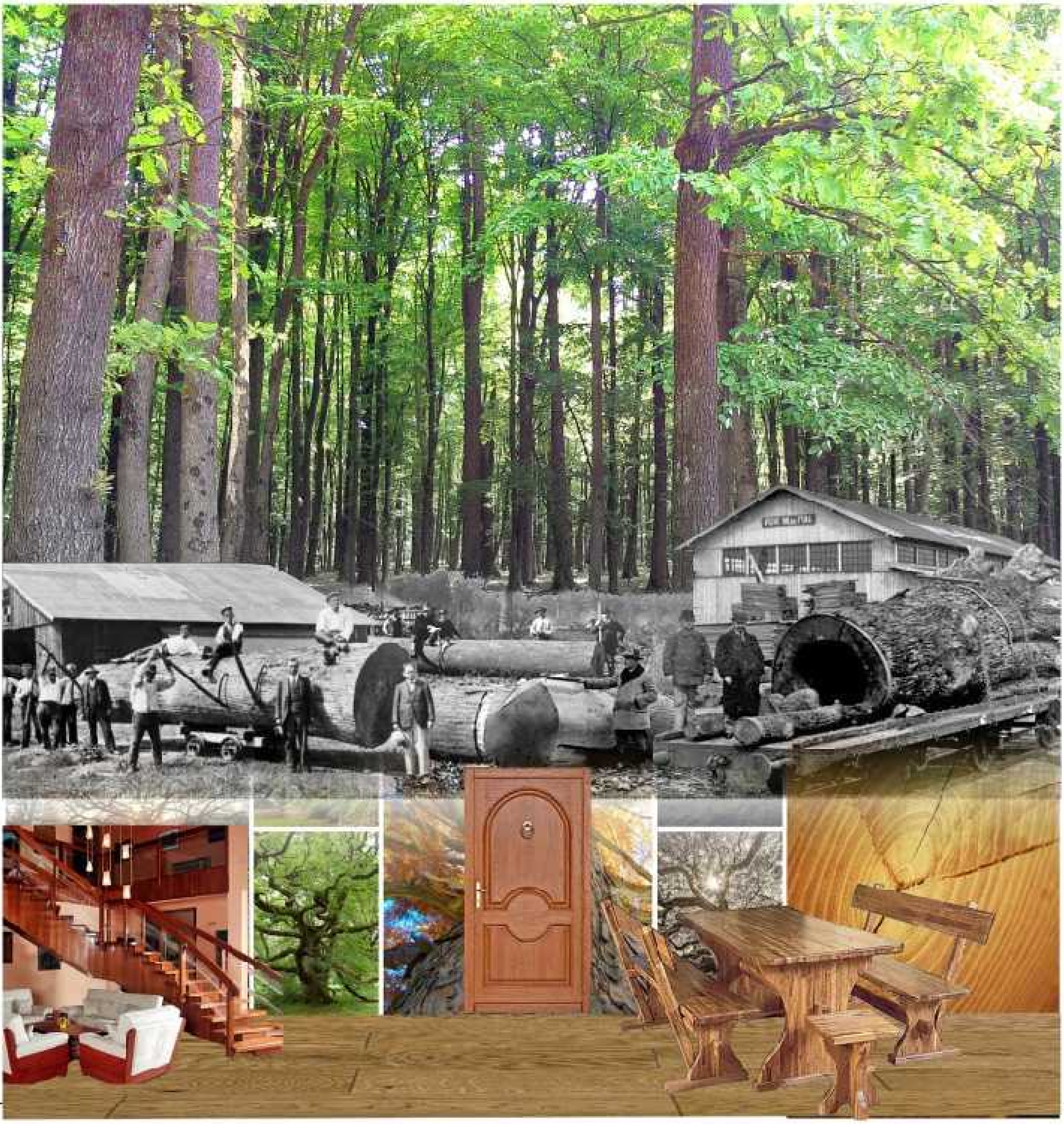
SUSTAINABILITY OF FOREST-BASED INDUSTRIES IN THE GLOBAL ECONOMY

VINKOVCI, CROATIA 2020



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

University of Zagreb
Faculty of Forestry

Competence Centre, Ltd.

International Conference on Wood Science and Technology

SUSTAINABILITY OF FOREST-BASED INDUSTRIES IN THE GLOBAL ECONOMY

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Preface

This proceedings of scientific papers is a compilation of articles submitted by authors that convey results of recently completed research. These results were presented at the international event titled SUSTAINABILITY OF FOREST-BASED INDUSTRIES IN THE GLOBAL ECONOMY, held in Vinkovci, Croatia, September 28th-30th 2020. This event was organized as two joined conferences: the 13th international scientific conference WoodEMA 2020 and the 31st international scientific conference ICWST 2020.

This year WoodEMA, i.a. was partnering University of Zagreb, Faculty of Forestry, Zagreb, Croatia and Competence Centre, Vinkovci, Croatia to organize joined event with two combined conferences and many side activities. Although the pandemic year 2020 (Covid-19) was the year to forget, the response to these conferences was higher than expected. All together 69 scientific articles were submitted for the event of which, after the international review, 63 were accepted and included in this book of proceedings.

The proceedings and conferences reflected the main theme: Sustainability of forest-based industries in the global economy, in forestry, wood processing and furniture manufacturing, from marketing, economy, management, technology and production point of view. The main goal of the event was to exchenge and transfer knowledge by international experts and scientists in an array of topics and issues facing the global forest and forest products sectors. Scientists and experts, 128 of them from 13 countries (Bulgaria, Croatia, Czech Republic, Finland, North Macedonia, Poland, Romania, Russia, Slovakia, Slovenia, Serbia, Turkey and Ukraine), presented their points of view important in market competitiveness and sustainability for industry, regardless of country or region.

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13th International Scientific Conference
WoodEMA 2020

SUSTAINABILITY
OF FOREST-BASED INDUSTRIES
IN THE GLOBAL ECONOMY

EXPERIENCE OF THE RUSSIAN FEDERATION IN JOINING STRATEGIC PLANNING OF THE GLOBAL FOREST SECTOR

Pryadilina, N., Lobovikov, M., Skvortcov, E.

Abstract. In the context of globalization of forest policy, long-term planning is becoming one of the most important tools for sustainable forest management at the national and regional levels. This thesis is confirmed by the experience of international organizations, such as Food and Agriculture Organization of the United Nations (FAO UN), World Bank (WB), European Forest Institute (EFI) and others. These organizations make a great contribution for the creation of methodologies for long-term planning (forecasting) of the global forest sector as well as practical recommendations for individual countries. These recommendations are aimed at the efficient use of forest resources based on a balance of economic, environmental and social interests of society. Intensive development of the forest sector requires mechanisms that will allow managing forest potential through increased profitability and improved natural forest conditions. A concept of long-term planning should lead to a mechanism for intensive development of the forest sector, taking into account regional factors. Certain attempts to change approaches to long-term planning were made by the FAO project "The Russian Federation Forest Sector Outlook Study to 2030". The outlook was prepared by the Russian scientists on the basis of methodological recommendations used by the UN FAO in the global and regional forest sector forecasts. The main novelty of the Russian outlook was orientation on domestic and export demand, estimated with models and expert evaluations. Forest sector alternative scenarios were designed on the basis of balance of goals and resources. However, resources supply was not guaranteed. The Russian forest sector outlook, which was supported by the FAO, has received wide international appreciation. Unfortunately, it did not become an official strategic planning document in the Russian Federation. Its development was not directly ordered by the Russian federal government.
Keywords: strategic planning, forecasts, forecast estimates, forest sector, demand for forest products, supply for forest resources

1. INTRODUCTION

Not only individual states, but also international organizations are engaged in long-term and strategic planning and forecasting within the framework of their international mandates. The concept is to help states to develop and adjust their own national strategies in the context of globalization and growing dependence of states on each other and on the general state of the economy, ecology and world society on the planet. Examples of such organizations are the Food and Agriculture Organization of the United Nations (FAO), the Organization for Economic Cooperation and Development (OECD), the United Nations Environment Program (UNEP), the International Energy Agency (IEA), the World Bank (WB) and others. These organizations have a mandate to develop global and regional forecasts, as well as commitments to assist Member States in developing their own strategic goals and development programs. Each international organization fulfills its role and fills in a certain niche, that was identified by the member states:

- FAO periodically develops, with the participation of the member countries, strategic forecasts for 10 to 20 years ahead in agriculture (OECD/FAO Agricultural Outlook), fisheries (Fisheries Outlook), forestry and forest industry (Forest Sector Outlook Studies - FSOS).
- The World Bank is engaged in global economic forecasts (Global Economic Outlook) and ratings of countries on the ease of doing business (Doing Business).
- UNEP produces a periodic environmental forecast (World Environmental Outlook).
- The International Energy Agency (IEA) compiles an annual energy review-forecast (World Energy Outlook).

2. FAO OUTLOOK STUDIES AND THEIR FEATURES

FAO forecasts are highly appreciated by the member states because they serve as reliable guidelines for the development and adjustment of their own national plans and programs for fisheries, agriculture and the forest sector. Analysis, assessment of the state and trends, as well as forecasting of the world's forest sector are an integral part of FAO's own strategy. Predictive studies highlight the long-term and most important trends in the forest sector and identify obstacles, difficulties and new opportunities. Based on data from various sources, attracting the best specialists and applying advanced methodologies, these studies support the political reviews and strategic planning necessary in a globalized world. They are based on several scenarios and show politicians and managers a possible set of acceptable solutions.

There are global, regional, country and thematic forecasts of FAO. Global studies analyze trends in the production, demand, trade and consumption of forest products in the world, or in certain thematic areas of interest to many countries, for example, furniture, energy, forestry, forest plantations, etc. Regional studies analyze a wider range of issues, but on regional scales (Asia, Africa, Europe, Russia, China, USA). These include issues and concerns that are particularly relevant to a region. At the same time, global, regional and thematic forecasts complement each other.

FAO forecasts deal with both today and the remote future. Their main goal is to support the reform of interested states, as well as private forest business, in order to implement the UN decisions on globalization, green economy, biodiversity and sustainable management. Forecasts indicate a range of possible alternatives, benefits and risks due to implementation of the alternatives. Forecasts contribute to the three main areas:

1. development of national forest policies and strategic planning together with the development of roadmaps;
2. development of a civilized national dialogue on forests;
3. assistance in attracting new investments.

In preparing the forecasts, FAO considers it important:

1. Involve all stakeholders, especially national experts, multilateral or bilateral organizations, the private sector, non-governmental organizations and national minorities in the forecasting process.
2. Use the process of producing forecast to increase the individual and institutional capacity of development participants.
3. To ensure the dissemination of data, results and knowledge in the country.
4. Promote the use of results to improve sustainable forest management.

Forecasts include both quantitative and qualitative elements of the study. Analysis based on supply and demand models is complemented by qualitative analysis. The problems that can significantly affect future development are considered.

At the global level, FAO has so far generated two forecasts for the possible development of the forest sector: the Global Forest Products Outlook Study (GFPOS) and the Global Fiber Supply Model (GFSM).

The first study analyzes trends in forest management with the goal of forecasting future production of forest products. The forecast for wood fiber materials is limited mainly to roundwood production. The results of the two complementary studies were used in other related studies, for example, in the FAO flagship report "State of the World's Forests" [1].

The Global Forest Products Outlook Study (GFPOS) is the fifth of a series of global supply and demand forecasts. This forecast has been compiled since 1982 with a frequency of approximately every five years. It went further than its predecessors and presented the most complete forecasting of supply and demand from the point of view of forest policy and management. Thus, the study went beyond the traditional question of how much wood is needed in the future. It answered the questions posed: where the wood will come from, who will produce it, where and how will the wood be processed and used. In addition, the forecast tried to answer the question of how policies should be changed and institutions restructured in the future.

The Global Wood Fiber Supply Model (GFSM) was first developed in 1995. Along with the predictive model, the analysis included fresh forest inventory statistics as well as recovered and non-wood fiber data. In general, this study contributed to the development of forest policy. It required reliable data and analysis of the sources and disposal of fiber materials. This has contributed to efforts to achieve sustainable forest governance in many countries. Both forecasts were based on a number of reports on different areas of relevant research.

Current regional forecasts include the following reports:

- Forest Outlook Study for West and Central Asia (FOWECA) "People, forests and trees in West and Central Asia. Outlook for 2020".
- A series of forecasts for Asia, including:
  - Asia-Pacific forests and forestry to 2020,
  - Asian Southeast forests and forestry to 2020,
  - East Asian forests and forestry 2020,
  - Pacific forests and forestry until 2020,
  - Forests and forestry in the Greater Mekong Subregion to 2020,
  - Asia-Pacific forestry to 2010 (report is updated subsequently),
  - Forest policies, legislation and institutions in Asia and the Pacific. Trends and emerging needs for 2020,
- In Europe:
  - European Forest Sector Outlook Study II: 2010-2030 (2012),
  - Russian Federation Forest Sector Outlook Study to 2030 (2013),
- For Latin America:
  - The Latin American Forestry Sector Outlook Study (LAFSOS) up to 2020,
  - Trends and prospects for the forest sector in Latin America and the Caribbean (2006 in Spanish).
- For North America:
  - The North American Forest Sector Outlook Study 2006-2030 (UNECE/FAO 2012),
- Outlook to 2060 for world forests and forest industries: a technical document supporting the Forest Service 2010 RPA assessment

All regional reports are built on country reports, which are also freely available to public. Each of the country reports is done by the best experts of their countries. FAO oversees the entire process, provides a methodology and, if necessary, on-site capacity building by FAO staff.

The result of each report is several (usually 3-4) alternative scenarios with the analysis of strengths and weaknesses of each. FAO is collaborating with other partner organizations to create country reviews and projections. In particular, all joint European forecasts, as well as the North American forecast, were published by the UN ECE (Economic Commission for Europe) in Geneva.

FAO forecasts are complemented by FAO flagship products, namely:

- Global Forest Resources Assessments, the report is updated every five years,
- The State of the World's forests, updated every two years.

They differ from the forecast in that they do not have a forecast component, but only describe the state of affairs in the industry.

3. RESEARCH FINDINGS AND DISCUSSION

Russia joined the FAO in 2006. Until 2006, insignificant information was collected by the FAO in Russia. Given the vast territory of land and forest land, this circumstance certainly made it difficult for the FAO to make any significant global conclusions and generalizations about the state and prospects of the world's forests.

In 2012, by the request and with the direct participation of the FAO, a forecast was prepared for the development of the forest sector of Russian Federation until 2030 [2]. The document was developed on the basis of methodological recommendations used by UN FAO in preparing regional forecasts for development of the forest sector.

The report presented an objective and independent expert assessment of the current state of the Russian forest sector and possible alternatives for its further development until 2030. This task was successfully and quickly completed by a group of 23 prominent experts under the guidance of prof. A.P. Petrov, rector of the All Russian Institute for Advanced Training of Leaders and Forestry Specialists

(VIPKLH). The Supervisory Board was headed by V.A. Chuyko (RAO Bumprom). The project manager from UN FAO and the editor of the report was M. Lobovikov, FAO Forestry Department Service Chief.

The multidisciplinary team included representatives from science, education, civil society and the private sector. The team successfully completed the task. The study analyzed the main system forest related problems of the Russian Federation and proposed solutions based on the balance of supply and demand for forest products.

The FAO report on the development prospects of the Russian forest industry is a multi-page publication with charts and tables. In the course of the research, a methodological base for forecast scenarios was developed. It is fundamentally different from the official approaches of the Rosleskhoz and Ministry of Industry and Trade and.

The report contains 12 chapters:

1. Russian Federation forest sector.
2. Methodology of the outlook study.
3. Forecast of forest resources.
4. Demand for wood products.
5. Forest industry sector development.
6. Forest regeneration, conservation and protection.
7. Forest resources and climate change.
8. Forest certification.
9. Illegal wood.
10. Forest ownership.
11. Forest policy.
12. Education and staff, science and technology.

Conclusions and recommendations.

Bibliography.

The outlook was based on a comparison of supply and demand for forest resources. This forecast methodology is fundamentally different from the forecast methodology implemented in the Strategy for the Development of the Forest Sector of the Russian Federation until 2020 and 2030 [3, 4] and in the draft State Program for the Development of Forestry until 2020 [5]. These forecasts are based only on the assessment of supply.

The forecast for the development of the Russian timber industry (an integral part of the forecast for the long-term socio-economic development of the Russian Federation for the period until 2030) was built on supply as well and ignored demand side of the balance. This forecast was prepared by the Ministry of Economic Development [6]. In the FAO forecast, all its authors are known. They are responsible for the veracity and recommendations. On the opposite, unlike the FAO forecast, the authors of the Ministerial forecast are unknown.

Forecasting the supply of raw materials in the FAO outlook study did not cause any particular difficulties and disagreements. The calculation was carried out according to the well-known models of VNIILM (Russian Research institute for Silviculture and Mechanization of Forestry) with a horizon far exceeding the specified parameters (until 2030). Demand modeling turned out to be much more complicated. It was revealed that there are no models for demand forecasting. Therefore assessment of demand had to be carried out by the expert evaluation method.

Market economy is built on different principles than planned economy. In market economy, the main goal is not to produce goods, but to sell them. When demand and resources are in place, it is possible to produce the goods demanded by the market. Therefore, the basis of the FAO project is balance of supply and demand for forest products. This distinguishes the FAO project from the above-mentioned government documents, which unilaterally take into account only supply side of the balance and ignores its demand part.

Analysis of the dynamics of forest products in the Russian Federation for the entire post-Soviet period showed that the main barrier to the development of the forest sector is the low demand for forest products in the domestic market. Low demand is mainly due to the low purchasing power of the population. Demand for the domestic forest products may fall due to increased imports. Liberalization of tariff and customs policies in the context of the accession of the Russian Federation to the WTO increases import of forest products and requires a flexible approach.

The FAO project convincingly showed that long-term planning should be based on stimulation of demand for forest products in the domestic market. This method was successfully employed for the development of the Russian automotive industry. It is necessary to develop economic foundations for strategic planning of the forest sector based on the demand assessment for wood products. Scenarios for the development of the forest sector were built on the basis of a balance of resources and goals. However, there were no guarantees provided for the resources availability [7].

The authors of the "Russian Forest Sector Outlook Study" called for urgent modernization of the Russian forestry sector, increasing attractiveness for investments, and stimulating domestic demand for forest products. Particular attention is paid to furniture, housing construction, forest management, legislation, illegal logging. The study showed that for the transition to the innovative scenario, the Russian forest sector needs to improve management efficiency and carry out constructive reforms and restructuring.

4. CONCLUSION

The FAO study "Russian Federation Forest Sector Outlook Study to 2030" was the result of cooperation between Russia and the Food and Agriculture Organization of the United Nations (FAO). The main novelty of the forecast was planning with the orientation of the forest sector on the demand for forest products in the domestic and export markets. Demand was estimated quantitatively and qualitatively by expert estimates due to lack of time and resources. The project accentuated the need for mathematical modeling of the market demand.

Unfortunately, the federal government bodies responsible for the development of the national forest sector did not learn from the lessons, that were provided by inoperative forest strategies in the subjects of the Russian Federation. They continue to develop forecasts based only on resource potential and estimated allowable cuts. At the same time, significant Russian and foreign forest investments are jeopardized due to the poor forest management efficiency.

The forest sector development forecast, that was carried out with the participation of FAO, has received great international appreciation. Nevertheless, it did not become an official document of strategic planning in the Russian Federation. Its development was not ordered by the federal government. Creating a scientific base for the long-term strategic forest forecasting and planning requires in the first place development of methodology for assessing the market demand for forest products in the domestic and export markets.

REFERENCES

1. FAO report "State of the World Forests – 2018" [Internet resource]. URL:http://www.fao.org/3/I9535RU/i9535ru.pdf
2. Russian Federation Forest Sector Outlook Study to 2030 [Internet resource]. URL: http://www.fao.org/3/i3020r/i3020r00.pdf
3. Order of the Ministry of Industry and Trade of Russia and the Ministry of Agriculture of Russia dated October 30, 2008. No. 248/482 "Strategy for the Development of the Forestry Sector of Russia until 2020" [Electronic resource] URL: http: //www.consultant.ru/document/cons_doc_LAW_99108/Order of the Ministry of Industry and Trade, 2008
4. Order of the Government of the Russian Federation of September 20, 2018 No. 1989-r "Strategy for the Development of the Forestry Sector of the Russian Federation until 2030" [Electronic resource]. URL: http://www.static.government.ru/media/files/cA4eYSe0 MObgNpm5hSavTdIxID77KCTL.pdf
5. Order of December 28, 2012 No. 2593-r State program of the Russian Federation "Development of forestry for 2013-2020" [Electronic resource]. URL: http://www.forestforum.ru/info/gosprodramma_lh.pdf
6. Forecast of the long-term socio-economic development of the Russian Federation for the period until 2030 [Electronic resource]. URL: http://www.consultant.ru/document/cons_doc_LAW_144190/
7. Pryadilina N.K. Approach to economic planning for the development of the forest sector at the regional level (case of Sverdlovsk region) // Economics: yesterday, today, tomorrow. 2018.V. 8. No. 1A. S. 122–133.

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OPTIMALITY GUIDELINES FOR DECISION MAKING IN FOREST CONSOLIDATION IN BULGARIA

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Abstract: Modern management of natural timber resources requires the elimination of all elements that reduce economic efficiency. In recent years in Bulgaria the cost of roundwood purchased by the wood working enterprises has been increasing mainly as a result of their scarcity. Access to the extraction terrain is becoming increasingly difficult. Production costs for timber harvesting and transportation are increasing. The high cost of harvested timber for the needs of the woodworking industry reduced the margins of woodworking enterprises. At that moment, the Bulgarian Forestry Agency decided to consolidate forest territories in order to improve access to forests and reduce costs. The purpose of this study is to formulate an initial model of optimality in this process.
Keywords: forests, land, consolidation, optimality

1. INTRODUCTION

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). According to Kies & Peter (2017) increasing fragmentation of privately-owned forest land represents a main challenge for the future round wood harvesting. In this context, Vitikainen (2004) describes land consolidation as a comprehensive reallocation procedure of a rural area.

To date, there is no formulated methodology for assessing the effects of forest land consolidation in the Bulgarian forest sector conducted since 2016 to 2019. The consolidation procedures carried out so far by the Bulgarian forest authorities aimed to gain greater efficiency for all the activities within forest management departments. The first stage in 2016 was the first step of consolidation of forest areas. Its combined effect is still not clear neither for the authorities nor for the academics. In fact it is controversially successful. The Ministry of Agriculture, Food and Forestry decided to repeat the “experiment”. For now, the second stage of consolidation, for which 1000000 Euro has been allocated, is being undergone. The previous stage, which began in 2016, costed 350000 Euro. The absence of the scientifically sound optimal criteria of forest land consolidation efficiency in Bulgaria determine the need of developing such a criteria for prescreening ant choosing the forest properties included. The purpose of this study is to provide optimization criteria in forest land consolidation that allow to determine its economic efficiency and support the responsible departments to choose best properties to buy. The study is conducted under the conditions of limited information about consolidation and exploits only data, available for expert assessmetns of the consolidated properties.

1.1. Objectives, benefits and costs of consolidation in forests

Vitikaninen (2004) defined the objectives of forest land consolidation as division of agricultural, forest land and land properties in villages; infrastructure improvement, i.e. roads, piping, drainages; improvement of activities, i.e. their easiness and applicability. Thomas (2004) defined almost the same purposes of infrastructure and management improvement. The achieved objectives are the benefits gained throughout the consolidation. Hudecová (2015) and Endo (2010) stated and the most important benefits include the cadastral map with higher positional accuracy and standardized cadaster base. Vitikainen (2004) and Kies & Peter (2017) again complete the picture with the costs appeared before, during and after the consolidation. They are for procedures and implementation. For now the costs for procedures in the Bulgarian case are not clear except the price of the land properties, which is the greater part and consequently subject of optimization model development.

The previous stage costs can be classified as direct and fixed in respect of land areas. The main purpose of consolidation in Bulgaria is to enlarge the state-owned land in expense to private-owned. The campaigns in 2019 and in 2016 required each individual land purchased to be within the interval of 0,1-5 ha. This requirement provides some rules for decisions and allocation of the areas. At the same time, it places doubts if it is necessary to make costs for activities in which not the effect, but the costs or the price is the most important criteria. The authorities particularly especcially created departments in each Bulgarian Forest Enterprise (they are six at total) prescreen the forest land properties submited by the private owners into the application procedures. Departmenst choose these properties whic are close to roads and clasify them by price. When the purchasing costs (sum of the prices of the properties) ammounts approximately 50000 EUR they stop and by the properties included in the classation. Again the properties inside are not well assessed by the efficiency, but only the costs.

2. MATERIALS AND METHODS

Distribution of benefits throughout forestry have been extensively studied (Kolev & Yovkov, 2011), which state that the fairness is achievable if the distribution is almost 50%/50% between society and the forest owners. This distribution in the consolidation process would be close to equal, if in prescreen (classified) properties are included more features than only the price. In the current study economic efficiency is applied as technical efficiency (Coelli, 2005) of each property included in the selection procedure. The costs for consolidation are included into efficiency ratio in multiple output and multiple input. The analysis of technical efficiency gives the highlights of reducing the inefficient choices. One of the approaches for that is the Data Envelopment Analysis (DEA). It was introduced by Charnes, Cooper & Rhodes (1978) for the assessment of relative efficiency of similar economic units (DMU) that use particular inputs to produce outputs. DEA provides a measure of efficiency of each DMU allowing, in particular, to separate efficient from non-efficient DMU and to indicate for each inefficient DMU its ‘efficient peers’ (Bouyssou, 1999). Efficiency assessed by DEA for the purpose of forestry is quite spread trough many research(see Boosari et. al, 2015; Viitala&Hanninen, 1998). Cooper et al. (2007) developed the mathematical equations and successfully used by Zadmirzaei et al. (2016), Neykov et. al. (2020), Korkmaz (2011), Sporcic, et al. (2009) and many others.

The model used here is in the envelopment form (dual model with slacks) with constant returns to scale (Zhu, 2014):

$$\min \theta \,, \tag{1}$$

$$\text{Subject to: } \sum_{i=1}^{n} \lambda_j x_{ij} - \theta x_0 \leq 0 \tag{2}$$

$$\sum_{i=1}^{n} \lambda_i y_{ij} - y_0 \geq 0. \tag{3}$$

$$\max \sum_{i=1}^{n} s^- + \sum_{r=1}^{s} s^+ \,, \tag{4}$$

$$\sum_{i=1}^{n} \lambda_i x_{ij} - \theta^* x_0 = -s^- \tag{5}$$

$$\sum_{i=1}^{n} \lambda_i y_{ij} - y_0 = s^+ \,, \tag{6}$$

λj - individual coefficients of *j-th* forest land property
Θ is the so-called efficiency scores and Θ^* is the optimal efficiency
s+ and s- - lacks that measure shortage of benefits from the property or surplus of resources (x_{ij} *i-th* type of resource of *j-th* property).

Estimation of the DEA efficiency model has been made for 13 properties. They have been under consideration by the State Forest Enterprise of the North Western Region and currently are in negotiations. The outputs are forest stand site index (FSSI) used in Bulgaria (Mihov et. al., 2009), plentitude of forests (PFC) or forest cover (Petrin, 2007) and the inclusion (Popov et.al., 2011) of the predominant tree species (IPTS). The FSSI varies from 1 to 4 for the properties included. It describes the quality of timber which consequently is the highest at value of 1 and lowest at 4. The PFC varies between 0 and 1, but sometimes can be over 1. Inclusion (IPTS) can be in the interval between 0-1.

Additionally in the study have been forecasted revenues per 1 EUR costs for purchasing the properties in order to support decision makers in the Enterprise in context of future better revenues.

3. RESULTS AND DISCUSSION

The results for the efficiency are derived under assumption of the threshold in certain amounts. The Enterprises practice during the consolidation process and properties choice to put a threshold of the total amount of the consolidation budget. The properties inside are negotiated with their owners, the other fall off the procedure.

Results in the current study are intrseting with peculiarity, that optimality exists only under budget constraints. So the model here can be considered as constrained optimal algoritm with DEA linear function. The results for the revenues are shown on Figure.1

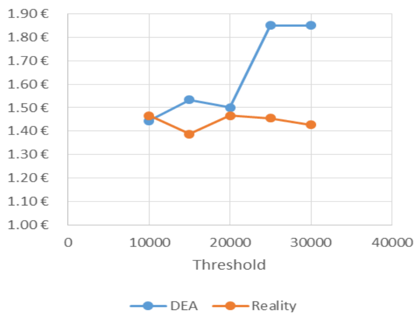

Figure 1. Revenues per 1 EUR consolidation costs (costs efficiency)

The figure presents the convincing advantage of the DEA model. Definitely its use will contribute to improving the economic condition of the State Forest Enterprise and its divisions. Improvement of the revenues is quite visible at every threshold, besides 10000 EUR. Before it the bargains with properties for consolidation is in inefficient scale. The FSSI varies in different way, than the revenues (Figure 2.). Figure 2 presents the nature of the FSSI after thresholds establishment.

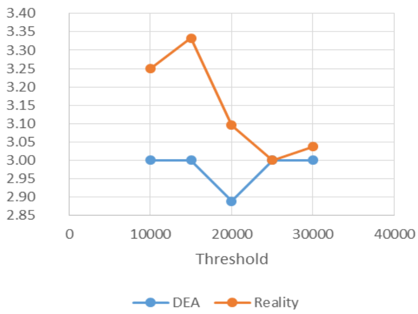

Figure 2. FSSI of the consolidated areas in different budget thresholds, the value of 2.85 is the highest quality index

The figure shows that DEA achieves much higher quality than the minimum cost criteria practiced in reality. As the scale increases, the DEA results approach real data. Forest enterprises can only succeed with the quality of their plantations at large budgetary thresholds.

The criteria of PFC (plentitude) and IPTS (inclusion) are additional, but not less important – *Figure 3*.

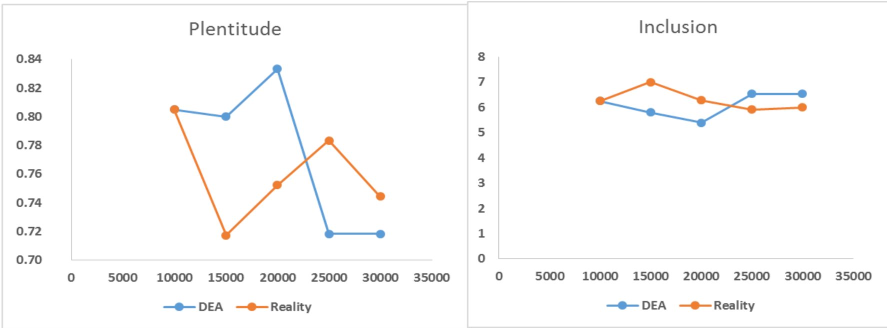

Figure 3. FSSI of the consolidated areas in different budget thresholds, the value of 2.85 is the highest quality index

Plentitude and inclusion determine the extent to which consolidated properties will contribute to forestry productivity. PFC decreases at high budget thresholds, which means that damaged plantations can be included in the list of consolidated areas. The IPTS is high at the large thresholds, which is good in terms of the assortment structure of the wood sold and the ease of harvesting. The two indicators interchange each other, but the plentitude is more important one, which can de compensated only by the total revenues, caused mostly by the more expensive tree species. A lower budget threshold means lower revenues, lower quality but denser forests. The higher budget threshold the higher the revenue but higher risk of danaged forests.

4. CONCLUSSION

The use of DEA will definitely improve the choice of land consolidation areas. Forest enterprises with the help of this methodology will be able to make cost-effective selection of properties. Minimizing costs deprives companies of short-term and long-term opportunities to generate profit. Setting it over a super-strategic period of time puts the whole consolidation process at risk of low profitability.

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REFERENCES

1. Boosari, J. M., Limaei S. M., Amirteimoori A. (2015): Performance evaluation of forest management plans (Case study: Iranian Caspian forests), Caspian J. Environ. Sci. 2015, Vol. 13 No.4: pp. 373-382
2. Charnes A., Cooper W., Rhodes E. (1978). Measuring the efficiency of decision making units. European Journal of Operations Research, (2), 429-444.
3. Coelli, T., Rao D.S.P., O'Donnell, C.J., Battese, G.E. (2005). An introduction to efficiency and productivity analysis: Springer Science-i-Business Media, Inc.
4. Cooper, W., Seiford W., Lawrence M., Tone K. (2007): Data Envelopment Analysis: A Comprehensive Text with Models. Applications, Refer-ences, And DEA-Solver Software. 2nd Edition: Springer Science+Business Media
5. Endo, V. (2010): Applying the Land Governance Assessment Frameworkin a Middle-Income Economy: The Case of Peru. Innovations in Land Rights Recognition, Administration, and Governance, A World Bank Study: pp. 281-291
6. Hudecova, L. (2015): The Effectiveness of Land Consolidation in Slovakia. FIG Working Week 2015.
7. Kies, U., Peter, A. (2017): Forest land consolidation of community forests in North Rhine-Westphalia, Readjustment of property as a solution for land fragmentation and inactive small-scale private forest owners in Germany. SIMWOOD Pilot Project NRW Summary Report: 3.
8. Kolis, K., Hiironen, J., Riekkinen, K. & Vitikainen, A. (2017): Forest land consolidation and its effect on climate. Land Use Policy, (61): pp. 536-542

9. Kolev, K., Yovkov. I. (2011): Social Equilibrium as a Criterion for Sustainable Development of Public Output. Economic Thought journal, Bulgarian Academy of Sciences - Economic Research Institute, (3): pp. 68-91
10. Korkmaz, E. (2011): Measuring the productive efficien-cy of forest enterprises in Mediterranean Region of Turkey using data envelopment analysis. African Journal of Agricultural Research Vol. 6(19): pp. 4522-4532
11. Kovalčík, M. (2011): Profitability and competitiveness of Forestry in European countries, Journal of For-est Science, 57, 2011 (9): 369–376
12. Mihov, I., Bogdanov K., Poryazov K., Tonchev T., Dobrichov I., Velinova M. (2009): New stand site index tables as basis of forest management organization, Management and Sustainable Development 1/2009 (22): pp. 123-130
13. Neykov, N., P. Antov, Savov V. (2020): Circular Economy Opportunities for Economic Efficiency Improvement in Wood-based Panel Industry, Conference: 11th International Scientific Conference "Business and Management 2020“At: Vilnius, Lithuania, DOI: 10.3846/bm.2020.493: pp. 8-15
14. Pertin, R. (2007): Inventory and ecological analyze of the wooded territories in Kyustendil Regional Forestry Board and possibilities for improvement of species composition, Management and Sustainable Development 1/2007(16): pp. 91-99
15. Popov, E., Torchyk V., Holopuk G. (2011): Douglas-fir plantations – as a means of increasing the productivity of forests in Belarus and Bulgaria, Plant studies, Volume I, Number 6, 2011: pp. 88 - 93
16. Sporcic, M., Martinic, I., Landekic, M., Lovric M. (2009): Measuring Efficiency of Organizational Units in Forestry by Nonparametric Model. Croa-tian Journal of engineering, 30- : pp. 1-13
17. Thomas, J. (2004): Modern Land Consolidation: Recent Trends on Land Consolidation in Germany. Proceedings of Symposium on modern land consolidation, Volvic, France: pp. 10-11.
18. Viitala, E-J., Hanninen H. (1996): Measuring the efficiency of public forestry organizations, Forest Science (44) 1998: pp. 298-307
19. Vitikainen, A. (2004): An Overview of Land Consolidation in Europe. Nordic Journal of Surveying and Real Estate Research, (1): pp. 23-44
20. Zhu, J. (2014): Quantitative Models for Performance Evaluation and Benchmarking Data Envelopment Analysis with Spreadsheets, Springer, ISBN 978-3-319-06646-2 : pp.11-20

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SUSTAINABLE DEVELOPMENT AND SPATIAL LOCATION OF PROTECTED GREEN SPACES IN BULGARIA

Marinov, P.

Abstract: At present, the twenties of the XXI century are increasingly influencing the life cycle of society, influenced by the Biosphere with its interconnected earth's crust and ecosystems. Protected natural sites in a global or regional aspect appear as part of this symbiosis. Sustainable development, as a concept associated with balancing the natural resource potential of the planet, and in the context of scientific material, will be applicable to the presentation of different types of protected areas in Bulgaria - history, definitions, location, percentage, socio-economic development and their potential for development, according to the Law on Protected Territories of the country.
Keywords: Sustainable development and protected areas

1. INTRODUCTION

It is obvious that the use of natural resource capital cannot be exploited at such a furious pace, typical of the beginning and middle of the XX century. Continuing at the same pace, the extraction of natural resources at the rates of the 50s and 60s of the XX century will lead to a shortage of the same or a global environmental catastrophe. This reveals the research philosophy of the scientific teams - the relationship between natural resource potential and climatic changes, making developments commissioned by the Club of Rome.It still has a direct impact on lifestyle, regardless of the individual's adaptability in which climate zone he lives. New technologies used in people's daily lives to improve the quality of life cannot overcome the negative effects of climate change in the long run, or in the short term. On the other hand, it is directly related to the Green Spaces locally or globally. In the field of sustainable development related to the natural resource potential and protected green areas, a number of scientists work with many developments (Meadows 1972, Reimers 1990, Pearce 2013, Marinov 2018, Nedeva 2015, Bashev 2010, Todorova 2017, Mihailova 2019, Markov 2019).

The International Union for Conservation of Nature (IUCN) has developed a common applicable classification for the comparability of green territories, which, according to the purpose of management, formulates six categories of protected areas (categories I-V were approved in 1978 and category VI was added in 1992). Bulgaria is part of the World Network of Green territory, the laws and regulations are synchronized with international norms and requirements. The Protected Areas Act (PAA), identifies six categories of protected areas in line with international requirements and categories of (IUCN): reserve (IUCN category I), national park (IUCN category II), natural landmark (IUCN category III), maintained reserve (IUCN category IV)), a nature park (IUCN category V) and a protected area (IUCN category VI). The specific regime of protection and management of protected areas is determined by management plans in accordance with the relevant category and the requirements of international treaties.

2. MATERIALS AND METHODS

During the development of the material the definition of Sustainable Development was applied, as well as the same for the formation of the natural resource potential. It uses the statistics from the NSI, as well as the LPAA, in the classification of the different typologies, protected areas. For the analysis of protected areas, the classification for the same of the International Union for Conservation of Nature (IUCN) is applied. For greater reliability and chronological consistency, historical and comparative methods have been applied.

3. PRESENTATION

The idea of sustainable development was first introduced by (Mill, 1848), who introduced the term "steady state". In this category, it determines the development at a level at which the typical statistical population is served by statistical capital. A new look at Sustainable Development gives (Daly, 1977), which connects it with a constant supply of population and resources, in which technical progress and the population are presented as an integral part of the environment. Humanity as a system is evolving within certain limits and must take this into account in order to avoid irreversible global consequences. The research of Prof. Dr. Dennis Meadows "Limits of growth" (1972) looking for answers to the questions:

- What will happen if the pumping of natural resources continues at an accelerated pace, their quantity?
- What will be left for the next generations?

Of course, the answer is too frightening and leads to a global apocalypse.

