next generations, as well as obtaining some data on construction techniques to be used for creating alternative solutions for contemporary wood architecture.

Therefore, a study of 9 vernacular buildings located in different regions in Macedonia was performed (Figure 2 and 3). Analyses were focused on building construction, as well on architectural elements such as wooden envelope, windows, doors, roofing, flooring, stairs, etc. (Table 1).

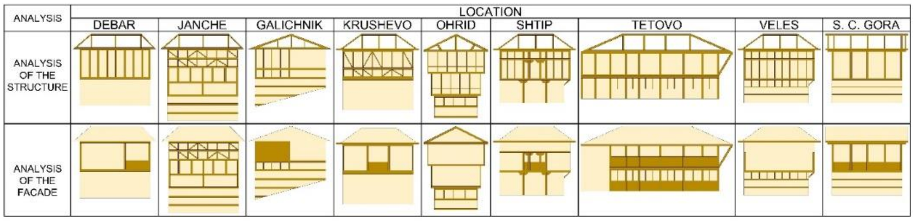

Figure 2. Selected vernacular buildings in Macedonia - analyze of construction and presence of wood in architectural elements

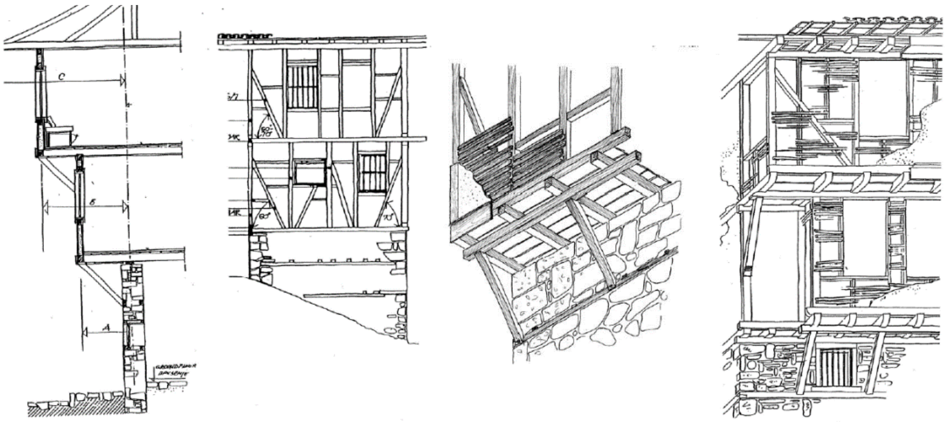

Figure 3. Characteristic Timber-Frame Construction ("Bondruk) in Central Balkans- residential house in the town Ohrid [3]

Use of wood on the façade was analysed; it depends on architectural elements, on cladding size, on the balcony (čardak) - size and position (in the middle or on the side), on balcony railing, on the wooden façade decoration etc. The measurement of wood on the façade envelope on different buildings was done by "AutoCAD" software package (Table 1).

Table 1: Typical selected vernacular buildings located in Macedonia- analysis façade [Index: Cladding (c), windows (w), doors (d), stairs (s), balcony (b), railing (r), decoration (d)]

Location	Name	Figure of Typical House	Wood on the façade – architectural elements
Debar	Refik Selja House (Ground Floor + 1 Floor)		12% [w,d,s,b,r]
Janche	House in Janche (Ground Floor + 1 Floor)		21% [c,w,d,s,b,r]
Galichnik	House in Galichnik (Ground Floor + 1 Floor)		29% [c,w,d,s,b,r]
Krushevo	Symmetrical Krusevo house (Ground Floor + 2 Floors)		16% [w,d,s,b,r,d]
Ohrid	House in Ohrid (Ground Floor + 2 Floors)		20% [w,d,s,r,d]

Radika River	Residence building (konak) in the monastery of Sveti Jovan Bigorski (Ground Floor + 1 Floor)		19% [c,w,d,s,b,r,d]
Shtip	House in Stip (Ground Floor + 1 Floor)		19% [c,w,d,s,b,r]
Tetovo	Arabati Baba Tekke (Ground Floor + 1 Floor)		38% [c,w,d,s,b,r,d,]
Veles	House of Koco Racin (Ground Floor + 1 Floor)		10% [w,d,s,b,r]
Skopska Crna Gora	House in Skopska Crna Gora (Ground Floor + 1 Floor)		26% [w,d,s,b,r]

From the analysis we can find out that the building materials for the dwellings were limited to autochthonous natural materials: stone, wood, and lime. In the construction of the basements was stone mainly applied, the ground walls, and often these stone walls were raised high and exceeded the first floor. The stories and semi portion levels were accomplished by a timber frame system - a timber skeleton. "The horizontal and vertical elastic constructions were bonded into a stable whole" [1, 6] and with aid of triangular forms which were incorporated into the walls, rough thin cut boards were affixed from both sides and were plastered with mortar (lime and sand). So the walls were formed from two screens with air between them, fabricating efficient thermos insulation. Often, the building idea was also followed in the roof construction which was carried out by a vertical support and by minimal slanting, thus a key element in the roof system became the roof tiles (Table 1: Ohrid-5, Shtip-7, Veles-9). The slab, stairs and roof structure were completely made from wood in all the analyzed houses. In addition, the windows frames and doors vary in shapes, sizes, proportions and decorations, but they are generally made of wood. Fences on the balconies (chardaks) and stairs in the interior and exterior are also completely made of wood.

4. CONTEMPORARY DEVELOPMENT OF PREFABRICATED TIMBER HOUSES IN MACEDONIA

In recent decades, the coice of materials in Macedonia is very limited; ccompanies are accustomed to build with the same materials, without creativity or giving a chance of trying something different. Due to the intensive use of steel and especially concrete, wood has, to a certain degree, lost its importance in Macedonia.

After the earthquake in Skopje in 1963, several countries helped the city by building new structures, from different structural materials. In order to meet the housing needs of the people left without home in the earthquake, new system of timber prefabricated houses was introduced in Macedonia. These houses were built on several locations in Skopje and they were called Swedish and Finnish prefabs or Swedish timber houses. Prefabricated wood houses are ideal solution since wood is low in weight in relation to its load-bearing capacity and strength, the material ideally suited to industrial construction, making transport, erection and installation on site much easier [5]. Similar timber frame houses for the same purpose were built in Madzari, in the eastern part of Skopje (Figure 4).