In 1983, the World Commission on Environment and Development was established at the OUN. She was tasked with producing a report entitled "Our Common Future", led by Mrs Gru Bruntland, then Prime Minister of Norway. The publication of the report took place in 1987, which marked the beginning of modern ideas about the interaction between human society and the way of exploitation and conservation of natural resources. The OUN Agenda 2030, adopted by world leaders in 2015, represents the new global framework for sustainable development and sets 17 goals for sustainable development. It is a commitment to eradicating poverty and achieving sustainable development by 2030 worldwide, ensuring that no one is ignored. The goals of sustainable development are balanced between the three dimensions of sustainable development: economic, social and environmental. They have specific dimensions for the next 15 years and are aimed at: 1) human dignity; 2) regional and global stability; 3) the good condition of the planet; 4) just and sustainable societies and 5) building prosperous economies. They help to promote cohesion between EU countries, within societies and with the rest of the world. In the social and economic literature there are different definitions and opinions for Sustainable Development. The anthropogenic philosopher (Pearce, 2013) expresses an opinion on sustainable development: "…every society that sets itself the task of sustainable development must develop economically and socially in a way that minimizes those activities whose costs are for at the expense of future generations and, where these activities are unavoidable, to provide compensation to future generations for these costs". The natural complex of Bulgaria is formed by three components: natural environment, natural resources and natural conditions. The main elements included in their structure are: geographical location, relief, high and low carbon resources, climate, water, soil, vegetation and fauna. All of them take part in one way or another in the formation and development of economic complexes and territorial units of the country. There is a close connection between the three components, the development of landforms and the structure of the Earth's crust. The great diversity of high and low carbon natural resources in the country is determined by the long and very different in nature (continuing) geotectonic development of the Balkan Peninsula and in particular Bulgaria. There are different conceptions of natural conditions, which are reduced to the same interpretation, leading to a minimal distinction with the concept of natural resource.

The natural resource potential includes all elements of the natural environment, protected areas are part of this "huge global and local ecosystem". The main function of these areas is the protection of biological diversity, preservation of natural processes in the ecosystems of the country, protection of endemic and relict species or preservation of the entire natural picture of Bulgaria. On the other hand, natural resources can be grouped according to their use and purpose: means of labor - arable land, waterways (lakes, rivers, seas and oceans), irrigation water, and low-carbon energy sources, energy sources - hydropower, uranium and high carbon energy sources. Consumption products are drinking water, biological species of the World Ocean (plant and animal). Natural resources can also be considered from an economic point of view, as this term refers to all-natural resources that directly and indirectly create prerequisites or conditions for economic and social development of society.

The Paris Climate Conference, held on 12.12.2015, with 195 countries participating, signed an agreement, which enters into force on 4.11.2016. This act is the first global agreement between countries on concrete measures against rising temperatures on the planet. The Treaty includes 31 pages with specific quantitative parameters, which should strengthen the implementation of the OUN Framework Convention on Climate Change, launched at the Earth Summit in 1992 in Rio de Janeiro. The Paris

Agreement includes three main objectives: 1) Limiting global warming to less than 2 °C by 2050 compared to the pre-industrial period. The goal is to limit warming to just 1,5 °C by the end of the 21st century. 2) Increasing the ability to adapt to the negative effects of climate change and promoting the resilience of climate change and reducing greenhouse gas emissions in a way that will not harm food production. 3) Promoting the flow of funds in the field of reducing greenhouse gas emissions and resilience to climate change. It is necessary to reduce greenhouse gas emissions and CO2 in the atmosphere from 40% to 70% in order to reduce the rise in temperature values from anthropogenic activity.

These changes have been a concomitant factor for humans during their evolutionary development. It still has a direct impact on the way of life, regardless of their adaptability in which climate zone they live. New technologies, such as air conditioning systems and all such varieties, make people's lives easier, but there is no way to overcome the negative effects of global climate change. Climate change will lead to changes in ecosystems (displacement and adaptation of flora and fauna to new climatic elements on a planetary level), modification of crops, the formation of “new patterns” of life. Stopping this process is the creation of Green and Smart Cities (building the necessary green spaces, as protected areas with a single goal - the formation of a micro climate), meeting the changes and needs of human civilization (Marinov, 2019).

4. RESULTS AND DISCUSSION

The construction of protected areas in Bulgaria has a 70-year tradition and history. In 1928 with the establishment of the “Union for the Protection of Native Nature”, on 12.09.1931 in the first protected territory in our country was declared, Natural Hrastovo Monument (near Devin), with an area of 300 decares of black pine forests. One of the first activities in this direction is related to the renewal of the reserve “Silkosia” in Strandzha Mountain on June 29, 1933. In 1977 protected areas in Bulgaria covered 1% of its territory, in 1991, they were 2%. As of 31.03.2002 Bulgaria has one of the most developed networks of protected areas in Europe, including 725 protected areas with a total area of 565618,0 ha or 5,21% of the country's territory. After the accession of Bulgaria to the EU, certain areas are included in “Natura-2000” as part of the European network. Based on Directive № 92/43/EEC (Habitats Directive) of 1992, consisting of special protection areas under the Birds Directive №79/409/EEC and special conservation areas under the Habitats Directive in Bulgaria “Natura-2000” covers 33,89% of the territory.

As of 31.12.2019 according to the PAA and a decision of the Council of Ministers on the territory of the Republic of Bulgaria there are: 118 protected areas for protection of wild birds, covering 22,6% of the state, 231 protected areas for protection of habitats, covering 30% of the same. A protected area is a place where there is an established natural ecosystem or culturally significant site, these areas are declared in accordance with the PAA. A total of 336 “Natura-2000” protected areas have been accepted in Bulgaria, covering 34,3% of the country. Within 27 years, there has been a slight increase in the area of protected areas by 0,42%. Most of these areas are located in rural areas of the country, which are characterized by a specific way of life and culture. Again, according to the above-mentioned law on protected areas, subject to certain conditions, the local population is encouraged to develop socio-economic activities related to ecology, ecosystem protection, rural and cultural tourism (breeding of certain types of animals and production of typical foods). The development of a certain type of crafts characteristic of the certain rural area.

Reserves comply with IUCN category I, certain areas on which natural ecosystems develop, characterized by the presence of endemic and relict species. They are exclusively state property. Their total number and occupying spaces are listed in table 1. Some of them are located in the National Parks of the country. The purpose of these areas is to preserve the flora and fauna in their natural state. On the territory of Europe there is a network of similar types of spaces. The use of the reserves may be for scientific purposes or to collect natural material for its restoration elsewhere in the country. From 1990 to 2013 the total area of forest territories has increased by 407,628 ha or 10,8%, of which 2,905,586 ha or 69,51% are state forest territories and 170,514 ha or 4,08%, are located in national parks and reserves. On the table 1 shows the condition of the reserves, comprising a very small part of the territory of the country.

Table 1 Protected areas according to the LPAA as of 2019

Territory	Number	Area of ha	km²	% from BG
Reserves	55	76979	769,79	0,69
Maintained reserves	35	4571	45,71	0,04
National parks	3	150362	1503,6	1,35
Nature parks	11	256455	2564,6	2,31
Landmarks	346	16373	163,73	0,15
Protected areas	492	73434	734,34	0,66
General condition	942	578484	5784,8	5,21

Information from the LPAA and calculations of the autho

Maintained reserves comply with IUCN category IV in which rare plant and animal species are stored. Their maintenance is related to the preservation of ecosystems in their natural form, all kinds of human activities are prohibited with the exception of scientific and educational visits. On the territory of the country their number is 35 from table 1, as the covered area of them is extremely small below one percent.

National parks in the country are a total of three Rila, Pirin and Central Stara Planina, meet IUCN category II. Territories within which settlements do not fall are declared national parks. They include natural ecosystems with a great variety of plant and animal species and habitats, with characteristic and remarkable landscapes and sites. The following zones are distinguished in these types of parks: 1) reserves and maintained reserves; 2) tourist area; 3) areas of the huts; 4) the administrative centers for management and maintenance of the parks and the sports facilities; 5) other areas according to the specific conditions in the parks. From table 1 it can be seen that they have the largest area in percentage compared to the other protected sites. Reserves and maintained reserves, which fall within the boundaries of national parks, retain their regimes.

Nature parks comply with IUCN category V, include a wide variety of different types of ecosystems, characteristic relics and endemics for a particular type of landscape. Within the boundaries of natural parks there may be settlements, settlements and resorts, as well as productions that do not pollute the environment. On the territory of the country their number is 11, covering a little over two percent of the country.

Natural landmarks comply with IUCN category III, include sites with a characteristic relief and landscape profile, such as – rock formations, rock discoveries of scientific value, earth pyramids, caves, sinkholes, waterfalls, fossils, minerals and others. There is a ban on the territory of an activity that may disturb the natural character of the natural forms. In table 1 their number is 346 and occupy one 0,15% of the country's territory. These natural formations are characterized by their great diversity and distribution everywhere.

Protected areas in accordance with IUCN category IV are declared areas with characteristic or remarkable landscapes, including those that are the result of harmonious coexistence of man and nature. Habitats of endangered, rare or vulnerable plant and animal species communities and ecosystems. There are opportunities for research, educational activities and environmental monitoring, providing opportunities for tourism and spiritual enrichment. On the table 1 their number is 492, as the largest of the protected species in the country, but occupy a relatively small part of the territory.

5. CONCLUSIONS

Sustainable development as a concept can be used in any variety, but if it is concretized in a certain direction, it acquires meaning and weight. Sustainable development of protected and green areas in Bulgaria can occur throughout the territory, thanks to the natural and climatic elements. Protected areas are part of Bulgaria and their preservation and development is directly related to the entire ecosystem of the continent. Area of forests and other green areas, classified by type of forests and by the possibility of wood supply, as well as the share of forests and other wooded lands in the total area. This indicator provides a comprehensive picture of forest resources and is a valuable source of information on national forestry policies and planning. The area and especially its changes are a key element in the assessment of sustainable management of green spaces. EU forests account for 5% of the world's forests and have been growing steadily for the last 60 years. The largest share is occupied by coniferous forests 50%, followed by deciduous 27% and mixed 23% of the total forest area. On the territory of the country forests occupy 37,37% of the land area, and in the last 10 years there has been a steady trend of increasing areas. The natural resource potential of Bulgaria is one of the most diverse on the continent of Europe, thanks to the geographical location of the country. The potential for the creation and development of an ecological environment is great, as well as the accompanying socio-economic activities, but everything ultimately depends on the mentality of society, whether it is able to change its paradigm.

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REFERENCES

1. Bachev, H., (2010), Mechanisms of governance of agro-ecosystem services, in Achieving environmental security: ecosystem services and human welfare. IOS Press, Washington, DC.
2. Daly, H., (1977), Steady State Economics, Freeman, San Francisco.
3. Marinov, P. (2019), Changing Europe, Plovdiv, ed. Fast Print Books, ISBN 978-619-236-104-4.
4. Marinov, P. (2018), Natural resource potential in the rural areas of the South-Central region, Plovdiv, ed. Fast Print Books, ISBN 978-619-236-000-9.
5. Markov N., (2019), Spatial analysis of trade activity using geographic information systems, Economic Thought Journal, p. 111, ISSN 0013-2993.
6. Mill, J. St., (1848) Principles of Political Economy.
7. Mihailova, M., (2019), Urban forests: Bioeconomy and Added value, 12th International Scientific Conference Digitalization and Circular Economy: Forestry and Forestry Based Industry Implication, Varna, Bulgaria, September 11-13. 2019, pp 117-125.
8. Nedeva K.N., Nanev N.N., Marinov P.P. (2015), The Green infrastructure - a new approach to achieve sustainable development in the region, a scientific international Conference – „Promising problems of Eeconomics and Mmanagement-collection of scientific articles“, Publishing house „BREEZE“, Montreal Canada, 26-30.10.2015 y., pp. 141-145, ISBN 978-617-7214-09-9.
9. Pearce, D., (2013), Global Catastrophic & Existential Risk - Sleepwalking into the Abyss, publish – Amazon.
10. Reimers, F., (1990), Nature Management, Dictionary-Reference, M.: “Thought”.
11. Todorova, K. (2017), Adoption of ecosystem-based measures in farmlands – new opportunities for flood risk management, Trakia Journal of Sciences, Vol. 15, Suppl.1, ISSN 1313-7069 (print), pp. 152-157.
12. Law on Protected Areas Act, Prom. SN num. 133 from 11.11.1998.

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FORESTS, WOOD PRODUCTS AND BIOENERGY IN CLIMATE CHANGE ADAPTATION AND MITIGATION

Šupín, M., Loučanová, E., Olšiaková, M.

Abstract: Global challenges like climate change, ecosystem degradation, limited resources coupled with a growing population force us to seek new ways of producing, consuming and innovating while respecting the ecological boundaries of our planet. This also applies to the wood processing industry. The main objective of this paper is to describe, analyze and forecast the development of the forests, wood products and bioenergy in climate change adaptation and mitigation. At the same time, it is necessary to achieve sustainability, which constitutes a strong incentive to modernize and innovate wood and furniture industries as well as the way of using wood as source of bioenergy and thus to also reinforce their position in a highly competitive global economy. They have to produce and consume products and materials within healthy ecosystems through a sustainable bio-economy.
Key words: climate change, sustainability, bio-economy, bioenergy, renewable resources

1. INTRODUCTION

Climate change is one of the most pressing and complex issues facing society in the 21st century. Human induced climate change is one of the most pressing and complex issues facing society in the 21st century. By 2025, the average global temperature is expected to increase by 1.5 degrees Celsius (Brack, D. 2018; Loučanová, E. et al. 2017).

The current global economic model which relies on fossil raw materials is not sustainable in the long term. This is especially true as megatrends of demographic growth and climate change continue. This situation makes it necessary to explore alternative models that minimise the overall consumption of energy and material and maximise the share of renewable resources in the economic system. The bioeconomy is one such alternative model. It offers both opportunities and challenges for forest resources. (Parobek, J. et al. 201.; Parobek, J. et al. 2016 a; Kaputa, V.; Paluš, H.; Vlosky, R. P. 2016).

Forests are biggest renewable natural resource in terms of material and energy supply. At the same time, they provide much more than only biomass. They support a rich portfolio of other ecosystem services that range from protective functions (e.g. preventing soil erosion) to cultural services (e.g. recreation) and the provision of goods such as game and mushrooms. Sustainably managed and non-managed forests are both important carbon sinks. Their conversion to other land uses is a significant cause of CO_2 emissions. Some forest management programmes now include carbon sequestration in their management objectives (Loučanová, E., Kalamárová, M., Parobek, J. 2015; Paluš, H., Parobek, J., Dzian, M., Šupín, M. 2018).

This situation offers great opportunities for a holistic forest-based bioeconomy through the intelligent use of biomass as well as through developing innovations relating to the entire spectrum of forest ecosystem services. However, an increased use of renewable biological resources needs to consider planetary (sustainability) boundaries, e.g. by taking care of biodiversity and climate change mitigation (Parobek, J., Paluš, H., Loučanová, E., Kalamárová, M., Glavonjić, B. 2016; Parobek, J. et al. 2016 b; Banja M., Scarlat N., Monforti-Ferrario F., Dallemand J.F., 2013).

Therefore the aim this paper si to describe, analyze and forecast the development of the forests, wood products and bioenergy in climate change adaptation and mitigation.

2. METHODOLOGY

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

3. RESULT AND DISCUSSION

Forest natural and artificial provide many economic, social and environmental benefits. They help fight diversification, desertification, protect river basins and biodiversity, regulate the climate and maintain the social and cultural values of countries. In economically developing countries, forests help meet basic needs - providing food, medicine, wood, energy and feed. (FAO Forestry paper 177, 2016).

The paper focuses on forests, wood and climate change, describing the role that forests play in the global carbon cycle, and the various options for mitigating climate change using forestry and wood products.

When considering the management of forested lands to mitigate climate change it should be recalled that forests are often managed for multiple purposes, including industrial wood production, fuelwood production, production of non-timber forest products, protection of natural resources (e.g. water and soil), wildlife management, and recreation. Following international concern about climate change, carbon sequestration has now become an additional objective for certain forest management programmes. There are many forest management strategies which can reduce global CO_2 emissions. For example, preventing deforestation and unsustainable agricultural and land-use practices is one of the most cost-effective, and environmentally beneficial actions that can be taken now to arrest global climate changes.

Wood products and products from forests, both natural and planted, make an important contribution to many national and local economies. Just as significantly, forests provide a range of environmental services that are, ultimately, fundamental for the survival on our planet. For example, they play an important role in stabilizing soils and protecting land from erosion by wind and water, and they help to maintain a steady supply of clean freshwater. Trees and forest soils also lock up atmospheric carbon. Forests thus play an important role in reducing concentrations of one of the main greenhouse gases causing global warming. While in the past forests were seen primarily as a wood resource to be exploited, and then to use soil for agriculture activities, in recent years there has been a paradigm shift in society's attitudes towards forests. It is now widely recognized that forests can provide much more than timber, fuelwood, and nonwood forest products. Forests are increasingly seen as part of the human and natural landscape, and thus in need of a more holistic approach to their management, an approach that recognizes the complex links between forest, environment and society. The world's forests hold a stock of carbon of over 1,200 billion tons, almost double the amount of carbon held as CO_2 in the atmosphere.

These findings we can group into five categories:

a) - forests as a source of livelihoods and human well-being

b) - the importance of in perpetuity ecosystem health to preserve all values from forests

c) - the need to integrate forestry with other economic sectors

d) - the need to share forest benefits more equally

e) - the need to develop forest resource governance systems that enable society to reach its objectives.

Forests and trees make direct contributions to the subsistence and income of well over a billion people. The global community is turning to forests for mitigation of climate change.

The indirect impacts of forested lands are equally important in providing inputs and maintaining productivity in rural activities, especially agriculture.

The view of forests is changing with continued population growth, urbanization, changes in values, demands for social and political equality, and increasing demand for environmental services, all adding to the demands on forests.

The means for sustained development must be ascertained in the short, medium, and long term. Probably the greatest opportunity to meet the demands on forests and forest products for people and rural livelihoods as well as the environment is the growing ownership or clear user rights of farmers, the landless, local communities, and forest-dependent people over land and forest resources.

Good governance is an essential part of the enabling environment for sustainable forest management to contribute towards development goals.

Biodiversity is the variety and variability of life on Earth. Biodiversity is typically a measure of variation at the genetic, species, and ecosystem level. Terrestrial biodiversity is usually greater near the equator, which is the result of the warm climate and high primary productivity. Biodiversity is not distributed evenly on Earth, and is richest in the tropics. These tropical forest ecosystems cover less than 10 percent of earth's surface, and contain about 90 percent of the world's species. Marine biodiversity is usually highest along coasts in the Western Pacific, and in the mid-latitudinal band in all oceans (Parrotta, J. A. et al. 2012).

Biodiversity decline is expected to continue if current trends persist. A wide range of efforts will be required to stop this long term downward trend and halt the further loss of biodiversity. The fate of biodiversity depends directly and indirectly on human production and consumption patterns. Biodiversity loss is mainly driven by increasing demands for food, wood, fibre, energy and freshwater, further exacerbated by expected climate change.

Today, agricultural land, managed more or less intensively, makes up about one third of the global land area.

The activities and pressures with bearing on biodiversity losses link closely with human development in terms of volume and orientation, and are therefore inextricably linked with activities by economic sectors to satisfy consumption.

The demand for these goods is of primary concern, as they are being produced on agricultural fields, in forests or extracted from and collected in natural and semi-natural ecosystems. Hence it drives land-cover and land-use changes with consequences for biodiversity and avariety of ecosystem services.

Forests, especially those in tropical and subtropical regions, contain most of the world's terrestrial biodiversity and provide a broad range of ecosystem services. These services directly benefit people both globally and locally, in particular the hundreds of millions of people whose livelihoods depend, at least in part, on forests. One of these global services - carbon sequestration - is receiving international attention because of forests' important contribution to the global carbon cycle.

Deforestation, resulting mainly from ongoing conversion of forests to agricultural land, is the major cause of global biodiversity loss in terrestrial ecosystems. It is also the second largest anthropogenic source of carbon dioxide emissions to the atmosphere after fossil fuel emissions. Forest degradation (changes in forest condition that affect a forest's capacity to provide goods and services) is a major contributor to global anthropogenic CO_2 emissions, and an important driver of biodiversity loss.

Biodiversity is of fundamental importance to forest productivity and other critical ecosystem processes and services. While some forest ecosystem services, such as erosion control, are only weakly related to biodiversity, losses of biological diversity can adversely affect the resilience of forest ecosystems to ongoing human impacts, environmental change, and the long-term provision of many ecosystem services, including carbon storage.

Increased use of forests and wood products, while not replacing the need to reduce greenhouse gas emissions at source, does make an important contribution towards tackling the problem of climate change. Forests are critical to mitigation, having a dual role. They function globally as a net carbon sink but are also responsible for about 10 to 12 percent of global emissions. Forests and wood products offer both developed and developing countries a wide range of options for timely and cost-effective mitigation. Afforestation/reforestation offers the best option because of its short timescale and ease of implementation. Reducing deforestation, forest management and forest restoration also offer good mitigation potential, especially because of the possibility for immediate action. Yet forest contributions to mitigation also go beyond forest activities.

The use of wood products can also provide broader social, economic and environmental benefits. However, these broader developmental benefits are not always recognised, nor do they always materialise in tandem with climate change mitigation initiatives. The aims should be to improve understanding of the benefits of, and linkages between, the use of wood products to mitigate climate change and the capacity to deliver broader human development.

Biofuels can provide answers to current global energy and economic crises - both as a sustainable energy source and through promoting economic development, especially in rural areas of developing countries. Dependence on non-renewable fossil fuels as well as environmental concerns related to air pollution and greenhouse gas effects contributing to global warming and climate change have stimulated interests of policy makers and industry to promote bioenergy as part of energy security and climate change mitigation strategies (Souza, G. M. et al. 2015).

Trade-offs between biofuels and environmental resources are inevitable. The mitigation of climate change via reducing GHG emissions through a transition to low carbon energy systems such as selected biofuels offers a logical trade-off, as long as the design of expanded biofuel production avoids areas of special biodiversity concerns or embeds new production areas within a sustainable matrix of natural and transformed ecosystems. Few positive influences on biodiversity and ecosystem services result from biofuels development.

Sustainable biofuels and biodiversity management requires cross-sectoral integrated planning and regular monitoring of selected, cost effective and policy relevant indicators.

4. CONCLUSION

The wood processing sector is similarly to the agricultural sector, both dependent on forest ecosystems and their goods and services and it is a major contributor to forest biodiversity loss. While the direct impact of the wood production sector on deforestation and the conversion of natural forests is relatively limited, compared to agriculture. The demand for wood-based products such as roundwood, fuelwood, pulpwood and paper is still increasing. In the future we can await that trend of the demand will continue to increase. Also the increase will continue in demand for wood-based bio-energy, driven by greenhouse gas emission reduction targets. In the future is awaiting that the demand will increase. The main ecosystems for the required resources are forests. The wood processing sector is highly dependent on forests and their production capacity.

Wood products and wood energy can replace fossil-intense products in other sectors, creating a virtuous cycle towards low-carbon economies. The bioenergy is an essential component of GHG reduction technologies displaying a critical role for environmental security and climate change mitigation.

The mitigation potential and costs of the various options differ greatly by activity, region, system boundaries and time horizon. Policy makers must decide on the optimal mix of options, adapted to local circumstances, for meeting national climate change and development goals.

Global warming levels greater than 2°C will lead to significant adverse impacts on biodiversity, ecosystem services, natural ecosystems, water supply, food production and health.

Sustainable production methods in forests will keep the harvest intensity within the forests regrowth potential. Sustainably managed forest ecosystems also provide services for agriculture, water management and other sectors.

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REFERENCES

1. Banja M., Scarlat N., Monforti-Ferrario F., Dallemand J.F., (2013): *Renewable Energy Progress in EU 27 (2005–2020)*, Joint Research Centre, Ispra, Italy, 2013.
2. Brack, D. (2018): *Sustainable consumption and production of forest products*. UN Forum on Forest. Global Forest Goals. UN 2018. 74p.
3. FAO Forestry paper 177 (2016). *Forestry for a low-carbon future Integrating forests and wood products in climate change strategies.*
4. Kaputa, V.; Paluš, H.; Vlosky, R. P. (2016): *Barriers for wood processing companies to enter foreign markets: a case study in Slovakia*. In: European journal of wood and wood products, 2016, 74 (1): pp., 109-122.

5. Loučanová, E. et al. (2017): *A course of innovations in wood processing industry within the forestry-wood chain in Slovakia: A Q methodology study to identify future orientation in the sector*. In: Forests, 8(6), 210.
6. Loučanová, E., Kalamárová, M., Parobek, J. (2015): *The competitiveness of wood products from the perspective of used materials.* In: Acta Facultatis Xylologiae Zvolen, 57(2): pp. 155−163.
7. Paluš, H., Parobek, J., Dzian, M., Šupín, M. (2018): *Determinants of Sawnwood Consumption in Slovakia*. In: BioResources 13(2), pp. 3615-3626.
8. Parrotta, J. A. et al. (2012). *Understanding Relationships between Biodiversity, Carbon, Forests and People: The Key to Achieving REDD+ Objectives.* IUFRO World Series Volume 31. Vienna. 161 p.
9. Parobek, J. *et al*. (2016 a): *Energy Utilization of renewable Resources in the EU – Cluster Analysis Approach.* In: BioResources 11(1), pp. 984-995.
10. Parobek, J.; Paluš, H.; Loučanová, E.; Kalamárová, M.; Glavonjić, B. (2016): *Competitiveness of central European countries in the EU forest products market with the emphasis on Slovakia.* In: Acta Facultatis Xylologiae Zvolen. 58 (1): pp. 125-136.
11. Parobek, J. et al. (2016 b): *Comparative analysis of wood and semi-finished wood product trade of Slovakia and its Central European trading partners.* In: Drewno. 2016. pp. 183-194.
12. Parobek, J.et al. (2014): *Analysis of wood flows in Slovakia*. In: BioResources 9 (4): pp. 6453-6462.
13. Souza, G. M. et al. (2015). *Bioenergy & Sustainability: bridging the gaps*. In: Scientific Committee on Problems of the Environment (SCOPE), Sao Paulo.
14. ***Sustainable development. (2019). *Transforming our world: the 2030 Agenda for Sustainable Development.*
15. URL: https://sustainabledevelopment.un.org/ post 2015/transforming our world
16. ***: EUROSTAT (2020): Database–EUROSTAT.
17. URL: http://ec.europa.eu/eurostat/data/database
18. ***: FAOSTAT (2020 a): Compare data. Rome.

URL: http://:fao.org/faostat/en/#compare/

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GLOBALIZATION OF THE FOREST SECTOR: CAUSES AND CONSEQUENCES

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Abstract. The successes of the post-industrial development of the world economy largely depend on the globalization process. Different sectors of the economy with varying degrees of preparedness and results participate in the processes of globalization. The greatest success in this process was achieved so far by the global trade. Already in the first half of the past century, tools were developed to regulate the process of trade globalization. These tools streamline the spontaneous actions of individual countries with the help of a common and mandatory for all countries code of "traffic rules" in the global market for goods and services. The World Trade Organization (WTO) has emerged due to the increase in the volumes and nomenclature of the international exchange of goods and services, expanding international production cooperation and growing dependence of all countries on the international exchange of goods and services. Another sector of politics and economics that is subject to globalization processes is nature management and environmental protection. The United Nations Conference on Environment and Development in Rio de Janeiro in 1992 (UNCED) was the result of a realization of the need to prevent negative environmental impacts. The Conference has adopted the "Forest Principles". They secured a global consensus on the management, conservation and sustainable development of all types of forests, although they lacked of legal force. Forest principles were the first global consensus to offer all countries a common path for the creation and development of their national forest policy. In accordance with the stated principles, national states have the sovereign and inalienable right to use their forests, manage them and conduct forestry in accordance with their needs and their level of socio-economic development. National forest policy must not contradict the principles of sustainable development and forest legislation. Forest principles have formed the framework and conceptual approaches to the development and implementation of the national forest policies in globalization context. Future planning is becoming one of the most important tools for the sustainable forest management at the national and regional levels in globalization era.
Keywords: globalization, anti-globalization, forest sector, forest policy, strategic planning

1. INTRODUCTION

Globalization is a diverse and complex concept that has become firmly established in economics, ecology, policy and international relations in the mid-80s. However, globalization and its antipode - anti-globalization, is not a new phenomenon that arose only at the end of the last century. The roots and origins of this phenomenon can be traced back to the emergence of the human race and its exodus from Africa to the Eurasian continent. Globalization phenomena proceeded, slowed down and again accelerated throughout the history of mankind long time before the term "globalization" became popular. Examples are the war conquests of Alexander the Great, Roman Empire and Genghis Khan, the Silk Road, the colonization of America, the invention of writing and printing, radio and television, etc. The prevalence of anti-globalist trends in China led to the closure of the Chinese market to the West, technological and military lag and, as a consequence, the country's total defeat in the Opium Wars in the mid-19th century. The example of China provides strong evidence of the danger of underestimating the role of globalization, especially in the rapidly changing world today.

The origin, nature, causes and consequences of globalization is a subject of quite sharp public debate [1]. Opposition to globalization in the face of anti-globalists is representing various interest groups and is growing over time. The anti-globalism is growing, especially in the economically underdeveloped countries that suffer from it and thus negatively perceive globalization processes.

2. REASONS AND CONSEQUENCES OF THE GLOBALIZATION

There are many definitions of the term globalization. In general, this term implies the process of the world economic, environmental, political, cultural and religious integration of countries and regions and their growing interdependence with all the advantages and disadvantages arising from the fact.

Globalization of the world economy is part of the overall process of globalization of the world. The term “globalization” itself has firmly entered modern vocabulary thanks to the economic science. In particular, K. Marx used this term in his correspondence with F. Engels. However, the term gained wide popularity only after the publication of T. Levitt's article "Globalization of Markets" [2], which popularized it and put it into active circulation to describe the integration processes of the modern world.

The main new features for the modern historical stage of globalization are the development of transport, travel, communications, and especially the phenomenal development of computer information technologies, which cannot be compared with the methods of disseminating information in the previous years. Thanks to the new technologies, communications and information, a "new commercial reality" has arisen and global markets have emerged for selling standardized consumer goods at lower prices due to savings by increased concentration and economic scale of production. Global companies such as Coca-Cola, Kelloh's and McDonald's were the first to appreciate and successfully use this new reality. Consumers from almost all over the world buy their products as "their" own traditional products. Global monopolies satisfy and successfully change the tastes and needs of local markets with their uniform products. In the course of globalization, they are crowding out traditional trans-national monopolies from their traditional markets.

In a paper devoted to marketing, T. Levitt [3] postulates the idea that goods are only a means of achieving the company's goal. The goal is to satisfy consumer demand. This idea has become an axiom in the global economy. Those companies that focus on the production of goods, rather than meeting consumer demand, inevitably become an anachronism and disappear in competition battles for consumers.

Globalization and its consequences are ambiguous and often controversial. On the one hand, globalization accelerates the economic growth of the entities involved in it, increases the accessibility of capital markets and resources. Globalization allows to quickly compensate for the lack of natural resources, capital, knowledge and technology. This was clearly demonstrated by the example of Southeast Asia, especially China. Globalization is helping competitive industries gain greater benefits in international markets. An example is the successful trade of the Russian armament, space technology, nuclear industry, metal, oil, gas and other raw materials in the world markets.

On the other hand, globalization repeatedly emphasizes the interdependence and economic stratification of economic entities, strengthens and deepens economic crises. Even the least integrated and developed countries are becoming victims of periodic global crises in the globalized economy. This was revealed by the world financial crisis of 1997-1999, which arose in Southeast Asia in 1997. In 1998, it hit Russia. Then, a year later in 1999, it reached Latin America and closed up the crisis loop around the globe. The global financial and economic crisis of 2008 developed similarly, and is often compared with the "great recession" of the 1930s. It began with a mortgage crisis in the United States in 2007 and soon it has become global. The crisis caused a widespread decline in market demand, commodity and energy prices, rising unemployment and social upheaval around the world.

The processes of globalization are not in themselves negative or positive. Their influence depends on the country's governance, availability of scientific foresight, forecast, strategy, planning, flexible program and political will. With the correct approach, globalization can strengthen national economies. For example, increased competition in the international and domestic market can be both a positive and a negative factor. Competition strengthens the economy with a flexible strategy and competent economic management of the country. In their absence, competition leads to economic dependence and decline. Non-competitive sectors of the national economy of many countries are forced to curtail due to the influx of cheap foreign goods. An example is Russia's consumer goods industry. This process is accompanied by the loss of capacity, profits and jobs in the country.

At the same time, with a strategically correct approach, competition helps to find new technological opportunities and specialization in competitive sectors. The forest sector of Russia, given its vast forest resources, has the great potential to become one of the most competitive sectors in the globalized world. Realization of this goal will require scientific potential, strategic forecasting, planning, visionary decisions and strong political will.

Globalization is not limited by economics only. Similar globalization processes, with their pros and cons, are happening and are rapidly intensifying in the planetary ecology. Ecology has long ceased to be set of individual countries. It has become a matter of real concern for the entire Planet. The demographic explosion in the recent decades, the growing population of the planet, the rise in prosperity and in poverty, the rapid growth of industry, agriculture, the exploitation of the earth's soil, mineral and water resources exacerbate environmental losses and loss of biodiversity on a global scale. Ecology of the Earth does not recognize political state borders. It is global in nature. The massive loss of forests, growing emissions and pollution in one corner of the Planet immediately affects the neighboring states and the ecology of the entire Earth.

3. GLOBALIZATION IN THE FOREST SECTOR. RESEARCH FINDINGS AND DISCUSSION

After the signing of the "Forest Principles" at the UN Conference in Rio de Janeiro in 1992 [4], the process of globalization of forest policy developed in the following main directions:

1. Creation and development of institutions engaged in the interaction of states at the global level.
2. Organization and implementation of international negotiation processes on sustainable forest management at the regional and sub-regional levels,
3. Bringing national forest policies and forest laws in line with the "forest principles" based on sustainable development.

An important event in the globalization of the forest policy was the agreement of countries at the level of individual regions on issues of assessing the sustainability of forest management. Increased was the global control over implementation of environmental, economic and social functions in the national states. As a result, the Pan-European (Helsinki) process for the European countries and the Montreal process for countries with temperate and boreal forests have both emerged. During the Montreal process, the following basic definitions were agreed and confirmed:

• criterion - a category of conditions or processes as a basis for assessing state of sustainable forest management,

• indicator - a measure (measurement) of a criterion.

The forest sector is one of the fundamental and unique sectors of the global economy. It embraces the vital interests of the economy and the environment. At their intersection, certain contradictions and conflicts arise. The forest industry, as one of the components of the forest sector, reflects mainly the interests of the economy and market demand for consumer goods and services. Forestry reproduces the forest resources, natural environmental benefits, services and products.

The causes and consequences of globalization in the forest sector as a whole are the same as in the other sectors of the economy. However, in the forest industry and forestry, they express and manifest themselves in different ways [5]. The reason for this is different economic nature of the two economic sectors, the imperfection and inconsistency of their economic organization, the presence of conflicting and often mutually exclusive economic incentives (Table 1).

Table 1. General opportunities and threats to forestry and the forest industry

		Forestry	
		Opportunities	**Threats**
Forest Industry	**Opportunities**	• Sustainable resource provision • Production of wood energy and biomaterials • Better business relationships, including business intelligence • Improving labor productivity by expanding the use of technology, including logistics • Breakthroughs in research and development of biotechnology • Domestic and regional outsourcing to increase labor productivity • Stable global institutions and regulatory and operational frameworks (such as the Kyoto Protocol) • Public support for renewable resources and the environmental image of wood	• Foreign direct investment (FDI) abroad (exodus of the forest industry from the region) • Low barriers to import industrial raw materials • Competition for the import of raw materials / Globalization of sources of natural resources • Loss of jobs due to the increased labor productivity • International / global component manufacturing outsourcing • Global institutions, regulatory and operational frameworks (such as the WTO) are increasingly encouraging foreign direct investment abroad

	Threats	• Large shortage of wood raw materials leads to higher wood prices • Wood bioenergy • Alternative non-productive business models, rules that limit the use of wood but encourage other viable business models for forestry (recreational services, carbon sequestration) • Growing demands on forests for environmental protection and recreation and the availability of viable business models to meet these needs	• Increasing competition in the import of parts, components or finished wood products • Decreased export competitiveness • Decrease in profitability of the forest industry. Politics governs more sustainable forest management, but does not pay enough attention to market development and experimentation. • Urban people more often consider forests as ideally untouched nature; Unprofitable forest management is becoming more common • Changing of the climate • Low public and private investment in research

Forestry and the forest industry deal with the same resource - forest. They complement each other and are traditionally linked into one sector of the economy. This complementarity and interdependence is particularly manifested in the fact that many opportunities and threats act in one direction in both branches of the forest sector, both in forestry and in the forest industry.

On the other side, the opportunities for the forest industry, which arise from globalization can threaten the interests of forestry. Consequently, new opportunities for forestry can adversely affect the forest industry development. Therefore, they are often administratively separated under different jurisdictions in Russia, as well as abroad.

4. CONCLUSION

It is theoretically believed that globalization in the long run will bring increasing benefits at the global, regional and country levels. It is expected that increased competition, free trade, democracy, transparency, free exchange of achievements, information, technology and know-how will ultimately contribute to the growth of the world's welfare by optimizing the division of labor between countries and regions.

In practice, quite opposite picture is often observed. Rich countries get richer, and poor countries become even more poor. Outsiders often gain progress, but at a much slower pace. As a result, the gap between the countries is not decreasing as expected, but is widening.

In fact, the term "globalization" often hides, as we can see, the Americanization, Europeanization or Sinization (in Asia) of the world. The United States, the European Union and China dominate in the globalization space. They define international trade policies and make the most of globalization for their national economies. The economic strategies of these countries are clearly defined and manifested in the international relations. They influence international processes and organizations, including WTO, FAO, UNFF, etc. In such global organizations, these countries actively promote their own national interests through adoption of international agreements and obligations that are beneficial to them.

The experience of these countries and global companies shows that the benefits of globalization are often obtained not by the entities that have a natural or other development potential, but those who know how to use this potential, understand the dynamics of markets, can predict them, plan and quickly learn from own and others' mistakes.

In the context of globalization, the winner is the one who looks ahead and develop strategic planning. It becomes not just a simple necessity, but also a vital need for the growth of wealth and the very survival of nations in the new era.

Strategic forest planning is an important competition tool. It allows individual countries and groups of countries (for example, the European Union) to benefit from the globalization of forest policy. This is proven by the experience of international organizations such as the Food and Agriculture Organization of the United Nations (FAO UN), the World Bank, the European Forest Institute. These organizations have long been involved in the issues of globalization of forest policy through the development of global, regional and national forecasts, strategies and recommendations.

REFERENCES

1. Strakhov V.V., Pisarenko A.I., Borisov V.A. 2001. Globalization of forestry. In Russian. Editor: S.V. Provornaya, M., 2001. - 400 p.
2. Levitt, T. 1983. The Globalization of Markets. Harvard Business Review, May - June 1983.
3. Levitt, T. 1960. Marketing Myopia. Harvard Business Review, 1960
4. Statement of principles for global consensus on the rational use, conservation and sustainable development of all types of forests Adopted by the United Nations Conference on Environment and Development, Rio de Janeiro, June 14, 1992 // https: //www.un. org/ru/documents/decl_conv/conventions / forest.shtml
5. Nilsson S. (Project Leader)., E. Rametsteiner, H. Bottcher, P. Navlik, F. Kraxner, S. Leduc, M. Obersteiner, F. Rydzak, U. Schneider, D. Schwab, b. Willmore. 2007. Study of the effects of globalization on the Economic Viability of EU Forestry. IIASA Reference 06-157.

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PROBLEMS IN AUDIT AND REPORTING IN BULGARIA'S FORESTRY

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Abstract: An object of analysis in the paper is the quality of the information in the audit reports of forestry in Bulgaria, as a basis for attracting investments, increasing the confidence in the enterprises and achieving sustainability of the industry in macro level. The subject of analysis are the annual financial statements of public and private forestry for the period 2007 - 2017. A priority objective is to analyze the auditor's opinions on the annual financial statements of the Bulgarian forestry. An additional objective is to analyze the overall reporting of the financial-economic status and development of enterprises for the period 2007 - 2017. Main research tasks are: 1) to study the financial development and strategy of public and private forestry, as well as to compare it with the adopted and applied accounting policies; 2) to examine the audited opinions of the financial statements of the target group enterprises for 2017, as well as to analyze the quality of the audit performed and in this respect the reliability of the financial statements. The applied research methods are based on logical, deductive and comparative methods, as well as methods of analysis and synthesis. Main conclusions of the study are: violations of the control environment, lack of disclosed information in the financial statements of enterprises and the application of accounting policies irrelevant to the financial and economic status of organizations.
Keywords: forestry, audit, fraud, disclosures, crimes

1. INTRODUCTION

Although audit, as a tool of achieving sustainability in forestry, is a subject of analysis and discussion in the literature (Brotto and Pettenella, 2018, p. 264; Auditing Forests: Guidance for Supreme Audit Institutions, 2010; Danescu et al., 2014), it is still a neglected factor for efficient and effective planning and management of resources, as well as for the prevention of fraud and illegal actions by Bulgarian enterprises. Currently, a primary document that defines the national strategic policy for achieving long-term and sustainable forest management is the National strategy about development of the forestry sector in the Republic of Bulgaria for the period 2013 – 2020 (NSRGSRB 2013 - 2020). The measures proposed in the strategy do not cover issues related to the financial audit of forest enterprises. However, the SWOT analysis published in the NSRGSRB points out the following weaknesses of the sector: high intensity of violations in forest areas, low efficiency of the application of the penal provisions provided in the forest legislation, as well as the inappropriate absorption of European funds. Based on the model of the three lines of defence (Bankova, 2019, p. 18), audit is a form of a public interest protection and can be perceived as a means of minimizing the stated weaknesses. It is therefore a priority to monitor the transparency of the currently used, supervision and audit measures. The requirements for independent financial audit in Bulgarian forest enterprises are regulated in: the Forest Act, the Accounting Act (AA), the Independent Financial Audit Act, the International Auditing Standards and the applicable accounting standards. State-owned forestry are also subject to an annual financial audit by an elected from the Management Board certified public accountant who must be a registered auditor at the Institute of Certified Public Accountants in Bulgaria. He is obliged to present to the Management Board his opinion based on the annual financial statements of the company (Forest Act, Art. 170, para 1). Privately owned enterprises are subject to independent financial audit, upon reaching legally defined criteria related to the book value of assets, net sales revenues and average number of staff.

Based on the agents' theory we could describe the relationship: accountant - manager - auditor, as a system in which each agent is imperfect and affects the others. This idea is confirmed by the research of Donald Cressey (Cressey, 1950), who suggests that the triangle of fraud outlines the factors that affect the criminal behavior of employees, namely - pressure, opportunity and rationalization. Current practice shows that the auditors cannot prevent the criminal behavior of the management and employees in the Bulgarian state-owned forestry. In addition, 118 cases related to violations of regulations in 2018 are stated (Annual Report of the Forest Agency, p.64). It directly affects the budget of the Forest Agency. The existence of vicious practices, weaknesses in the internal audit control and illegal actions helps to strengthen the weaknesses of the forest sector outlined by the NSRGSRB 2013 - 2020. It is therefore important to take proactive and preventive measures. Specific certification of auditors by the Forest Stewardship Council (FSC) can be mentioned as part of the adopted measures. Often this certificate is a requirement of state-owned forestry that have announced a public tender for the selection of an auditor. It requires auditors to have additional qualifications and knowledge, but at the same time it limits the persons who can perform an audit. In this respect, the main object of analysis in the paper is the quality of the information in the audit reports as fundamental for the reliability of the forestry financial statements and the disclosures to them. This is seen by the authors as one of the factors that attract investment and increase social trust in forestry, while leading to the sustainability of the industry at macro level. Subjects of analysis are published annual financial statements of forestry (state-owned and private-owned), incl. their annexes, activity reports, audit reports, accounting policies. Main purpose of the study is to analyze the audit opinions on the annual financial statements of Bulgarian forestry for 2017. The selection of the target group is based on both the reported crimes and violations in the industry, as well as the fact that forestry are directly related to the implementation of forestry plans and programs, afforestation and protection activities, timber harvesting, marking of plantations and trees. The control over such activities is responsibility of each agent, incl. auditors. An additional goal of the paper is to make an analysis of the statements, annual reports and disclosures about the economic development of the enterprises for the period 2007-2017. In order to fulfill the outlined goals, the following research tasks are set: (1) to study the financial development and applied strategy of forestry, comparing the data with the accounting policy adopted by them; (2) to study the expressed audit opinions of the financial statements of the enterprises for 2017. The adopted research methods are logical, deductive and comparative methods, as well as the methods of analysis and synthesis.

2. ANALYSIS OF THE FINANCIAL STATEMENTS AND DISCLOSURES OF THE FORESTRY ENTERPRISES IN BULGARIA

In Bulgaria, according to the public information presented on the website of the Ministry of Agriculture, Food and Forestry, there are 8 operating private-owned enterprises[1] and 7 state-owned enterprises[2], related to forestry. Without claims for a whole comprehensive analysis, the subject of further study are the annual financial statements and attached annexes (including activity reports, references, disclosed significant accounting policies) of forestry enterprises for the period 2007-2017. A limitation of the study is that for the selected period of time the financial statements of all state-owned forestry are analyzed starting from 2011. It is so due to the fact that in 2011 the selected state-owned forestry are established based on an Order of the Minister of Agriculture and Food. Exceptions are the financial statements of State Enterprise "Kabiyuk" and „Fish resources“. An additional limitation is that for almost 33% of the enterprises included in the target group, no statements have been published for some of the years in the scope of the survey. In particular, no financial statements for 2008 are found for „Zeminvest“, none for „SAPI“ for 2016 and 2017, and none for „Fish resources“, North Central State Enterprise and State Enterprise "Kabiyuk" for 2017. The non-publication of financial statements for the last years under analysis could be explained by administrative delays in publishing the reports by the Registry Agency. However, other preconditions should be sought for the non-publication of statements as old as those in 2008. Although the paper does not focus on the reasons for not publishing financial statements, such practices are common in Bulgaria. The analysis of the accounted financial result (profit or losses) of the enterprises under review show no significant fluctuations. In this respect, 5 of the enterprises in the target group report a loss in more than 60% of the years under review. Nearly 26% of the state-owned forestry report a loss only during the year of bankruptcy of Corporate Commercial Bank, which can be explained by the accrued impairment of the cash of the enterprises in the bank and the accrued financial expenses (for interest and exchange rate differences). In terms of published disclosures, there is another limitation. For the analyzed period, there are no published annexes in nearly 73% of the financial statements in

[1] „Agrovodinvest“ SOJSC; ;„Agrolesproekt“ private LLC; „Vrana“ SOJSC; „Zeminvest“ SOJSC; „Irrigation systems“ SOJSC; „Fish resources“ private LLC; „SAPI“ private LLC; „Varietal seeds - Elite“ SOJSC.
[2] Northwestern State Enterprise; North Central State Enterprise; Northeastern State Enterprise; Southwestern State Enterprise; South Central State Enterprise; Southeastern State Enterprise; State Enterprise "Kabiyuk".

different years from those under study. However, compared to the accounted financial results during the years where there are lack of disclosed annexes, no dependencies are found. Based on a more in-depth analysis of the content of published annexes, the following conclusions can be drawn: (1) Nearly 53% of forestry apply national accounting standards (NAS) throughout the period under review as a basis for preparing their statements. All state-owned forestry, with the exception of State Enterprise "Kabiyuk", apply the national accounting standards until 2012 inclusive, after which they switch to the international ones (IAS). All companies applying IAS publish richer textual information. This confirms previous research showing that Bulgarian enterprises implementing the NAS disclose more limited data (Georgieva, 2020). (2) The companies (nearly 40 %) that account losses for most of the years under analysis indicate: deteriorating financial condition and autonomy, and liquidity indicators based mainly on asset ownership problems, bad debts, and low quality of the human capital. They point out the need for a recovery policy, which includes strategies for enterprise development related to design and construction of forest roads; renewal of fixed assets and improvement of material and technical base; increase of revenue collection; staff training; more active participation in European projects; cooperation with research and educational institutions. However, the stated policies and strategies by the forestry remain relatively unchanged through the years. (3) All companies under analysis apply a stabilization type of accounting policy, the elements of which presuppose the presence of economic stability, lack of frequent changes in the regulatory framework, lack of threats from the external and internal environment. Such conditions are opposite to those stated by the enterprises at their reports. A change in accounting policy as a result of material misstatement has been disclosed by one forestry. However, it is not related to use of defensive accounting policy. The previous conclusions may be perceived negatively by the financial statements' stakeholders and contribute to the reduction of the confidence in the company by investors and society. If the financial statements are audited by a certified public accountant, this is an indicator of their reliability. In this respect, the subject of subsequent analysis are the expressed audit opinions on the financial statements of the forestry under review.

3. ANALYSIS OF AUDIT OPINIONS ON THE FINANCIAL STATEMENTS

From the 15 forestry under study, the authors were able to find available annual financial statements for 9 of these enterprises (see Table 1). No financial audit is made for some of them, and for others, no published data is found in the site of Commercial Register. This poses significant risks associated with access to information for the society and for the public interests.The opinion in 6 audit reports is unmodified. In one of the audit reports there is an emphasis of matter paragraph by the lead auditor. Emphasis is placed on the disclosure of assets and liabilities. This problem is common in financial and accounting practices in Bulgaria. It should be noted that in the company “Irrigation systems” there are 13 qualifications, 5 key audit matters and 3 emphasis of matter paragraph. Without generalizing and identifying the critical remarks that they are a guarantor of the quality of the performed audit, there are obvious serious mistakes in the activity of this forestry. Based on the analysed data there are only 2 qualified opinions from the auditors indicating problems in the activity of the forestry. In conclusion by conducting a financial audit and a specialized audit, auditors cannot prevent the criminal behavior of human capital in forestry.

Table 1. Audit opinions on the financial statements of forestries for 2017

№	Company	Auditor`s opinion
1.	Agrovodinvest	Unmodified opinion, but there is a problem with disclosed information in section IV Other disclosures, item 2 “Contingent assets and liabilities”. There is a large number of objects with unclear technical and physical conditions.

2.	Vrana	Unmodified opinion
3.	Zeminvest	Qualified opinion. In the auditor`s report it is pointed: 1) accumulated losses; 2) the equity is below the amount of the share capital; 3) there is significant uncertainty as to whether the entity is operating; 4) the real value of the tangible fixed assets has not been determined and sufficient and relevant audit evidence has not been obtained; 5) there are significant increases in liabilities to staff.
4.	Southeastern State Enterprise	Unmodified opinion
5.	South Central State Enterprise	Unmodified opinion
6.	Southwestern State Enterprise	Unmodified opinion
7.	Irrigation systems	Qualified opinion. In the auditor`s report it is pointed: 1) the owned properties, machines, facilities, lands, buildings are not used and depreciated, as their future use is very limited due to their poor condition; 2) the owner of part of the assets is not identificate; 3) there is a possibility for overestimation of the value of the assets; 4) there are immovable inventories, and there are impairments of materials and products; 5) no confirmations have been received from no confirmations have been received from external sources regarding trade receivables and payables; 6) there is a termination of a contract with a key supplier, the occurrence of a lawsuit, which leads to an unclear financial result; 7) court cases have been filed in which the company is a defendant and leads to limitation of the period for accrual of provisions; 8) the company's equity includes reserves that are formed as a result of revaluation of assets. About the limitations, the assessment and completeness of the reserve have not been established; 9) the activity of the company is carried out with morally and physically obsolete assets, as it has not been established whether the submitted quantities of water masses to the users are reported correctly and aren`t completed; 10)difference in the prices for sale of water; 11) it is not clear how exactly the revenues and expenditures related to grants provided by the state are distributed; 12) unclearly charged repair costs; 13) there is significant uncertainty as to the company to going concern basis.
8.	Northwestern State Enterprise	Unmodified opinion
9.	Northeastern State Enterprise	Unmodified opinion

Source: own analyses based on data extracted from https://public.brra.bg/

The asymmetric information in the audit reports is not a precedent. It is therefore fundamental that the relevant measures are taken into account by the managers of this type of enterprises. The question is - how can audit reports be improved to provide more valuable and reliable information to the public and investors? In this respect, the International Auditing and Assurance Standards Board propose how audit services quality can be improved (A framework for audit quality key elements that create an environment for audit quality, 2014). The most significant factors are: the way of receiving information, the procedures, the results of the performed procedures, key actions for the preparation of the financial statement and contextual factors. Each of these factors affects the right functioning of the framework in relation to the appropriateness of the audit. However, it is important to pay attention to human and institutional capital: management, government, consumers and regulators. Even if internal policies are developed by high-level auditors, without legal and institutional changes it is impossible to properly, effectively and efficiently conduct financial audits in any sector, including forestry. A good example of institutional control is the pre-trial proceedings initiated in 2020 at the State Forestry Company - Velingrad. It is the result of the joint efforts of: General Directorate for Combating Organized Crime (GDCOC) at the Ministry of Interior, the Prosecutor's Office and the Forestry Agency. The reason is illegal extraction and subsequent marking by employees and issuance of transport tickets for the wood, in order to legalize its origin (https://www.monitor.bg). The illegal extraction of the material serves for illegal profit by the organized criminal group.

3. CONCLUSIONS

Based on the analyzes it can be stated that often the information in the financial statements of Bulgarian forestry is asymmetric. Weaknesses are identified in the control environment, which should be tested and updated to minimize losses to companies and the state treasury. It is difficult to calculate the current losses from this type of crime, so it is fundamental to take proactive and preventive measures. These can be done through the following measures: (1) Increasement of the oversight of the forestry by appropriate legislative and institutional reforms related to financial reporting. (2) To carry out subordination and coordination between the government departments. (3) The internal audit in enterprises should be improved. (4) To carry out additional alternative procedures by the auditors, such as the possibility to monitor the process of handing over and calculating the harvested timber, tracking the way of tickets which are issued and etc. (5) To make a detailed review of internal and external environmental factors in order to update the accounting policy and link it to the strategy of the organization. (6) To improve the control of publicly disclosed information by forestry in order to avoid lacks and non published data.

REFERENCES

1. A framework for audit quality key elements that create an environment for audit quality (2014), IAASB and IFAC, New York, ISBN: 978-1-60815-178-3
2. Bankova, D. (2019): *Metologicheski aspekti na publichnija nadzor nad oditorskata profesija*. IK-UNSS, Sofia.
3. Brotto, L., Pettenella, D. (2018): *Forest Management Auditing*. Certification of Forest Products and Services, Routledge.
4. Cressey, D. (1950): *The criminal violation of financial trust*. American Sociological Review, 15 (6), pp. 738 – 743.
5. Danescu, T., Călean, Io., Şandru, R. (2014): *Measuring the Activity of Internal Audit*. Case Study at the Autonomous Administrations in Forestry, Procedia Economics and Finance, 15 (2014), pp. 1339 – 1348.
6. Forestry Act, Published in the State Gazette No 19/2011, repealed, SG No 21/2020
7. Georgieva, D. (2020): *Factors that affects research and development disclosure of Bulgarian innovative enterprises*, Accounting and its contribution to the economic science, UNWE, pp. 341-348.
8. Hristova, A. (2019): *Some issues connected with the international environmental law*, International policy, XV/2019 (1), pp. 111-114.
9. National strategy about development of the forestry sector in the Republic of Bulgaria for the period 2013 – 2020. (2013). Ministry of Agriculture and Food.
10. ***: Auditing Forests: Guidance for Supreme Audit Institutions (2010).
URL: www.environmental-auditing.org
11. ***: Annual Report of the Forest Agency, Sofia, (2018).
URL:http://www.iag.bg/data/docs/God.Doclad_2018.pdf

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ECONOMIC EFFICIENCY OF THE FOREST INDUSTRY IN THE REPUBLIC OF BULGARIA IN THE TIMES OF ECONOMIC CRISIS AND PERSPECTIVES FOR REDUCING THE NEGATIVE IMPACT

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Abstract: The economic efficiency of the sectors in the national economy is crucial for improving the overall economic development of the country and the employed. Current economic conditions require the consideration of many factors that determine sustainable economic growth. The purpose of this study is to determine the impact of major factors on the overall economic efficiency of the forest industry in Bulgaria during the economic crisis. The reducing of possible impact of the pandemics of COVID-19 is considered like the pushing power toward innovations including FSC CoC certification.
Keywords: efficiency, forest industry, crisis, impact

1. FOREST INDUSTRY IN BULGARIA – STATE AND PROSPECTS

1.1. General characteristic of the Forest Industry in Bulgaria

The Forest industry is characterized by unattractive working conditions and a lack of career development, especially for the women in the sector. But in recent years, the industry has managed to get closer to the peak pre-crisis levels and in the industry there is a serious development of technology, there are numerous trainings and events related to the opportunities for the development of the industry.

The industry has a tradition of furniture production, raw material availability and export potential. The key factors affecting competitiveness in the industry are the upstream section of the value chain and the role of raw materials and components, the availability of skilled labor, investment in technology, R&D, innovation and design, relevant policies affecting the industry.

The industries in the forest sector are diverse and involve different processing stages. Depending on the purpose and consumption of the end products in the sector, the main outputs by economic activities according to NSI (CEA-2008) are:

- *Manufacture of wood and of products of timber and cork*, including: Cutting, planning and impregnation of timber; Manufacture of veneer and wood panels; Manufacture of prefabricated parquet tiles; Manufacture of joinery and other products of timber for construction; Manufacture of wood packaging; Manufacture of other articles of wood.
- *Manufacture of furniture*, including: Manufacture of office and shop furniture; Manufacture of kitchen furniture; Manufacture of mattresses; Manufacture of other furniture.

The largest share in the production in general is the activities "Furniture manufacturing", "Manufacture of veneer and wood panels" and "Cutting, planning and impregnation of timber", followed by " Manufacture of joinery and other wood products“. "Manufacture of wood packaging“ has a smallest share of total sector production, but “Manufacture of mattresses“ has increased in recent years. (BCWFI, 2017)

Manufacturing in the sector includes many other end products besides furniture, such as wooden toys, sports equipment, writing boards, coffins, household products and wood products. However, the production of these products is significantly lower than the products of the main production facilities mentioned.

Finished wood products are used in construction (joinery, beams, etc.) such as process fuel and heating (wood pellets, wood briquettes, wood chips, firewood), wood packaging (pallets, crates, chests, crates), as well as paper and cardboard.

1.2. Management challenges

The efficiency of the supply chain and logistics operations, as well as reverse logistics, are key factors in improving the competitiveness of the sector, characterized by a variety of materials, operations and finished timber products. The problems associated with reducing delivery time and logistics efficiency increase the requirements for information systems to provide the functionality and flexibility.

Most often, investments in the sector are made for technological upgrades. However, experts believe that investments must be balanced, both in production capacity and in terms of diversification.

The main challenges facing manufacturers are the constant pressure from traders to reduce prices or to market analogy of old models, but at lower prices. On the other hand, the prices of materials and wages in the sector are rising and, accordingly, these circumstances lead to a decrease in margins, a decrease in quality and the entry of more foreign products through large chains. (BCWFI, 2018)

Therefore, the main challenges facing the management of Forest industry enterprises and increasing economic efficiency are related to:

- *improvement the production and operations management* - improvement of the organization and operational management in the enterprises; production specialization and certifications;
- *improvement the marketing management* - marketing positioning and branding related to Marketing 4.0; entering new markets and increasing exports;
- *improvement the innovation management and cooperation* - collaboration with universities and research centers to develop new products and technologies through EU projects and programs; mergers in clusters and supply chain associations;
- *improvement the human resource management* - investments in training according to changes in the industry (Industry 4.0).

2. MATERIALS AND METHODS

Martic et. al. (2009) define efficiency like the goals achievement with the minimum use of available resources. DEA is a well-known, nonparametric approach (Charnes et al., 1978) that is widely used to analyze the efficiency of for example - forest districts (Diaz-Balteiro, 2008; Korkmaz, 2011; Sporcic et al., 2009). Liu et. al. (2013) made a research that until 2009 the share of DEA-based papers about Forestry is only 0.86%, and about industry 4.66%, but the growth of such papers is almost exponential in the recent years. Forestry and ceonsequent industries are topical. Alzamora and Apiolaza (2013) estimated the efficiency of the usage of pine logs for grade producing, until Susaeta et al. (2016) successfully calculated the efficiency of an entire pine forest. Boosari (2015) directly compared alternate plans for forestry management. Kovalcik (2018) compared the Slovak forestry efficiency to other European countries, which is the only direct comparative study using the DEA approach throughout forestry of European Union countries. In forest-based industries, such as the wood-processing and furniture industry, the existing studies are related mainly to the enterprise level (see Ma, 2016; Vahid and Sowlati, 2007). In the curren study have been used the envelopment model by Charnes et al., (2007). If efficiency scores $\Theta=1$ the DMU (Decision Making Unit – the Forest industry in Bulgaria and other comparative industries) is optimal.

For estimation of the models have been used data from Eurostat for the years 2006 – 2017. The DMUs are the years of development of Bulgarian Forest industry and same industries of the EU28 countries, taken on total, by Eurostat. The compared indivators are:

- *Inputs:* Number of enterprises; Total purchases of goods and services - million euro; Personnel costs - million euro.
- *Outputs:* Apparent labour productivity (Gross value added per person employed) - thousand euro.

3. RESULTS OF THE SURVEY

The results for the efficiency scores are shown in Figure 1. The figure shows that there was great stagnation in the EU during the crisis. The collapse in sales has hit labour productivity very hard. In contrast, in Bulgaria the shocks are small. Productivity is ensured in a stable way, but efficiency cannot keep pace with European dynamics.

Comparing the graphs, it is revealed that the dynamics of European productivity during the crisis are the result of fluctuations in the scale of production. The production in the EU can much more dynamically adapt the scales to crisis than the Bulgarian one. This in this case seems to be an advantage of the Bulgarian economy. Bulgarian producers have managed to adapt their scale since 2008. They have higher efficiency than the European. This later led to an improvement in market positions since 2009 to 2011. The net economic efficiency of the forest industry in Bulgaria and the EU, ie. the quality of the resources used, without being influenced by the scale, shows that in Europe the they have functioned very well. After some disturbances before, during and after the crisis the resources in the EU forest industry has stable growth since 2011. The economy improves and is more likely to face the COVID-19 crisis with greater economies of scale than the Bulgarian one. EU have slowly adjusted the scale of production after 2011, following the positive trend and maintain the quality of resources – labour forces in the context of the current study. In the same time Bulgarian industry remain at the same level since 2010. The scale haven't been improved and the quality of labour forces has gone to the limit, as the flat curve after the 2010 reveals this. Better efficiency means good abilities to maintain the market positions but, to reveal the differences between average EU producer and Bulgarian one, have to be calculated the difference between their productivities. In the EU it is 2.21 to 2.9 times greater than Bulgarian. The second have been getting closer to that in EU in the recent years, which means that if the CCR and BCC coefficients remain of 1, the two productivities have to be equal in the next up to 20 years. The quick improvement can appear if the resources are saved in the appropriate way. Additional information is provided by the analysis of recommended cost savings. Bulgarian total purchases of goods and services has to be reduced in about 12% (14% in the EU), Personnel costs – 5% (13% in the EU) and Enterprises – 8% (16% in the EU). The results show that in Bulgaria the added value is too low, compared to the EU, given the differences in productivity. Wages in Bulgaria are too low, so the necessary savings are lower than those needed for the EU. The hidden key to the differences between Bulgaria and EU is the excess capacity. This is a phenomenon for the EU, not the Bulgarian forest industry. It proves, that the Bulgarian forest industry has functioning at the production line, and cannot react to economic expansion. The forest industry in EU had more than 8% excessive capacity to face the expansion. In Bulgarian one there is no reserves for that. Savings recommended by the models can be used for investments.

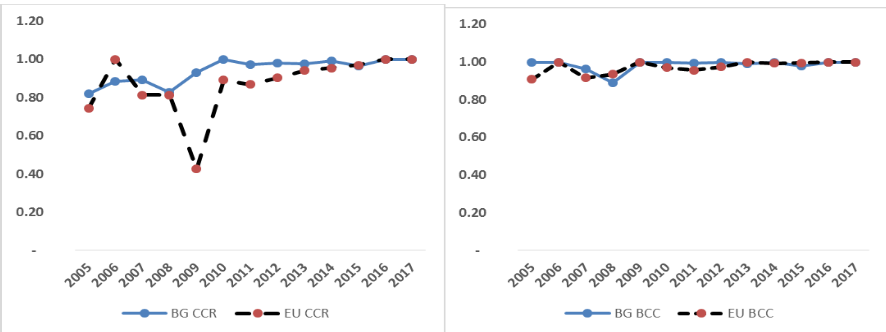

Figure1. Efficiency scores in variable return to scale – CCR and constant return to scale – BCC

4. CONCLUSIONS

The study of the economic efficiency of the Forest industry enterprises in Bulgaria has shown that it is resilient to crises. Unlike in the EU, it manages to maintain the efficiency of its production and labour productivity. The problems come when opportunities arise for recovery after the bottom of the crisis has been achieved. The efficient production without excessive capacity hinders the rapid response and the occupation of market positions vacated after the crisis. That why the savings recommended by the models have to be invested in to innovations like new technologies, especially in the context of Industry 4.0. Investments in standardization like in FSC – CoC or so, could only strengthen the capabilities to maintain the markets, but ton to expand them. European forest industry has abilities to work inefficient due to excessive capacity and to become efficient in every suitable moment.

Forest industry in Bulgaria has to improve the abilities to increase the productivity of labour in appropriate market structure. The efficiency gained by low wages and salaries can only support the survival in the time of crisis, but afterward is the great challenge.

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REFERENCES

1. Alzamora, R.M., L.A. Apiolaza (2013): A DEA approach to assess the efficiency of radiata pine logs to produce New Zealand structural grades, Journal of Forest Economics 19 (2013): 221–233.
2. Boosari, J.M., S. Mohammadi Limaei, A. Amirteimoori (2015): Performance evaluation of forest management plans (Case study: Iranian Caspian forests), Caspian J. Environ. Sci. 2015, Vol. 13 No.4: pp. 373~382.
3. Cooper, William W., Seiford, Lawrence M., Tone, Kaoru (2007): Data Envelopment Analysis: A Comprehensive Text with Models, Applications, References, And DEA-Solver Software, 2nd Edition, Springer Science+Business Media: p. 141.
4. Charnes A, Cooper WW, Rhodes E (1978): Measuring the efficiency of decision making units. European Journal of Operations Research, 2: pp. 429-444.
5. Diaz-Balteiro, L., C. Romero (2008): Making forestry decisions with multiple criteria: A review and an assessment, Forest Ecology and Management 255 (2008): pp. 3222–3241
6. Korkmaz, E. (2011) Measuring the productive efficiency of forest enterprises in Mediterranean Region of Turkey using data envelopment analysis, African Journal of Agricultural Research Vol. 6(19): pp. 4522-4532.
7. Kovalčík, M. (2018): Efficiency of the Slovak forestry in comparison to other European countries: An application of Data Envelopment Analysis, Central European Forestry Journal 64 (2018): pp. 46–54.
8. Liu John S. , Louis Y.Y. Lu , Wen-Min Lu , Bruce J.Y.Lin (2013): A survey of DEA applications, Omega 41(2013): pp. 893–902.
9. Ma, Y. (2016): An Analysis on the Relative Efficiency of Furniture Enterprises in Guangdong Province Based on DEA-BCC and Clustering Method, Open Journal of Business and Management, 2016, 4: 349-354.
10. Martic, M., M. Novakovic, A. Baggia (2009) Data Envelopment Analysis Basic Models and their Utilization, Organizacija, Volume 42: pp. 37-43.
11. Popova R. (2019) Innovation development of the furniture industry in Bulgaria, CBU International Conference 2019 - Innovations in Science and Education, March 20-22, 2019, Book of Proceedings, ISSN 1805-997X (Print), ISBN 978-80-907722-0-5 (Print edition), p.256-261.
12. Sporcic, M., I. Martinic, M. Landekic, M. Lovric (2009): Measuring Efficiency of Organizational Units in Forestry by Nonparametric Model, Croatian Journal of engineering, 30(2009) 1: pp. 1-13.
13. Susaeta , A., D. C. Adams, D. R. Carter, C. Gonzalez-Benecke , P. Dwivedi (2016): Technical, allocative, and total profit efficiency of loblolly pine forests under changing climatic conditions, Forest Policy and Economics 72 (2016): 106–114.
14. Vahid, S., T. Sowlati (2007) Efficiency analysis of the Canadian wood-product manufacturing subsectors: A DEA approach, Forest Products Journal 57(1):pp. 71-77
15. Eurostat (2020), Annual detailed enterprise statistics for industry (NACE Rev. 2, B-E). URL:https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=sbs_na_ind_r2&lang=en
16. Industry, Trade and Services Report (2018) http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=sts_intv_m&lang=en.
17. NSI (2008) Classifier of economic activities in Bulgaria. https://kik-info.com/spravochnik/kid-2008.php.
18. Report on the state of the EU woodworking sector for 2017/2018 (2018) https://timberchamber.com/exportportal_pages/446.
19. Technical Solutions for the Wood Products Industry, American Home Furnishings Alliance, U.S.A., 44. World Furniture Review Report 2018/2019 (2018)
20. https://timberchamber.com/exportportal_pages/453.

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SUSTAINABLE DEVELOPMENT – INTERNATIONAL FRAMEWORK – OVERVIEW AND ANALYSIS IN THE CONTEXT OF FORESTS AND FOREST PRODUCTS – SUSTAINABLE POLICY, TRADE AND MARKETS WITH FINANCING OPPORTUNITIES IN THE SUSTAINABILITY

Rantala, A.

Abstract: Forests and forest products constitute an important resource in the Bioeconomy and Green Economy policies. Policies, strategies and investments have a remarkable significance in the sustainable development in the forest-based sector. The forest sector is in an important role providing many new sustainable opportunities globally. Sustainable policy framework with technological development has a role in the future taking into consideration the climate change. The goal is in economic growth with environmental and socially equitable targets. There is international collaboration within the green initiatives. Innovations and investments give new opportunities in striving for sustainable development.
Forests and forest products provide opportunities for international trade and offer many possibilities for competitiveness. Quality constitutes a significant factor for the international markets. Markets with trade have an increasing importance nowadays. Quality includes certification.
Global framework is significant in the sustainable development. Sustainable development is included in the policy of the Green Economy, the Bio-economy and the Green Growth.
International and national policies have a significant role for the sustainable development. Forests constitute an important resource in the sustainable development and policy framework including forest certification.
The forest sector is in a remarkable role providing significant new sustainable opportunities globally. Sustainable policy framework with technological development has a role in the future taking into consideration the climate change. Climate change mitigation framework has a link with the CSR and Forest Law Enforcement, Governance and Trade, the FLEGT, sustainable trade and investments globally. Wood has an emergent role in the sustainable development framework from bio-based natural resources and in the Bio-economy policy. The CSR approach has a significant role in the sustainable development. Markets are linked to the sustainable development framework and green approaches and the bio-based economy. Wood has opportunities as a renewable material. There are opportunities in forests and forest products. The Corporate Social Responsibility, the CSR, covers forest certification and the FLEGT. Certification has an important role in the markets. The Corporate Social Responsibility constitutes a significant framework in the sustainable development.
This is a qualitative research based on literature. It is based on research articles and literature and organizational literature. Several academic sources are included, for example Proquest, Academic Search Complete (EBSCO), Agris, CAB Abstracts, SCOPUS (Elsevier), Web of Science (ISI) and Google Scholar and Internet sites.
Keywords: Sustainable development, forests and forest products, financing, competitiveness, CSR.

1. CSR GLOBALLY AND IN THE EU

Forests' biomass mitigates climate change. This biomass can be used to products acting as a carbon sink. (Laturi, Jani (2020))

Policy and strategy have an important role in the international and national sustainable development framework. The EU promotes Corporate Social Responsibility, the CSR, internationally in trade and business (European Commission (2019)).

More than 325 million hectares of forest area are certified with the PEFC. Two-thirds of all certified forests globally are certified with the PEFC. More and more double certification with the FSC exist. (PEFC (2020)). There are more than 211 million certified hectares of forest area certified with the FSC (FSC 2020)). In Finland, the PEFC and the FSC represent the certification schemes (Ministry of Agriculture and Forestry of Finland (2020)).

Forest Law Enforcement Governance and Trade, FLEGT, for legal logging and trade with the EU Timber Regulation includes due diligence and Voluntary Partnership Agreements (VPAs) (European Union (2017)).

The EU Action Plan for Forest Law Enforcement, Governance and Trade (FLEGT) in 2003 introduced a process and a plan by the European Commission against the widening illegal logging and related trade. COUNCIL REGULATION (EC) No 2173/2005 established the FLEGT licensing scheme for imports of timber into the European Community. Commission Regulation (EC) No 1024/2008 of 17 October 2008 laying down detailed measures for the implementation of Council Regulation (EC) No 2173/2005 on the establishment of a FLEGT licensing scheme for imports of timber into the European Community takes into consideration competitiveness in the international timber trade and the business. Regulation (EU) No 995/2010 of the European Parliament and of the Council of 20 October 2010 laying down the obligations of operators who place timber and timber products on the market includes the items.

The New EU Forest Strategy in 2013 supports efforts combatting illegal logging. It highlights the approach towards green economy and value of forests. A new EU Forest Strategy - European Parliament resolution of 28 April 2015 on “A new EU Forest Strategy: for forests and the forest-based sector” (2015) highlights that both the utilization of timber and other harvested wood products in renewable and climate-friendly raw materials and sustainable forest management have a significant role in achieving the European Union’s socio-political goals like the energy transition, climate change mitigation and adaptation, and the implementation of the Europe 2020 strategy targets as well as biodiversity targets (EU 2020 targets (2020)).

2. BIOECONOMY

The contribution of the bioeconomy to a more circular economy is based on renewable resources. The Bioeconomy is also able to contribute to decarbonisation of major industries. (REVIEW OF THE 2012 EUROPEAN BIOECONOMY STRATEGY (2017)) Nordic Bioeconomy has the following criteria: 1. Sustainable use of natural resources; 2. Technological innovation; 3. Environmental benefits; 4. Societal benefits; and 5. Business model innovation. (Nordic Council of Ministers (2017)) Finnish Bioeconomy Strategy introduces the following goals: 1. A competitive operating environment for the bioeconomy; 2. New business from the bioeconomy; 3. A strong bioeconomy competence base; and 4. Accessibility and sustainability of biomasses (Finnish Bioeconomy Strategy (2014)).

3. GREEN GROWTH STRATEGY and **NORDIC GREEN GROWTH** accentuate economic growth and development, sustainability, climate change mitigation, innovation, technology, new markets, competitiveness and investment (Green Growth Strategy (2011)**,** The Nordic Council of Ministers (2017)).

4. GREEN ECONOMY

Green economy results in enhanced human well-being and social equity, significantly reducing environmental risks and ecological scarcities. Green economy is low carbon, resource efficient and socially inclusive. The concept of the Green Economy has become a strategic priority for many governments in over a decade. (UNEP (2010))

5. FINANCIAL RESOURCES

Resources are tangible, e.g. financial or physical resources, intangible, e.g. knowhow, technology, reputation, trust and organizational culture, and human, e.g. skills, knowledge, motivation and personal interaction. (Nellis, G. J.; Parker, D. (2006)) Enhancing innovation is seen directing to competitiveness and better financial performance (Hansen, E. (2010)).

6. CONCLUSIONS

Policy has a remarkable role in the sustainable development and climate change framework. Forest Law Enforcement, Governance and Trade, the FLEGT, constitutes a significant policy within the Corporate Social Responsibility, the CSR, with a significant stakeholder collaboration in the sustainable development framework. The Forest Law Enforcement, Governance and Trade, the FLEGT, takes into consideration the climate change framework. Policy and the CSR have significance in the climate change framework providing a link as to sustainable new products in the forest sector and an opportunity for the competitiveness. The Corporate Social Responsibility, the CSR, covers financing. It includes forest certification and FLEGT. Certification and FLEGT have an important role in the markets and sustainable development and can have an important role in the climate change mitigation.