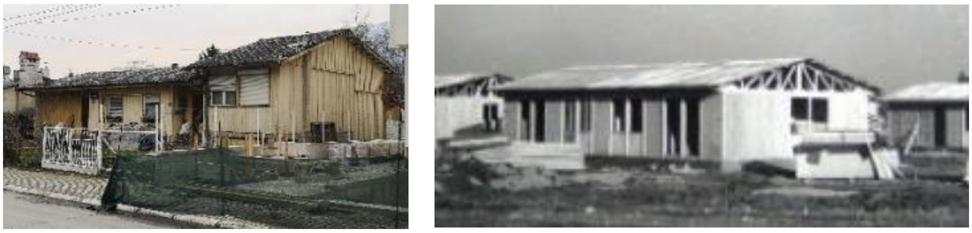

Figure 4: Swedish and Finnish prefabs; Houses in Madzari

Nowadays the innovative timber construction in Europe, as well as in Macedonia, is based on the use of sustainable materials, primarily wood, and different engineered wood products (EWPs). The construction of low-energy houses, as well as the construction of passive houses, results in an annual energy consumption of less than 15 kWh/m^2. In the last few years, due to the impact of European trends, construction workers, apartment buyers and timber house manufacturers in Makedonia have slowly been changing their opinions in a positive way regarding the use of EWPs [7]. Examples of producers of prefabricated timber houses in Macedonia are companies such as Geo-Ing Wood Construction in Skopje, Eco House MK in Skopje, Hot-Hot Construction – Representative Office in Skopje, Tehcom from Kochani and Ken Panel from Skopje, which are mainly active on the domestic and regional markets. Most Macedonian prefabricated timber house producers nowadays offer houses with panel construction, and timber frame construction (Figure 5).

a b

Figure 5: a-Some basic types of prefabricated timber houses in Macedonia [www.geo-ing.com], b- House in Pehchevo, Macedonia - façade completely covered with wood

The introduction of new products in the construction sector, however, is generally met with low awareness and high uncertainty in the marketplace; therefore, the communication of information is vital to market success (Figure 6).

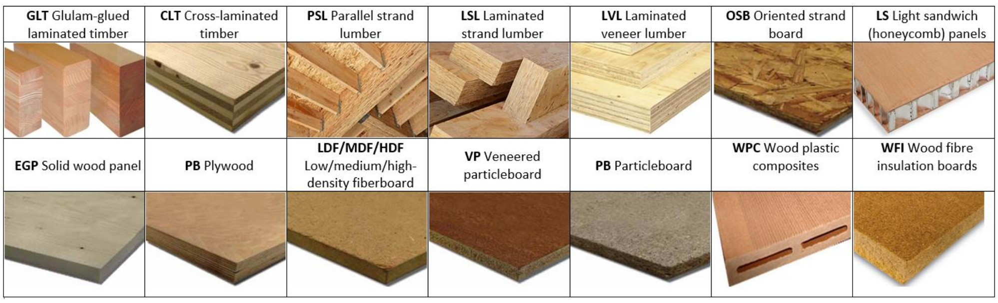

Figure 6: Engineer Wood Products (EWPs) [5]

4. CONCLUSION

The presence of wood is high in traditional houses from different regions in Macedonia, since it was a material that can be easily found in the surrounding environment. Examples of vernacular architecture in Macedonia are also evidence of the widespread use of wood in the interior design of the houses with beautiful carvings and decorations.

In contemporary architecture in Macedonia, wood as a structural material is neglected, still as a result of high intensity of construction with reinforced concrete and steel. However, the situation is changing in the last few years, due to the impact of European trends, and wood application is increasing, especially in residential buildings located in mountain regions. People's awareness is slowly evolving and they are beginning to see the positive features in living and using sustainable EWPs. Nowadays there are several companies and producers in Macedonia offering industrial manufacture of single-family timber houses. The richness of the natural local renewable materials present a strong base for the development of innovative approaches in the building sector using natural resources. The increased use of EWPs in Macedonian contemporary architecture is an important element of a more sustainable future built environment and therefore more information about its application and perceptions is needed.

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ANALYSIS OF THE REASONS FOR DEFECTS DURING FORMATION OF PROTECTIVE-DECORATIVE COATINGS ON WOODEN SURFACES

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Abstract: The defects on the film coatings are one of the major problems in furniture since they are easily detected and in the same time it is also hard to be prevented. They can originate during the process of film forming, upon their subsequent refinement or cleaning, during other operations or activities as furniture assembly, packaging, transportation. In some other cases, defects on the coatings could appear a bit later, while being exposed in the retail outlets or are already by the end users. Most often, those furniture defects are related to considerable financial consequences so thus to be fixed. This makes it very important to know the reasons for appearance of defects so thus the proper measures might be taken for their removal in a timely manner. Depending on the technological level and specifics of the produced articles, we can observe different frequency of defects occurring during the production process. Despite that, the causes for their appearance in most cases are quite similar. This allows us to make a summarized analysis of the causes for the appearance of defects with the same type.The article pays attention to the causes for the most common defects by through-feed layering of UV hardening protective-decorative coatings over wooden surface. Thus, a standard methodology has been used to determine the adhesion strength, hardness and gloss of water-dispersed coatings applied at industrial conditions.
Keywords: wooden surface, UV coatings, defects

1. INTRODUCTION

It is well known that coatings are a complex combination of raw materials that must be mixed, applied to a prepared substrate, dried and cured correctly to perform to their supreme quality. When developing a coating process, it is important to know the exact time it takes for the coating to dry or cure. There are many stages to the coating drying time. The modern furniture production achieves sharp reduction of the curing duration for coatings via the usage of lacquer-chemical materials that allow quick transit from liquid into solid state and due to technical equipment and technologies implemented for accelerating the curing process. The most practical method for decreasing the curing time of varnish coatings is UV irradiation. This technology provides excellent performance properties of the finished surface (Salthammer, 1997; Bongiovanni et al., 2002), but sometimes UV irradiation is the cause of defects in formation of protective-decorative coatings on wooden surfaces.

The defects in the lacquer film coatings may be classified according to the reasons for their appearance: defects due to usage of varnishes with poor quality; defects caused by non-compliance with the regulated conditions for the coatings appliance; defects that might result of deviations from the normal conditions for subsequent processing, storage, transportation and usage of the furniture. It is not generally obvious to establish the reason for the failure of a coating due to the many potential factors that may be involved (Kavalov et al., 2000). These could include formulation, surface preparation, application, drying and curing times and conditions, and environmental exposure, with more than one contributing factor often being involved. A single fault is in many cases due to a number of causes. In some cases, several defects occur simultaneously, so that the solution of the trouble is rendered more difficult (Hess, 1979). A defect in a surface coating can be the result of anyone of a number of causes and may therefore have a corresponding number of remedies (Oil and Colour Chemists' Association, 1984). Prior to application, defects can take the form of settlement, during application as runs and sags, shortly after application as solvent popping and orange peel, and during service as blistering. To determine the cause and mechanism of coating failure, all possible contributory factors must be evaluated together with a detailed history from the time of application to the time the failure was noted. On the other side a huge amount of economic loss is incurred every year as a result of failures on painted or coated surfaces not detected in time (Grassi et al., 2006). Sometimes the cost to repair such failures far outweighs the initial cost of coating (Bayer et al., 2004). Therefore it is very important to detect on time any appearance of defects and the proper measures to be taken for their removal.

Usually, the identification of defects on lacquer coatings is executed by visual observation, during which process no optical devices are used except for magnifiers with up to five times magnification. For determination the stage of defects expression, the coatings are evaluated by touching the surface with fingertips. If necessary, laboratory researches are undertaken for accurate quantification on a number of quality indicators for finished coatings like adhesive strength, gloss, hardness, water resistance and others. In those case, the assessment of the coatings suitability is done by comparing the values established during the study for the particular indicators with those that are referred by the normative standards.

Most of the mentioned defects appear during the production process itself. Thus, once they are detected, the respective measures for their elimination are taken, while in case repairs are not possible, those furniture details are treated as waste.

It is well known that adhesion strength of wood surface coatings has a great influence on coating performance. In production environment it is necessary to determine the adhesion of the protective-decoration coatings quite fast. Usually, for this purpose, the standard method ISO 2409 (2013) is used, which makes cross hatch adhesion test.

Often, the low adhesion strength of the coatings leads to defects that might appear much later, while the furniture is being used by the consumers. Those are mainly related to whitening in the coating base, appearance of cracks in the coating as well as its detachment from the base upon any impact. Such defects are in many cases impossible to be detached. Their appearance is due to strong pressure on the film and/or low adhesion between the coating and the wood. The following approach is used for their detachment: the full coating is removed and then a new coating is applied.

In the common case, the removal of defects that have originated during the period of furniture exploitation causes to the producer much more difficulties from technical, legal and financial nature. In order to overcome all that, it is recommended to have a preliminary check for each lacquer to be used. In this relation, the most appropriate at production conditions is to evaluate the adhesion strength of the coatings, especially if they are relatively tick. That way, indirectly could be determined the potential "hidden" defects in the production. An example of a "hidden" defect is the low adhesion strength due to uneven irradiation when linearly curved UV lamps have been used. The root cause for this defect is the overheating of the UV emitters at sudden interruptions in the power supply.

2. MATERIALS AND METHODS

The research has been conducted at production environment. The samples tested are the usually produced in the factory seats made of pine solid wood. The used protective-decorating materials (produced by Sherwin-Williams) are the following: water based stains (black-brown color - ESP 273-99620), base coat - UV Filler (Uvett™ Fill UK1373) and clear topcoat - UV curable lacquer (Uvett™ Clear UM1178).

The surfaces of the sample details have been sanded, stained and lacquered with UV roller coating machine (produced by Cefla S.C., Italy) at a feeding speed of 10 m/min. The initial sanding of the surfaces has been made with sandpapers P100 and P150 at a wide-belt sanding machine. The quantity of the roller applied stain was 35 g/m^2, while on the UV filler was 45 g/m^2 at temperature of 23 ^{o}C. The hardened via UV-rays filler has been sanded (P320/P400) and second layer is then applied (20 g/m^2). Afterwards, the lacquer (5 g/m^2) is roller applied followed by process of UV hardening.

The length of the UV emitters ray determines at great stage the properties and adhesion strength of the hardened coatings. The radiation in UV roller coating machine is generated by two types of UV-curing lamps with different wavelengths: mercury Hg (280÷320 nm) lamps to cure transparent and clear UV products and gallium Ga (390÷450 nm) lamps to cure pigmented UV products. Often, due to pollution and/or distortion of the UV lamps and the reflectors, the coatings are irradiated at less radiation than those set by technological standards. In this relation, the following experiment has been done: normally applied lacquer coatings are irradiated at lower values of UV radiation than those set by standard regime and their adhesion strength was determined (Tab. 2).

Adhesion strength of the coating films was determined by the Cross-cut test according to the standard STN EN ISO 2409 (2013). The Cross-cut test was done as follows: a crosshatch pattern was cut through the coating film to the substrate. The adhesion of the coating film was classified according to the standard STN EN ISO 2409 (Fig. 1).

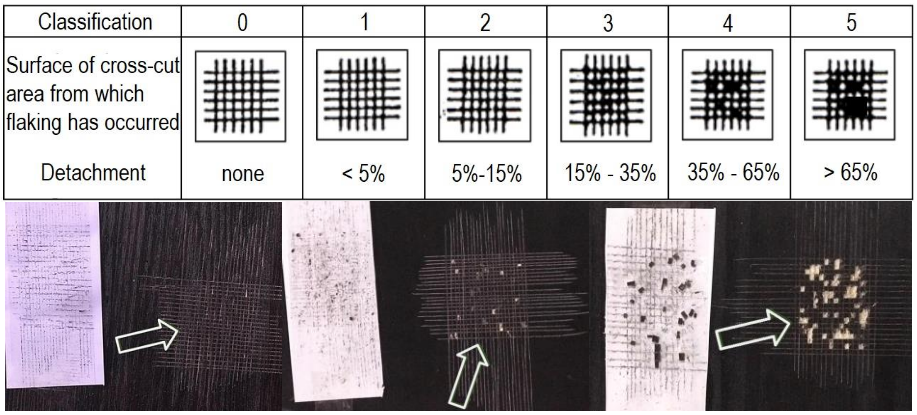


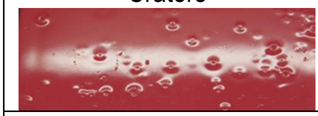
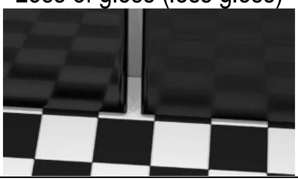
Figure 1. Classification of test results according to the standard STN EN ISO 2409 (2013)

Furthermore, the gloss was measured at 60° incidence angle according to the ASTM D523-14 (2018) using a glossmeter (BYK Gardner micro-gloss, Germany). Every reported value represents the average of six measurements.

3. RESULTS

Table 1 presents the most frequent production defects of protective-decorative coatings. Main reason for their appearance is the breaching of the regulated conditions for the film formation process. In the most common case, the defects appear due to: breaching the prescribed recipes for staining, lacquering; deviation in the prescribed temperature and humidity conditions, air pollution in the working space, direct sun light in the room, availability of air flow, insufficient time for drying of the applied layers during the coatings formation.

Table 1. Most common defects during formation of protective-decorative coatings

Defects	Probable causes	Preventions
Bubbles 	Thick applied lacquer layer; foamed lacquer; airflow and / or direct sunlight; hardener overdose; high temperature in the room.	Applying thin coatings; before applying the varnish, heat the wooden surfaces by 10-15 °C higher than the room temperature.
Craters 	Chemical incompatibility of some substances contained in wood (resins, essential oils) with the varnish systems used.	Pre-priming with appropriately selected insulating primers.
Orange peel 	Poor varnish spillage; high viscosity; incorrectly dosed composition; unsuitable technological regimes; airflow; high temperature drying.	Observing the technological regime, as the defect is very difficult to remove. It does not disappear completely even after sanding.
Loss of gloss (less gloss) 	Poor quality of varnishes; inaccurate dosing of components; sanding the film before it has reached technological hardness; unsuitable polishing regime.	Sanding and re-polishing; sanding and applying a new layer of high quality gloss varnish.