REFERENCES (alphabetical order)

1. ***: A new EU Forest Strategy - European Parliament resolution of 28 April 2015 on “A new EU Forest Strategy: for forests and the forest-based sector” (2015). Available at: https://www.europarl.europa.eu/doceo/document/TA-8-2015-0109_EN.html.
2. ***: A new EU Forest Strategy: for forests and the forest-based sector (2013). Available at: https://eur-lex.europa.eu/resource.html?uri=cellar:21b27c38-21fb-11e3-8d1c-01aa75ed71a1.0022.01/DOC_1&format=PDF.
3. ***: Commission Regulation (EC) No 1024/2008 of 17 October 2008. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32008R1024.
4. ***: COUNCIL REGULATION (EC) No 2173/2005. Available at: https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX:32005R2173.
5. ***: EU 2020 targets (2020). EU policy, strategy and legislation for 2020 environmental, energy and climate targets. Available at: https://ec.europa.eu/info/energy-climate-change-environment/overall-targets/2020-targets_en.
6. ***: European Union (2017). Available at: https://ec.europa.eu/environment/forests/flegt.htm.
7. ***: FSC (2020). Available at: https://fsc.org/en/facts-figures.
8. ***: Green Growth Strategy (2011). Available at: https://www.oecd.org/greengrowth/towards-green-growth-9789264111318-en.htm.
9. ***: Ministry of Agriculture and Forestry of Finland (2020). Available at: https://mmm.fi/en/forests/forestry/sustainable-forest-management.
10. ***: PEFC (2020). Available at: https://www.pefc.org/discover-pefc/facts-and-figures.
11. ***: REVIEW OF THE 2012 EUROPEAN BIOECONOMY STRATEGY 2017. Available at: https://ec.europa.eu/research/bioeconomy/pdf/review_of_2012_eu_bes.pdf.
12. ***: The EU Action Plan for Forest Law Enforcement, Governance and Trade (FLEGT) in 2003. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52003DC0251.
13. ***: The Nordic Council of Ministers (2017). Available at: http://norden.diva-portal.org/smash/record.jsf?pid=diva2%3A1070949&dswid=1409.
14. ***: UNEP (2010). Available at: http://www.unenvironment.org/explore-topics/green-economy/about-green-economy.
15. ***: Resource-Based Theory: Creating and Sustaining Competitive Advantage (2017). Ed. Barney, J. B. and Clark, D. N. Oxford University Press 2007.
16. Bernstein, S.; Cashore, B. (2012). Complex global governance and domestic policies: four pathways of influence. Available at: http://onlinelibrary.wiley.com/doi/10.1111/j.1468-2346.2012.01090.x/pdf.
17. Cohen, D.; Mathey, A.-H.; Biggs J.; Boyland, M. 2014. Corporate Social Responsibility in the Global Forest Sector In The global forest sector: changes, practices, and prospects 2014. Ed. Hansen, Eric, Panwar, Rajat, Vlosky, Richard P. Taylor & Francis 2014. Available at: http://www.crcnetbase.com/doi/pdfplus/10.1201/b16186-20.Corporate Social Responsibility (CSR) 2017. European Commission. Growth. Internal Market, Industry, Entrepreneurship and SMEs. Available at: http://ec.europa.eu/growth/industry/corporate-social-responsibility_en. Elliott, C.; Schlaepfer, R. 2001. Understanding forest certification using the Advocacy Coalition Framework. Available at: http://www.sciencedirect.com/science/article/pii/S1389934101000430.European ***: Commission Horizon 2020. The EU Framework Programme for Research and Innovation. Available at: http://ec.europa.eu/programmes/horizon2020/en/h2020-section/bioeconomy.
18. European Commission 2019. COMMISSION STAFF WORKING DOCUMENT ***: Corporate Social Responsibility, Responsible Business Conduct, and Business & Human Rights: Overview of Progress

Available at: https://ec.europa.eu/transparency/regdoc/rep/10102/2019/EN/SWD-2019-143-F1-EN-MAIN-PART-1.PDF.
19. ***: Finnish Bioeconomy Strategy (2014). Available at: http://biotalous.fi/wp-content/uploads/2014/08/The_Finnish_Bioeconomy_Strategy_110620141.pdf.
20. Freeman, R. E. et al. (2004). Stakeholder Theory and The Corporate Objective Revisited. Freeman, R. E.; Wicks, Andrew C.; Parmar, Bidhan. Organization Science 15.3 (May/Jun 2004): 364-369. Available at: http://pubsonline.informs.org/doi/abs/10.1287/orsc.1040.0066.Heikkurinen, P. (2011). Corporate responsibility for sustainable development: a review and conceptual comparison of market-and stakeholder-oriented strategies. Journal of Cleaner Production. Volume 43, March 2013, Pages 191–198.Available at: http://www.sciencedirect.com/science/article/pii/S0959652612006671.Heikkurinen, P. (2013). Reframing Strategic Corporate Responsibility. Available at: http://epub.lib.aalto.fi/pdf/diss/Aalto_DD_2013_156.pdf.
21. Hansen, E. N. (2010). The Role of Innovation in the Forest Products Industry. Journal of Forestry; Bethesda Vol. 108, Iss. 7, (Oct/Nov 2010): 348-353. Available at: https://academic.oup.com/jof/article/108/7/348/4599420.
22. Holopainen, J. (2016). Changing institutions and consumer-driven development of forest products and services. Dissertationes Forestales 223. Available at: https://helda.helsinki.fi/bitstream/handle/10138/165247/changing.pdf?sequence=3.Hurmekoski, E. and Hetemäki, L. (2013). Studying the future of the forest sector: Review and implications for long-term outlook studies. Forest Policy and Economics 34: 17–29. Available at: http://dx.doi.org/10.1016/j.forpol.2013.05.005.
23. Jagger, P.; Brockhaus, M.; Duchelle, A. E; Gebara, M. F.; Lawlor, K.; et al. (2014). Multi-Level Policy Dialogues, Processes, and Actions: Challenges and Opportunities for National REDD+ Safeguards Measurement, Reporting, and Verification (MRV). Forests; Basel Vol. 5, Iss. 9, (2014): 2136-2162.
24. Laturi, J. (2020). Optimal forestry under climate policy. Dissertationes Forestales 299. Available at: https://doi.org/10.14214/df.299https://dissertationesforestales.fi/pdf/article10412.pdf.
25. Lim, A.; Tsutsui, K. (2012). Globalization and Commitment in Corporate Social Responsibility: Cross-National Analyses of Institutional and Political-Economy Effects. Available at: http://journals.sagepub.com/doi/abs/10.1177/0003122411432701.
26. Mattila, O. (2015). Dissertationes Forestales 198. Towards service-dominant thinking in the Finnish forestry service market. Available at: https://helda.helsinki.fi/bitstream/handle/10138/156060/towardss.pdf?sequence=1.
27. Mikkilä, M. (2006). The many faces of responsibility: Acceptability of the global pulp and paper industry in various societies. Dissertationes Forestales 25. Faculty of Forestry. University of Joensuu. Academic dissertation. Available at: http://www.metla.fi/dissertationes/df25.pdf.
28. Molina-Castillo, F-J.; Munuera-Aleman, J-L. (2009). The joint impact of quality and innovativeness on short-term new product performance. Industrial Marketing Management 38(2009):984-993. Available at: http://www.sciencedirect.com/science/journal/00198501/38.
29. Nellis, G. Joseph; Parker, David 2006. Principles of business economics. Second Edition. Prentice Hall. Pearson Education.
30. Rametsteiner, E.; Simula, M. (2003). Forest certification — an instrument to promote sustainable forest management? Available at: https://www.researchgate.net/profile/Ewald_Rametsteiner/publication/10835520_Forest_Certification-An_Instrument_to_Promote_Sustainable_Forest_Management/links/561e2fb108aec7945a25424e/Forest-Certification-An-Instrument-to-Promote-Sustainable-Forest-Management.pdf.State of World's Forests 2011. FAO. Available at: http://www.fao.org/docrep/013/i2000e/i2000e00.htm.
31. Toivonen, R. (2011). Dimensionality of quality from a customer perspective in the wood industry. Dissertationes Forestales 114 Available at: https://dissertationesforestales.fi/pdf/article1896.pdf.
32. Wang, L.; Juslin, H. (2011). Corporate Social Responsibility in the Chinese Forest Industry: Understanding Multiple Stakeholder Perceptions. Available at: http://onlinelibrary.wiley.com/doi/10.1002/csr.286/pdf.

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THE IMPACT OF GLOBALISATION ON THE SLOVAK TIMBER TRADE

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Abstract: Globalisation stands for the growing interdependence of world economies, brought about by cross-border trade, technology, and flows of investments, people, and information. The positive, as well as, negative impacts of globalisation on the national economy has been observed for a long time and it is also noticeable in the case of timber trade. The Slovak timber trade is constantly developing and traditional trade is shaped by globalisation trends. The Slovak economy is open and its development depends on the demand in foreign markets, namely the EU markets. The study is focused on the assessment of the impacts of globalisation on timber trade in the Slovak Republic. The results show the relationships between the globalisation index and timber trade development. In particular, the development of exports and imports of industrial roundwood and the KOF globalisation index is analysed in the period from 2000 to 2017. Based on the correlation analyses the results indicate a positive linear relationship between the KOF index and timber trade development in the Slovak Republic.
Keywords: timber trade, globalisation, KOF globalisation index,

1. INTRODUCTION

The future course of the world is strongly determined by the development of globalisation. Intriligator (2009) describes the globalisation as a powerful real aspect of the new world system and distinguishes different dimensions of globalisation, namely the economic, political, environmental, health, social, cultural and other dimensions. Globalisation is a process of integration of global economic, political and cultural dimensions (Hamdi, 2013; Šupín, 2014). The concept of globalisation was firstly mentioned in 1980´s and, recently, this term is used in many different interpretations. Some authors described the globalisation as a force for advancing the world economy while others see it as a danger to economic systems (Intriligator, 2009). Globalisation is a process that brings both positive, as well as, negative effects. The most important issue connected with globalisation is whether it leads to the equality or to the inequality. Pleskovic (2002) shows that a trend of rising inequality in the latest 200 years have been reversed and the increased globalisation accelerated this decline.

The term globalisation refers to the process through which corporations, organizations and governments around the world interact. As stated by Zaidi (2019) every person is affected by globalisation in some form such as technology, employment, industrial expansion or energy consumption. As further stated by Zaidi (2019) the impact of globalisation in the developing economies had large impact on the cost of middle class, with significant political, social and stable consequences that will continue to be felt in the coming decades.

The impact of economic globalisation on forestry and related industries is inconsistent. The positive, as well as, negative impacts of globalisation on national economies has been observed for a long time and it is also noticeable in the case of the timber trade. Suchomel et al., (2012) point out that the consequences of globalisation for forestry are noticeable in countries with high forest area and the most important impact of globalisation causes an increase in log prices, which is reflected in the relocation of the sawmills, pulp and paper industries from the locations where they played an important role for the local development. The Slovak timber trade is constantly developing, and traditional trade is shaped by globalisation trends. Development of the Slovak economy, which is significantly open, depends on the development of demand at the markets of the major trading partners, namely the EU countries (National Forest Centre, 2018; Parobek, et al., 2014). These developments also affect the wood processing industry. As pointed by Pelegrinová et al. (2013) participation of countries in the process of globalisation should increase their productivity and also the amount of foreign trade. This increase of foreign trade is reflected in changes in the ratio of exports and imports.

This study examines the impact of globalisation on the Slovak timber trade. In particular, the development of exports and imports of industrial roundwood and the KOF globalisation index is analysed in the period from 2000 to 2017. In 2017 more than 2 million m^3 of roundwood was exported from Slovakia, while the total supply of roundwood in 2017 was almost 9.4 million m^3. Forest enterprises exported 341 thousand m^3, or 16.9% of the total export volume, respectively. The remaining 83.1% was exported by various non-forestry entities, mostly commercial trading companies. Timber was mainly supplied to the EU countries. On the other side, 927 thousand m^3 of roundwood was imported to Slovakia in 2017 (National Forest Centre, 2018).

In the EU, there have been rapid changes in the industrial processing of roundwood and the production of main categories of wood products, such as pulp, paper, or sawnwood in the last decade. The production of industrial roundwood in the EU is still increasing. Its production has increased by almost 10% with an increase of more than 30 mil. m^3. There is also a growing trend in the EU roundwood consumption, which showed almost 8% increase (UNECE, 2016).

2. MATERIAL AND METHODS

This study is aimed at the examination of the impact of globalisation on the Slovak timber trade. The development of exports and imports of industrial roundwood and the KOF globalisation index were analysed in the period from 2000 to 2017. The core data for analysis were drawn from the FAOSTAT (2020) database and the Swiss Economic Institute database (Swiss Economic Institute, 2019).

The KOF globalisation index measures the economic, social and political dimensions of globalisation. It represents the only global index that present information about the level of globalisation in individual countries. The current version of KOF globalisation index distinguishes between de facto and de jure globalisation. As Gygli et al. (2019) pointed de facto KOF globalisation index measures the actual international flows and activities, de jure globalisation measures the policies and conditions that, in principle, enable, facilitate and foster flows and activities. The KOF globalisation index includes large panel data incorporating 203 countries and including data from 1970 to 2017.

The Pearson r correlation was used to analyse the relationship between the KOF globalisation index and development of exports and imports of coniferous and non-coniferous industrial roundwood in Slovakia. The following formula was used to calculate the Pearson r correlation:

$$r_{xy} = \frac{n\sum x_i y_i - \sum x_i \sum y_i}{\sqrt{n\sum x_i^2 - (\sum x_i)^2}\sqrt{n\sum y_i^2 - (\sum y_i^2)^2}}$$

Where:
R_{xy} - Pearson r correlation coefficient between x and y
n - years from 2000 to 2017
x_i - value of exports and imports of industrial roundwood
y_i - value of KOF globalisation index

The statistical hypothesis H_0 assumes that there is no association between the KOF globalisation index and the Slovak timber trade, and the alternative hypothesis H_1 assumes that there is an association between the mentioned variables. Statistical hypotheses were verified using the SPSS statistic program, using the level of significance α=0.05 and probability 95%.

3. RESULT AND DISCUSSION

The development of exports and imports of coniferous and non-coniferous industrial roundwood in Slovakia was observed from 2000 to 2017. Figure 1 shows the development of exports and imports of industrial roundwood in USD. The trend of exports and imports development has been increasing in the examined period. The dominant part of the trade is represented by the export of coniferous industrial roundwood. The development of import of coniferous industrial roundwood has been more less stable over the last 17 years.

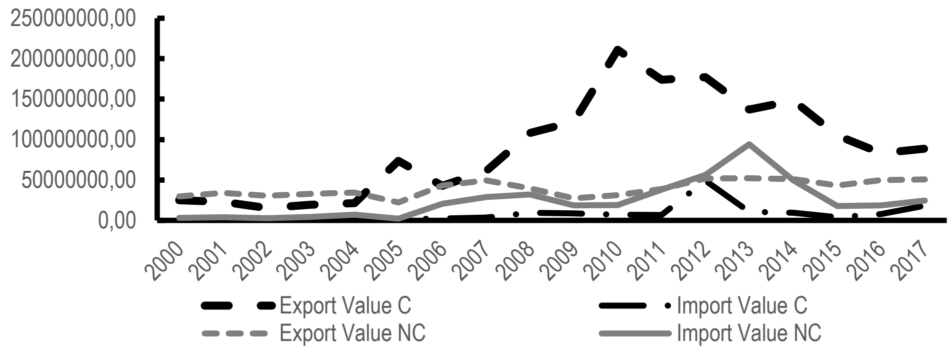

Figure 1 Development of exports and imports value of industrial roundwood in Slovakia (USD)

Figure 2 shows the development of KOF globalisation index in Slovakia from 2000 to 2017. In this case, a slightly increasing trend of the development of the KOF globalisation index can be observed. A significant improvement of globalisation index occurred in 2004, in the year of accession the Slovak Republic to the European Union.

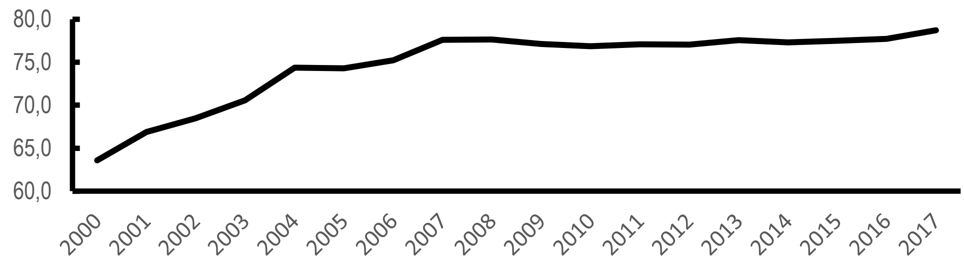

Figure 2 Development of KOF globalisation index in Slovakia

Following the methodology, the correlation between the KOF globalisation index and development of exports and imports of industrial roundwood in Slovakia was examined. The basic statistical characteristics are shown in Table 1.

Table 1 Basic statistical characteristics (Pearson Correlation Coefficient)

	Pearson Correlation Coefficient
Export Value (C)	0.661**
Import Value (C)	0.417**
Export Value (NC)	0.560**
Import Value (NC)	0.552**

*Value represents data in USD; C - coniferous; NC - non-coniferous; * - α<0.05; ** - α<0.001*

The results of correlation testing indicate some statistically significant relationship between the KOF globalisation index and the development of exports and imports of industrial roundwood in Slovakia. Export of coniferous industrial roundwood represents the most affected part of the foreign roundwood trade in Slovakia. Results indicates that globalisation strongly affects the exports of coniferous industrial roundwood while there was not influence on imports. Moderate positive relationships can be observed in the case of non-coniferous industrial roundwood. The development of both, exports and imports of non-coniferous industrial roundwood were strongly affected by globalisation. As it was already mentioned, the development of export and import volumes and values of industrial roundwood in Slovakia shows a slightly increasing trend. There are many factors affecting the industrial roundwood trade, one of the most significant is the volume of incidental felling. As pointed by Suchomel et al., (2009) the incidental felling affected the prices of industrial roundwood and others wood assortments. The volumes of exported and imported industrial roundwood are closely connected to domestic wood processing industry, its capacities and structure. Loučanová et al. (2018) mentions that there is an absence of the strategic development of the overall forest-based sector and the need for innovations in the wood processing industry. Results of the study by Pelegrinova et al. (2013) also confirm that the participation of countries in the process of globalisation should increase their productivity and possibility to expand into foreign markets. On the other hand, Kaputa et al. (2016) pointed that foreign competition is the most significant barrier for the Slovak exporters of wood products.

Several authors analysed the effects of globalisation. Globalisation brings positive as well as negative consequences. The exports of coniferous roundwood without any added value is the major problem of the Slovak forest industry as the high quality assortments are exported without further processing (National Forest Centre, 2018). Consequently, added value is created abroad, where inter alia, wood processing provides new jobs opportunities. Though, positive tendencies in exports decreasing and import increasing of higher quality assortments was observed in 2018 (National Forest Centre, 2019).

The impact of globalisation in Slovakia is highly debatable. From an economic point of view, globalisation brings many positive trends to Slovakia. As Pelegrinová et al. (2013) mentioned globalisation has a positive effect on foreign direct investment and also causes an increase in GDP. On the other hand, there are several negatives of globalisation that are reflected in the forest based sector in Slovakia. Increasing value of industrial roundwood exports causes outflow of added value from Slovakia and has impact on the domestic price of industrial roundwood.

4. CONCLUSION

This study analysed the impact of globalisation on timber trade in Slovakia. We examined the development of exports and imports of industrial roundwood from 2000 to 2017, as well as, development of globalisation in Slovakia. Our results pointed out the relationship between the globalisation index and timber trade development. There is a significant relationship between the KOF globalisation index and the development of exports and imports of industrial roundwood in Slovakia. It is not easy to evaluate the impact of globalisation on the timber trade in Slovakia. The results described the positive as well as negative effects of globalisation on foreign timber trade and domestic forest based industry.

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REFERENCES

1. FAOSTAT. (n.d.). Food and Agriculture Organization of the United Nations, Statistics Division. Forestry Production and Trade. Retrieved April 4, 2020, from http://www.fao.org/faostat/en/#data/FO
2. Gygli, S., Haelg, F., Potrafke, N., Sturm, J. E. (2019). The KOF Globalisation Index – revisited. *Review of International Organizations*, *14*(3), 543–574. https://doi.org/10.1007/s11558-019-09344-2
3. Hamdi, F. (2013). The Impact of Globalization in the Developing Countries. *Indiana Journal of Global Legal Studies*, *3*(11), 339. https://doi.org/10.2979/indjglolegstu.20.1.339
4. Intriligator, M. D. (2009). Globalisation of the world economy: Potential benefits and costs and a net assessment. *The Law and Economics of Globalisation: New Challenges for a World in Flux*, (33), 299–314. https://doi.org/10.1016/s0161-8938(04)00050-x
5. Kaputa, V., Paluš, H., Vlosky, R. (2016). Barriers for wood processing companies to enter foreign markets: a case study in Slovakia. *European Journal of Wood and Wood Products*, *74*(1), 109–122.

https://doi.org/10.1007/s00107-015-0954-5

6. Loučanová, E., Olšiaková, M., Dzian, M. (2018). Suitability of innovative marketing communication forms in the furniture industry. *Acta Facultatis Xylologiae*, *60*(1), 159–171. https://doi.org/10.17423/afx.2018.60.1.17
7. Ministry of Agriculture and Rural Development of the Slovak Republic, National Forest Centre. (2018). *Slovak Market Report 2018; Statement submitted to the 76th session of the ECE Committee on Forests and Forest Industry*. Zvolen. Retrieved from http://www.unece.org/fileadmin/DAM/timber/country-info/statements/slovakia2018.pdf
8. National Forest Centre. (2017). *Report on the Forest Sector of the Slovak Republic 2017 – GREEN REPORT*. Zvolen: National Forest Centre. ISBN: 9788080932541
9. National Forest Centre. (2019). *Report on the Forest Sector of the Slovak Republic 2018 - GREEN REPORT*. Zvolen: Ministry of Agriculture of the Slovak Republic, National Forest Centre. ISBN: 978 - 80 - 8093 - 286 - 2
10. Parobek, J., Paluš, H., Kalamárová, M., Loučanová, E., Dovčíková, A. (2014). Slovak foreign trade with industrial roundwood. In *POSITION AND ROLE OF THE FOREST BASED SECTOR IN THE GREEN ECONOMY* (pp. 118–121). Zvolen, Slovakia: WoodEMA, i.a.
11. Pelegrinová, L., Lačný, M. (2013). Analýza vplyvu globalizačných procesov na ekonomiky vyspelých krajín. *Annales Scientia Politica*, *2*(2), 27–35.
12. Pleskovic, B., Stern, N. (2002). *Annual World Bank Conference on Development Economics*. Washington: Oxford University Press, New York.
13. Suchomel, J., Gejdoš, M., Ambrušová, L., Šulek, R. (2012). Analysis of price changes of selected roundwood assortments in some Central Europe countries. *Journal of Forest Science*, *58*(11), 483–491. https://doi.org/10.17221/98/2011-jfs
14. Suchomel, J., Gejdoš, M. (2009). Analýza vývoja cien vybraných sortimentov surového dreva a výrobkov z dreva. *Financovanie 2009 Lesy-Drevo*.
15. Šupín, M. (2014). The Impact of the Global Recession on Wood Processing Industry and Wood Products Trade and the Road to Recovery. In *POSITION AND ROLE OF THE FOREST BASED SECTOR IN THE GREEN ECONOMY* (pp. 159–164). Zvolen, Slovakia: WoodEMA, i.a.
16. Swiss Economic Institute. (2019). KOF Globalisation Index. Retrieved May 15, 2020, from https://kof.ethz.ch/en/forecasts-and-indicators/indicators/kof-globalisation-index.html
17. UNECE. (2016). The Forest Products Annual Market Review. In *Products Annual Market Review*. Retrieved from https://www.unece.org/fileadmin/DAM/timber/publications/FPAMR2017.pdf
18. Zaidi, S. A. H., Zafar, M. W., Shahbaz, M., Hou, F. (2019). Dynamic linkages between globalization, financial development and carbon emissions: Evidence from Asia Pacific Economic Cooperation countries. *Journal of Cleaner Production*, *228*, 533–543. https://doi.org/https://doi.org/10.1016/j.jclepro.2019.04.210

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SUSTAINABILITY OR INTEGRITY? POST-CRISIS MODEL OF THE WOOD MARKET DEVELOPMENT IN POLAND

Wanat, L., Mikołajczak, E., Sarniak, L., Kusiak, W.

Abstract: The study attempts to identify the optimal model for the development of the wood market, adequate for the state of long-term economic crisis. It was verified whether, in a crisis situation, entities participating in the wood market should use identical development models. The comparative analysis was carried out on the example of elemental wood processing enterprises and companies providing key forestry services for the wood market. The study was conducted in the first half of 2020, using the diagnostic survey method and techniques of individual in-depth interviews (IDI), of an expert nature. The conclusion states that the market model preferred by market experts during the crisis is the relational model, which prefers to build cooperation networks.
Keywords: forestry, wood-based industry, wood market, pandemic economic crisis, Poland

1. INTRODUCTION

"Sustainable development", i.e. keywords that have made a huge career at the turn of the century, are derived directly from forest management. They refer to the concept that was formulated by Hans Carl von Carlowitz [6]. It is about conducting forest management in such a way as to obtain and process only the amount of industrial wood that can be restored with the help of forest renewals, in particular natural and natural regenerations [1]. But is simple "sustainability" enough? Does such a model take into account the specific, often very individual development ability of each of the market participants? Yes, important questions are posed about the social responsibility of subsequent generations, using the resources of the green economy as if on credit. But how should this responsibility be implemented in practice?

Almost at the beginning of 2020, it became clear that existing economic theories need to be revised. Also the Polish forest-wood sector has found itself in a completely new perspective. They asked how companies creating and shaping the wood market should behave. This market has been exposed to irregular and asymmetrical factors. Will the factors influencing the functioning of the wood-based market rather "balance" or "integrate" it? Will there be a new wood market or maybe even a new one?

The Polish wood-based sector is characterized by a specific market organization. It is a more institutional structure than a libertarian one, based also on a natural monopoly. The wood market is complementary sectors of the economy. These include forestry and wood industry. These sectors are permeated by the market environment: institutional, business, social, demographic and cultural. Mutual relations of wood market participants, especially the wood raw material market (primary segment), are only shaped to a small extent by the market mechanism [4]. This is mainly due to the ownership structure of Polish forests. State ownership dominates in it. This situation results in a number of objective barriers to entry into the sector. A specific wood sales model is also used, in which only selected aspects are subject to market laws. This does not change the essential links in the forest-wood value chain. It creates a "sector" of the economy, from raw forestry (management of timber resources "on the trunk"), forest services (acquisition of wood raw material and its transport), to industrial wood processing and its reuse. Of course, we will be talking about the first (primary) link in the entire chain, which makes up the circular economy model. It is an integral model, connecting the blocks of the chain the stronger, the more they are oriented on man and his natural environment.

The Polish wood market is a reflection of the state of the industry, more precisely the situation of forestry and the wood-based sector. This sector employs almost 350 thousand people. It creates over 2.5 percent of Poland's GDP [9]. In addition, the wood industry is almost entirely based on domestic timber resources from Polish forests. Thus, the wood market cannot be programmed only "classically"[8]. Especially in the face of the threat of a prolonged economic crisis, a "new" wood market model is sought, adequate to real competitive ability, which should be determined not so much by the "institutional market" as by the real one, which is created by entities creating supply and demand, i.e. us.

2. THE RESEARCH IDEA, MATERIAL AND METHODS

Similarly to the entire economy, also the wood-based sector found itself in the first quarter of 2020 in a threat of a prolonged crisis. This threat is not only a consequence of the pandemic state, but also the result of institutional and individual, market decisions resulting from this state. Therefore, effective ad-hoc solutions are sought, followed by effective business models and market structures. Yes, it is first about survival and maintaining the status quo, then at least relatively proper functioning, and finally about the development of all participants of the wood market. For these reasons, an attempt was made in this work to search for an adequate wood market model and strategy for its participants. The research was conducted on the example of entities from the "first line of the value chain": companies providing forestry services and entrepreneurs of elemental wood processing, operating in the realities of various restrictions resulting from the epidemic threat.

2.1. Purpose and scope of research

The aim of the study was to identify the optimal model for the development of the wood market, adequate for the state of long-term economic crisis. In addition, it was verified whether, in a crisis situation, entities participating in the wood market should use identical development models / strategies. The comparative analysis was carried out on the example of elemental wood processing enterprises and companies performing key forestry services for the timber market, i.e. logging and transport.

The research was carried out in the first half of 2020 (time range). A strictly selected group of wood industry enterprises and companies providing forest services (subject scope) was selected for the study. The companies were selected proportionally for the location corresponding to the territorial structure of 17 Regional Directorates of State Forests in Poland (spatial scope). The diagnostic survey method was used in the selection process and then in detailed tests. The technique of individual in-depth interviews (IDI) was used, having an expert character. Professional representatives of all entities participating in the research process, participating in everyday practice in making market decisions, were invited to the research [3].

2.2. Research scenario

The designed research scenario, based on the concept of hierarchical analysis, was divided into four stages. Their diagram is shown in Figure 1.

In the first stage, referring to individual expert analysis (IDI), five were selected from various strategies and business models that could be potentially used by entities participating in the sector. The experts assigned the highest weight to these selected "development directions". These directions were analyzed from the perspective of two groups of enterprises (subject scope): representing elemental wood processing (popular sawmills) and companies providing forestry services. Therefore, the following models were identified for further verification: M1 - neutral model; M2 - extensive model; M3 - intensive model; M4 - direct investment model and M5 - cooperation network model.

The matrix of five market development models was then included in the comparative analysis. In addition, a targeted selection of wood market entities was made, with representatives of whom individual in-depth interviews were conducted. Therefore 101 companies were included, including 52 woodworking companies and 49 companies providing forestry services. The location of enterprises corresponded evenly to the spatial distribution of each of the 17 Regional Directorates of State Forests in Poland. The share of wood market entities was proportional [8]. The main assumptions of the research scenario were retained and the study was performed.

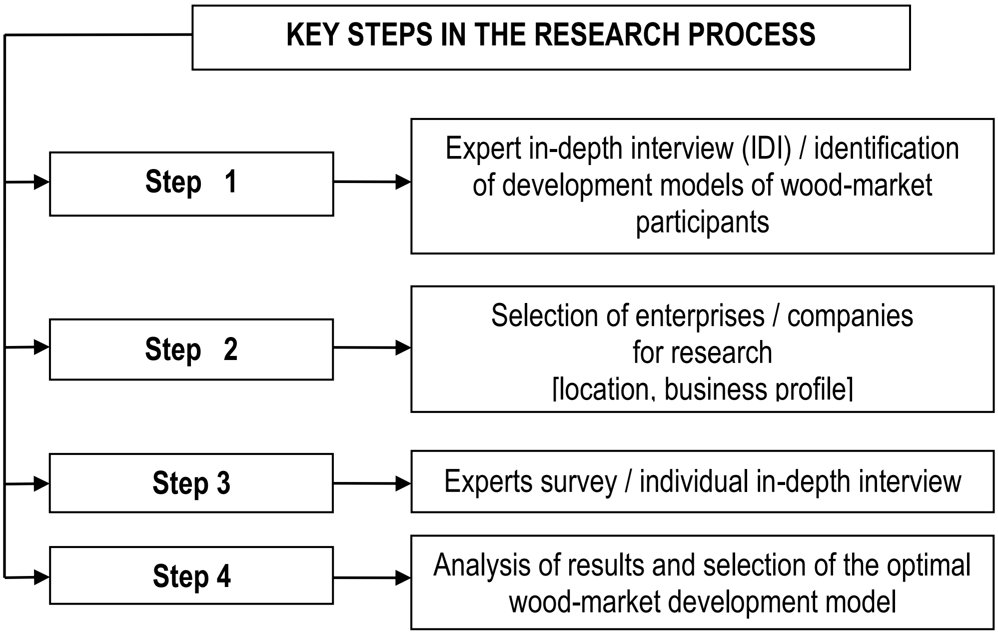

Figure 1. Visualization of the author's research scenario
Source: Own elaboration

3. RESULTS

The designed study was carried out thanks to the involvement of experts, representatives of the examined wood market entities, with whom (step 3) individual in-depth interviews (IDI) were conducted. It is worth noting that experts were not expected to indicate preferences for a specific market development model directly, i.e. directly. Experts, however, indicated "only" relationships between individual models that were selected earlier (step 1). The relationships between the examined models were determined using the Saaty method [2]. The answers were ordered and then a ranking of models for both examined subsectors was made. This design of the study allowed to preserve the specifics and separateness of the subsectors: wood industry enterprises and forest services companies. Then, the responses were aggregated, including all surveyed entities. Numerical values (weights) were assigned to individual models, depending on the degree of significance, then converting them into percentage points [7]. The results were aggregated and tabulated, following step 4 of the research scenario. Table 1 summarizes the "preferences for choosing the optimal model for the development of the wood industry enterprises (WIC) in the conditions of the economic crisis" (WIC models preferences).

Table 1. Preferences for the selection of the optimal model for the development of wood industry companies (WIC) in the conditions of the economic crisis

Place / WIC Model	Neutral	Extensive	Intensive	Direct Investment	Cooperation Networks
Place I	0,0%	0,0%	0,0%	0,0%	100,0%
Place II	30,8%	0,0%	46,2%	23,1%	0,0%
Place III	3,8%	15,4%	42,3%	38,5%	0,0%
Place IV	11,5%	59,6%	11,5%	17,3%	0,0%
Place V	53,8%	25,0%	0,0%	21,2%	0,0%

Source: Own elaboration

The preferences for the selection of the market model for forest service enterprises were set up in a similar way.

Table 2. Preferences for the selection of the optimal development model of forest service companies (FSC) in the conditions of the economic crisis

Place / FSC Model	Neutral	Extensive	Intensive	Direct Investment	Cooperation Networks
Place I	0,0%	0,0%	0,0%	0,0%	100,0%
Place II	0,0%	0,0%	20,4%	79,6%	0,0%
Place III	34,7%	42,9%	22,4%	0,0%	0,0%
Place IV	6,1%	38,8%	34,7%	20,4%	0,0%
Place V	59,2%	18,4%	22,4%	0,0%	0,0%

Source: Own elaboration

In turn, in Table 2 you can find "preferences for choosing the optimal model for the development of forest service enterprises (FSC) in the conditions of the economic crisis" (FSC models preferences). The strength of preferences is expressed in percentage points reflecting acceptance or non-acceptance for a specific answer (market development model). The aggregated results were verified, prioritized and discussed using benchmarking and descriptive analysis tools.

It is worth returning here to the subject scope, which the experts invited to the research covered, and then selected five potential market models for participants of the primary wood market in this perspective. Therefore, five models were considered:

M1: NEUTRAL, market model, assuming the dominant influence of market relations on the situation of industry participants: thus "the market will do its own, who survives the crisis, we will continue to work with it";

M2: EXTENSIVE, resource model, assuming stimulation of development and possible support for economic activity, based on resources, own or borrowed; it was described as follows: thus, "we will grant" resource "credit to our partners, we will make available resources and raw materials, materials, semi-finished products, we will extend payment periods, especially in a situation where we do not bear other additional costs ourselves";

M3: INTENSIVE, effective model, assuming support for the entity's income activities and elimination of unprofitable ones; and therefore: "we only conduct activities that are active and profitable, while the remaining ones are frozen or eliminated, until exiting the industry";

M4: DIRECT INVESTMENT model, pro-investment, and therefore "an industry partner with strong resources makes a takeover or capital entry to a weaker entity, and the investment is permanent or temporary, but always intensive";

M5: COOPERATION NETWORK model, coopetitive or relational, and thus: "existing industry partners of varying sizes and potential, create cooperation networks, initiate resource clusters, mutually making available those resources that are necessary for maintaining and developing activities; but without interfering in the ownership relations of the partners".

Against this background, it may seem surprising that the representation of entities with diverse, sometimes conflicting interests, expressed in a difficult, at least ambiguous issue, a consensus position [5]. The market model of cooperation network in the wood-based sector was definitely recognized as an opportunity to overcome the threats arising from the long-lasting economic crisis.

4. CONCLUSIONS

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

1) The preferred market model for the time of crisis, recommended by experts representing entities participating in the primary wood market, is the cooperation network model, which assumes coopetition and building lasting relationships.

2) Alternative, noteworthy market models also include: the intensive model (from the perspective of the wood industry enterprises) and the direct investment model (from the perspective of companies providing forest services).
3) It is worth noting that participants of the wood-based industry generally do not consider the choice of a neutral model, recognizing the need for intervention on the Polish wood market. This is probably due to the growing awareness of the specifics of the market being analyzed, quasi monopolistic, sensitive to institutional influences.

In conclusion, it should be emphasized that the idea of "sustainability" was almost not noticed by market practitioners recommending the search for platforms for integration, building relationships, active, long-term cooperation to the best of each of the wood market participants.

REFERENCES

1. Kusiak, W., Mikołajczak, E., Wanat, L. (2018): *Institutional and Industrial Symbiosis Case Study of Cooperation for Development in Forestry and Wood-Based Sector*. [In:] Increasing the use of wood in the global bio-economy. Glavonjic B. (ed.), September 26th-28th, 2018, University of Belgrade, Belgrade, Serbia, pp. 388-399.
2. Łuczak A. (2016). *Wielokryterialne metody ilościowe w diagnozowaniu i modelowaniu rozwoju lokalnego*. Poznań: Wydawnictwo Uniwersytetu Przyrodniczego w Poznaniu.
3. Mikołajczak E., Wanat L., Styma-Sarniak K., Czarnecki R., Topczewska A. (2020): *The Prospects to Applying the Best Practices Model as One of the Pillars of Business Management in the Wood Market*, [in:] D. Jelačić (ed.) Management Aspects in Forestry and Forest Based Industries, WoodEMA ia., Zagreb, pp. 125-136.
4. Paluš H., Parobek J., Vlosky R.P., Motik D., Oblak L., Jošt, M., ... & Wanat L. (2018): *The status of chain-of-custody certification in the countries of Central and South Europe*. European Journal of Wood and Wood Products 76(2): pp. 699-710, https://doi.org/10.1007/s00107-017-1261-0.
5. Potkański, T., Wanat, L., Chudobiecki, J. (2011): Leadership in time of crisis or crisis of leadership? Implications for regional development. Intercathedra, 4(27).
6. Von Carlowitz, H. C. (1713): *Sylvicultura Oeconomica*. Leipzig: Braun.
7. Wanat L., Mikołajczak E., Sarniak Ł., Czarnecki R., Topczewska A. (2020): *Application of Analytic Hierarchy Process (AHP) Algorithm to Optimize Business Model for the Kitchen Furniture Marke*t, [in:] D. Jelačić (ed.) Management Aspects in Forestry and Forest Based Industries, WoodEMA ia., Zagreb, pp. 111-124.
8. Wanat L., Potkański T., Chudobiecki J., Mikołajczak E., Mydlarz K. (2018): *Intersectoral and Intermunicipal Cooperation as a Tool for Supporting Local Economic Development: Prospects for the Forest and Wood-Based Sector in Poland.* Forests 9 (9), 531, 1; https://doi.org/10.3390/f9090531.
9. ***Statistical Yearbook of Forestry 2019. Central Statistical Office (GUS 2019). Warsaw.

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WOOD TRADE IN SLOVAKIA

Šatanová, A., Danková, M., Sowa, B.

Abstract Forests are an inseparable and indispensable part of human existence. Wood is one of the many advantages and benefits that forests provide us with every day. Slovakia is known for its relatively large wooded area, and it is therefore the aim of the present article to describe the management of wood in Slovakia, characterize the current situation in which the forestry-wood processing sector in the SR is, and its close connection with Slovakia's subsequent foreign trade with wood and related wood products. The objective of the article was also to evaluate the overall effectiveness of the utilization of Slovakia's potential in cross-border timber trade and to outline the possible direction of its further development in this area, taking into account all the relevant influences.
Keywords: forests, wood, commodity, timber trade, development, industry, Slovakia

1. WOOD AS A COMMODITY IN SLOVAKIA

Wood represents an important renewable resource for the Slovak economy, which we currently use and valuate at a much lower level than we have in the past. As a result of changes related to the transition to a market economy, the privatization of timber companies, the liberalization of foreign trade, the downturn in industries using timber products, the natural development of timber factories and the indebtedness of many processors to producers of raw wood, there have recently been insufficiently utilized capacities in the woodworking industry and an increase in the export of raw wood.

The forest area in Slovkia is 2 006 939 ha, that is approximately 41 % of the country's total area. Compared to the average forest area in the EU, which is around 38 % (*Statistical Office of the SR, 2016*), Slovakia is just above the European average. Although EU forests with their 161 million ha only occupy about 4 % of the world's wooded area, there is no doubt about their further expansion within the European region. Between 1990 and 2010, their area increased by about 11 million ha (*Ragonnaud, 2016*). Thanks to this fact and constant efforts for continuous afforestation, they continue to be of social and economic importance.

Wood production is one of the forest's basic production functions. Just one hectare of an average forest in the temperature zone is capable of producing about 8 tons of wood per year. According to ecological and scientific definitions, the forest is characterized fairly accurately as „an area larger than 0.5 ha of which more than 10 % is covered with trees, and where the trees should be able to reach a minimum height of 5 m." (*Forest portál, 2015*). The wooded area in Slovakia continues to increase year after year. In 2015 it reached 1 942 567 ha, and it continues to have a growing tendency (see Figure 1).

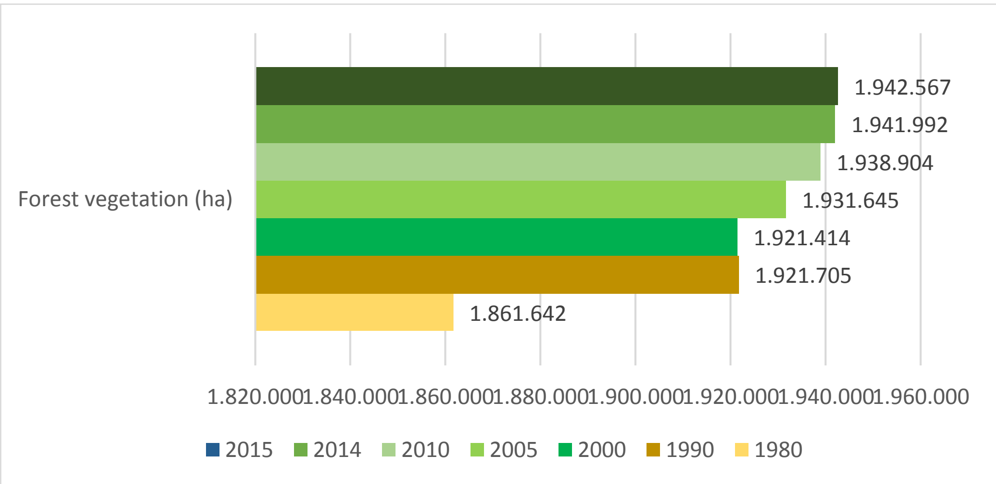


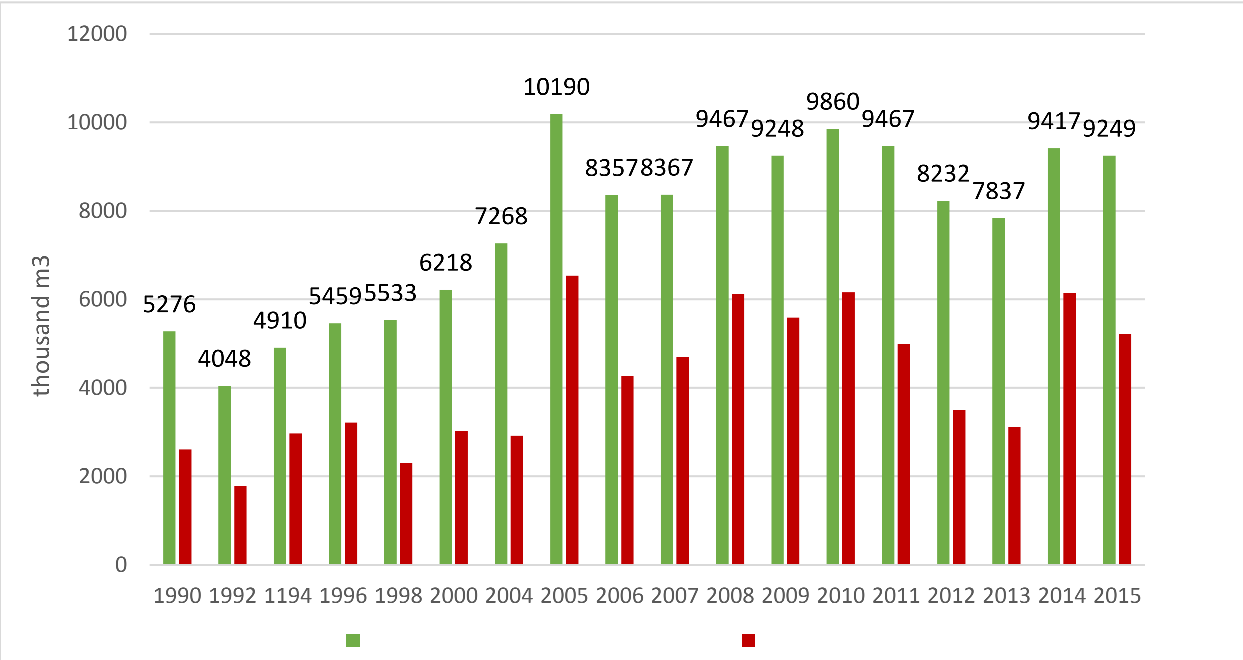
Figure 1 Development of the wooded area
Source: NLC-ÚLZI Zvolen, Summary of forest conditions in the SR 1980-2016

The composition of Slovak forests is quite varied, with a significant dominance of deciduous woods over coniferous woods; the species with the highest representation is beech with about 33.2 %, followed by spruce with 23.4 % (*Ragonnaud, 2016*). The species composition of trees is of great importance from both an ecological and economic point of view. Over the past 70 years, the number of deciduous trees increased by almost 10%, which is highly appreciated by experts with regard to their subsequent processing and utilization (*Čaboun, 1996*). When assessing the forest production capacity, the wood volume is an important indicator. However, it is also important to respect the subsequent logging equilibrium and to take into account the preservation of the permanence of future production. The current wood volume in Slovakia reaches 478.12 mil. m^3 (wood without bark on the trunk). Europe has approximately 26.8 billion m^3, and it is generally a continent with one of the highest annual increases in wood volume and logging (*MP SR, 2015*).

In terms of the long-term trend, the volume of logged wood in Slovakia has a growing tendency as shown in Figure 2. This is mainly associated with the current age of forests. In 2015, 9.25 mil. m^3 of wood was logged, but the planned logging volume was not reached. However, in comparison with 1990, there was almost a 75 % increase in the logged volume (*NCL Zvolen, 2015*).

Wood processing is one of the oldest industries in Slovakia. The capacities of the woodworking industry in Slovakia are currently insufficient to process the wood logged in this country. Their distribution and size stem primarily from the development of the economy up until 1990.

The gross value added in the production of logs, i.e. basic raw wood, is only 16 %. In the woodworking industry it is more than double, namely 34 %, and in pulp and paper production it is up to 50 % (*MP SR, 2010*). According to OECD statistics, more than half of Slovak demand for final products is directed at and satisfied by products whose added value has been created abroad. In the wood industry,



this difference is even more striking (*OECD, 2016*)

Figure 2 Overview of the evolution of logging with a differentiation of real logging and accidental logging (calamitous)
Source: NLC-ÚLZI Zvolen, Summary of forest conditions in the SR 1991-2016

One of the most powerful branches in the woodworking industry is the pulp and paper industry, despite the slight decline in its performance over the last five years (see Figure 3). It covers 100 % of paper production in Slovakia (*MPRV SR, NLC, 2016*).

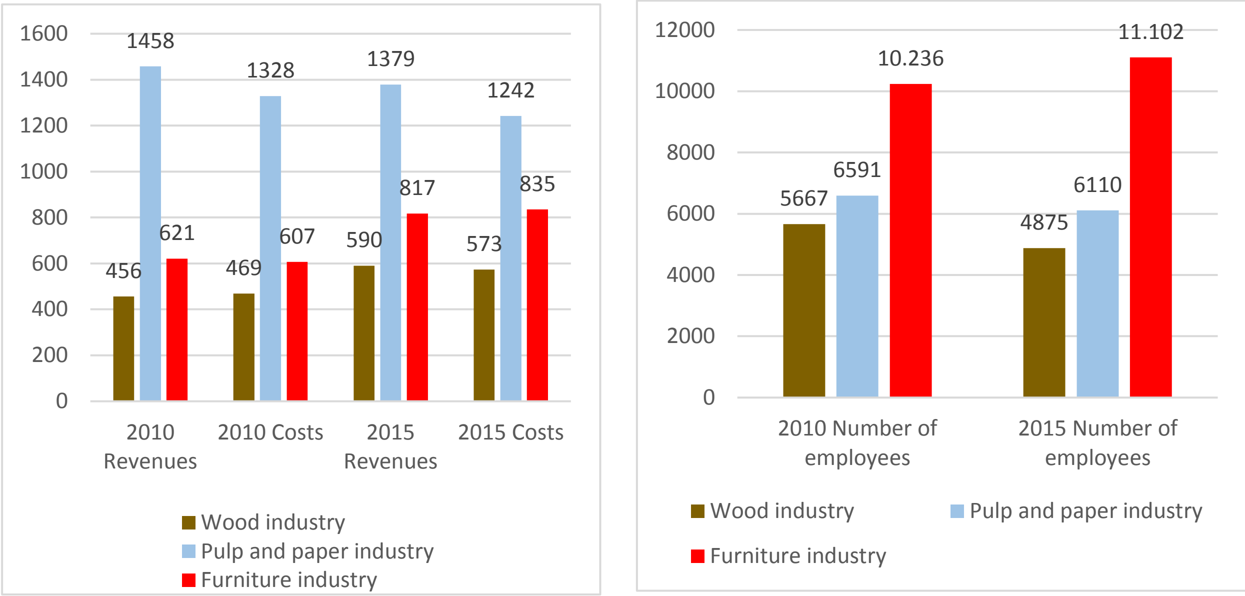


Figure 3 Selected economic indicators of the woodworking industry (mil. €)

- Woodworking industry
- Pulp and paper industry
- Furniture industry

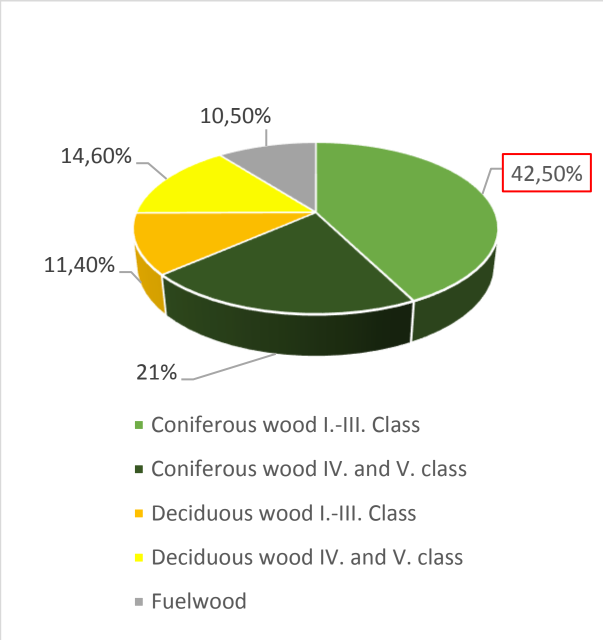
2. TIMBER TRADE AND THE FACTORS OF ITS SUCCESS

In the area of timber trade, Slovakia specializes primarily in the sale of raw wood. Up to 80% of the total forestry sales consist of the sale of logs. Another interesting feature is the export of predominantly high-quality class 1 and 3 coniferous woods; this shows a preference of foreign buyers over domestic processors, i.e. export at the expense of domestic production (Figures 4, 5) (*Švec, 2017*). Despite the sufficient volume of wood, low-quality wood is paradoxically imported from abroad, accounting for almost 70% of the volume of imports (*MPRV SR, NLC, 2015*). The main cause of this phenomenon is mostly the significant price differences in the raw wood markets in Slovakia and abroad. Slovak forest owners see a greater chance of higher valuation in selling high-quality wood for its secondary processing abroad than in Slovakia, where second-stage processing is still lagging behind.

In 2015, 2.687 thousand m^3 of raw wood was exported; the most significant buyers of wood from Slovakia were Poland, Austria, and the Czech Republic. Imports amounted to 549 thousand m^3. By comparison, in the same period the exports of raw wood by the largest exporter, i.e. Russia, reached 19.437 thousand m^3.

The development of export and import volumes of raw wood in Slovakia is shown in Table 1.

On the other hand, the volume of timber products traded by Slovakia is negligible from the perspective of world markets. The flow of exported furniture last year accounted for 0.3 % of the world's trades (*UNECE/FAO, 2016*). From a national perspective, in 2015 the value of exported wood products (including paper, etc. but excluding raw wood) was about 2.2 % of the total value of Slovak exports (*Statistical Office of the SR, 2017*). In comparison, Slovenia, with half the amount of logged wood, exports roughly three times as much furniture as Slovakia. By processing just 1m^3 of wood, it is possible to achieve a revenue of about 464 €/m^3, while only a revenue of 60 €/m^3 can be achieved by the direct export of raw wood. Moreover, about every 270 m^3 of raw wood requires an average of 1 job, thus supporting employment in the woodworking industry (*MPRV SR, 2013*).



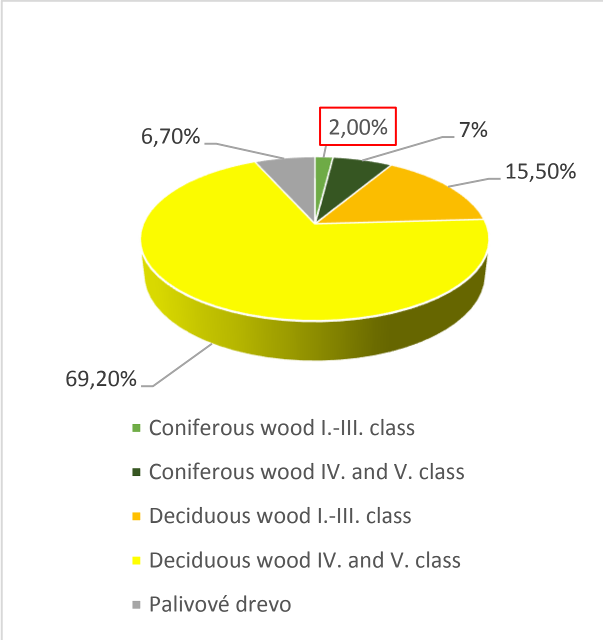


Figure 4 Export of raw wood assortments
Figure 5 Import of raw wood assortments from abroad in 2015

- *Class 1-3 coniferous wood*
- *Class 4 and 5 coniferous wood*
- *Class 1-3 deciduous wood*
- *Class 4 and 5 deciduous wood*
- *Fuel wood*

Table 1: Export and import of raw wood in the SR (in thousands of m^3)

	2015	2014	2010	2009	2005	2004	2000	1995
Export	2 687	3 408	2 564	2 686	1 815	1 210	1 612	919
Import	549	1 020	650	565	105	246	129	138

Source: UNECE/FAO, Timber database, 2015, MVPSR 2006 - 2015

Another factor that affects the timber trade are the prices in the timber market based on supply and demand. The European market is characterized by a demand for raw wood that exceeds its production; its increased consumption is linked to the economic growth and prosperity of Western European countries in particular. The development of prices of wood substitutes such as plastic or iron also has a major influence on the formation of raw wood prices, with fuel wood competing against crude oil, for example. Again, nature is an unavoidable factor. Strong calamities lead to the urgent logging of wood, its subsequent surplus on the market, and an overall decline in wood prices as well as its products on local and global markets (*Greppel, Paluš a kol, 2007*). Figure 6 shows the development of world wood prices since the 1990s.

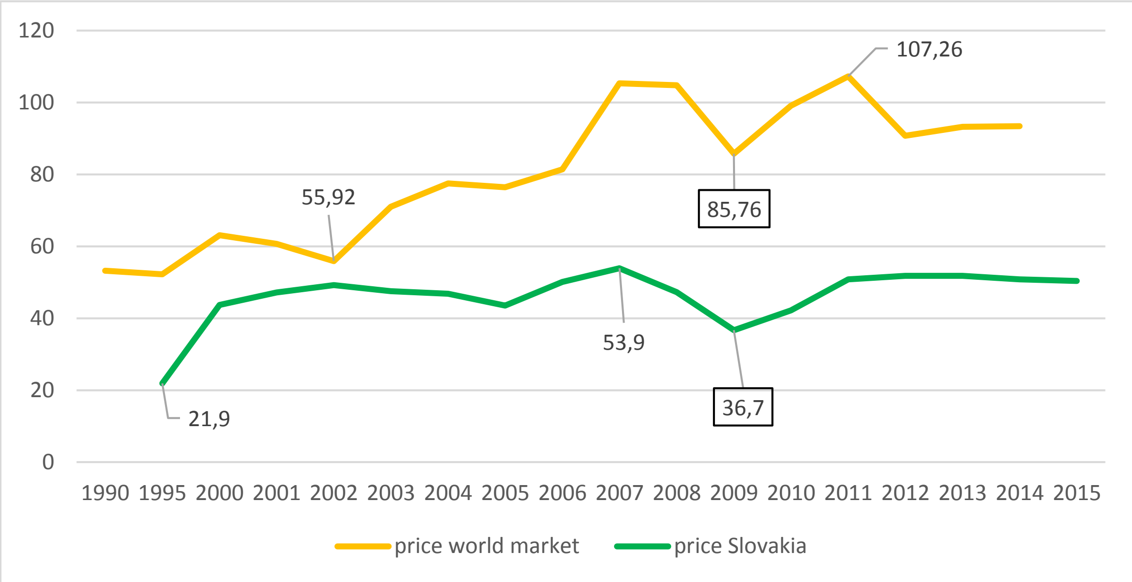


Figure 6 The development of raw wood prices in world markets and in Slovakia (in USD)
-World price – Price in the SR

Price developments on the Slovak market are roughly copying world trends. In 2004 Slovakia was hit by a wind disaster, which was also reflected in the prices of raw wood in the country. In comparison with the surrounding countries, i.e. Austria, the Czech Republic and Germany, wood prices in Slovakia were about 10% lower (*MP SR, 2010*). There are currently efforts to gradually reduce this gap. In 2015, more than 80% of Slovak forestry yields from timber sales came from domestic transactions, but at an average monetization of only 47 €/m^3 (*MPRV SR, NLC, 2016*).

REFERENCES

1. ČABOUN, V. (*1996*):*Ekológia lesa.* Zvolen: Technická univerzita vo Zvolene, 184 s. ISBN 80-228-0540-8
2. EUROPEAN COMISSION. *International trade, by reporting country, total product* [online]. Eurostat, European Comission, ©15. 11. 2016 [cit. 24. 11. 2016]. http://ec.europa.eu/eurostat/tgm/refreshTableAction.do?tab=table&plugin=1&pcode=tet00002&language=en
3. FAO. *Foreign direct investment* [online]. FAOstat, FAO, ©2016 [cit. 19. 11. 2016]. Dostupné z: http://faostat.fao.org/beta/en/#data/FDI
4. FAO. *FAOSTAT: Forestry production and trade* [online]. FAO, ©2017 [cit. 3. 2. 2017]. Dostupné z: http://www.fao.org/faostat/en/#data/FO
5. FAO. *Forest products statistics* [online]. FAO, 5. 1. 2017 [cit. 3. 2. 2017]. Dostupné z: http://www.fao.org/forestry/statistics/80938@180724/en/
6. FAO. Tariff and non-tariff measures in trade of forest products. *State of the world´s forests* [online]. FAO, 2005, s. 108-115 [cit. 3. 2. 2017]. Dostupné z:
7. FOREST PORTAL. *Postavenie lesného hospodárstva* [online]. Zvolen: Národné lesnícke centrum, ©2015 [cit. 19. 11. 2016]. Dostupné z: http://www.forestportal.sk/lesne-hospodarstvo/ekonomika/makro-ekonomicke%20ukazovatele/ /Stranky/postavenie-lesneho-hospodarstva.aspx
8. GREPPEL, E., PALUŠ, H. a kol. 2017 :*Kvalita dreva a obchod s drevom.* Zvolen: Národné lesnícke centrum, 2007. 181 s. ISBN 978-80-8093-028-8
9. LEBEDYS, A., a LI, Y. 2016: *Contribution of the forestry sector to National Economies, 1990 – 2011* [online]. Rome: FAO, 2014 [cit. 18. 11. 2016]. Dostupné z: http://www.fao.org/3/a-i4248e.pdf

10. LESY SR. *Les a jeho funkcie* [online]. Lesy Slovenskej republiky, ©2012 [cit. 26. 1. 2017]. Dostupné z: http://www.lesy.sk/showdoc.do?docid=1613
11. MCCUSKER, A. In: *Forest products annual market review* [online]. UNECE, FAO, 5. 10. 2015 [cit. 4. 3. 2017]. Dostupné z: http://www.unece.org/fileadmin/DAM/timber/other/fefped-fao-unece.pdf
12. MINISTERSTVO PODOHOSPODÁRSTVA A ROZVOJA VIDIEKA SR. *Zelená správa pre rok 2014* [online]. Ministerstvo pôdohospodárstva a rozvoja vidieka Slovenskej republiky, 2015 [cit. 24. 11. 2016]. Dostupné z: file:///C:/Users/ntb/Desktop/zelena_sprava_2015.pdf
13. MINISTERSTVO PODOHOSPODÁRSTVA A ROZVOJA VIDIEKA SR, NLC. *Zelená správa pre rok 2015* [online]. Ministerstvo pôdohospodárstva a rozvoja vidieka Slovenskej republiky, NLC, 2016 [cit. 6. 3. 2017]. ISBN 978-80-8093-223-7 Dostupné z: http://www.mpsr.sk/index.php?navID=122
14. MPRV SR, NLC ZVOLEN. *Národný lesnícky program Slovenskej Republiky* [online]. Ministerstvo pôdohospodárstva Slovenskej republiky, NLC Zvolen, 2007 [cit. 26. 1. 2017]. ISBN 978-80-8093-036-3 Dostupné z: file:///C:/Users/ntb/Desktop/BC/lesnicky%20program%20sr%202007.pdf
15. NLC. *Forest Portal: Hospodárske a finančné ukazovatele* [online]. Zvolen: Národné Lesnícke Centrum, © 2016 [cit. 24. 11. 2016]. Dostupné z: http://gis.nlcsk.org/IBULH/HafUkazovatele/HafUkazovatele
16. NLC ZVOLEN. *Forest portal: IBULH* [online]. Národné lesnícke centrum Zvolen, ©2017 [cit. 27. 1. 2017]. Dostupné z: https://gis.nlcsk.org/IBULH/Zasoby/Zasoby
17. NLC ZVOLEN. *Forest portal: lesné hospodárstvo* [online]. Národné lesnícke centrum Zvolen, ©2017 [cit. 30. 1. 2017]. Dostupné z: http://www.forestportal.sk/lesne-hospodarstvo/ekonomika/ocenovanie-lesov/Stranky/ /hodnotenie-drevo-produkcnej-funkcie-lesa.aspx
18. NLC ZVOLEN. *Forest portal: Informácie o lesoch* [online]. Národné lesnícke centrum Zvolen, ©2017 [cit. 25. 2. 2017]. Dostupné z: http://www.forestportal.sk/lesne-hospodarstvo/informacie-o-lesoch/Pages/default.aspx
19. NLC ZVOLEN. *Lesy našej krajiny* [online]. Národné Lesnícke Centrum Zvolen, 2011 [cit. 12. 3. 2017]. Dostupné z: file:///C:/Users/ntb/Desktop/BC/lesy%20nasej%20krajiny.pdf
20. OECD. *Global Value Chains: Slovak republic* [online]. OECD, 2016 [cit. 18. 2. 2017]. Dostupné z: *http://www.oecd.org/sti/ind/GVCs%20-%20SLOVAK%20REPUBLIC.pdf*
21. OECD. *Level of GDP per capita and productivity* [online]. OECD.stat, ©18. 11. 2016 [cit. 18. 11. 2016]. Dostupné z: http://stats.oecd.org/Index.aspx?DataSetCode=PDB_LV
22. RAGONNAUD, G. (*2016*) : EÚ a lesy. In: *Europarl.europa.eu* [online]. Európsky parlament, 09/2016 [cit. 17. 11. 2016]. Dostupné z:
23. ŠTATISTICKÝ ÚRAD SR. *Accounts for individual institutional sectors* [online]. STATdat, ©22. 11. 2016 [cit. 24. 11. 2016]. Dostupné z: http://statdat.statistics.sk
24. ŠTATISTICKÝ ÚRAD SR. *Bilancia ekonomickej aktivity obyvateľstva* [online]. DATAcubes, ©13. 9. 2016 [cit. 18. 11. 2016]. Dostupné z: http://datacube.statistics.sk/
25. ŠTATISTICKÝ ÚRAD SR. *Hustota obyvateľstva* [online]. STATdat, ©2. 11. 2016 [cit. 18. 11. 2016]. Dostupné z: http://statdat.statistics.sk
26. ŠTATISTICKÝ ÚRAD SR. *Hrubý domáci produkt podľa ekonomických činností* [online]. SLOVstat, ©2016 [cit. 18. 11. 2016]. Dostupné z: http://www.statistics.sk/pls/elisw/casovy_Rad.procDlg
27. ŠTATISTICKÝ ÚRAD SR. *Indexy vekového zloženia* [online]. STATdat, ©2. 11. 2016 [cit. 17. 11. 2016]. Dostupné z: http://statdat.statistics.sk
28. ŠTATISTICKÝ ÚRAD SR. *Slovenská republika v číslach 2016* [online]. Ústredie ŠÚ SR, 30. 6. 2016 [cit. 6. 11. 2016]. Dostupné z: https://slovak.statistics.sk/PortalTraffic/fileServlet?Dokument=8f7caa44-edc2-4f5b-92be-07fb72f48fa7
29. ŠTATISTICKÝ ÚRAD SR. *Školstvo a vzdelávanie* [online]. DATAcubes, ©13. 9. 2016 [cit. 18. 11. 2016]. Dostupné z: http://datacube.statistics.sk/
30. ŠTATISTICKÝ ÚRAD SR. *Total Import and total Export by Sections in Harmonized system* [online]. STATdat, ©28. 9. 2016 [cit. 24. 11. 2016]. Dostupné z: http://statdat.statistics.sk
31. ŠTATISTICKÝ ÚRAD SR. *Tovarová štruktúra vývozu* [online]. SLOVstat, ©2017 [cit. 3. 3. 2017]. Dostupné z: http://www.statistics.sk/pls/elisw/casovy_Rad.procDlg
32. ŠTATISTICKÝ ÚRAD SR. *Úplné náklady práce podľa ekonomických činností* [online]. SLOVstat, ©2016 [cit. 20. 11. 2016]. Dostupné z: http://www.statistics.sk/pls/elisw/casovy_Rad.procDlg
33. ŠTATISTICKÝ ÚRAD SR. *Vybrané ukazovatele lesného hospodárstva* [online]. SLOVstat, ©2017 [cit. 3. 3. 2017]. Dostupné z: http://www.statistics.sk/pls/elisw/casovy_Rad.procDlg
34. ŠTATISTICKÝ ÚRAD SR. *Vysťahovaní z trvalého pobytu v SR* [online]. SLOVstat, © 2016 [cit. 19. 11. 2016]. Dostupné z: http://www.statistics.sk/pls/elisw/casovy_Rad.procDlg
35. ŠTATISTICKÝ ÚRAD SR. *Zahraničný obchod* [online]. SLOVstat, ©2017 [cit. 3. 2. 2017]. Dostupné z: http://statdat.statistics.sk

36. ŠTATISTICKÝ ÚRAD SR. *Zamestnanci podľa ekonomickej činnosti* [online]. STATdat, ©2. 11. 2016 [cit. 18. 11. 2016]. Dostupné z: http://statdat.statistics.sk
37. ŠVEC, P. (*2017*): *Export surového dreva zo SR* [online]. Trend.sk, 2017 [cit. 7. 2. 2017]. Dostupné z: http://www.etrend.sk/trend-archiv/rok-/cislo-Marec/export-suroveho-dreva-zo-sr-rastie-vyvoz-nabytku-a-vyrobkov-z-dreva-realne-klesa.html
38. UNECE. *Forest products annual market review 2015-2016* [online]. UNECE, FAO. United nations publications, 2016 [cit. 5. 3. 2017]. ISBN 978-92-1-117115-0. Dostupné z: http://www.unece.org/fileadmin/DAM/ /timber/publications/fpamr2016.pdf
39. UNECE/FAO. *Forest products. Annual market review 2015-2016: Mayor furniture trade flows* [online]. UN COMTRADE, 2016 [cit. 4. 2. 2017]. Dostupné z: http://www.unece.org/fileadmin/DAM/timber/statsdata/trade-flow-fpamr2016.pdf

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THE INFLUENCE OF COLOUR SHADES OF SOLID BIRCH WOOD ON THE POTENTIAL CUSTOMERS´ DECISION-MAKING

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Abstract: The article focuses on the possibilities of utilization of birch (Betula pendula, Roth) wood in products with higher value added, mostly in furniture making. Marketing analysis of colour parameters preferences of birch wood was carried out by a questionnaire survey on a sample of customers. Results showed an unambiguous customers´ preferences of colours of heat treated birch wood. Only ca. 10 % of responses of potential customers preferred the reference sample of wood without the heat treatment. The differences in colour of solid birch wood were results of different levels of heat treatment of birch wood samples. On top of that, heat treatment has a positive impact on the quality of birch wood.
Keywords: birch, customer preference, questionnaire survey

1. INTRODUCTION

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. 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. (Dudík et al. 2018a, Dudík et al. 2018b).

There is not much literature on heat-treated birch wood. This topic is, for example, in works of Anderson et al. (2019), Irbe et al. (2017) and Sundqvist (2002).

There are works showing that the heat treatment of wood gives it, among other things, an attractive colour (Dos Santos et al. 2014). Wood colour is an important parameter for the identification, use and determination of its market value with regard to aesthetic factors (Rosu et al. 2010). Therefore, 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.

The aim of this article is to evaluate the potential of heat-treated solid birch wood for the prospective use in the furniture industry. In fact, this is the initial finding of whether it makes sense from the customers' point of view to consider the importance of colour changes in birch wood. Most decisions to introduce new products to the market are made after marketing research, as reported by Bhuiyan (2011). The opinion of customers was discovered by a questionnaire survey.

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 solid birch wood (1 reference sample and 5 samples with different degrees of thermal treatment) was determined and evaluated. For solid wood samples, the Roman numerals I to VI were used, while the reference sample was marked I. 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:

I. Solid wood - untreated (BR-SW-REF) – the lightest colour shade
II. Solid wood - treated at 160 °C / 3 h (BR-SW-160-3).
III. Solid wood - treated at 170 °C / 3 h (BR-SW-170-3).
IV. Solid wood - treated at 180 °C / 3 h (BR-SW-180-3).
V. Solid wood - treated at 190 °C / 3 h (BR-SW-190-3).
VI. Solid wood - treated at 200 °C / 3 h (BR-SW-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 solid birch wood, 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 last optional question was about the opinion on which tree species the individual samples are made of. The full text of the questionnaire is published in the article by Dudík et al. (2020). The data obtained by the questionnaire survey were processed in the basic phase by graphical methods of descriptive statistics.

3. RESULTS AND DISCUSSION

In the area of sample preference in the case of purchasing an accessory and a new apartment, we see a greater preference for darker shades when renovating a flat or house. When purchasing accessories for existing equipment, people tend to avoid the darkest shade (see Fig. 1). Furthermore, a low level of preference for samples of solid birch wood without heat treatment is evident, at the level of about 9 % in the case of new apartment equipment and about 11 % in the case of acquiring a supplement (Dudík et al. 2020).

The level of attractiveness of each individual sample of solid wood follows from Figure 2. The maximum number of all possible answers shown in Figure 2 is 612, ie. 6 answers of one respondent (one answer for each sample of solid wood) times 102 respondents. Figure 2 shows that for solid wood, the degree of preference 4 (significant preference - the sample likes significantly) was used most often, in 176 cases of responses. The least used preference was 1 (insignificant preference - the sample likes the least), in a total of 65 cases. Sample IV, BR-SW-180-3, had the highest absolute value of the number of responses in case of preference 4, a total of 45 answers. At the same time, this sample had the 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 (I. BR-SW- REF), namely 26 - 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.

Another view on the distribution of preferences in solid wood samples is published in the article by Dudík et al. (2020). In this article, the attention is paid to each specific sample of solid birch wood and the related share of respondents' preferences related to the sample. In this respect, the distribution of preferences for the darkest shade (sample VI. BR-SW-200-3) is interesting, where there is a significant proportion of high preferences (47 responses for preferences 4 and 5) and at the same time a significant proportion of low preferences (42 responses for preferences 1 and 2).

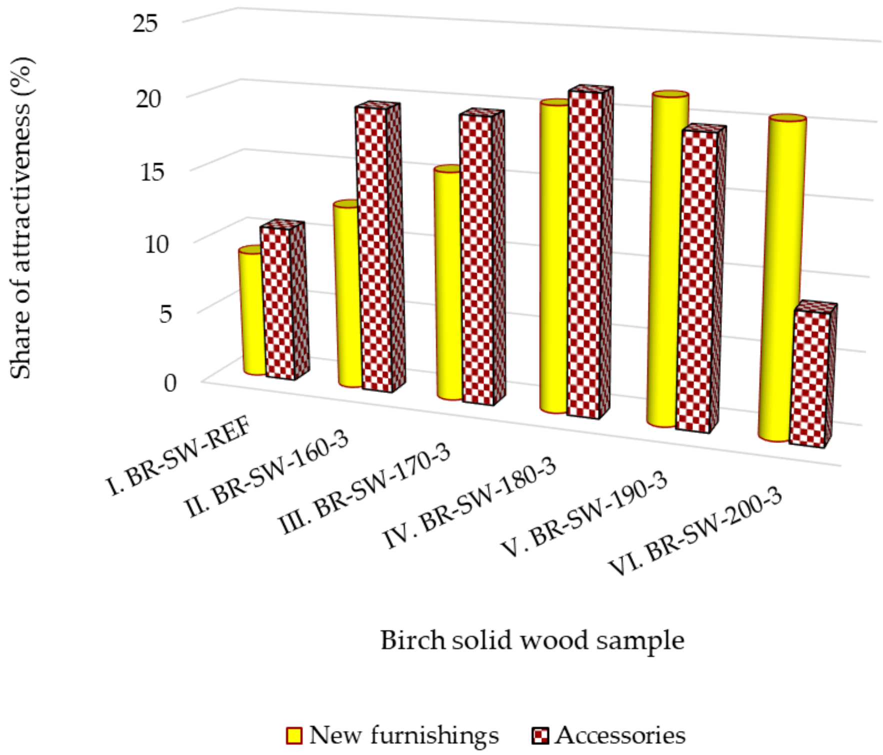

Figure 1. The preference in the samples in the case of purchasing accessories and new furnishings – solid birch wood

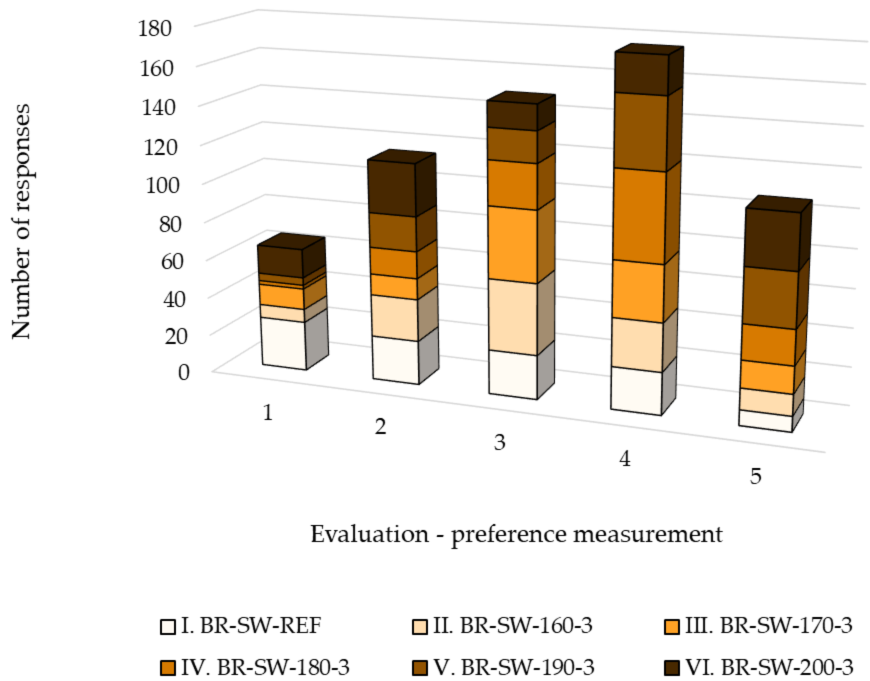

Figure 2. The colour distribution of the samples depending on the preference level - solid birch wood

4. CONCLUSION

The graphically processed results of the questionnaire survey clearly show the predominant preferences of heat-treated samples of solid birch wood, while the preference of darker shades over light ones predominates. The analysis of data obtained from the questionnaire survey thus confirmed the assumptions of other authors (e.g. Rosu et al. 2010) about the higher attractiveness of heat-treated wood compared to reference samples without heat treatment. We can say that customers' decisions when buying a wood product are influenced by the colour shade of the wood, and in interviews with respondents that took place after completing the questionnaire, this was confirmed.

The results of the survey also indicate a possible change in the sentiment of potential customers in the preference of colour shades towards darker colours (Dudík et al. 2020). However, further investigation would be appropriate to confirm this hypothesis.

The differences in colour scale acquirable after various particular heat treatment of birch wood enables its use for furniture supplements in already-made furnishings that were made also from different type of wood. Results of this survey can be used also in other countries. Many European countries currently face the impacts of ongoing calamities resulting in above-average amounts of salvage fellings. Because of that, replacing monocultures and promoting diversity of tree species is supported. Utilization of other than current commercial species (in this case birch with short rotation) including changes in customer preferences provide another incentives for decision-making processes regarding possible forest management changes in Czech forests.

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REFERENCES

1. Andersone, I.; Dobele, G.; Andersons, B.; Kurnosova, N.; Kuka, E.; Volperts, A.; Grinins, J. A study of thermo-hydro-treated (THT) birch wood by chemical analysis and Py-GC/MS. Holzforschung 2019, 73, 653–661. DOI: 10.1515/hf-2018-0169.
2. Bhuiyan, N. A Framework for successful new product development. Journal of Industrial Engineering and Management 2011, 4, 4, 746-770. DOI: 10.3926/jiem.334.
3. Borůvka, V.; Dudík, R.; Zeidler, A.; Holeček, T. (2019). Influence of Site Conditions and Quality of Birch Wood on Its Properties and Utilization after Heat Treatment. Part I—Elastic and Strength Properties, Relationship to Water and Dimensional Stability. Forests 2019, 10, 189. DOI: 10.3390/f10020189.
4. Dos Santos, D.V.B.; De Moura, L.F.; Brito, J.O. Effect of heat treatment on color, weight loss, specific gravity and equilibrium moisture content of two low market valued tropical woods. Wood Research 2014, 59, 2, 253-264.
5. Dudík, R., Borůvka, V., Zeidler, A., Holeček, T., Riedl, M. Influence of Site Conditions and Quality of Birch Wood on its Properties and Utilization after Heat-treatment. Part II—Surface Properties and Marketing Evaluation of the Effect of the Treatment on Final Usage of such Wood. Forests 2020, 11(5), 556; https://doi.org/10.3390/f11050556.
6. Dudík, R., Palátová, P., Borůvka, V., Riedl, M. (2018b). The prices and utilization of birch and beech raw wood in the Czech Republic - A bioeconomic dimension. In Increasing the Use of Wood in the Global Bio-Economy, Belgrade; Serbia, September 28th-30th, 2018; Glavonjić, B. Eds.; WoodEMA, i.a., 90-95.
7. Dudík, R., Šišák, L., Riedl, M. (2018a): Regeneration of declining spruce stands in the Czech Republic - economic view of an alternative species composition. In Book of Abstracts "SUSTAINABLE FOREST MANAGEMENT FOR THE FUTURE – the role of managerial economics and accounting". Croatia. May, 2018. 25-26.
8. Irbe, I.; Grinins, J.; Andersone, I.; Andersons, B. Susceptibility of thermo-hydro-treated birch plywood to mould and blue stain fungi. Wood Material Science & Engineering 2017, 13, 296–304. DOI: 10.1080/17480272.2017.1335346.