The results from the experiment for determination of the influence of the UV-lamps and/or reflectors pollution on the properties of the roller applied coatings are presented in Tab. 2. Based on them, a common conclusion could be made that the pollution of the UV lamps and/or reflectors leads to in significant decrease in the adhesion strength of the coatings. It is caused by the reduced UV radiation intensity. On the other hand, the reduction of the UV radiation results into low values for the coatings gloss.

Table 2. Regimes for UV curing of lacquer coatings and evaluation of coatings

Technological operation	Standard UV radiation		Reduced UV radiation for curing coatings	
	UV energy, mJ/cm^2	UV radiation intensity, mW/cm^2	UV energy, mJ/cm^2	UV radiation intensity, mW/cm^2
Complete hardening of UV filler (two Hg lamps)	400	300	350	280
Incomplete curing of UV filler (one Hg lamp)	150	300	100	280
Complete hardening of UV top lacquer (two Hg lamps)	270	300	220	280
Cross-cut adhesion test	0 (ISO 2409:2013)		3 (ISO 2409:2013)	
Gloss value at 60° angle	13,9		8,5	

The admission of low adhesion strength of the coatings is a prerequisite for the appearance of numerous defects when furniture is further used.

4. CONCLUSION

The most effective way for fight against defects in lacquer coatings is to establish such production and operating conditions that would ensure their occurrence is reduced to least possible. Defects prevention is mainly focused on:

1. Use of highly qualified staff for execution of all operations in the areas for lacquer coatings formation.
2. Organization of incoming control, including strict checks of all materials supplied in the factory and used for lacquer coatings formation.
3. Work upon scientifically based and experimentally tested recipes and regimes for coatings formation.
4. Regular conduct of ongoing technological control combined with efficient measures for fast elimination of established deviations.
5. Exercise periodic outgoing control on the appearance and the main quality indicators of the finished lacquer coatings (adhesion strength, hardness, etc.).
6. Keeping a diary for identified defects or incoming claims, where to list the established reasons and circumstances at which they have appeared, as well as the undertaken measures for their reduction or overcoming.

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SELECTED RISKS IN THE STORAGE OF BIOMASS IN HEATING PLANTS OF URBAN-TYPE – SLOVAKIAN CASE STUDY

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Abstract: Long-term storage of biomass for energy purposes in large volumes is often associated with the occurrence of risks. These risks include, in particular, the risk of spontaneous combustion fires and the production of phytopathogens and fungi which endanger human health. In this paper, we analyzed three large-capacity wood chips storages in urban-type heating plants in Slovakia. The risk of fire in these heating plants and the occurrence of phytopathogens and fungi in piles of stored wood chips were analyzed. The piles consisted of energy chips, which represented a mixture of 80% deciduous trees and 20% conifers. From each pile, 5 samples (15 in total) were taken for analysis in the year 2020. In each pile, 3 samples were taken from the surface and 2 samples from a depth of 0.5 m of the pile. The results of long-term monitoring of large-capacity wood chip dumps, which are used for energy purposes in urban heating plants, show that although this biomass is regularly handled, mixed, continuously fed, and removed, the health risks resulting from the presence of phytopathogen spores are permanent.
Keywords: biomass, storage, risks, wood chips, heating plants

1. INTRODUCTION

The strategy for the use of renewable energy sources in the European Union is currently set primarily for a high share of biomass in the energy mix. In Slovakia, however, in 2019 wood biomass partially fell out of subsidy support schemes (except for wood waste wood biomass). Slovakia's energy consumption is currently largely ensured by the import of primary energy sources. At present, the share of "green energy" in the final energy consumption of the Slovak Republic is approximately 11.9%. In 2018, renewable energy sources accounted for 17.98% of the EU. In 2017, renewables accounted for almost 30% of electricity generation in the EU (Gejdoš, Lieskovský, 2020).

With increasing demands on the quality and quantity of biomass produced, as the main element of the knowledge economy, man and the question of his safety and health at work come to the fore. With the development of various types of technologies and the increase of automation elements, working conditions in forestry and the wood processing industry are also improving (Očkajová et al. 2018; 2020). At the same time, however, the demands placed on workers in terms of the necessary knowledge and skills and the related neuropsychological burden are also increasing.

Potential sources for the production of forest biomass and forest wood chips mostly represent mainly forest harvesting waste material, purpose-fast growing trees plantations of resp. energy plantations, thin trees from sneds and thinnings, resp. the crown parts of harvested trees, unsuitable for the production of higher quality raw-wood assortments. The acquisition and storage of wood chips from trees for energy purposes, but also from forest harvesting waste material, is often a complex technological process and requires adequate technical and technological equipment as well as a skilled workforce. In Slovakia, wood chips in heating plants are mostly stored in large-capacity storage in large volumes with continuous supply and removal of raw materials. The production and storage of wood biomass chips are thus influenced by numerous factors and bring many health and safety risks to the workers who implement them. This work aims to analyse and review the most serious categories of these risks, which arise during the storage of wood chips for energy purposes and can seriously endanger human health and property.

2. MATERIAL AND METHODS

2.1. Wood chips sampling

3 large-capacity storages of Urban-type heating plants in the Banská Bystrica Self-governing region in Slovakia (radius 65 km) were selected for sampling. All storage and heating plant operations were located in urban areas of the city (population from 5772 to 12,696). A sampling at all warehouses on October 20, 2020, was provided. All storages were uncovered, located in an open area. The piles were formed from wood chips on a reinforced concrete base, in a sunny location. The piles consisted of energy chips, which represented a mixture of 80 % non-coniferous trees and 20 % conifers.

5 samples (15 in total) were taken from each pile in the heating plant for analysis. In each pile, 3 samples were taken from the surface and 2 samples from a depth of 0.5 m of the pile. Sampling points were determined at random to represent the entire area and volume of the current pile of chips in the heating plant. Samples were taken with a spatula and the volume of each sample was 2 l. Each sample was stored in a hermetically sealable plastic bag and numbered.

2.2. Laboratory analysis

The first group of laboratory analyses was performed by an accredited laboratory of the Regional Office of Public Health in Poprad. The samples were stored in hermetically sealable plastic bags until analysis. Microbiological examination of the identification of specific fungi was performed by a test method by ISO 21527-2. Quantification of fungi (Colonies per unit per gram [KTJ / g]) was analysed by a method by standard STN 56 0100. Individual species of fungi were identified according to the literature (Fasati, 1979).