9. Jirouš-Rajković, V.; Miklečić, J. Heat-Treated Wood as a Substrate for Coatings, Weathering of Heat-Treated Wood, and Coating Performance on Heat-Treated Wood – review article. Advances in Materials Science and Engineering 2019, Article ID 8621486, 9 pages. DOI: 10.1155/2019/8621486.
10. Kaputa, V.; Šupín, M. Consumer Preferences for Furniture. In Wood Processing and Furniture Manufacturing: Present Conditions, Opportunities and New Challenges, Vyhne, Slovakia, October 6th-8th, 2010; Paluš, H. Eds.; International Association for Economics and Management in Wood Processing and Furniture Manufacturing–WoodEMA, i.a.: Zagreb, Croatia, 2010, 81-90.
11. Loučanová, E.; Paluš, H.; Dzian, M. A Course of Innovations in Wood Processing Industry within the Forestry-Wood Chain in Slovakia: A Q Methodology Study to Identify Future Orientation in the Sector. Forests 2017, 8, 6, 210. DOI: 10.3390/f8060210.
12. Parobek, J.; Paluš, H. Modelling of wood and wood products flow in the Slovak Republic. In COST Conference on a European Wood Processing Strategy: Future Resources Matching Products and Innovations, Milan, Italy, May 30th – June 3rd, 2008; Ghent University: Ghent, Belgium, 2008; 93-99.
13. Rosu, D.; Teaca, C-A.; Bodirlau, R.; Rosu, L. FTIR and color change of the modified wood as a result of artificial light irradiation. Journal of Photochemistry and Photobiology B: Biology 2010, 99, 3, 144-149. DOI:10.1016/j.jphotobiol.2010.03.010.
14. Sundqvist, B. Color response of Scots pine (Pinus sylvestris), Norway spruce (Picea abies) and birch (Betula pubescens) subjected to heat treatment in capillary phase. Holz als Roh- und Werkstoff 2002, 60, 106–114. DOI: 10.1007/s00107-001-0273-x.

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IMPACTS OF GLOBALISATION ON THE FOREST INDUSTRY: APPLICATION OF COMPARATIVENESS ANALYSES

Parobek, J., Slašťanová, K.

Abstract: Economic globalisation in general has effects on the sustainable development and natural environment with regard to the forest base industry. The paper deals with the analysis of the forest based industry competitiveness with a focus on mechanical wood processing. The study analyses the development of the timber and wood base panels materials. According to the foreign trade of the selected countries the results describe competitiveness of the selected sectors in the period 2003-2018. The Slovak position is characterised by the Trade Specialisation Index and Export/Import Ratio. The selected indicators of competitiveness described development of Slovak position on the EU timber and wood base panels markets. Result find out that Slovakia has revealed comparative advantage in the products with lower added value like coniferous and, non-coniferous sawnwood and wood based panels.
Keywords: globalisation, forest, timber, wood base panels, comparativeness analyses

1. INTRODUCTION

All sectors, as well as, countries try to improve their position on the market. Companies management could set up the strategy established on consumer's demand by permanent researching of markets (Kaputa, Šupín, 2010). In general, competitiveness represents driving force of the whole economy. The global market is driven by increasingly demanding customer requirements, that is why, companies produce higher value-added products and to streamline use of resources to improve the efficiency of the overall production process. At the national level, competitiveness forces development of foreign trade mainly exports and expand the profits over the longer term. Competitiveness is a measure of a country's advantage or disadvantage in selling its products in international markets. Competitiveness of countries is directly linked to ability of selling products on the world markets. From this point of view, we can try to define competitiveness from two different point of views (at the company level and at the country level). According to the OECD (2011) both of these levels have different objectives and therefore require a different approach to research. Company competitiveness is strictly linked to profitability. It describes how the firm can penetrate in the market in an effort to sell products and finally rich a profit. A competitive forest industry brings many benefits to society and the national economy. The sector is affected by several other factors and policies, such as environmental protection, energy efficiency and public procurement. The aim of the future strategy is to stimulate a positive framework to improve competitiveness and support sustainable growth in the forest.

Many researches has been done for forest industry sector. For instance, Vu et al. (2019) applied in his research new indicators measuring industrial international competitiveness. They constructed a comprehensive international competitiveness index by combining the variation coefficient and the entropy method. In their study, they compare and evaluate the international competitiveness of the wood processing industry in Vietnam using a comprehensive international competitiveness index. Their results found that it is more accurate to use the combined variation coefficient and the entropy method to evaluate the international competitiveness of the wood processing industry, compared to the single index.

The Slovak wood processing industry has been traditionally built on the domestic forest resources and its production capacities adapted to the volume and structure of wood supply (Loucanova et al., 2017). A few years ago, research focused on competitiveness of wood processing industry in Slovakia was done (Parobek et al., 2014, Palus et al., 2014, Parobek et al., 2016). The competitiveness indicators showed that Slovakia had a comparative advantage in the trade of low added value wood base products (as sawnwood, paper and paperboard products), while there was a comparative disadvantage in trade with wood based panels. Palus et al. (2014) calculated RCA indicator revealed a low comparative advantage also in wood based panels trade of Slovakia. In this research, the Slovak Republic is the country which has comparative advantage in most of the analysed products. In case of certain products trade (e.g. non-coniferous sawnwood) the revealed comparative advantages pointed out connection to countries' resource endowments. On the other hand, the values of competitiveness indicators and thus intensity of comparative advantages in the trade of some wood products followed the economic development of countries. This approach is essential in a changing business environment. However, competitiveness indicators in the trade of certain wood products followed the general economic development of countries. The performance indicators of trade in the forest industry show that Slovakia has a comparative advantage in trade in wood-based products with higher added value. Indicators of comparative advantage, despite their limitations, provide useful evidence for confirming the basic comparative advantage and offer a new perspective on the use of wood raw material resources in the field of paper and board production. (Parobek et al, 2014).

2. METHODOLOGY

The study adopts the widely accepted trade and competitiveness indicators. Trade performance and competitiveness of the Slovak forest industry is examined based on forest products trade data for the years 2003-2018. The FAO classification of forest products (FAOSTAT, 2020) was applied to set up main category groups of products according to the added value. Particular products and product groups included in the analyses were coniferous sawnwood, non-coniferous sawnwood and wood based panels. Production of wood base panels include huge group of the wood products, namely veneers, plywood, particleboards and fibreboards. According to methodology of Paluš et al. (2014), we applied Trade Specialisation Index –TSI and Export/Import Ratio index. The analyses of competitiveness data will obtain an overview of the development of the competitiveness of the sawmill industry and wood base panels industry in the period from 2003 to 2018.

Trade Specialisation Index

The trade advantage in a particular economy sector is be obtained by calculating the Trade Specialisation Index as a ratio of net trade to the total trade in the category of commodity (Balassa, 1966). According to Prasad (2004) the index is often considering as the Net Trade Revealed Comparative Advantage Index and can be calculated as:

$$\mathrm{TSI}_j^A = \frac{X_j^A - M_j^A}{X_j^A + M_j^A} \quad (1)$$

where:
X_j^A - country A's export of product j (sawnwood, wood base panels)
M_j^A - country A's import of product j (sawnwood, wood base panels)

The value can range from -1 – without export of product j (X_j^A = 0) to +1 – without import of product j (M_j^A = 0). The values indicate comparative disadvantage when it is between –1 and 0 and comparative advantage when the value is between 0 and +1 (Paluš, et al. 2014). However, if it is equal to 0, it indicates that exports and imports of a particular product are equal. More specifically, this index measures the degree of specialisation of a country in exporting a particular product (Prasad 2004).

Export/Import Ratio

The export/ import ratio is calculated as:

$$\mathrm{EIR}_j^A = \frac{X_j^A}{M_j^A} * 100 \quad (2)$$

The higher the value of the ratio, the more a country has international trade competitiveness in a particular industry. A positive value of this index indicates international trade competitiveness of a country for a particular product, and a negative value of the index implies that there is no international trade competitiveness.

3. RESULTS

According to FAOSTAT (2020) data we analysed the Slovak foreign trade of sawnwood and wood base panels.

The balance of the foreign trade of non-coniferous and coniferous sawnwood and wood base panels is described in Table 1. The fluctuating development of values was caused by several factors. For instant; forest calamity like wind disasters in 2004, 2006, 2007, 2010; the global financial and economic crisis in 2008; problems with bark beetles after wind calamity in huge areas of forests in Slovakia. These causes had an impact on accidental felling and on the wood processing industries. Table 1 shows significant differences during last decades. In 2018, data describes the higher level of coniferous sawnwood and wood based panels export. On the other side, import also represents one of the highest values in 2008 and 2018.

Table 1. Development of the foreign trade in thousand USD of the selected commodities

Slovakia	sawnwood C		sawnwood NC		wood based panels	
	E	I	E	I	E	I
2003	90 173	7 938	61 255	5 728	92 150	115 013
2004	71 500	8 199	56 362	6 407	121 191	121 837
2005	121 812	13 074	63 646	9 858	166 105	166 214
2006	151 142	23 938	69 234	10 191	177 933	219 016
2007	184 091	59 636	79 565	14 741	251 208	309 287
2008	192 258	39 936	87 434	14 617	300 012	279 663
2009	119 371	24 607	58 162	26 127	140 872	205 040
2010	170 488	86 525	81 582	18 009	184 353	246 190
2011	196 295	58 934	48 819	21 821	149 654	232 250
2012	151 149	57 068	123 370	71 985	146 845	240 652
2013	162 483	68 300	71 280	42 740	129 427	183 345
2014	178 113	75 639	52 201	25 000	171 796	229 600
2015	128 384	71 927	59 563	10 378	183 088	195 324
2016	144 870	64 612	70 762	11 907	205 804	209 203
2017	153 340	73 488	57 686	11 902	237 570	211 363
2018	196 480	85 990	69 036	13 321	269 517	228 815

Source: FAOSTAT (2020)

In 2018 the share of coniferous sawnwood import reached approximately 43.8 % of the total value of exports. It represents the highest value of differences between exports and import during analysed period. The largest year-on-year decline in coniferous sawnwood exports was achieved in 2009. In contrast, the highest increase in imports was achieved in 2010. The year 2012 was significant for the wood products trade namely; non-coniferous sawnwood due to the highest values of foreign trade during the observed period, as well as, the highest values of the year-on-year increase in exports and imports.

In 2018 the export of wood based panels reached almost 90 % compare with year 2008. In this year, the highest value was reached. Particle boards (about $ 121,6 thousand) and plywood ($ 116 thousand) had the most significant share in this commodity group. The largest year - on - year increase in exports of wood base panels is recorded in 2007 and the most significant year - on - year decrease in 2009.

The main importer of sawnwood to the Slovak Republic was the Czech Republic (38% of the total value of imports) into the Slovakia. Austria (16.2%) and Poland (14.4%) also contributed significantly to imports in 2018. On the other side, in 2003 we imported most sawnwood from the Czech Republic (only 26.5%), Ukraine (10.5%) and Indonesia (9.1%).

In 2018, sawnwood export was mostly realized to Hungary, Italy, the Czech Republic and Austria. These countries represent 64% of the total value of the sawnwood export. In this year, sawnwood from the Slovak Republic was also exported in Korea (1.45%) and China (0.76%). In 2003, the largest share of sawnwood export was made to Hungary, Italy, the Czech Republic and Germany (66% from the total export of sawnwood).

In 2018, the Slovak foreign trade with wood base panels focused on EU countries (Czech Republic, Austria, Germany, Hungary, Poland, Romania, Italy). However, trade between non-EU countries also took significant place. More than 18% of the total value of veneer was imported from Ukraine. The Russian Federation, as one of the most important business partners, exported plywood to the Slovak Republic. The amount of plywood from Russia represent almost 15.8% of the total value of plywood imports. On the other side, we exported plywood to Switzerland. The share of Switzerland export was more than 14% of the total value of plywood export in 2018.

Following the value of foreign trade, the index of trade specialization was accounted. During the analysed period, the index of trade specialization of the sawnwood production reached positive values from 0.25 till 0.84. This determines the predominance of exports of sawnwood over their imports. The course of the indicator was fluctuating throughout the analysed period (Table 2).

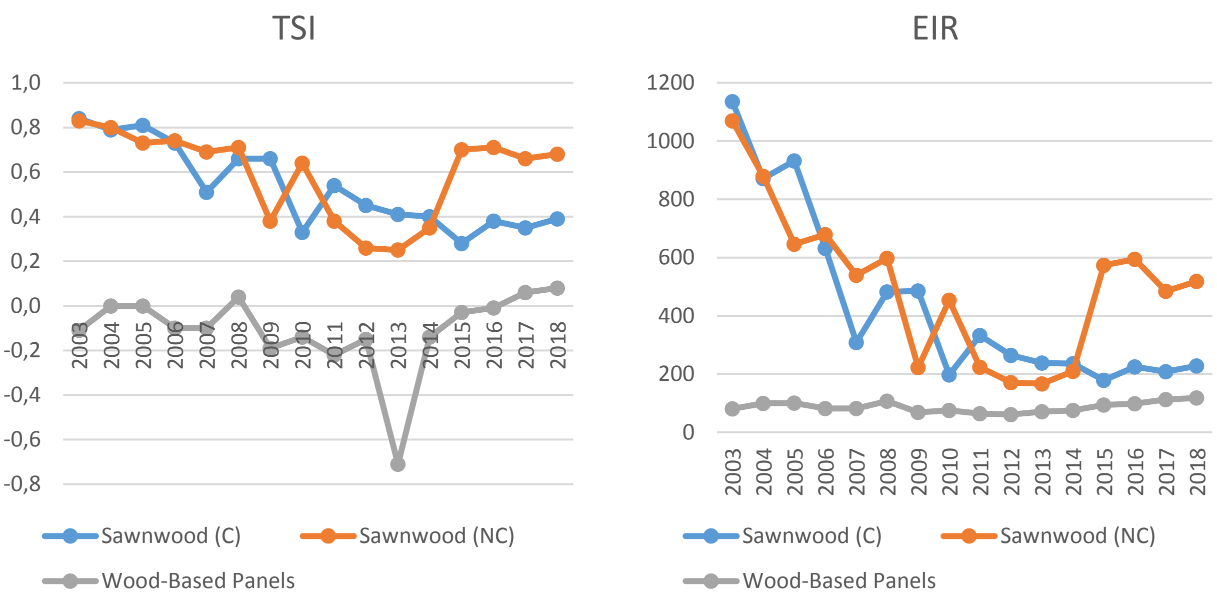
The highest value 0.84 of the index of trade specialization of coniferous sawnwood was recorded in 2003, which indicates the predominance of the export over its import. In 2013, the lowest level of the competitiveness indicator of non-coniferous sawnwood was recorded. The value of TSI was 0.21. The very low value of the index is due to a significant value of non-coniferous sawnwood imports. This fact represents a comparative disadvantage of the Slovak Republic for an analysed commodity.

The analyses show a declining trend in the degree of specialization of coniferous sawnwood comparing the values of the trade specialization index from 2003 to 2018. The value of TSI reached only 46% in 2018 compared to the value 0.83 in 2003. In contrast, for non-coniferous sawnwood TSI value have increased compared to previous decennium. This affirm a predominance of exports of this commodity over its imports.

Table 2. Development of TSI and EIR of the selected commodities in the period from 2003 to 2018

Year		**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Sawnwood (C)	**TSI**	0.84	0.79	0.81	0.73	0.51	0.66	0.66	0.33
	EIR	1 135.97	872.06	931.71	631.39	308.69	481.78	485.11	197.04
Sawnwood (NC)	**TSI**	0.83	0.80	0.73	0.74	0.69	0.71	0.38	0.64
	EIR	1 069.40	879.69	645.63	679.36	539.75	598.17	222.61	453.01
ood-Based Panels	**TSI**	-0.11	0.00	0.00	-0.10	-0.10	0.04	-0.19	-0.14
	EIR	80.12	99.47	99.93	81.24	81.22	107.28	68.70	74.88
Year		**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Sawnwood (C)	**TSI**	0.54	0.45	0.41	0.40	0.28	0.38	0.35	0.39
	EIR	333.08	264.86	237.90	235.48	178.49	224.22	208.66	228.49
Sawnwood (NC)	**TSI**	0.38	0.26	0.25	0.35	0.70	0.71	0.66	0.68
	EIR	223.72	171.38	166.78	208.80	573.94	594.29	484.67	518.25
ood-Based Panels	**TSI**	-0.22	-0.15	-0.17	-0.14	-0.03	-0.01	0.06	0.08
	EIR	64.44	61.02	70.59	74.82	93.74	98.38	112.40	117.79

In the analysed period the trade specialisation index of wood base panels acquired significant differences of values (positive, negative and zero). Negative values of this index has been achieved in most of the analysed years. It means a higher volume of imports of a wood base panels compare with exports. However, data shows a growing trend of Slovak foreign trade in wood base panels. Although, index balanced around zero between competitive advantage and disadvantage. Last years, the TSI has positive trend and in 2018 it reaches the highest value for the entire analysed period (Graph 1).



Graph 1 Values of the EIR and TSI indexes in the period from 2003 to 2018

4. CONCLUSION

The paper deals with analysis of the competitiveness of the Slovak Republic in the sawmill sector and wood base panels production. TSI and EIR indexes were calculated from the obtained data to describe the development of competitiveness in both sectors in the period from 2003 to 2018.

Positive values of trade performance indicators for the Slovak Republic mean the predominance of exports over imports of analysed commodities (comparative advantage). We observe these for groups of commodities, as well as, in foreign trade of particular commodities (e. g. sawnwood, plywood and chipboard). However, veneers (mostly from non-coniferous), OSB and fibreboards represent a comparative disadvantage for the Slovak Republic, as the indexes reach negative values. Nowadays, the foreign market and production of commodities from primary wood processing have rising trends.

The higher share of sawnwood exports over imports represents a comparative advantage. From the terms of sustainable development and support of the national economy we cannot consider it as a positive effect. The priority of the national economy is to use domestic resources as roundwood in a way with the highest possible degree of efficiency.

We will achieve positive forest industry contribution for the development of the national economy of the Slovak Republic through the effective collaboration between other industrial sectors in an effort to maximize added value. The current level of good competitiveness of sawnwood is due to the high export and finalisation of production through subcontracting to foreign companies. Therefore, in the Slovak Republic it is necessary to increase the production of products with higher added value even at the cost of a comparative disadvantage. Wood base buildings is one of the most important sector for forest industry from the increasing efficiency point of view. Sedlak et al. (2019) focused on innovative approaches in the development of the low-cost system in wood base buildings. Their conclusions have a great potential to influence the competitiveness of the wooden building sector on the market.

By increasing the degree of finalization of the processing of the resources and increasing the capacity of the forest industry, we will achieve an increase in the production of high-quality large-area commodities and a subsequent growth the foreign trade of these commodities.

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REFERENCES

1. Balassa, B.; (1966): *Tariff Reductions and Trade in Manufactures among Industrial Countries*. American Economic Review 56: pp. 466-473.
2. FAOSTAT (2020): *Forestry Production and Trade*. URL: http://faostat3.fao.org/faostat-gateway/go/to/download/F/FO/E (accessed on 10 July 2020).
3. Kaputa, V., Šupín, M. (2010): Consumer preferences for furniture. In Wood processing and furniture manufacturing: present conditions, opportunities and new challenges. Zvolen: Technical University in Zvolen, 2010, p. 81-90, ISBN 978-80-228-2160-5.
4. Loučanová, E.; Paluš, H.; Dzian, M. (2017) *A Course of Innovations in Wood Processing Industry within the Forestry-Wood Chain in Slovakia: A Q Methodology Study to Identify Future Orientation in the Sector.* Forests, 2017, *8*, 210 pp. 1-13. DOI:10.3390/f8060210
5. OECD (2020): *OECD STAN INDICATORS 2011 - Collection of Calculation Formula*, URL: http://www.oecd.org/sti/ind/47447210.pdf.
6. Paluš, H.; Parobek, J.; Liker, B. (2015): *Trade Performance and Competitiveness of the Slovak Wood Processing Industry within the Visegrad Group Countries*, Drvna Industrija, 2015 66 (3): pp. 195-203. DOI: 10:5552/drind.2015.1431.
7. Parobek, J.; Paluš, H.; Kliestik, T.; Maťová, H. (2014): *Konkurencieschopnosť papierenského priemyslu SR: Competitiveness of paper industry of Slovak Republic*. Globalizácia a jej sociálno-ekonomické dôsledky ´14: recenzovaný zborník z medzinárodnej vedeckej konferencie. Žilina: Žilinská univerzita v Žiline, 2014, pp. 479-483. ISBN 978-80-554-0927-6.
8. Parobek J.; Paluš H.; Loučanová E.; Kalamárová M.; Glavonić B. (2016): *Competitiveness of central European countries in the EU forest products market with the emphasis on*. In: Acta Facultatis Xylologiae Zvolen, 2016, 58 (1): pp. 125–136. DOI: 10.17423/afx.2016.58.1.14.
9. Prasad, R. N. (2004): *Fiji's export competitiveness: A comparison with selected small island developing states. Reserve Bank of Fiji*, Suva. URL: http://www.rbf.gov.fj/docs/2004~06%20WP.pdf.
10. Sedlák, P., Búryová, D., Štefko, J. (2019): *Innovative design of the low-cost structural system for wood-base houses.* Digitalisation and circular economy: Forestry and forest based industry implications, Proceedings of Scientific Papers 12th WoodEma Annual International Scientific Conference. Sofia: Union of Scientists of Bulgaria, 2019, p.87-92, ISBN 978-954-397-042-1.
11. The International Trade Centre (2020): Trade Statistics. URL: https://www.trademap.org/Index.aspx. (accessed on 3 July 2020).
12. Vu, T. T. H.; Tian, G.; Khan, N.; Zada, M.; Zhang, B.; Nguyen, T. V. (2019): *Evaluating the International Competitiveness of Vietnam Wood Processing Industry by Combining the Variation Coefficient and the Entropy Method*. Forests 2019, 10, 901.

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THE STRATEGIC ANALYSIS OF THE IMPLEMENTATION OF GREEN PURCHASING IN THE FOREST-BASED SECTOR

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Abstract: Green purchasing is an important tool for achieving environmental policy objectives for the use of resources and sustainable consumption and products, especially given the importance of spending on goods and services in businesses. Green purchasing can be applied to exclusion and selection contracts, while ensuring a minimum level of compliance with environmental criteria for suppliers and subcontractors. The forest-based sector is one of the most important, dynamically developing EU industrial sectors, accounting for around 10% of the entire EU manufacturing industry. Because the forest-based sector includes multiple sectors, each has a significant impact on the performance of others. Environmental policy strategies lead the sector companies to meet customers' needs with minimal environmental impact. Through the analysis of external and internal environment this paper uses the SWOT analysis to evaluate the opportunities and challenges for applying green purchasing in the forest-based sector companies. At the same time it aims to outline the possible alternatives for future development of green purchasing as well as conditions and solutions for its implementation.
Keywords: green purchasing, forest-base sector, SWOT analysis

1. INTRODUCTION

Nowadays, the use of wood shall be considered to be environmentally friendly due to its renewable nature. The forest-based sector manages technological activities during which the raw wood material is changed to different wood products, such as sawn wood, particle boards, plywood, fuel wood, pulp, paper, furniture, etc. The environmental production policy is marked by the generous tendencies to broaden the range of indirect sustainable management tools, one of them being green purchasing, based on both the voluntary activities of producers as well as the growing environmental awareness of consumers. The systems of environmental labelling are being widely applied, declaring the products dispose of characteristics that neglect or even exclude adverse environmental effects [1]. Consumers prefer ecolabels with detailed information about the environmental benefits associated with eco-labelled products [2]. Moreover, brands have become a very effective tool of communication. By these, consumers inform other members of their social group who they are and if they really belong to a specific social group [3]. Recently, one of the modern trends has been to assess the product life cycle as a whole, i.e. from obtaining the raw material through its processing, product use to its recycling. Environmental labelling shall effectively enhance introduction of the environmental policy principles in practice – it improves the business environment and environmental situation within industrial as well as non-industrial spheres, it helps to preserve cultural specifics, it saves natural resources and, finally, it increases the product traceability [4]. Hence, it is necessary to point out the advantages and opportunities of green purchasing for the forest-based sector. On the other hand, there is a number of disadvantages and threats that might affect the implementation of green purchasing within the forest-based sector [2].

2. THEORETICAL FRAMEWORK

Every year, more than 13 mil. hectares of forests disappear over the world, vast majority of it contrary to the legal requirements. Also because of that, the numerous environmental activities contributing to the sustainable management of forest resources appeared in Europe already in 1980s, one of them being the introduction of so-called environmentally friendly recyclable and biodegradable products [5]. In order to generate such products, manufacturers may also introduce the principles of environmentally preferable purchasing or green purchasing that stands for a purchasing of goods and services by public as well as private institutions with a minimal negative impact on the environment [6]. The objective of such purchasing is to obtain the most environmentally friendly goods and services that are necessary for manufacturing processes – the environmental friendliness origins mainly from the modest material and energy consumption, recyclability, health safety, biodegradability, short distance from producers to consumers [5].

In order to help the forest-based sector companies to prevent the use of raw wood from controversial sources (illegal logging), the governments together with the various interest groups introduced a range of certification schemes with the technical requirements and specifications aimed at the principles of sustainable forest management [7]. The criteria of different aspects of sustainable management of forest resources create an important part of the forest certification schemes, such as FSC or PEFC schemes [8, 9]. Recently, more and more consumers demand warranties of use of environmentally friendly processes within the manufacturing and business practices, although consumer's purchase behaviour is still not clear enough for marketers [10]. In the case of the forest-based sector, the chain of custody certification serves as a mechanism for monitoring of raw wood material origin from the forest stand to the final product, therefore ensuring the traceable connection between the certified forests and final products.

Likewise, environmental labelling serves as a voluntary environmental protection tool. Environmentally friendly products shall meet the strict environmental and health safety criteria, thus they shall create less negative impact on the environment in comparison to another products with the same functional and utility properties, not only during their manufacturing, but also during their use and disposal [5]. Finally, due to their environmental value added, the competitiveness of such goods and services on the green market is much higher [11].

3. METHODOLOGY

The objective of this paper is to assess the possibility of implementation green purchasing in the forest-based sector using the technique of the SWOT analysis.

SWOT analysis serves as a basic tool for assessing the present state and conditions of different objects or processes. Its main task is to identify various factors – strengths, weaknesses, opportunities and threats – that shall have an eminent impact on the further achieving of the business unit objectives [12]. SWOT analysis is generally considered to be the starting point for the development of optimal relations between the internal abilities of the enterprise and its external environment [13]. It is based on the assumption that the effective strategy maximises strengths and opportunities and, in contrary, minimises weaknesses and threats. Moreover, it proposes possible alternatives for future development of the business activities [11].

The objective of the SWOT analysis in this case is to assess both the internal possibilities (strengths and weaknesses) as well as external market conditions (opportunities and threats) of implementing green purchasing in the forest-based sector [12]. The strengths are viewed as the internal competencies that help to implement green purchasing, while the weaknesses are considered to be such inabilities. The opportunities are viewed as the external advantage that help to implement green purchasing, while the threats are considered to be such disadvantages. The methodological approach was as follows:

- The four groups of different factors – strengths and weaknesses as well as opportunities and threats – were identified, five factors within each group.
- Using an expert estimation, the individual score ranging from 1 to 3 points was assigned to each factor. This score expresses absolute importance of identified factors in the case the green purchasing is implemented.
- Using Fuller's triangle [13], the different weights were assigned to each factor so that the sum of weights within each group of factors is equal to 1. The weights express relative importance of each identified factor within the respective group of factors.
- The final score for each group – strengths and weaknesses as well as opportunities and threats – was calculated as the sum of products of individual scores and respective weight within the respective group of factors. The final score of strengths and opportunities is expressed in a "plus" way, while the final score of weaknesses and threats is expresses in a "minus" way – then, it is possible to state whether strengths dominate over weaknesses or vice versa and whether opportunities dominate over threats or vice versa.
- Finally, one of the following strategies was proposed according to the ultimate final score:

1. S/O strategy – the prevailing strengths and opportunities shall favour the implementation of green purchasing in forest- based sector,
2. W/O strategy – the prevailing weaknesses shall be eliminated so that the prevailing opportunities may be used to implement green purchasing,
3. S/T strategy – the prevailing strengths shall be used to overcome the prevailing threats and
4. W/T strategy – the prevailing weaknesses and threats do not favour the implementation of green purchasing in forest- based sector [14].

4. RESULTS

The main objective of the SWOT analysis is to describe the present condition of the analysed object or process – in this case, in connection to the possibilities of implementation of green purchasing in the forest-based sector. Based on the SWOT analysis results, it is possible to identify the strengths and opportunities that support the implementation of green purchasing. Moreover, the results also help to identify the weaknesses and threats that need to be improved, eliminated or taken in account when the implementation of green purchasing is considered. Hence, the SWOT analysis is used to decide whether or not to implement green purchasing in the forest-based sector, taking into account the real situation, including possible risk factors.

Table 1. Assessment of strengths of green purchasing implementation in the forest-based sector

Strengths	Score	Weight	Total
Implementation of environmental management system	2	0.10	0.20
Certification of suppliers	3	0.18	0.54
Existence of general agreements with suppliers	3	0.40	1.20
In-time supplies	2	0.27	0.54
Support of sustainable management principles	2	0.05	0.10
In total	12	1	+ 2,58

Table 2. Assessment of weaknesses of green purchasing implementation in the forest-based sector

Weaknesses	Score	Weight	Total
Inter-departmental cooperation	2	0.10	0.20
Existence of technical equipment to protect environment	2	0.10	0.20
Special provisions on sub-contractors	2	0.10	0.20
Increased product prices	3	0.30	0.90
Reporting duty in the case of certification failures	3	0.40	1.20
In total	12	1	- 2,70

Table 3. Assessment of opportunities of green purchasing implementation in the forest-based sector

Opportunities	Score	Weight	Total
Support of environmental technologies	2	0.10	0.20
Possible saving of financial means	3	0.25	0.75
Extension of product life cycle	2	0.20	0.40
Accurate disposal of used products and their packaging	2	0.05	0.10
Increased competitiveness	3	0.40	1.20
In total	12	1	+ 2,65

Table 4. Assessment of threats of green purchasing implementation in the forest-based sector

Threats	Score	Weight	Total
Need to follow special rules (e.g. FLEGT requirements)	1	0.10	0.10
Suppliers do not meet technical specifications	2	0.20	0.40
Low awareness of green purchasing	2	0.10	0.20
Customers insolvency	3	0.40	1.20
Problematic disposal of used products and their packaging	2	0.20	0.40
In total	10	1	- 2,30

When assessing the strengths, the great emphasis is placed on the existence of general agreements with suppliers. On the other hand, the most serious weakness is in the area of reporting duty in the case of certification failures. Considering the external environment, possible saving of the financial means is one of the most important opportunities. In contrary, the customers insolvency is perceived as one of the most serious threats.

Based on the ultimate final score of the analysis, it is obvious that the weaknesses slightly prevail over the strengths while the opportunities more considerably prevail over the threats. Thus, when considering the implementation of green purchasing in the forest-based sector, the W/O strategy shall be applied.

5. CONCLUSION

The results of the SWOT analysis show that there are serious opportunities that may be used to help to implement green purchasing in the forest-based sector. However, it is necessary to be prepared for such implementation as there are still slightly prevailing weaknesses, even if they might be eliminated by the clever exploitation of the market opportunities. One shall also be aware that the differences between the strengths and weaknesses, on one hand, and between the opportunities and threats, on the other, are not that significant.

In general, the implementation of green purchasing in the forest-based sector shall be recommended. The enterprises within this sector shall use external market opportunities for such implementation and, moreover, they need to invest in their strengths in order to improve their competitiveness. Especially, the long-term general agreements with the suppliers shall be promoted together with the introduction of general environmental management systems.

Another set of measures, which would promote the implementation of green purchasing in the forest-based sector, shall include following actions: (i) implementation of innovative approaches in supplier-customer relations, (ii) financial support of implementation of environmentally friendly manufacturing technologies and equipment to combat environmental pollution, (iii) use of new innovative materials for product manufacturing and packaging, (iv) optimization of deliveries in terms of time and space, and (v) general support of circular economy.

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REFERENCES

1. Rusko, M.; Kralikova, R.; Mikulova, M.; Ilko, J. (2016): *Labelling of Products from the Context of Environment, Quality and Safety.* In book: DAAAM International Scientific Book, 2016, p. 419-434. DOI: 10.2507/daaam.scibook.2016.37.
2. Jošt, M.; Kaputa, V.; Nosáľová, M.; Pirc Barčić, A.; Perić, I.; Oblak, L. (2020*): Changes in customer preferences for furniture in Slovenia.* In Drvna industrija: znanstveni časopis za pitanja drvne technologije. ISSN 0012-6772, vol. 71, broj 2, s. 149-156.
3. Majerova, J.; Sroka, W.; Krizanova, A.; et al. (2020): *Sustainable Brand Management of Alimentary Goods*. Sustainability. 12(2):556.
4. Regulation (EC) (2010): No. 66/2010 of the EP and of the Council on the EU Ecolabel.
5. Chovancová, J.; Rovňák, M.; Dialská, M. (2014): *Zelené nakupovanie a možnosti jeho využitia pri znižovaní spotreby energie v malých a stredných podnikoch na Slovensku.* https://www.pulib.sk/web/kniznica/elpub/dokument/Adamisin2/subor/Chovancova.pdf
6. Kanchanapibul, M.; Lacka, E.; Wang, X.; Chan, H. K. (2014): *An empirical investigation of green purchase behaviour among the young generation.* Journal of Cleaner Production, 66, 528-536.
7. Marco, P.; Chenyi, S.; Andrea, C.; Xiaohui, W.; Antonio, M. (2018): *SWOT Analysis of the Application of International Standard ISO 14001 in the Chinese Context. A Case Study of Guangdong Province.* Sustainability, 10(9), 3196; https://doi.org/10.3390/su10093196
8. URL: www.fsc.org.
9. URL: www.pefc.org
10. Kaputa, V.; Šupín, M. (2010): *Consumer preferences for furniture. In Wood processing and furniture manufacturing : present conditions, opportunities and new challenges*. Zvolen: Technical University in Zvolen, ISBN 978-80-228-2160-5, p. 81-90.
11. Porter, M. E. (1994): *Konkureční stratégie*. Praha:Victoria Publishing. ISBN 80-85605-1-2.
12. Shizuka H. (2015): *Forest stewardship council certificate for a group of planters in Vietnam: SWOT analysis and implications*. Journal of Forest Research, 20:35–42, DOI 10.1007/s10310-014-0472-z
13. Friebelová, J.; Klicnarová, J. (2007): *Rozhodovací modely pro ekonomy*. České Budějovice: EF JU, ISBN 978-80-7394-035-5, p. 130
14. Sedlák, M. (1997): *Manažment.* Bratislava: ELITA 1997, ISBN 80-8044-015-8.

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MARKETING COMMUNICATION TOOLS AND CHANNELS FOR THE FUTURE INDUSTRY

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Abstract: One of the most noticeable trends in the industry 4.0 is the digitization of relationships between key market players (in B2B and B2C). The direction of changes is determined by e-commerce and the ever-growing expectations of a growing group of so-called digital customers that companies must meet, not to create a competitive advantage, but to survive on the market. The furniture industry is one of the key and dynamically developing sectors, which actively uses digital and mobile channels, which have become an integral part of the purchasing process. Manufacturers and distributors of home furnishings mostly see the benefits of using marketing communication tools and channels using internet technology. The article analyses both the tools and marketing communication channels used by the furniture industry and the formulas of brand images created by Polish furniture companies on the Internet. The analysis showed both advantages and sources of inspiration for furniture companies using social media.
Keywords: marketing communication, social media, content marketing

1. INTRODUCTION

Poland is ranked eighth among developed countries in terms of the value of creative industry exports, the United Nations Conference on Trade and Development (UNCTAD) said in a recent report. According to UNCTAD, the value of Polish creative sector exports amounted to USD 7.43 billion (PLN 27.9 billion) in 2015. The creative sector is a part of the market created by entities conducting business activities related to culture and technology. It includes, among others, industries such as advertising, architecture, design, fashion, film, video games, music, advertising and the publishing market. Design is by far the most profitable part of the Polish creative industry - the export value of this industry amounted to USD 4.2 billion, (PLN 15.8 billion) in 2014.The UNCTAD report, which covers the years 2002-2014 / 2015, also shows that Polish exports of the entire creative industry doubled during this period. The top ten largest exporters of the creative sector of developed countries include the United States, France, Italy, Great Britain, Germany, Switzerland, the Netherlands, Poland, Belgium and Japan. Such a good result of the Polish creative industry and design is, among others, a derivative of the success of the Polish furniture industry [Rząsa 2019].

According to the data of the Polish Development Fund, among the manufacturing industries, furniture industry is the second industry in terms of net export value and forms a significant part of the Polish economy. Sales of medium and large furniture producers, i.e. those employing over 49 employees, have been maintaining a level of about 2% of GDP for many years.

The article presents interpretation of the results of research on marketing communication used by selected manufacturers of the interior design industry, which includes furniture manufacturers. The study was carried out in 2019-2020 using CATI, CAWI and PAPI methods.

2. THE IMPORTANCE OF MARKETING COMMUNICATION FOR ENTERPRISES

In a dynamically developing digital economy, enterprises compete not only in the product or services quality, but also in the field of communication with both internal and external environment. Organizational communication is a complex process that has many functions and contributes to the definition and achievement of various tasks. There are three types of the communication in the enterprise: managerial, marketing and organizational [Van Riel 1995].

Integrated marketing communication (IMC) emerged during the late twentieth century and its importance has been growing ever since [Grove, Carlson, and Dorsch, 2002]. Owing to the impact of information technology, changes came about in the domains of marketing and marketing communications which led to the emergence of IMC [Kitchen et al ., 2004]. The multiplication of media, demassification of consumer markets, and the value of the Internet in today's society are just three of the areas in which technological innovation has impacted [Pilotta et al ., 2004; Peltier, Schibrowsky, and Schultz, 2003].

In the first decade of the new millennium, the technological development of the Internet has fundamentally changed the behaviour of its users in the production and acquisition of information. The technical changes taking place in the Internet cause a lot of psychological changes for users, also affecting the process of communication between the company and consumers. The place and role of these enterprises in the marketing communication process have also changed.

Communication channels are constantly widened; more possibilities to communicate with target groups are discovered. Marketing communication mix consists of eight major modes of communication: advertising, sales promotion, events and experiences, public relations and publicity, direct marketing, interactive marketing, word-of-mouth marketing, personal selling [Kotler and Keller 2012].

Marketing communication plays an important role in business strategies and therefore must be managed with due care. This need is even more important in connection with the development of digital technology which affects both the economic environment and client segments.

Therefore, business organizations should analyse selected marketing communication tools and look at the impact they have on a specific target group to be able to submit innovative proposals for optimization of company's marketing strategies.

Social media are currently a modern marketing communication channel. Social media is defined as digital media and technologies (social software) that enable their users to create and exchange media content between themselves in two and many directions. Social media includes all media (platforms) that, through digital channels, allow users to communicate with each other and interactively exchange information.

A. Kaplan and M. Haenlein (2010), presenting the essence of social media, state that they constitute a group of applications enabling the creation and exchange of user-generated content that is based on the ideological and technological foundations of Web 2.0. The term Web 2.0 is used in the literature to refer to the next stage of Internet development that took place at the beginning of the 21st century. Web 2.0 should be understood as a number of technological solutions and their applications on the Internet that allow for interaction between its users. At the same time, attention is paid to changes in the behaviour of Internet users.