Agar accumulation cultures were used to identify and isolate microscopic fungi. Agar plates were cultured at 25 ° C for five to seven days. Isolates were inoculated onto identification media. The following nutrients were used for identification: capers agar with yeast extract - CYA; Agar with wort extract - MEA, Agar with creatine and sucrose - CREA, Czapek agar with yeast extract, and 20% sucrose - CY20S. After obtaining pure cultures of microscopic fungi, the identification of individual genera, resp. species did based on morphological and culture traits according to keys reported in the literature (Hoog De et al. 2000; Klich, 2002; Samson et al. 2001).

A standard methodology for measuring the properties of biomass was used to evaluate the energy properties of the samples taken. Samples were dried and weighed to determine moisture content (Jirjis, 2005; Afzal et al. 2010). The samples were dried at 105 ° C ± 2 ° C to constant weight. After weighing on laboratory scales with an accuracy of 0.01 g, the values of the moisture content of the energy chips were calculated. The moisture content at the individual sampling points was calculated by the ratio of the weight of water contained in the samples to the weight of the wet samples, expressed as a percentage. The calorific values of the samples (calorific value in MJ / kg) were determined with an IKA C200 calorimeter by the procedure set out in STN ISO 1928 and ÖNORM M 7132, and the ash content was determined by STN ISO 1171.

3. RESULTS

3.1. Occurrence of phytopathogens

The results of the evaluation of the occurrence of phytopathogens in large-capacity storages in 3 district heating plants are summarized in Table 1. The lowest abundances of identified microorganisms were in storage no. 2, while the abundance of identified species was the lowest at storage no. 3. The most dangerous species posing a risk to human health when inhaled were *Aspergillus sp.* and *Penicillium sp*., which were present in each stored pile, in almost all samples taken (both from the surface and from a depth of 0.5 m).

Table 1. Microorganisms in storage piles (heating plants)

Storage/samples	Storage Nr. 1	Storage Nr. 2	Storage Nr. 3
Nr. of identified species	10	7	6
The most common species	*Aspergillus brasiliensis* (3)	*Penicillium sp.* (4)	*Penicillium sp.* (5)
Nr. of $CFU.g^{-1}$	702 300	103 550	450 000

The identified species of microorganisms can cause serious diseases in the form of mycoses, skin allergies, aspergillosis, lung diseases, and carcinogenic diseases. When handling biomass, personal protective equipment should therefore be mandatory for workers handling this material. A serious problem can also be the fact that stored piles are close to human houses, mostly directly in urban areas.

3.2. Energy parameters of wood chips

Table 2 evaluates the energy parameters of wood chip samples from three Urban-type heating plants.

Table 2. Average energy parameters of the samples from storage piles

Average Value	Samples from storage Nr. 1	Samples from storage Nr. 2	Samples from storage Nr. 3
Moisture content (%)	66,45	66,56	65,41
Ash Content (%)	0,083	0,021	0,045
Calorific value STN ISO 1928 (MJ/kg)	4,35	4,54	4,66
Calorific value ÖNORM M 7132 (MJ/kg)	4,22	4,42	4,54

At all storages, the samples showed relatively high moisture content, which confirms that it was fresh material from the top layers of the piles (since the supply and removal are continuous). The high moisture content of the chips also negatively affected the energy parameters, where the average calorific value from all storages determined by two methods ranged from 4.22 to 4.66 MJ / kg. The ash content was the highest of the samples coming from the first storage. The lowest was at the second storage. The energy properties of the chips in the upper layers of large-capacity piles therefore significantly influence the weather conditions. Higher moisture content and temperature provide a suitable environment for the reproduction of phytopathogens and thus increase the health risk.

Lower moisture content and temperature, on the other hand, increase the risk of spontaneous combustion and fire. Requirements for fire protection of the warehouse are laid down in Decree no. 258/2007 Z. from. on fire safety requirements for the storage, warehousing, and handling of solid flammable substances. The main deficiencies found in the storages of the heating plants from the point of view of this decree were, in particular, insufficient internal lines connected to the main roads, insufficient marking, equipment with fire extinguishers, and hydrants. In one warehouse, there was even an ash dump in the immediate vicinity of a pile of wood chips, which poses a serious risk of fire. The risk of spontaneous combustion is relatively high with this method of chip storage and it is necessary to monitor the stored piles at regular intervals.

Dry biomass also poses a risk of wood dust production, which, as in wood processing plants, also poses a serious health risk to operators and people moving near the pile being handled.

4. CONCLUSION

Awareness of employees, as well as operators of urban-type heating plants, about the potential risks to the handling of biomass and wood chips during their processing and use, is relatively low. The health problems caused by phytopathogens are manifested only over a long period, and the sensitivity and exposure time of workers is also important. Such an adjustment results from the corporate attitude of companies in Slovakia, insufficient motivation, and, last but not least, economic crises due to global developments and pandemics (Hitka et al. 2014; Klaric et al. 2016; Vetráková et al. 2018).

Rational risk management is a key factor leading to the minimization of occupational risks (Stacho et al. 2016). Employers should seek to minimize risks directly at the workplace and, to this end, set up a safety management system that includes risk assessment and monitoring procedures. In some operations such a system works, in some they do not attach the necessary importance to it. The employer must ensure that employees are adequately informed about the risks affecting safety and health at work and what their claims are for possible compensation and personal protective equipment. Especially in forestry operations, but also in operations where biodegradable material is handled, shortcomings were found in this regard. Employees should receive accurate information from managers on workplace safety conditions and any existing risk of injury, as well as on measures to protect them from risk factors.

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BIOTECHNOLOGICAL PROCESSING OF WASTE WOOD BIOMASS

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Abstract: Waste wood biomass is a widespread and available substrate. Its processing can provide several value-added products. Waste wood biomass is lignocellulosic biomass and for that reason, its biotechnological processing requires chemical pre-treatment and usually detoxification. The reason is the formation of toxic substances formed during pre-treatment, which can hinder in further biotechnological processes (enzymatic hydrolysis and fermentations). The main energy products that can obtained from waste wood biomass are liquid biofuels and biogas. In this work are summarized the knowledge about the possibilities of production of these products.
Keywords: waste wood biomass, bacterial pre-treatment, fungal pre-treatment

1. INTRODUCTION

Biomass is the organic matter of all organisms on the Earth. Waste biomass from agriculture or forestry is also suitable for biotechnological processing. It is lignocellulosic biomass, so its processing into various value-added products (liquid biofuels, biogas, organic acids and chemicals, bioplastics) is a complex process.

The main steps of biotechnological processing are (i) biomass pre-treatment (fractionation), (ii) saccharification of cellulose and hemicellulose (hydrolysis) and (iii) fermentation processes. Pre-treatment processes aim to increasing the enzyme accessibility to biomass that would result in a higher yield of fermentable sugars. Chemical pre-treatment methods are carried out at high temperatures, pressures, using chemicals, while various undesirable by-products are also formed from biomass. However, pre-treatment is also possible biologically (via microorganisms or enzymes), thanks to which pre-treatment takes place under mild and ecologically acceptable conditions.