Social media is referred to as [Bonek and Smaga 2001]: websites whose users create profiles and use them mainly for social and entertainment purposes (eg Facebook, Google+, NK); microblogs that are used to exchange short information (e.g. Twitter); industry communities or professionals (e.g. Linkeld, Goldenline); portals whose content is created by users (e.g. Wikipedia, YouTube, Pinterest, Demotivators); citizen journalism services; blogs and discussion forums; opinion and recommendation services; e-commerce websites using social mechanisms such as auctions or exchanges.

Activity in social media is a very important point in business strategy. It is also one of the key elements of internet marketing, because it gives the opportunity to create an effective platform for direct contact with the customer. Almost all companies (96% of respondents) have a Facebook profile and treat it as the basic area of communication with fans (Fig. 1). In marketing activities, most of the surveyed companies also communicate on Instagram. YouTube ranks third among the most popular social networks. Even fewer respondents also indicate Pinterest as a medium in which constant brand communication is carried out [Brzęczek 2020].

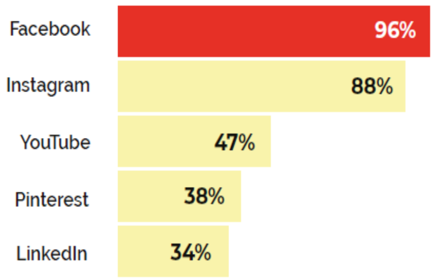

Figure 1. Ranking of social media channels in 2019.

According to respondents' opinion, Instagram will see the largest increase in marketing communication, where maintaining a constant dialogue with target groups may prove to be the most important among all social media. At the same time, representatives of the surveyed companies mostly indicate that the importance of Facebook is decreasing, while almost as many respondents indicate that its importance will remain unchanged. The owner of both portals constantly introduce changes that are aimed at distinguishing their functions and development. However, Instagram is constantly recording increases in the number of users involved, unlike Facebook. Over 3/4 of respondents indicate that they devote a certain amount of funds to paid campaigns on social media channels. Due to dynamic changes in the algorithms of portals such as Facebook or Instagram, allocating part of the marketing budget to achieve a specific goal becomes a necessity.

Advertising on social media can bring measurable business benefits, is easily available and can be generated in a dozen or so minutes. However, effective campaign execution requires professional knowledge and experience. Targeting is the key of the communication. Among the most important social media channels, respondents indicated that they most often carry out advertising activities on Facebook - 90% of companies participating in the study use this option in this channel. Instagram is the second choice for a paid social media campaign. This is probably due to the cooperation of both portals - administrators often run the same advertisement on Facebook and Instagram simultaneously. Only 2.5% of respondents use the option of paid promotion on Linkedin, and 2% on YouTube. The majority of respondents (63%) indicated that the most frequently chosen goal of their paid social media campaign is to increase product sales. Less than half the main goal of sponsored posts is to get more fans of your brand's profile. This may indicate that marketing managers of interior design companies treat social media mainly as a tool to support online sales - by redirecting customers to online stores, taking advantage of special offers, new promotions or remarketing activities.

3. CONTENT MARKETING AS THE INNOVATIVE MARKETING COMMUNICATION TOOL

Among the seven most important goals of conducting communication activities, nearly 70% of the representatives of companies from the interior design industry indicated as increasing the brand awareness among the recipients. Almost equal to knowing the brand is trust placed in it. When designing the strategy of communication activities, marketing specialists to a large extent are also guided by generating better sales results in the perspective of time. Significant incentives should also include the desire to effectively communicate product knowledge and supporting the introduction of new products on the market. Designing marketing activities in 2020, according to interior design companies, will be based on four key pillars. In addition to the very important role that communication through social media will play (also with the support of influencers), 66% plan to create content dedicated to more immediate stakeholders - architects and interior designers. Content marketing and content management about the brand are the third of the most frequently indicated areas of communication activities in 2020 [Brzęczek et al. 2020].

Research shows that the vast majority of companies dealing with the production of interior design elements carry out intensive content marketing activities. 90% of respondents declared that they willingly use content marketing. Photos and video are the most popular tools for promoting products for the home. In the opinion of 92.1% of those conducting communication via social media, Instagram turned out to be the most effective social media channel.

Manufacturers and distributors of home furnishings mostly see the benefits of using content marketing tools. Interesting content that companies share via the Internet is a less intrusive form of promotion than advertising, and also allows you to create a brand image and communicate with recipients. In the face of widespread use of content marketing tools, the challenge for marketers will be to effectively reach a specific target, distinguish messages from similar companies, as well as engage recipients in dialogue with the brand. Content allows you to stand out, which is especially valuable in the extremely colourful interior design industry.

Content marketing is known to be based on content. Tracking friendly and helpful tools in publishing content, transferring them quickly and efficiently to the right places on the web that we care about, is a challenge for every marketer. Companies from the interior design industry are most likely to share visual content with their recipients. Respondents' responses also indicate the trend of sharing expert knowledge, transmitted in short forms - articles on the Internet are created by over 70% of surveyed companies, while longer documents, such as industry reports. Companies in the interior design industry share content marketing content mainly through social networks - Facebook and Instagram. Interestingly, 1/3 of respondents publish posts on LinkedIn, and over 15% on Twitter. This shows that marketers treat content marketing not only as a way to reach end customers, but also to build or maintain business relationships.

Over 92% of respondents citing Instagram as a source of inspiration for clients are convinced that it is this channel that will be the leader in providing interesting content. This may be associated with the more frequent publication of videos by Internet users not only via YouTube, but also Instagram and Facebook.

Influencers are also one of the marketing communication tools. In 2019, nearly 2/3 of companies will decide to promote their products through popular Instagram profiles or read blogs. Compared to last year, the number of companies interested in working with influencers increased by 16%. The most desirable subject of the publication will be metamorphoses in influencer flats.

4. CONCLUSION

The basic advantage of social media is that they can be used on any scale, because they bring together groups of people with many interests. Thus, providing the enterprise with the possibility of creating and disseminating information in a most often free-of-charge way. Social media creates the conditions for repeated duplication and forwarded to subsequent recipients of published information, thanks to which it spreads virally. In addition, it allows you to precisely identify the group of potential buyers of the company's products, which makes it possible to carry out both mass campaigns and those targeted at a narrow group.

REFERENCES

1. Bonek, T. ,Smaga, M. (2001): *Biznes na facebooku i nie tylko. Praktyczny po-radnik o promocji w mediach społecznościowych.* Wolters Kluwer Polska S.A. Warszawa.
2. Brzęczek, M., Czech, A., Dróżdż, D., Haniszewski, M., Węgrzyn, J. (2020): *Komunikacja marki w branży wnętrzarskiej. Trendy 2020. Raport z badania*. Sfera Group. Wrocław.
3. Drzazga, M. (2013): *Media społecznościowe w procesie komunikacji marketingowej przedsiębiorstw handlu detalicznego z rynkiem* [in:] Komunikacja marketingowe. Współczesne wyzwania i kierunki rozwoju. Bajdak A. Wydawnictwo Uniwersytetu Ekonomicznego w Katowicach: p. 98 – 111.
4. Grove, S.J., Carlson, L., and Dorsch, M.J. (2007) *Comparing the application of integrated marketing communication (IMC) in magazine ads across product type and time. Journal of Advertising*, 36 (1): p. 37– 54.
5. Haniszewski, M., Jagodzińska, A., Węgrzyn, J., Wolska, M. (2019): *Content marketing w branży wnętrzarskiej. Trendy 2019. Raport z badania.* Sfera Group. Wrocław
6. Kaplan, A.M., Haenlein, M (2010): *Users of the Word, Unite! The Challenges and Opportunities of Social Media. Business Horizons*. No. 53 (1)
7. Kitchen, P.J., Brignell, J., Lit, T., and Jones, G.S. (2004): *The emergence of IMC: a theoretical perspective*. Journal of Advertising Research. 44 (1): p. 19– 30.
8. Kotler, P., Keller, K. (2012): *Marketing Management*. Essex : Pearson: p. 800
9. Loučanová, E., Olšiaková, M., Dzian, M. (2017): *Suitability of innovative marketing communictaion forms in the furniture industry*. Acta Facultatis Xylologiae Zvolen 60(1): 159−171, 2017 Zvolen, Technická univerzita vo Zvolene DOI: 10.17423/afx.2018.60.1.17
10. Peltier, J.W., Schibrowsky, J.A., and Schultz, D.E. (2003): *Interactive integrated marketing communication: combining the power of IMC, the new media and database marketing*. International Journal of Advertising. 22 (1): p. 93– 115.
11. Pilotta, J.J., Schultz, D.E., Drenik, G., and Rist, P. (2004): *Simultaneous media usage: a critical consumer orientation to media planning*. Journal of Consumer Behaviour. 3 (3): p. 285– 292.
12. Rząsa, D. (2019): *Polska wśród największych eksporterów sektora kreatywnego na świecie*, URL https://300gospodarka.pl/news/polska-wsrod-najwiekszych-eksporterow-sektora-kreatywnego-na-swiecie-news-300gospodarki
13. Van Riel, C.B.M (1995), *Principles of corpotate comunication*, PRENTICE HALL, London-Ney York.

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DIGITAL MARKETING IN DEVELOPING INTERACTIVE BUSINESS -TO-BUSINESS AND BUSINESS-TO-CONSUMER RELATIONSHIP WITHIN WOOD PRODUCTS MARKET

Pirc Barčić, A., Lovrić, I., Motik, D.

Abstract: The key to quality marketing is attention - being where consumers are. Today, all consumer attention is focused on digital media. The goal of any successful business relationship is to create value with his product and/or service for the customer. According to previous research on consumer habits and desires, the decision-making process can be influenced at any time. The paper describes the motivation, behavior, and perception of consumers, and how to create and change consumer attitudes in certain social and cultural environments. The purchasing decision-making process gives space and time to bidders to better present themselves through digital activities with their ideas, it is only necessary to first research what the target consumer group expects. One of the ideas of digital marketing, to facilitate buying from the comfort of your own home is 3D space modeling that has various capabilities. It is shown how the interactive consumption affects the buyer and manufacturer, answering the question is it an easier way to buy and how the customers feel when they have the "control" over space they want to edit.
Keywords: digital marketing, consumer behaviour, purchase decision process, interactive relationship, 3D modelling

1. INTRODUCTION

The global market is a celebration of diversity. Diversity exists not only among consumers, but also among providers; not only among manufacturers but also among sellers. Consumers differ not only in the usual ways - by age and gender, education and occupation, but also by their activities, interests, and preferences. And the job of the provider is to understand, attract and satisfy the needs and desires of consumers, whatever those consumers are, whatever they want, wherever they live (Sontag and Dugger, 1998).

Segment of consumer research has evolved as an extension of the field of marketing research focusing almost exclusively on consumer behavior rather than other aspects of the marketing process. Just as the results of marketing research were used to help make managerial decisions, so were the results obtained from consumer research. The initial reason for studying consumers was to enable bidders to predict consumer reactions to promotional messages and to understand the reasons why consumers make exactly the decisions they make when buying. Bidders assumed that, if they learned all the necessary information related to the consumer's decision-making process, they could develop marketing strategies and promotional messages that would influence the consumer in the desired way (that is, to buy a particular product or service) (Schiffman and Lazar Kanuk, 2004). Over the last decade, the Croatian furniture industry market has undergone changes that have made markets more interesting for domestic and foreign investors. Furniture manufacturers and retailers continue to try to identify the best ways to adapt to customer needs, and an understanding of furniture buyers provides useful information to the furniture industry. Some of the research showed differences in consumer preferences for materials and styles when buying furniture, so in a 2016 study it was found that wood is widely preferred among respondents as a furniture material (Kaputa et al., 2018). A house or apartment is not just a set of rooms but a home, in which people spend their time. Spaces should be organized so as to affect the positive mood, and here the furniture plays a very important role. The choice of individual elements, furniture for all spaces in which time is spent, significantly affects the quality of life. Companies, furniture manufacturers are experiencing strong global exchanges in the market (Pirc et al. 2010), and are therefore forced to always look for new ideas to convince consumers to buy their products, while furniture consumers qalways have differenet wants, needs and preferences (Pirb Barčić et al. 2016).

In addition to the goals that companies must set for themselves in business, they must also prepare a successful marketing strategy. This is achieved by taking into account the most important factors in the process of buying furniture. A survey conducted in 2017 (Oblak et al., 2017) showed that three factors are more important than the others when making a purchase decision, namely quality, price, and additional services. There are not many wood products that customers would buy impulsively, without additional encouragement and thought. The decision of a potential buyer regarding the type of product usually goes through a review process in such a way that for a more expensive product the consideration is more detailed. The process of making a decision to buy a product has five stages: identifying the need, searching for information, evaluating alternatives, making a purchase decision, and behaving after the purchase. The company must identify what is important to its potential customers at every stage of the purchasing decision-making process. Based on this, the company must determine the measures that will affect the consumer at certain stages of the review process (Oblak et al., 2017; Oblak et al. 2019). With more modern times come more modern technologies. Main marketing is now in a different form - digital. Businesses need to recognize the importance and impact of being where potential consumers are and that is the Internet. The company's digital activity can be achieved in many ways, and previous research has shown that we still do not pay enough attention to them. Potential consumers are not familiar with the diverse offer, ie. it is not visible to them in the places where they spend the most time. Therefore, this paper will also show an example of one of the possibilities of how to create a diverse offer for consumers and how they can make a purchase according to their needs and desires from the comfort of their own armchair.

The aim of this paper was to determine how the interactive consumption affects the consumer and how the producer. Is it an easier way to shop and how do customers feel when they have "control" over the space they want to arrange. Can this influence the decision when making a purchase and how much potential consumers accept the way of shopping through digital media.

2. MATERIALS AND METHODS

2.1 Modeling and animation tools

In this paper, a 3D modeling program - 3ds Max - was used as an example how to apply digital marketing to the furniture shops/producers/manufacturers. It is a professional computer graphics program for creating 3D animations, models, games and images. It is developed and produced by Autodesk Media and Entertainment. They are often used by video game developers, as well in many television commercial studios, and architectural visualization studios.

In this research, an interactive room was created for the idea of modeling in this program. In that room, upholstered furniture was modeled - a sofa, armchair and floor covering. In programs that are modeled, one of the essential features is the careful selection of textures and materials. It is very important to know how to choose materials and their settings that will make a certain object realistic at the very end and present it as such to the rest of the space in which it is located (Lovrić, 2018). In addition to textures and materials, the rendering system is important, in this case V-Ray was used.

V-Ray is a commercial add-on for 3D computer graphics. They are used for visualizations and computer graphics such as media, entertainment, film and video game production, industrial design, product design and architecture (web 4). That rendering system actually deserves to make the final picture look very realistic. There are a lot of settings in this system that affect the end result of the work. Some of the essential ones are the V-Ray Camera, V-Ray Light and the V-Ray Sun, which imitate and give a real picture of nature. The better the settings are selected, the better the picture, the better the quality of the picture. It is difficult to tell whether it is modeled or photographed. The quality and settings of the rendering system also depend on the performance of the computer (Lovrić, 2018).

2.2. Questionnaire development and data collection

In the website prototype included a survey questionnaire was included with aim to get as much as possible information about digital marketing activities from wood furniture consumer as well as from furniture sellers/manufacturers/producers.

Based on research objectives, a questionnaire was developed and pre-tested with a sub-sample of selected respondents. Questions were formed based on the available literature. On-line surveys by using "Google Forms" tool were conducted. The questionnaire, as an appropriate method of data collection, was chosen because the costs of this method of data collection are financially acceptable (Dillman, 2000) and also allows the collection of data from a wide geographical area (Zahs and Baker, 2007).

In addition to general information about the furniture company (furniture selling company/furniture producer), a developed questionnaire was a part of the web page. The first step for the users was to link to the web page and the second one was to go into "create your space", see how it works and answer the questions from the survey based on that. At the very beginning of the survey, the user chose which questions to answer. The questions were different depending on whether the respondent is a potential consumer (buyer) or a bidder (manufacturer, company). The selection opened a special set of questions for everyone.

In the survey that was assigned to customer, in first part of the questionnaire questions were focused to personal information in order to create a specific profile of potential consumers. Users were asked to indicate what gender they were, how old they were, completed their education, how often they used the Internet, and whether they had so far purchased any type of furniture online.

Certain statements in the questionnaire were measured using the Five-point Likert scale, so that ranges from 1 to 5 were given to individual statements of individual variables, where 1 stands for 'extremely disagree' or 'irrelevant', and 5 denotes ‘extremely agree’ or ‘very important’, i.e. respondents determined the degree of satisfaction or meaning they attach to individual statements. Furthermore, some of the questions are defined by multiple statements, as it has been determined that a particular variable / element will be better described by applying multiple statements rather than just a single one (Thorndike, 1967; Churchill, 1979; Lewis-Beck et al., 2004).

The respondents were asked to evaluate the answers to the questions: how important is the visibility of the website when researching the company, their activity on social networks, the way of contacting and feedback, experiences from others. Then the questions were related to the prototype website. Would such a way of creating help them make a final decision on the purchase of interior design products, and do they consider such an interactive relationship an easier way to buy in the future. In the end, the questions were related to the user's shopping experience and in the same way with the scale of importance they answered the questions: how important would be the feeling of comfort creating space from their own armchair, how important is the way of shopping 0-24 and the most important today how important time savings are.

The snowball method was used to sample the subjects. Sampling with this method starts from a certain number of respondents in the target population who meet the criteria to enter the sample, and in this case it is the age that must be greater than or equal to 18 years. Sharing the survey questionnaire with acquaintances and friends who meet the criteria increases the number of samples and this chain is repeated until the required number of samples is collected (Baćak, 2006; Goodman, 1961).

On the other hand, website link was sent to furniture companies (sellers/manufactures) -bidders, also via e-mail. The database of companies engaged to furniture processing and production was created using the Bisnode database, taking into account companies that their main activity is focused to the wood processing and furniture manufacturing (according to the National Classification of Activities (NKD 2007) belong to areas C16 - wood processing and C31 - furniture production). By selecting a set of questions for companies in the survey, the questions followed in a similar order as for furniture consumers. In the first part of the questionnaire, the general information about furniture companies were asked, such as: which county they are from, when the company was founded, how many employees they have, and an estimate of total revenue from last year. In this survey, the important questions were how they view digital marketing and therefore the questions were, how much do they invest, do they have a special person / department to deal with it, how do they advertise online and did they notice a larger purchase than when they digitally active. This was followed by questions related to the prototype website. They answered questions: do they think that such an interactive relationship of creating their own space would help their potential customers in selling their products, when should they change something on their site if they have it, would they add such a configurator a configurator, and finally do they think about improving digital marketing activities in their company. Data were collected during a COVID-19 pandemic in the time of ‘lock-down’ in Croatia (April, 2020 – May, 2020). Data from the survey questionnaires were uploaded into a Microsoft Excel spreadsheet (database). Statistical analysis was performed using the statistical program SPSS Statistics 17.0.

3. RESULTS
3.1. Website prototype creation

The idea of “Create your own space” feature arose as an interactive configurator in which consumers align the space with offered products. This prototype had three types of products, each of which had three different colours or, in the case of floor coverings, a stacking method. Interactivity between the potential bidder and the consumer is achieved on the website by the detailed realization in a 3D program. Each product is first created for itself, along with its shadows in a specific place in the room. The resulting image had to be transparent so that it could later be combined with other products. These three offered products, with three colour changes, achieved 27 space layout combinations, with only 9 renders. The number of renders is growing linearly due to the separate display of each product separately, although the number of combinations has increased exponentially. Figure 1 is an example of creating space combinations. Adding a new product with three colours would increase the number of combinations to 81, and the number of renders would increase by only three, or a total of 12. Building complex scenes is only possible with this approach to rendering. That have a large number of possibilities and combinations, given that a render can take several hours on a modern computer. Thanks to this method, every potential consumer can choose a certain product and colour for himself. In this way, a potential consumer can likely be influenced by offering him as many products and colours as possible, striving to fulfill his wishes.

Figure 1. Ways to create furniture combination

This prototype website shows what a website should contain. It needs to have a certain space with the offered products, a gallery of pictures where those products are already placed somewhere, how they look realistic in the space, how in the salon where they are exhibited for sale. It is always necessary to write about the design of the product, how it was created, what its purpose is. Find the target group of your consumers with certain qualities that adorn the product. Each product should have its origin, if it is a domestic product it should be highlighted, also emphasized if it is an eco-product and natural materials. This affects the consumer, if it is emphasized enough that its presented product does good for the environment, the environment in which it is located, and thus for its future. In addition to the various certificates that a company can use to promote itself, it is also important which information the product contains. Consumers certainly love the multitude of images, but also, of course as much information as possible that can influence any part of the purchase decision process. Each product can contain a description of the product with a few sentences, dimensions, price, technical data, declaration, product documentation. In addition to all the various information that is important for the purchase decision, it is also important what is the product warranty, delivery time, availability, delivery price, i.e. what are all the additional services offered at the time of purchase. Today, feedback and experiences of others are very important to consumers, so it is desirable to highlight such experiences. Different providers companies have researched according to which they should present themselves to their target group of consumers, therefore they should show themselves exactly as they require.

Very important, what each website should contain is the way of contacting. How and in what way potential consumers can contact the manufacturer for various inquiries and doubts that are an obstacle in a possible final decision. Simple ways of contacting the consumer give the impression of openness and a friendly relationship with the provider. Everyone will be able to inquire about the desired product without any pressure. In addition to the method of contact, there are also social networks through which consumers can connect with a particular provider and monitor further work. They can be used to maintain regular contact with a specific target group, announce a new product, use a video to show the working atmosphere or the creation of a product. Here you can write and read various feedback, experiences of others, announce fairs in which to participate, and organize prize games that are popular for gathering as many "followers" who will stay and follow the upcoming work.

From previous research in the wood industry, one can find very good websites that leave a good impression, thus encouraging a return to the site in order to make a purchase. This prototype site had the role of how to reach consumers even more, how in addition to product images and information, to retain consumers, offer them more opportunities and create their experience. The idea is for potential consumers to create their own space, to help them when designing a space or any purchase.

This prototype had an easy-to-use drop-down menu with products. Each product had a choice of colour that the consumer chooses by clicking on it. With the way the images are made, on the website they are stacked on top of each other so that with a certain click on the colour, you can change and create an individual experience for a particular combination.

3.2 Potential consumer profile who would use “Create your own space”

Using the previously mentioned snowball method, 146 potential consumers, i.e. users, were collected. 60.3% were women and 39.7% were men. Regarding age groups, 23.3% of respondents were aged 18-24, 56.2% aged 25-34, 19.9% aged 35-64 and 0.7% aged 64 or more. Of the completed level of education, 40.4% had completed high school, 51.4% had a university degree and 8.2% had an Mr./Dr. degree.

Table 1. General data of potential consumers

Age	%	education degree	%	use of the internet	%
18-24	23,3	Elementary School	0,0	don't use every day	1,4
25-34	56,2	High school	40,4	less than 2 hours	4,1
35-64	19,9	Higher education/university	51,4	from 2-5 hours	24,0
64 or more	0,7	MSc/PhD	8,2	from 5-8 hours	30,1
				more than 8 hours	40,4

When using the Internet, there were 1.4% of those who do not use it every day, 4.1% use less than 2 hours, from 2-5 hours it was 24%, from 5-8 hours 30.1%, and more than 8 hours are used by 40.4% of respondents. The survey stated that 42.5% have bought any type of furniture online so far, while the rest, i.e. 57.5%, have not bought it.

Using a 5-point Likert scale, respondents rated: 1-unimportant and 5-extremely important. When asked how important website visibility is to them when researching a company, 74% of them indicated that it is extremely important to them. Compared to the website, their activities on social networks (Facebook, Instagram, LinkedIn, YouTube, Twitter…) show diverse results: 9.6% think they are irrelevant and while only 16.4% think they are extremely important, the most there are them in the middle who are neutral, i.e. they indicated them with a grade of 3, 30.8% of them. 48.6% of respondents expressed importance of ways of contact. Potential consumers very often like to hear feedback or the experiences of others. The consumer creates an image of the manufacturer and thus influences the consumer's decision from the final purchase decision. There is 40.4% in the survey, and they stated that the feedback and experiences of others are extremely important.

After visiting the site and trying out the prototype configurator "Create your own space", they answered questions about whether such a way on the site would help them make a final purchase decision, and do they agree this is an easier way for purchasing in the future.

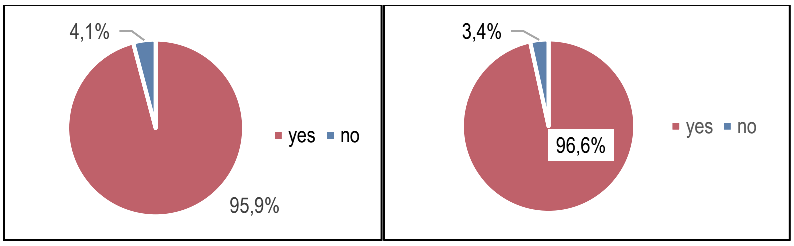

Figure 2. Would "creating your own space" help you make final decisions (left) and do they agree this is an easier way for purchasing in the future (right)

The configurator was followed by questions about how important it is for them to feel comfortable creating space from their armchair, where 40.4% of respondents indicated a grade of 5 as extremely important, and a grade of 4 as important 45.9%. Which together makes up 86.3% of respondents.

The possibility of shopping from 0-24h is related to the webshop, the advantage of the online platform for stores, shopping outside their working hours in the store. Respondents showed in the survey that this is not even that important to them, although it can be seen from the previous diagram that most have not bought any type of furniture online so far. Regarding purchasing availability 0-24h, 41.8% of respondents declared themselves neutral, that it is not important to them. 17.1% or 19.9% of respondents are extremely important or important.

Precious time has proven to be in this survey as an extremely important thing in an individual's life. In addition to various obligations, work, family, entertainment, vacation, respondents choose how time savings are extremely important or important, they mark it with 52.7% and 30.1%, respectively, which together makes up 82.8% of respondents.

3.2 Potential wood-furniture manufacturers who would use "Create your own space"

The companies and bidders were sent a website and a survey questionnaire via e-mail, which was found on their website or in the media through which they advertise. Note that some companies from the database did not have a website or any way of contacting the Internet to reach them. 96 emails were sent, of which 18 companies or 18.75% solved the survey. Most of the companies responded are from Zagrebačka and Vukovarsko-srijemska counties. Most of them were small (those with up to 50 employees) and micro-companies (up to 10 employees). Together they make 66.6% of respondents. Furhter more, 72.2% stated that they had an income of more than 1 000 000HRK in the last year (2019).
How much they invest in digital marketing had to be judged by themselves. There are 16.7% of them who do not invest at all, 38.9% invest very little, same number of companies invest enough, and 5.6% invest a lot. Besides, they also stated that 55.6% of them do not have a person or department that deals with digital marketing, and 44.4% have.

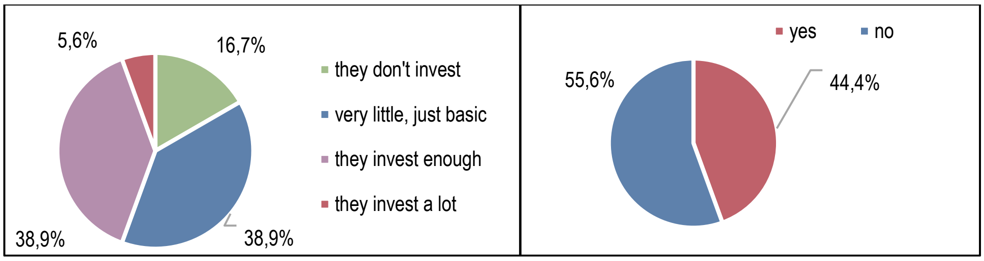

Figure 3. How much do they invest in digital marketing and do they have a digital marketing department/person

Sixteen companies or 88.9% of respondents have a website, while 2 do not, and these two do not have any of the listed marketing activities on the Internet. Depending on their online activity, they had to assess whether the purchase of their products increased, decreased, or remained the same. 55.6% said that the purchase had increased, and 16.7% confirmed that it was the same as before.

After they tried on the "Create your own space" page, 77.8% of them indicated that such an interactive way of creating space would help their customers when making a purchase decision, and 22.2% said no because it depends on the type their product or service, and what their target consumer group is. When they should add something to their website, the question was whether one of the ways would be this prototype "Create your own space". 72.2% found it interesting and would use it this way, 16.7% would not use it this way, 5.6% already have something similar on their site and 5.6% they don't think they have to change anything on their site. The last question of this questionnaire was whether they are thinking about improving digital marketing activities, 33% believe that they have investing enough and that nothing needs to be changed, 28% were not active at all, but will now consider this option, and 39% invest constantly, follow trends, but feel that there is always room for improvement.

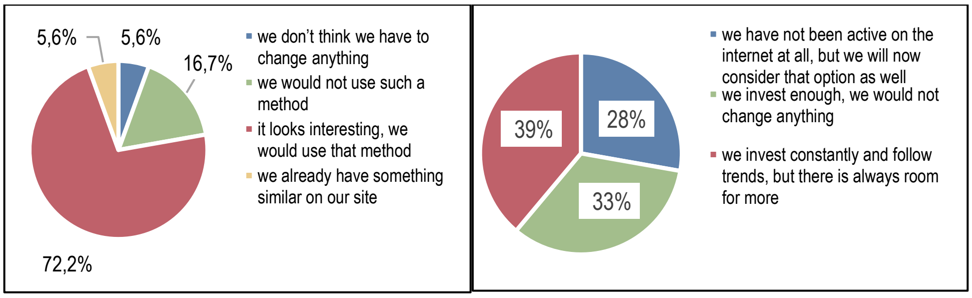

Figure 4. When should you add something to your site, would one of the ways be this prototype, and are you thinking about improving your digital marketing activities?

4. CONCLUSIONS

The importance of digital marketing in creating an interactive relationship between supply and demand in the wood products market is shown by the research in the paper. Whatever can be desired can be achieved with the help of digital media. The results of the research show that potential consumers are interested in an interactive relationship, they want as many opportunities as possible, information via the Internet. It is necessary to reach the consumer as much as possible, to see what his needs and desires are, and in that way to provide him with what he is currently looking for. An interactive relationship between the consumer and the provider would establish simple communication, where individual would be approached in a way that the producer is open to suggestions, advice, concerns, and problems. The consumer would feel satisfied and the manufacturer could influence his final purchase decision at any time. The prototype of the website together with the research is proof that the market needs as many such or similar types of interactive relationship offers. It is important to have as accessible communication as possible, the visibility of the website, various activities on social networks. Consumers care about feedback, experiences from others, such messages of promotion need to be emphasized, highlighted, as well as any other qualities related to the product. In today's time where the fast-paced lifestyle has become normal, an interactive website with as much information as possible would save every consumer time and money. Wood product manufacturers still don't see the big role of digital marketing because they are uninformed and think that it is still something expensive and they have to set aside a lot of time. In addition to educating companies, research is needed to see how great the possibilities are, what is the wide range of ideas under which an individual consumer can be acted upon. Therefore, this survey was also sent to companies with the hope that they will investigate, look at what surrounds them, what the requirements are, how they can contribute to their development in the future. Although a small number of companies responded to this research, it is still a great success that some have decided that they might use this method on their website. Besides, even greater success is that some companies have not been digitally active at all, and after this survey, they will consider these options on how to enter the market via the Internet and how to reach their potential consumers. This was just one small survey with a big message that companies should and should embark on this way of advertising, opportunities, and tools that are easily available. The success of marketing is based on the company's ability to adapt to target group of potential consumers at all times. Every company needs to understand that quality marketing starts and ends with the customer.

REFERENCES

1. Baćak, V., 2006: Uzorkovanje upravljano ispitanicima: novi pristup uzorkovanju skrivenih populaciji, Filozofski fakultet Sveučilišta u Zagrebu.
2. Churchill, Jr. G. A.: A paradigm for developing better measures of marketing constructs, Journal of Marketing Research, 16(1):64-73.
3. Dillman, D. A., 2000: Mail and Internet Surveys – the Tailored Design Method. John Wiley & Sons, Inc. New York, USA.
4. Goodman L.A., 1961: Snowball sampling, Annals of Mathematical Statistics 32(1): 148-170
5. Kaputa V., Pirc Barčić A., Maťová H., Motik D., 2018: Consumer Preferences for Wooden Furniture in Croatia and Slovakia, BioResources 13(3), 6280-6299
6. Lovrić I., 2018: Uloga digitalnog marketinga u povećanju prodaje proizvoda od drva na tržištu krajnje potrošnje, završni rad, Šumarski fakultet, Sveučilište u Zagrebu.
7. Oblak L., Pirc Barčić A., Klarić K., Kitek Kuzman M., Grošelj P., 20176: Evaluation of Factors in Buying Decision Process of Furniture Consumers by Applying AHP Method, Drvna industrija, 68(1): 37-43.
8. Oblak L., Glavonjić B., Pirc Barčić A., Bizjak Govedič T., Grošelj P., 2019: Preferences of Different Target Groups of Consumers in Case of Furniture Purchase, Drvna industrija, 71(1) 79-87 (2020)
9. Pirc A., Motik D., Moro M.,Posavec S., Kopljar A., 2010: Analiza pokazatelja stanja na tržištu drvnih proizvoda Republike Hrvatske, Drvna industrija, 61(1): 229-238.
10. Pirc Barčić A., Motik D., Paluš H., Klarić K., Liker K., Oblak L., 2016: Analysis of Fiurniture Selling Place sin Croatia, Slovenia and Slovakia, Drvna industrija, 67(3) 257-262 (2016)
11. Schiffman L., Lazar Kanuk L., 2004.: Ponašanje potrošača, sedmo izdanje, prevela: Marija Fridl, Prijevod djela: Consumer Behavior, Mate, Zagreb
12. Sontag D., Dugger C.W. 1998.: The New Imigrant Tide: A Shuttle Between Worlds, New York Times A1, 29-31
13. Thorndike, R. L., 1967: The analysis and selection if test items. Editors: D. Jackson, S. Messick, Problems in human assessment, 201-206, McGaw Hill, New York
14. Zahs, D., R. Baker, 2007: Telephone and Mail Surveys: Advantages and Disadvantages of Each. Market Strategies, Inc.

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ANALYSIS OF THE INFORMATION SECURITY SYSTEM WHEN ORDERING FURNITURE ONLINE

Żywiołek, J., Nedeliaková, E.

Abstract: Data, information and knowledge are processed by enterprises for conducting basic and auxiliary processes. Thanks to processing, the production process takes place, but also the products offered by the audited company are sold. The surveyed company deals in the production of furniture, for 5 years also sells it in an online store. Sales allows you to configure modules prepared by the manufacturer or design your own solutions. The most common problems are errors in the interpretation of ideas or making wrong measurements. The article presents solutions that would solve problems with analyzing data and information during the order processing process from order to post-warranty service. The article also presents a risk analysis for the security of this information.
Keywords: phasellus, vestibulum, tempor convallis

1. INTRODUCTION

It cannot be denied that the areas in which entrepreneurs can compete with each other today are drastically diminishing, giving the choice of competing in quality or price. Especially when we think about our own business in terms of the future. Price competition in the long term does not allow development, and even this development inhibits. To compete on the market, the products and services offered by enterprises must be at the highest possible level [Krawiec Ożarek, 2014]. Low-quality products and services are eliminated from the market - the customer values quality and, above all, uniqueness. In the era of digital services, online shopping, compulsory purchasing services, "something more" is something that was once in the world of "analog" economy - standard, we are talking about customer privacy. Many employers are unaware of their obligation to protect the personal data of their clients and contractors and thus commit many deficiencies in this respect. This employer is even common among employers who have decided to run their business on the Internet.

2. DATA PROTECTION

The functioning of the state and the economy in the information sphere requires an appropriate approach to information management as well her safety. The development of information technologies is one of the important factors dynamizing the development process of the global information society, while influencing the perception of information that is gaining more and more value in strategic and economic terms [Oleksiewicz, 2017].

In view of the significant increase in the importance of data, information and knowledge in organizations, which plays a key role in increasingly complex economic processes, an appropriate approach to managing these assets is required [Dziekański, 2012]. This is evidenced, for example, by the fact of identifying information management as a separate field of management sciences [Cisek, 2002], the creation of ISO 27000, training in information security and cyberterrorism.

Losses that may result from a breach of information security, such as breach of business continuity, loss of trust of customers, suppliers in the field of entrusted data, incurring costs due to the removal of damage arising as a result of a security incident, impact on the future activities of the organization and the like, can be significant [Żywiołek, 2018].

Ensuring an appropriate level of security in terms of data, information or knowledge in an enterprise is a challenge, and assessing the risk of information security breach and the impact on relationships between business partners forces the creation of an appropriate business ecosystem [Axelrod, Bayuk, Schutzer, 2009].

3. INFORMATION SECURITY MANAGEMENT AND RISK ANALYSIS

Information security management in an organization is based on risk assessment, as well as levels of its acceptance, formulated in such a way as to effectively deal with it, manage and mitigate. According to J. Pera, a correctly performed risk analysis is one that results in the minimized risk being as low as possible or completely suppressed, and its impact on the functioning of the enterprise is minimal [Pera, 2012].

Risk analysis of requirements for information protection and the use of appropriate safeguards and principles contained in normative acts contribute to the successful implementation of the Information Security Management System [Ożarek, 2013]. Processes occurring in the management system [Szlachcic, 2014], i.e. development, establishment, monitoring and maintenance, take place on the basis of the Deming cycle, presented in Figure 1, which is the basis of all acts normative in the field of information security.

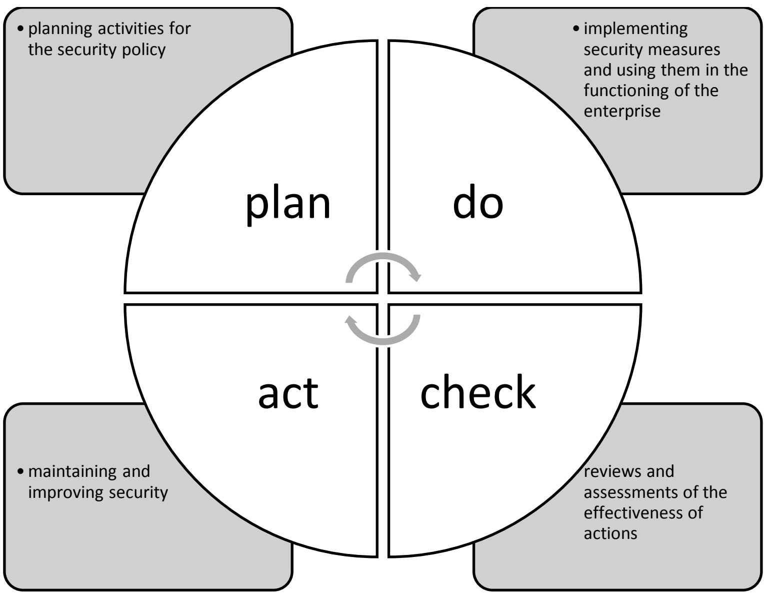

Figure 1. Implementation of the Deming cycle into the Management System Information Security

Awareness of losses caused by negligence related to the loss of data or trust among customers has kind of forced entrepreneurs to carry out risk analysis in their companies in this regard. Table 1 presents a list of threats prepared for the examined company with an indication of the probability of occurrence.

Table 1. Analysis of threats occurring in the examined enterprise

threat category	type of threat	
physical hazards	1	random threats - natural disasters, catastrophes, accidents that affect the information security status of the organization (e.g. fire in a building in which information media are stored)
	2	industrial espionage
	3	documentation theft
	4	providing information to unauthorized entities / persons
IT threats	5	hacking
	6	intentional or accidental action by third parties in relation to the network or system
	7	fraud / phishing

The next step is to determine the likelihood and amount of the potential risk (table 2). risk is estimated based on probability and threats. These are estimated values based on past and possible opinions. The probability is set on a scale of 1 to 10, where it is almost absent and 10 it sleeps frequently.