2. PRE-TREATMENT OF WASTE WOOD BIOMASS

Generally, lignocellulosic biomass is the most abundant, sustainable, and renewable resource that is convertible to bio-chemicals, biopolymers or biofuels (Alvira et al., 2010, Lee and You, 2020). It is considered as a primary candidate for their production, because it consists from cellulose and hemicellulose, which are source of fermentable saccharides (Wang et al., 2019, tab.1, Hernández-Beltrán et al., 2019).

Lignin degradation and modification are the main hurdles for successful processing of lignocellulosic biomass (Munk et al., 2015, Schneider et al., 2020). Among the pre-treatment techniques, although chemical methods can be effective in biomass decomposition or lignin/hemicellulose fractionation. The associated disadvantages are including high cost, serious corrosion to equipment and environmental hazards (Tadesse and Luque, 2011, Sathitsuksanoh et al., 2013, Tian et al., 2019).

Tab.1 Content of cellulose, hemicellulose and lignin in wood biomass

Wood biomass	Composition (% Dry Basis)		
	Cellulose	Hemicellulose	Lignin
Birch	40	18	24
Eucalyptus	52	24	24
Pinewood	38	24	34
Poplar	46	17	26
Spruce	25	10	35
Sawdust waste	32	26	25
Willow sawdust	36	22	29

The authors also described 5-hydroxymethylfurfural, furfural, acetic acid and phenolic compounds as products which usually formed in the chemical pre-treatment process and significantly affect the availability polysaccharides for enzymatic hydrolysis (Li et al., 2017). Jafari et al. (2016) stated organosolv with ethanol as promising method for a biorefineries, because is possible to simultaneously producing the fermentable sugars and high-purity value-added lignin. They found that aqueous ethanol has a better performance in delignification than pure ethanol, which also reduces the production cost. Tongbuekeaw et al. (2020) described pre-treatment with ethanol (in combination with the hydrothermal method) in the processing of rubber wood waste into biogas. Nowadays rubber wood waste is a major feedstock for power plants in Southern Thailand. It is processed by combustion whereas produces carcinogenic substances (polycyclic aromatic hydrocarbons). The formed ash contains heavy metals. Therefore, there are searching new possibilities of using this wood waste.

In this context, it is necessary to mention green waste, which is produced mainly in urban areas and is currently processed mainly by composting. It is biomass with a low lignin content. Its processing can be by direct compression/extraction of valuable compounds, chemical and fermentative conversion into chemicals and functional materials (Langsdorf et al., 2021). Compression of this biomass is obtained solid and liquid fractions. The solid cake contains more carbohydrates (almost 64% of the total cellulose content) and lignin, liquid fraction contains a large number of organic acids and various nutrients. Therefore, it can be served as a culture medium for microorganisms (*Saccharomyces, Lactobacilli*) and production a variety of value-added bioproducts. Langsdorf et al. (2021) also added that there are still no studies on the economic use of this biomass, even though it is known to have great potential and its production is relatively large.

2.1 Biological pre-treatment

Biological pre-treatment involves the action of microorganisms or their enzymes on biomass (Fig.1, Usmani et al., 2021). Microbial enzymes (lignases, cellulases, hemicellulases) are able to break down lignocellulosic biomass into basic components and produce saccharides. Their fermentation results in the production of bioproducts such as biofuels (ethanol, methane, hydrogen), various organic acids, enzymes, acetate, lactate (Usmani et al., 2021, Tsegaye et al., 2019). Microbial pre-treatment can also take place in vivo - directly in nature when microorganisms (bacteria, fungi or actinomycetes) attack lignocellulosic biomass

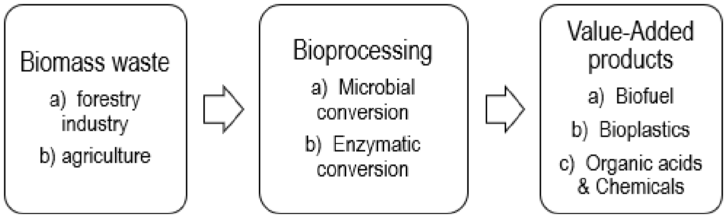

Fig. 1: Bioprocessing of waste biomass

by their enzyme complex or in vitro, when microorganisms or directly microbial enzymes are added towards the biomass. Typically, the microbiological pre-treatment in nature would take a long time (weeks, months) and therefore cannot be compatible with the usual industrial processing. However, the advantages of microbial pre-treatment consist in the fact that no inhibitory substances are formed which have to be removed in the next steps of the technology (Langsdorf et al., 2021). In addition, bacterial and fungal pre-treatment are eco-friendly and strains can be genetically engineered for specific products (Chio et al., 2019).
Biological pre-treatment of wood biomass is usually used in the bioethanol production, but wood biomass is also suitable for production of biogas. Shrestha et al. (2017) recommend that enzyme application combined with other physical and/or chemical pre-treatment methods to increase efficiency and biogas yield. Baghbanzadeh et al. (2021) tested application of extrusion in the pre-treatment of waste wood before microbial step.

2.1.1 Bacterial pre-treatment

Biomass pre-treatment using the most suitable bacterial strain is followed by enzymatic hydrolysis and fermentation for biofuel production (Usmani et al., 2021). Bacteria are producers of lignases, cellulases and hemicellulases. Lignases (laccases, lignin peroxidases, manganese dependent peroxidases) are produced by *Pseudomonas sp., Pseudobutyrivibrio sp., Bacillus subtilis. Rhodococcus jostii* RHA1 (Ahmad et al., 2011, Chio et al., 2019) and *Pseudomonas putida* KT2440 (Salvachúa et al., 2015, Chio et al., 2019) are as well studied as lignin degrading bacteria. Bacterial cellulases are endoenzymes, they are produced in small amounts and their isolation is difficult. Cellulases produce *Streptomyces sp., Thermomonospora sp., Bacillus sp., Clostridium sp.*. Hemicellulases are mainly characterized by xylanase, β-glucosidase, α-galactosidase or mannanase activities. Producers of hemicellulases suitable for wood biomass processing are *Bacillus sp*. (Paz et al., 2020) or *Pseudobutyrivibrio xylanivorans* (Camlibel et al., 2020). However, breaking down the lignin is much more difficult as cellulose and hemicellulose. Ma et al. (2016) revealed that *Pantoea ananatis* secrete a group of enzymes which can degrade lignin and hemicellulose along with cellulose.

2.1.2 Fungal pre-treatment

Fungi are abundantly present in nature and readily produce various ligninolytic (Kumar and Chandra, 2020), cellulolytic (Zhao et al., 2018) and hemicellulolytic enzymes (Andlar et al., 2018) which help in degradation of biomass. Two families of ligninolytic enzymes - phenol oxidase (laccase) and peroxidases (lignin peroxidase and manganese peroxidase) play a key role in the enzymatic degradation of lignin (Krause et al., 2003, Malherbe and Cloete, 2002), the presence of other enzymes was detected as well - glyoxal oxidase, glucose oxidase, oxido-reductase and methanol oxidase (Eriksson, 2000). Fungal species involved in the degradation of biomass include white-rot fungi (*Phanerochaet chrysosporium*, *Schizophyllum sp*.), ascomycetes (*Trichoderma viride, Trichoderma reesei, Penicillium sp., Aspergillus sp*.) and brown-rot fungi (*Fomitopsis palustris*) among the others (Paudel and Qin, 2015). *Trichoderma reesei* was one of the first cellulolytic organisms isolated in 1950s. It was though a good producer of hemi- and cellulolytic enzymes, but it was unable to degrade lignin (Saritha et al., 2012). Several authors (Pérez et al., 2002, Saritha et al., 2012) stated that the lignin fungus *Phanerochaete chrysosporium* can decompose lignin most efficiently. Wang et al. (2020) recommended spraying wetted biomass by fungus-containing solution.

2 CONCLUSION

Waste wood biomass can be the source of a whole range value-added products (biofuel, biogas, organic acids and chemicals, bioplastics). Their production is demanded and the specific technology depends mainly on the composition of the input biomass. The presence and content of lignin, which belongs to the hardly degradable components of biomass, is often problematic. From the point of view of the bioconversion process, an important step is the pre-treatment of biomass. Pre-treatment can take place by various methods, biological methods use the action of microorganisms (bacteria, fungi or actinomycetes) or their enzymes. They are environmentally friendly.

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OCCUPATIONAL HEALTH AND SAFETY (OHS) DURING VACUUM-PRESS DRYING OF WOOD

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Abstract: Conventional convective kiln drying is nowadays the most common way of drying wood in the Republic of Croatia, but it takes a relatively long time for the wood to dry. Therefore, wood processing companies have lately been investing in vacuum-press kilns. Those kilns allow them certain flexibility and speed to respond to customer requests, since the drying processes in them are usually much shorter. Since vacuum-press technology is a novelty in wood processing companies in the Republic of Croatia, in this paper vacuum-press drying process in one Croatian wood processing company was analysed from the point of occupational health and safety. The hazards which are present during the preparation and implementation of drying in vacuum-press kilns were detected and basic guidelines for safe operation in accordance with ISO 9001 standard are proposed.
Keywords: wood drying, vacuum-press, occupational health and safety, safety instructions, ISO 9001

1. INTRODUCTION

During the production of wooden products at least one of the thermo-hydro-mechanical processes of wood modification has to be conducted, *e.g.* wood drying. Wood drying is an obligatory process which has to be conducted before the final products are made, because the water from wood has to be expelled. If possible, each wood processing company will strive to implement air drying before artificial drying in order to reduce energy and time consumption and thus lower production costs. Nowadays, artificial technical drying is usually conducted at atmospheric pressure, mostly in a form of conventional convective kiln drying.

Figure 1. Air drying of wood (photo: Klarić M.)

Figure 2. Conventional convective kiln drying (photo: Klarić M.)

Conventional convective kiln drying is nowadays the most common way of drying wood in the Republic of Croatia, but this technology implies a relatively long drying time. Therefore, wood processing companies have lately been investing money in vacuum-press kilns, as this technology ensures certain flexibility and speed to respond to customer requests, since the drying processes in them are usually much shorter. In vacuum-press kilns the reduction of the boiling point of water at low pressure facilitates an important overpressure to enhance moisture migration (Torres, 2011) and drying, therefore, due to the use of lower temperatures, drying defects are also fewer.

Occupational health and safety (OHS) is an extensive multidisciplinary field, invariably addressing the issues related to scientific areas such as medicine – including physiology and toxicology – ergonomics, physics and chemistry, as well as technology, economics, law and other areas specific to various industries and activities (Alli, 2008). OHS is incredibly important in any organization, and it is necessary that OHS is constantly improved and upgraded, especially with the introduction of new technologies. It is shown that the top management that provides its full support to what can be called a "culture of safety", has the best safety records (Michael and Wiedenbeck, 2004). According to the International Labour Organization, more than 7600 people die from work-related accidents or diseases every single day (ISO, 2021a). The company can confirm its commitment to occupational health and safety and implementing „culture of safety" by implementing the ISO 45001 standard for Occupational Health and Safety Management. ISO 45001 standard builds on the success of earlier international standards in this area such as OHSAS 18001, the International Labour Organization's ILO-OSH Guidelines, various national standards and the ILO's international labour standards and conventions (ISO, 2021a). Although wood industry is a business sector where workers encounter many hazards, this industry is at the bottom with regard to number of ISO 45001 certificates, as only 0.16 % certificates in the World are from wood industry (ISO, 2021b). Since ISO 45001 certificate is one of the main indicator of OHS awareness this shows that wood industry is still not developed enough in that area. Implementation of integrated systems for quality (ISO 9001) and OHS (ISO 45001) with identification of risk management and application of different methods such FMEA can help companies to prevent injuries. Research on implementation of "ISO" standards confirm foregoing, since the awareness on ISO 9001 standard implementation is still not developed enough, and the companies decide to certify due to market requirements (Klarić, *et al.*, 2014).

Vacuum-press technology is a novelty among wood processing companies in the Republic of Croatia. Therefore, the aim of this paper is to analyse the hazards present during the preparation and implementation of drying in vacuum-press kilns in order to define basic guidelines for safe operation in accordance with the ISO 9001 standard.

2. MATERIAL AND METHODS

Two vacuum-press kilns (Turboenergetika d.o.o., VSOP-6 II) were delivered and installed in one wood processing company in Republic of Croatia during first part of 2021. The kilns are cylindrical in shape and made of stainless steel (A304). Basic specification of the individual kiln is as follows: kiln dimensions are 1.8 m (dia.) × 11.8 m (length), stack dimension are 2 × (5.06 × 1.18 × 1.3 m), installed heating power is 100 kW, the heating medium is water (drying up to 65 °C), there are 44 aluminium heating plates and dimensions of each plate are 506 × 118 × 1.5 cm. Transport of wood in to the kiln is via cart. Both installed kilns are identical, and they are shown on Figures 3. and 4.

A comprehensive and meticulous analysis of the initial commissioning of the vacuum-press kilns has been conducted. Research data were collected during kiln filling with wood and start of the drying process. During this procedure, the kiln manufacturer experts were also present to provide additional clarification.

Figure 3. Vacuum-press kilns (photo: Klarić M.)

Figure 4. Interior of vacuum-press kiln (photo: Klarić M.)

3. RESULTS AND DISCUSSION

During the commissioning of the vacuum-press kilns, the data were collected and analysed, *i.e.*, a risk assessment was performed. In general, activities during data gathering were as follows: determination of material and equipment, study of applied technology, establishing work procedures, identification and mitigation of risk for workers, analysis of hazards and risks, determination of safety measures.

3.1. Hazards

Many hazards have been taken into account during risk assessment, but only those recognized as having the most significant risk potential are listed. Almost everything in workplace may pose a risk and cause harm by itself or in combination with other factors. Therefore, constant monitoring and detection of hazards needs to be carried out in the future.

3.1.1. Mechanical hazards

Forklifts – *there is very high risk and potential for harm*. Forklift drivers are driving fast in a narrow space with poorer visibility due to buildings and turns. There is a possibility of wooden elements falling from the pallets, crushing workers with pallets or lowering the pallets on worker's feet. The risk could be reduced as follows: manipulation area for workers and forklifts should be marked, workers should wear shoes with a protective cap, reflective protective vests and protective helmets; by constant education of workers and forklift drivers on safety measures.

Means of horizontal load transfer – *there is low risk and potential for harm*. The wood enters the kiln on carts that travel on rails and during this process there is a possibility of crushing workers body parts. As carts cannot move quickly due to the heavy weight, there is a low probability of injury. In order to mitigate the risk and ensure the quality, procedure for loading kiln with safety measures should be implemented.

3.1.2. Hazards of falls

At the same level – *there is medium risk and potential for harm*. There is a possibility of workers falling at the same level, either over the rails of the cart, or due to a possible mess around the kiln. To reduce the risk, skipping rails should be prohibited, the work surface around the kiln should not be clogged and all this risks can be reduced by implementation of procedures and constant training.

3.1.3. Hazards of electricity

There is low risk and potential for harm. Electrical installations are well done, and are in accordance to safety requirements, protected with all of warnings clearly visible. However, the potential danger is always present and the worker should work with caution.

3.1.4. Thermal hazards

Hot substances – *there is medium risk and potential for harm*. There are pipes with hot water used for heating in the kilns. The pipes are mostly well insulated. There are vacuum pumps on the back of the kilns, and they can develop a high surface temperature of the pump and surrounding parts. In order to mitigate the risk only authorized executives and maintenance workers should access the space where the pumps are located and shall handle pipes according to procedures.

3.1.5. Chemical hazards

Acids from wood dissolved in condensate – *there is low risk and potential for harm.* During the drying process, small amount of easily soluble wood compounds may end up in the condensate discharged from the kilns. These condensates may be acidic. However, condensate is not under pressure, it should not be very hot, and the amounts of easily soluble wood compounds in condensate are generally small, but workers should be informed that they exist.

3.1.6. Biological hazards

Infected people – *there is low risk and potential for harm.* As for biological hazards, the only danger is from people infected with infectious diseases that spread easily, *e.g.* SARS-CoV-2.

3.1.7. Physical hazards

Reduced pressure – *there is medium risk and potential for harm.* With this technology, the wood is dried at pressures lower than atmospheric in a hermetically sealed kiln, which cannot be opened from the inside. The worker must never stay inside the kiln during operation. Strict working procedures should be implemented, which will prescribe the procedure for filling the kiln. Workers need to be trained on the danger of “vacuum” in the kiln.

3.1.8. Statodynamic effort

Repetitive movements with the use of force / hard physical work – *there is low risk and potential for harm.* When the kiln is being filled with wood, the wooden elements need to be stacked by hand on heating plates for several hours. Of course, wooden elements weigh only up to several kilograms, depending on their dimensions. The other problem is the mass of aluminium heating plates that workers stack between each row of wood. It is recommended to install a cargo handling system to assist the transfer of plates and wood samples.

In the next chapter safety instructions for work with vacuum-press kilns are summarized. It should be borne in mind that these instructions are the basis for further upgrading in accordance with the hazards identified in the future.

4. GUIDELINES FOR SAFE OPERATION

HAZARDS:

- ***Mechanical hazards*** (forklift manipulation, movement of kilns cart with wood in and out of the kiln)
- ***Hazards of falls at the same level*** (fall over the rails of the wagon)
- ***Hazards of electricity*** (the kiln uses electricity to operate)
- ***Thermal hazards*** (there are hot pipes with hot water inside, the vacuum pump and some parts nearby may be hot)
- ***Chemical hazards*** (the condensate may be acidic)
- ***Biological hazards*** (infections of fellow co-workers)
- ***Physical hazards*** (dangerous reduced pressure-vacuum is in the kiln during operation, statodynamic strain during load handling)

SAFETY INSTRUCTIONS

- Only trained and authorized personnel is allowed to operate the plant.
- It is forbidden to approach and operate the plant under the influence of alcohol or/and drugs.
- Before starting work, be sure to check that the kiln is in proper condition and that everything is in order, including that the protective devices are in place.
- Be sure to wear the protective equipment assigned to you (minimum: work clothes, work shoes with a cap, reflective protective vest and protective helmet).
- Take care of your colleagues you work with and do not disturb them with conversation or jokes while working.
- If an injury or dangerous situation occurs, inform the manager present, in order to take appropriate measures to protect the life and health of those present.
- Manipulative space and work space must be clean and free from obstacles.
- Pay attention to the movement of forklifts and other vehicles and pay attention to manipulative paths.
- Be careful how you move and walk, and do not walk over the rails of the cart.
- Watch out for colleagues when you push the cart in and out of the kiln.
- The kiln uses electricity to operate, watch out for possible live parts.
- The kiln uses hot water, and some parts can be very hot, do not touch the pipes or other hot parts.

- The parts around the vacuum pump can be very hot, do not touch the installation around pumps.
- The condensate coming out of the kiln may be acidic, do not touch it.
- Hold your body properly while carrying the load, and do not carry too much weight.
- Observe all signs related to occupational health and safety
- Condensate from the kiln must not be spilled uncontrollably into the environment and into work area.

5. CONCLUSION

Occupational health and safety (OHS) is very complex because there are an incredible number of factors and interactions among the factors that affect safety at work. Through this article an attempt was made to assess the hazards and risks in this case on two installed vacuum-press kilns in one wood processing company in Republic of Croatia. As known, it is very hard to detect all possible dangers and risks in a production process or in a particular technology. With this article it is given a good basis regarding the basic instructions for safe work on vacuum-press kilns, but in each specific case and organization it is necessary to identify and mitigate the risk, constantly upgrading the instructions and staff training on safety procedures. This need to be done especially when new technology has not been used before in an organization. In conclusion, besides safety instructions, during any work it is important to be dedicated to work at the moment, to work thoughtfully and not sloppily, and to be present with thoughts and use common sense.

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