Threat	Threat weight	Probability (1-10)	Risk of occurrence
1	6	6	36
2	8	3	24
3	5	5	25
4	7	7	49
5	7	4	28
6	5	6	30
7	6	5	30

On the basis of calculated data on risk, a limit level is determined at which risk requires additional leveling actions on the part of the enterprise (Fig. 2).

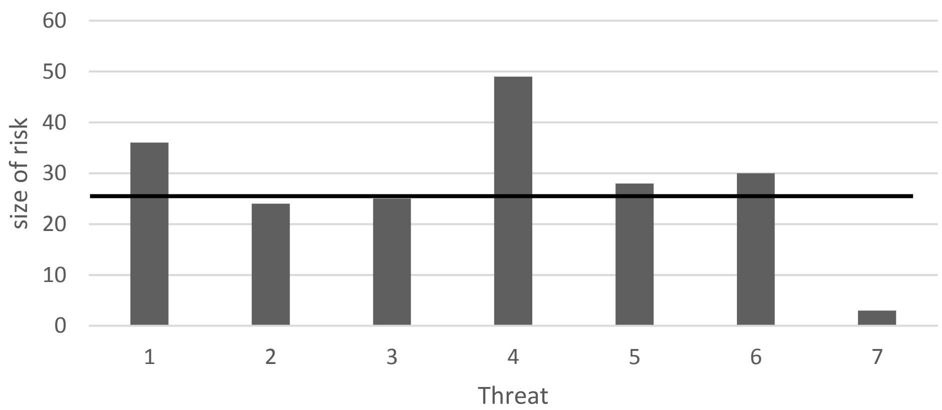

Figure 2. Size of risk

The line established at around 25 states that the risk specified above requires corrective and corrective actions and may threaten the enterprise.

The next stage is to present problems and solutions for online furniture sales orders in the examined company. The risk analysis carried out somehow introduces the problem of online orders, information security problems are the result of handling online orders. There are extremely rare cases of problems with information security outside this sphere of business activity (Fig. 3.)

Figure 3 shows how much information about servicing internet orders are, it is also necessary to illustrate the problems that arise when handling them (Fig. 4).

The service of internet orders caused many difficulties, after analyzing these problems, the company decided to prepare instructional videos on how to order, as a remote control showing individual actions in single steps, the importance of furniture sizing was added by adding standard dimensions as a pattern, which accelerated the module service. The system also does not provide the option of passing without providing the data necessary to process the order, and informs customers that the order processing process will not be carried out if no advance payment / payment is received depending on the system's calculations.

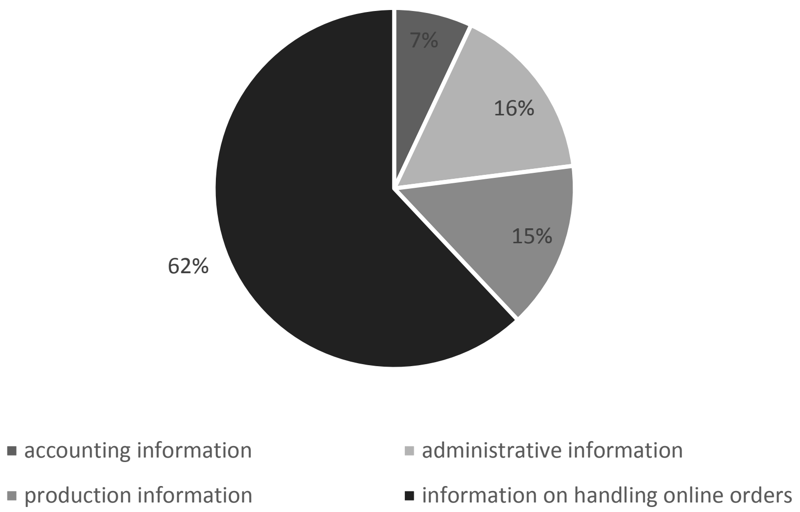

Figure 3. Types of information about problems in the enterprise

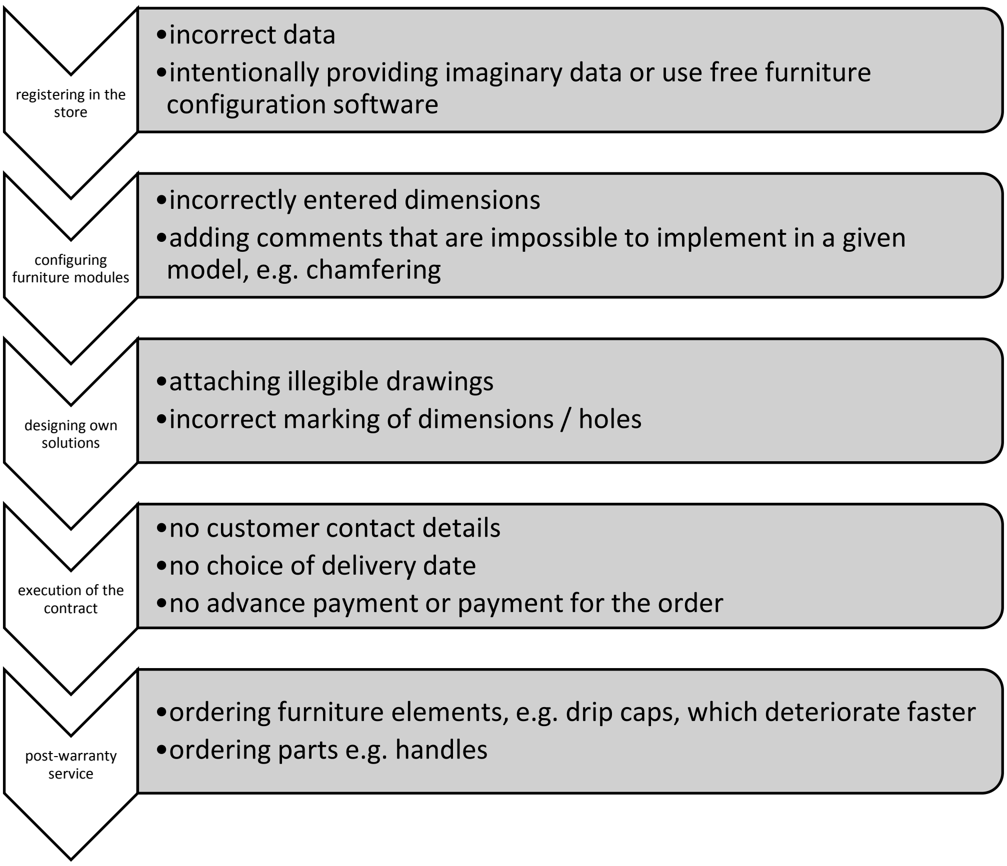

Figure 4. Problems encountered with online store service

4. SUMMARY

The purpose of the article was to analyze the current state in the surveyed enterprise dealing with the production of furniture and service of online orders related to the sale of own products. The performed risk analysis and activities for the analysis of enterprise activities allowed the identification of problems and their initial elimination. The study was a preliminary study, the next step will be the analysis of qualitative and qualitative factors talking about relationships in the form of Pearson's C coefficient, which will allow to determine between which factors there are strong relationships.

REFERENCES

1. Axelrod, C.W., Bayuk, J.L., Schutzer D. (eds.), (2009), Enterprise Information, Security and Privacy, Artech House, Norwood.
2. Cisek S. (2002), Filozoficzne aspekty informacji naukowej, Wydawnictwo Uniwersytetu Jagiellońskiego, Kraków.
3. Colwill, C., (2009), Human factors in information security: The insider threat e Who can you trust these days?, Information Security Technical Report 14.
4. Dziekański P. (2012), Informacja jako dobro ekonomiczne będące źródłem przewagi konkurencyjnej, „Nierówności Społeczne a Wzrost Gospodarczy", z. 24, Wydawnictwo Uniwersytetu Rzeszowskiego, Rzeszów.
5. Krawiec J., Ożarek G. (2014), System Zarządzania Bezpieczeństwem Informacji w praktyce Zabezpieczenia, Wydawnictwo Polskiego komitetu Normalizacyjnego, Warszawa.
6. Łuczak J., Tyburski M. (2010), Systemowe zarządzanie bezpieczeństwem informacji ISO / IEC 27001, Wydawnictwo Uniwersytetu Ekonomicznego, Poznań.
7. Oleksiewicz I. (2017), Bezpieczeństwo informacyjne jako wyzwanie w XXI wieku, „Zeszyty Naukowe Wyższej Szkoły Informatyki, Zarządzania i Administracji w Warszawie", t. 15, z. 4(41), Wydawnictwo Wyższej Szkoły Informatyki, Zarządzania i Administracji, Warszawa.
8. Ożarek G., (2013), System Zarządzania Bezpieczeństwem Informacji – budowa i wdrożenie, [w:] Ochrona danych osobowych w praktyce, Polski Komitet Normalizacyjny Warszawa.
9. Pelnekar C. (2011), Planning for and implementing ISO 27001, „ISACA Journal", Vol. 4, ISACA, Minneapolis.
10. Pera J. (2012), Niepewność a problem mitygacji ryzyka w przedsiębiorstwie, „Zarządzanie i Finanse", nr 1, cz. 1.
11. Szlachcic B. (2014), Analiza ryzyka i zarządzania ryzykiem jako element systemu zarządzania kryzysowego w organizacji, „Zeszyty Naukowe Uniwersytetu Przyrodniczo-Humanistycznego w Siedlcach. Seria: Administracja i Zarządzanie", nr 30(103), Wydawnictwo Uniwersytetu Przyrodniczo-Humanistycznego, Siedlce.
12. Tutton, J., 2010. Incident response and compliance: A case study of the recent at-tacks, Information, Security Technical Report ,15.
13. Żywiołek, J., (2018), Monitoring of Information Security System Elements in the Metal-lurgical Enterprises, MATEC Web of Conferences, https://www.matec-conferences.org/articles/matecconf/pdf/2018/42/matecconf_qpi2018_01007.pdf, 2018.

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ONLINE DISTRIBUTION CHANNELS OF BULGARIAN WOOD CRAFTS AND ARTWORK MICRO ENTERPRISES

Ivanova, M., Slavova, G.

Abstract: Nowadays the global information systems have proliferated in almost all businesses and industries, offering new opportunities for connection, communication and distribution. Forestry and wood-related sectors also align with this worldwide trend. However, micro-enterprises, dealing with wood crafts and production of wooden artwork might find it difficult to distribute their products and to reach the potential customers. Which online channels are the most popular for those products? Which online channels are the most efficient to reach the relevant target customers? Are there any particular online platforms specialized in specific products of wood crafts and artwork? The answers of the above questions would significantly assist the micro-producers of wooden toys, woodcarving, jewellery, souvenirs, wooden frames and any other wooden pieces of art, to improve their distribution strategy.
This paper aims to explore the variety of online distribution channels used by the Bulgarian micro enterprises (MEs) specialized in wooden crafts and artwork. The research steps on secondary data, collected from the Bulgarian MEs digital presence and summarized in a comparison table. The analysis sheds light to what extent Bulgarian MEs utilize the distribution opportunities of their own websites, of any specialized online platforms and regular online retailer shops. In addition, the study provides further insights for the emerging challenges and ideas, and finally sets recommendations for improvement.
Keywords: micro enterprise, wood art, wood products, Bulgaria, online distribution

1. INTRODUCTION

Internet and online platforms have dramatically changed the supply chain relations in all industry sectors. The opportunity to connect directly to the final customer, skipping the intermediaries has provided a tremendous chance for the companies to save significant distribution costs and reach easier their target group. Forestry and wood-related sectors also align with this worldwide trend. Along with the major scaled enterprises, dealing in the timber industry and furniture, the numerous small and micro companies have their important stake for the development of the sector and their own region. However, micro enterprises (MEs), dealing with wood crafts and production of wooden artwork might find it difficult to distribute their products and to reach the potential customers.

The aim of this paper is to explore the variety of online distribution channels used by the Bulgarian MEs specialized in wooden crafts and artwork. The study explores the specific products of MEs in the wooden industry, their traditional distribution strategies, and then reviews the enormous opportunities provided by online distribution channels – in general and in particular for the MEs in the wooden industry. Finally, the research of Bulgarian MEs, producing wooden products reveals what distribution channels they use and analyses them.

2. LITERATURE REVIEW

2.1. Micro enterprises in wooden industry

Small and medium enterprises are considered as the driving force of economy (Dušak *et al.*, 2017), because of their significant contribution to the job creation, introduction of new products, flexibility and impact on the regional and local development. The micro-enterprises are determined as companies that employ less than 10 employees and have income less than 2 million EUR (EUR-Lex, 2003). They are very typical for the wood-processing industries, mainly represented by craftsmen or little boutique companies, creating small art items, souvenirs, wood-carvings, frames, and/or any traditional indigenous stuff. In many countries, those MEs have special status – e.g. craftsmen, subject to special licensing, or freelancers, or art people, whose work is at the edge of a piece of art or has a direct practical application (Dobreva, 2017a). Many of the woodworkers operate either as single entrepreneurs, or craftsmen and/or as a micro company. Often, those MEs are situated in rural regions and are also considered as valuable for the local communities (Sana, 2016), because they pass the traditions to the next generations, or popularize the indigenous culture abroad (Ivanova, Ivanov and Yanev, 2015). Therefore, the target market of wood industry MEs is often too dispersed assuming a lot of efforts to elaborate well focused marketing and distribution strategies.

Wooden products are very diverse (i.e. trees are broken down into many products, D'Amours *et al.*, 2017), which results in numerous supply chains for each of them. Wood material comes from the forest, but it undergoes so many transformations and flows through many channels of wholesalers and retailers before reaching the end customer (D'Amours *et al.*, 2017). Besides, each actor along the supply chain follows his own strategy and develops his own target market audience. Big companies usually develop a network of suppliers and distributors around them but the small and micro enterprises experience huge challenges in the path to meet their demand (Larsson, Stendahl and Roos, 2016). Therefore, many of the wood industry micro-enterprises are niche players who rely mostly on limited public and produce boutique or small scale production, that is easier to realize on the market.

2.2. Online channels for distribution

E-commerce and internet-based distribution channels have long established new game rules in supply chain management and distribution strategies. Online Platforms have proliferated both personal and business lives (Parker *et al.*, 2016). With the numerous business models and entangled economic and/or social relationships among the diverse actors, platforms provide infinite opportunities for higher efficiency and faster processes in the supply chain, thus reconfiguring the traditional value generation within it (Ivanova, 2020). For the micro-, small- and medium-sized enterprises online platforms present a very prospective alternative to the way they distribute their products (Andreopolou *et al.*, 2009). Starting with the establishment of their own website with an e-shop, companies can utilize the “billboard” effect of the various online intermediaries (Ivanova *et al.*, 2015) that would bring them higher customer awareness and access to new markets. Many of the conventional wholesalers and retailers nowadays are converted to huge online marketplaces where suppliers and customers can implement transactions and payments without the need to store and move inventories or sign preliminary written agreements (Parker *et al.*, 2016).

There are different models and configurations in the distribution, combined with a lot of revenue mechanisms (Ivanova, 2020). B2C (business-to-customer) is among the most popular business model, connecting the consumers to the business, while B2B (business-to-business) represents relations within the internal levels of the supply chain, i.e. between business/companies. Since many of the craftsmen do not represent a company, they can also easily utilize the P2P (peer-to-peer) platforms, dedicated to physical persons, not companies.

2.3. Online distribution channels for micro-enterprises in the wooden industry

In the ocean of diverse online platforms, we searched for specialized e-shops, dedicated entirely to products from the wooden industry, typical for the MEs – i.e. souvenirs, artwork, toys, crafts and any other wooden handmade items. Table 1 summarizes our findings. It turns out that there are very few online platforms worldwide that deal exclusively with wood or wood-processed products. Because of the small scale or lower prices, wooden items are classified as sub-section of gifts, souvenirs, jewellery, decoration, artwork and crafts within the general retail platforms (e.g. eBay, Storenvy). The focus is mostly on e-shops of handmade production (Aftcra, ArtFire, etc.), which again implies small scale and lack of economic efficiency, with weak emphasis on the wood as a special ingredient. The multisided marketplaces (e.g. Etsy, Folksy, etc.), that operate on P2P basis also appear as a popular distribution channel for the wood MEs.

Table 1. Online distribution channels for wooden products

Name	Web site	Type
Aftcra	https://www.aftcra.com	Retail for crafts and art
Amazon Handmade	https://www.amazon.com/Handmade/b?ie=UTF8&node=11260432011	Retail for crafts and art
ArtFire	https://www.artfire.com	Retail for crafts and artwork
Be Timber	https://www.betimber.com	Wholesale and retail platform for wood products
Bonanza	https://www.bonanza.com	General retail, with wood products section
Craft Gate	http://www.craftgate.com/Wood-Art	Register of products
Craft is Art	https://www.craftisart.com	Retail for crafts and art
Crafts Fair Online	http://www.craftsfaironline.com	Register of companies and entrepreneurs
eBay	https://www.ebay.com	General retail
eCrater	https://www.ecrater.co.uk	General retail
Etsy	https://www.etsy.com	Retail for crafts and art
Folksy	https://folksy.com	Retail for crafts and artwork
Handmade Artists	https://handmadeartists.com	Retail for crafts and artwork
iCraft Gifts	https://icraftgifts.com	Retail for crafts and artwork
Storenvy	https://www.storenvy.com	General retail
Wood Barter	https://woodbarter.com	Specialized forum/social network for woodworkers
Zibbet	https://www.zibbet.com	Retail for crafts and artwork

3. METHODOLOGY

In Bulgaria there are numerous MEs, dealing with wooden products – furniture, souvenirs, toys, frames, artwork, etc. However, most of them are not registered as companies. Rather, they operate as craftsmen or freelancers. Bulgarian traditional crafts are closely related to wood processing – there are wood items, used in everyday life, but also as gifts, souvenirs and decoration. Nowadays most of those crafts (like wood carving) are no more utilized for real life, but rather are implemented in museums, craft streets and art stores, and are considered as part of the historical and cultural heritage of the country (Sana, 2016). They are especially popular for tourism because craftsmen organize demonstrations of their work and tourists like to buy wooden products as traditional Bulgarian souvenirs.

Many of those woodworkers actually perform as artists, and their production is considered as an artwork, or applied arts (Dobreva, 2017a). But still, they hardly maintain a commercial enterprise and prefer to perform as physical persons. Therefore, it is impossible to identify the real number of all woodworkers in Bulgaria – there is not any such register or database. Hence, we based our research mostly on the internet registered companies and woodworkers. We searched with keywords in browsers to identify Bulgarian MEs offering their wood products online. Afterwards, we classified the findings in a table, inserting the platform's name, web link, type and other general comments. Since the target population is only Bulgarian, we used only Cyrillic written keywords in the search. Also, in the findings are included online channels of crafts and artwork, because most of the wooden products are considered as part of crafts and art pieces. The following findings are only a representative sample from all results.

4. RESULTS AND DISCUSSION

The secondary research produced a lot of results, but only a few of them relevant, hence valid. Table 2 represents a summary of our findings.

The found Bulgarian online platforms might be classified into several groups, according to their organization as distribution channels, and also as a payment/transaction model. The simplest online distribution channel is its ***own online selling website***. It is typical for producers with a wider range of products, who can afford to build and maintain their own e-shop. The majority of Bulgarian MEs use exactly this model (e.g. Byklica, ShahTabla, KrokiToys). It is very good for the launch of their own products and skipping the commission of the intermediaries, but at one point serves only the local market and it is difficult to find it from abroad. Moreover, most of these e-shops are in Bulgarian language only.

Another popular form among Bulgarian MEs dealing with wood products is the ***private retail***. In contrast to the global platforms, Bulgarian ones prefer to keep full control on the inventory, to maintain own warehouse and to have internal/offline contracts with the suppliers, thus performing as regular stores with an online presence. The P2P model is very weakly used – we have found only one – NaMaistora, where each craftsman registers as a physical person, presenting his products.

The last form of online distribution is the ***general retail*** platforms, which are horizontal stores, i.e. offering numerous products from various industries, thus serving as "one-stop-shop" for the customers (e.g. VisVitalis, SteMaGo). Some of them have a special section, dedicated to wooden products, gifts, souvenirs, but usually, the products are filtered not by their ingredients (in our case wood), but by their functional characteristics.

The findings have shed light on several implications. First, Bulgarian woodworkers and MEs still rely only on their local market and in general do not consider the numerous opportunities found abroad. They need to open their business on a global scale, to enlarge their vision because in this way they would enhance their business. One of the reasons for the weak online presence of Bulgarian wood MEs might be the lack of digital skills and knowledge about the online distribution channels. Moreover, most of the craftsmen are older and they tend to be more conservative and suspicious towards novel ideas and technologies. However, the numerous cases of cyber frauds additionally prevent people from trusting unknown peers and using only online channels for communication and distribution.

Second, the majority of Bulgarian companies prefer to avoid any type of intermediaries, in order to save on the commissions and any additional distribution costs. In general, this is a good strategy for well-developed and popular brands, but for the MEs the online intermediaries would enhance the "billboard" effect, thus pushing their overall brand awareness and performance. Another reason for such avoidance could be the comparatively low final prices of the products that do not allow a higher margin to ensure enough profit both for the intermediaries and the producers. Small scale production, assuming higher production costs additionally contributes to this negative effect.

Third, the P2P models (like Etsy or Amazon Handmade) are still in the infant age of development for the entire Bulgarian economy, including MEs and wood industry. Since most of the Bulgarian craftsmen are also considered applied artists, and their production – an artwork with cultural significance, they are subject to additional state funding and are encouraged to act as cultural entrepreneurs (Dobreva, 2017b).

Table 2. Bulgarian online platforms

Name	Web site	Type
Art Zamaka	https://www.art.zamakabg.com	Retail for crafts and artwork
Artex studio	https://www.artex-studio.com	Private retail for crafts and artwork
Bellamie	https://bellamiestore.com	**Private retail for wooden toys only**
BG Hlapeta (BG kids)	https://bghlapeta.com	**General retail**
Bg Souvenirs and gifts	https://www.gifts-bg.com	Private retail for crafts and artwork
BGSuveniri	http://www.bgsuveniri.net	Private retail for crafts and artwork
Byklica	https://www.byklica.com	**Producer and e-shop**
Eco toys	http://www.ecotoys.bg	**Private retail for wooden toys only**
Irely	http://www.irely.eu	**Producer and e-shop for**

		wooden toys
Krokitoys	https://www.krokitoys.com	**Producer and e-shop for wooden toys**
Lazer graving	https://lazernogravirane.com	**Producer and e-shop**
Mouse Toys	https://mousetoys.eu	**Private retail for wooden toys only**
Na Maistora	namaistora.com	Retail for crafts and artwork
Nicey Toys	http://nisatoys.eu	**Producer and e-shop for wooden toys**
ShahTabla	https://shahtabla.com	**Producer and e-shop**
SteMaGo	https://stemago.com	**General retail with wood toys section**
SuvenircheBG	https://bg-souvenirs.com	**Producer and e-shop**
Tonkov	https://tonkov.eu	**Producer and e-shop**
Top Gifts	https://www.topgifts.bg	Private retail for crafts and artwork
ViK Stroy	http://woodentoysm.com	**Producer and e-shop for wooden toys**
VisVitalis	https://visvitalisbg.com	**General retail**

5. CONCLUSION

The current paper explored the online distribution channels used by MEs from the wood industry worldwide and in the context of Bulgaria. The findings revealed that Bulgarian woodworkers have a certain path to go, in order to catch up with the global trends. The reasons for their lower use of online channels are diverse, but economic and cultural perceptions stand out among the rest. Woodcraft and artwork MEs are generally one of the most vulnerable market players, because of the smaller scale production and high-cost basis. Hence their behaviour of risk aversion is completely understandable.

REFERENCES

1. Andreopoulou, Z. S., Koutroumanidis, T., & Manos, B. (2009). The adoption of e-commerce for wood enterprises. *International Journal of Business Information Systems*, *4*(4), 440-459.
2. D'Amours, S., Marier, P., Rönnqvist, M., Azouzi, R., & Fjeld, D. (2017). Game—The online wood supply game. *INFORMS Transactions on Education*, 18(1), 71-87.
3. Dobreva, N. (2017a). Arts marketing: new directions in theory and practice. Proceedings from the International Conference "Marketing – experience and perspectives", held at the University of Economics, Varna, 29-30 June 2017 (pp. 240-248).
4. Dobreva, N. (2017b). Cultural Policies for Cultural Entrepreneurship. Case-Study: Bulgaria. Proceeding of Paths to Innovation in Culture. 29 September 2017. Sofia: Sofia Development Association, pp. 163-172. URL: https://www.goethe.de/resources/files/ pdf148/cma-publication-final.pdf
5. Dušak, M., Jelačić, D., Barčić, A. P., & Novakova, R. (2017). Improvements to the production management system of wood-processing in small and medium enterprises in southeast Europe. *BioResources*, 12(2), 3303-3315.
6. EUR-Lex (2003). Micro-, small- and medium-sized enterprises: definition and scope. Commission Recommendation of 6 May 2003 concerning the definition of micro, small and medium-sized enterprises (notified under document number C (2003) 1422) (OJ L 124, 20.5.2003, pp. 36–41)
7. Ivanova, M., Ivanov, S. and Yanev, H. (2015) Distribution channels of eco and rural guest houses in Bulgaria: a fiction or reality. Proceedings of International Conference "Eco and Rural Tourism in Bulgaria", Bourgas, 18-19 June 2015 (pp. 162-174).
8. Ivanova, M. (2020). Navigating through the ocean of Platform economy. *Proceedings of the International Jubilee Conference 11 May 2020 at University of Economics-Varna*. (forthcoming).

9. Larsson, M., Stendahl, M., & Roos, A. (2016). Supply chain management in the Swedish wood products industry–a need analysis. *Scandinavian Journal of Forest Research*, *31*(8), 777-787.
10. Parker, G. G., Van Alstyne, M. W. and Choudary, S. P. (2016). *Platform Revolution: How Networked Markets Are Transforming the Economy? and How to Make Them Work for You*. WW Norton & Company.
11. Sana F (2016) Wooden Toys of Varanasi Weakly Developed the Isolated Sector and Shortages of Income and Employment Opportunities. *Arts and Social Science Journal*, 7(3), 1000195, doi:10.4172/2151-6200.1000195

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PRODUCT FLYER AS A BASIC TOOL OF MARKETING COMMUNICATION IN FURNITURE RETAIL

Kollárová, D., Ungerová, M.

Abstract: One of the fundamental techniques of marketing communication in retail trade is a product leaflet. In print, or in an electronic version it informs customers about advantages of the purchase, usually about favourable prices at a specific retail shop. The purpose is to address consumers with an appealing offer of goods and make them come to the store. Theoretical basis findings are paid to a product circular and its position in marketing communication of small traders. The object of our empirical investigation are product flyers in a retail chain with furniture, lamps and other household utensils in specialized shops - Jysk in Slovakia. We focus on, e.g., examining their periodicity, content (ratio between casual and seasonal goods), average number of pages, number of products depicted at a page, coloured layout, applied types of price tags, presenting people or animals, or declared discounts.
Keywords: retail, marketing communication, product leaflet

1. RETAIL TRADE WITH FURNITURE

Fašiang, Kusá and Grešková define retail trade as *„trade in small, which is typical of activities related to the preparation and sale of goods to the end user."* We understand as an end user individuals or households, who usually buy for personal use in small amounts. Retail sale takes place in or out of a chain of shops. As regards retail outside the sales network, this retail covers mail order sales, catalogue sales, telemarketing, e-commerce, mobile sales applications, vending machines, door-to-door sales, and ambulatory sales. The basic assumption for the implementation of retail in the network of stores is the existence of the outlet. The main types of units of a permanent stationary retail network in European conditions are generally considered to be the following: *„specialized and narrowly specialized shops, stores with miscellaneous goods, self-service grocery shops, supermarkets, discount grocery shops, hypermarkets, specialized (professional) wholesale stores, shopping malls, and specialized department stores*."

Assortment specialization leads to the emergence of specialized stores, such as shops with furniture, lamps, and other household commodities. The furniture completes the atmosphere of a house, workplace, school, or medical facility. In general, we divide it according to: the used material (into wooden, metal, plastic, upholstered, wicker); the place of use (into residential, office, school, medical, restaurant, garden, etc.); the design (into straight, shaped, laminated, pressed, etc.); the surface treatment (into furniture in natural design, with surface treatment, and so on) and the degree of gloss (into furniture with high gloss, semi-gloss, semi-matt and matt). According to the type and purpose of utilisation, we separate furniture into: cabinet, bed, table, seating and accessory.

1.1. Marketing communication and product circulars

In our works, we have long been inclined to explain marketing communication, which takes into account the initiative of the company (to inform, make acquainted with the products, explain their properties, highlight their utilities, qualities, values, usefulness, and use), as well as its ability to listen, receive suggestions and requirements from consumers and respond to them. The essence of marketing communication is to influence the consumer purchasing behaviour in order to sell company´s products. To influence them, external (advertising, public relations, direct marketing) and internal (personal selling, sales promotion) tools of marketing communication are applied in retail. Among the communication mix techniques, merchandising, POP and POS materials and product flyers have the most important position.

One of the basic marketing communication techniques for retailers is a product leaflet. In printed or electronic form, it informs customers about the benefits of purchasing, usually a bargain price, at a particular retail outlet. The intention is to address consumers with an attractive range of products and get them to attend the shop. It is assumed that even if the customer is brought to the point of sale by an offer from a flyer, due to an impulsive decision-making they will eventually buy also other goods. Its continued use in the communication mix of retailers is influenced by several factors, the most important of which include the structure of the retail chain, the degree of competition among retailers, and, last but not least, the development of the segment of private brands (also referred to as private labels or store brands).[3] Companies carrying out distribution of circulars guarantee their delivery to 1, 940, 000 Slovak households in case of interest. According to available statistics, special offer goods account for more than half of the sales of retail chains in Slovakia in 2018. These were commodities from product booklets, products discounted just before the expiry of the minimum shelf life, or goods included in the sales promotion. At the same time, items form product leaflets accounted for a third of purchases of Slovaks in the second quarter of 2018, while households of older couples, or individuals aged 50 to 64 without children used circulars to a much higher extent.

Compiling a product flyer is a long-term systematic process. A product leaflet should reflect the full assortment of the retailer, taking into account seasonal goods. Jesenský claims that this type of a circular has approximately 24 to 32 pages, while one page displaying approximately 10 products at a weekly periodicity. Zamazalová adds that the quality of the selected paper, the colour of the booklet, the location and quality of the products, or the types of price tags used should not be underestimated. The Czech distribution company researched the creative design of leaflets and the depiction of people in them. The results showed that if there are people portrayed in the product, or promotional flyers, these are mainly women without any company (61%) with long hair (98%). Couples appear in the promotion of food and household equipment; families and groups are portrayed at sports equipment and toys. From the perspective of declared discounts, products with a discount up to 25% were promoted most often in the category of clothing and food; goods with a reduction of 25 to 40% were advertised most often in the category of furniture, cosmetics, drugstore and hygiene. In the case of higher discounts, people promoted most commonly items in the category of furniture.

Product booklets spread to consumers are most often distributed as non-addresses items to postal letter boxes in the catchment area of retailers, if in an electronic form they are posted on retailer´s websites, or at the point of sale at the entrance to the sales area displayed in leaflet stands. To a lesser extent, however still happening, retailers order the insertion of flyers in newspapers and magazines.

2. METHODOLOGY

The main purpose is to define product circulars as a basic tool of marketing communication in furniture retail trade. The partial aims are, as follows: to identify terms, such as, retail, furniture, marketing communication, product leaflet and to carry out a content analysis of the product flyers of the company Jysk. University textbooks, proceedings of scientific works, as well as the website of the company Jysk and 53 of its product leaflets issued in 2019 served as information sources for our research. When processing the materials, we applied standard scientific methods, including research, description, analysis, deduction, and content analysis.

Content analysis as a research method is a procedure for an objective, systematic and quantitative description of the obvious content of communication. Content analysis of text documents is used mainly in gathering theoretical and practical basis for further development of a particular field of science. Quantitative description is a purposeful and continuous procedure in the analysis of the text content on the basis of numerical expression of the frequency of occurrence of the analysis elements or the degree of attitude intensity, or another quantification procedure. When performing content analysis, the following quantification procedures are usually applied: determining the frequency of the analysed category occurrence, measuring the time devoted to a particular problem, measuring the area dedicated to a specific content in a written or printed text, quantification according to the system of categories with

[3] *GfK Consumer Reporter*, Vo. 03/2018. [online]. Available at: <https://www.gfk.com/fileadmin/user_upload/country_one_pager/SK/documents/2018/181101_GfK_Newsletter_ConsumerPanel_03-2018_skfin.pdf.pdf.> [2019-01-04].

equal intervals and absolute zero point, in order to fully capture the time variable, spatial variable, or other indicators.

With the carried out content analysis, we focused on the examination of the product leaflets of the company Jysk in the following quantification procedures: periodicity, number of pages, number of products displayed at a page, colour version, used price (discounts) marking, depiction of persons or animals, main topic of the front and last pages. We chose the front and last pages of the circulars, because the most important themes are usually placed on these pages of the periodical, as this is the most visible space of the booklets.

2.1. Research object - Jysk Slovakia

Our object of research is the company Jysk, a multinational retail network with 2, 900 outlets in 51 countries in the world, offering furniture, lamps and other household utensils in specialized shops. Jysk opened its first store in Slovakia in 2006. Currently, it operates 47 physical shops and an online shop, in which the company´s employees served 2.7 million customers in the 2018/2019 financial year. The company´s product mix consists of product lines, as follows: furniture, lighting, mattresses, textiles, and accessories for the bedrooms, study rooms, living rooms, dining rooms, storage spaces, windows, gardens, and households. In terms of quality and price level, a large part of the assortment of Jysk is divided into the categories Basic (good products at a low price); Plus (products of good quality at a reasonable price); and Gold (products of exclusive quality at an affordable price). In addition, Jysk offers a range of products that guarantee the same low price every day.
The takings of Jysk in Slovakia have been continuously growing every year. In the financial year 2018/2019 (September 1, 2018 – August 31, 2019) the company achieved a record turnover of € 72.7 million. In the past financial year, Jysk in Slovakia sold goods with a trade margin of more than 50 %. After taking into account other costs and taxes, its net profit reached € 10.2 million.

3. PRODUCT LEAFLETS OF JYSK SLOVAKIA

For the needs of compiling a product catalogue, Jysk has a detailed design manual, it which it is regulated, for example, the use of logotype on the front page, colour, layout of images, types of product photos used, location of the description to the depicted products, customer reviews, or graphic display of prices in the flyer. By a product photography, we mean the photographic genre that captures the visual properties of the promoted product: its design, construction, and significant parts. The company Jysk uses several types of product photos in its circulars: product photos taken on a white background for a simple and accurate display of the item; photographs taken indoors or outdoors, representing products in an environment that imitates a real house; secluded places, in which the photographer arranges and intervenes in the composition of the products, while it is noticeable that the scene was set in a planned way, and so on. No people or animals are shown at the images of the company Jysk.

3.1. Size of product circulars

The calendar year 2019 consisted of 52 weeks, and Jysk published 53 product leaflets during this period. The basic layout of the pages of the product flyer corresponds to the layout of the newspaper grid. In one edition of the leaflet, the two-column and four-column grids are usually alternated. The layout of the content of the pages according to the invisible grid makes it easier for readers to orientate themselves in the viewed content. On average, one product leaflet was valid for 13 days, with 2 to 3 product flyers coming into force within one month. The size of issued leaflets was from 8 to 32 pages, so on average the flyer had a range of 20 pages.

As the number of pages increased, so did the number of products displayed on one page, as well as the number of items promoted in flyers. Using a product leaflet, Jysk advertised and supported the sale of at least 806 products in 2019 (see Table 1).

Table 1 Number of pages of the product leaflet Jysk Slovakia

number of pages	leaflets issued in 2019	average number of promoted products in the whole flyer	average number of promoted products on one page of a leaflet
8	7	98	12
16	28	178	11
24	15	220	9
32	3	310	10

Source: own processing, 2020

3.2. Price display

In 2016, Slovaks spent 6 % of their total consumption expenditures on furnishing, equipment and routine household maintenance. These expenses grew before Christmas, but the interest of Slovaks in, for instance, sofas and custom furniture was highest in January and February. This reflected the period of winter clearance sale in the company Jysk (December 25, – February 13, 2019, lasting 50 calendar days). Consumers look for home accessories, lamps, carpets, or furniture handles, regardless of the season. However, the offer of certain assortment is seasonal, e.g., garden furniture, or air mattresses. The clearance sale of seasonal furniture and exhibited pieces of furniture during the summer sale in the company Jysk took 63 calendar days (June 13, – August 14, 2019). Most retailers use yellow and red colours to communicate discounts, since red encourages action and yellow activates optimism. In addition, these are contrasting colours that have a greater opportunity to attract the consumer´s attention. Prices of the company Jysk are shown only in white colour with black framing, which is rounded in the corners. Reductions are given in percentages, for example, 49 % discount. The bargain offer is highlighted.

3.3.Lead photograph and lead topic of the leaflet

Out of the 53 front pages of the Jysk´s product leaflets, the lead photos showed furniture 41 times. Most often, it was garden, bedroom, and dining room furniture. Other front pages covered topics of mattresses and household textiles. On the last pages, there dominated themes related to the provision of additional or time-limited discounts on selected products. They were either tied to household textiles or to the whole purchase, including furniture, e.g., Extra discount of 15 % on everything that fits in a blue bag of Jysk (a bag measuring 18 x 70 x 60 cm can take unassembled furniture of smaller dimensions), Extra discount of 10 % on the entire purchase, Extra discount of 20 % on one product.

The smallest page size (8) had a product leaflet just after the Christmas holidays, after the winter and summer clearance sales. The Christmas season is the most successful time of the year for traders and low or advantageous prices, whether in the form of bargain offers or seasonal sales, are an important factor in Slovak consumer decision-making, so it is understandable that Jysk offered the smallest number of products during or shortly after these periods.

The 24-page circulars focused mainly on the Christmas offer (4), the seasonal sales (3) and the celebration of the anniversary of Jysk´s presence on the international market. The most extensive product leaflets, containing 32 pages, involved special offers related to the Christmas holidays at home (2) and the celebration of the anniversary of the company´s operation on the Slovak market. Other editions of product flyers consisted of a relatively common universal offer.

CONCLUSIONS

In the course of investigation, we found out that we had set a very ambitious goal. The selected categories represent a lot of data. A much larger number of categories can be examined and evaluated. If we had responded more quickly, we could have examined Jysk´s communication during the pandemic. Our main findings are, as follows: The company Jysk has complied a design manual to set up a product leaflet. The basic layout of the pages of the circular corresponds to the layout of the newspaper grid. On average, the leaflet in 2019 included 20 pages.
In its circulars, Jysk uses several types of product photographs. It works with pricing tactics in an intensive way. Every new flyer contains a different mix of products that are currently discounted.
Out of the 53 front pages of Jysk´s product circulars, the lead photographs depicted furniture 41 times. The most commonly shown was furniture of gardens, bedrooms and dining rooms. The smallest size of pages had a product flyer just after the Christmas holiday, atter the winter and summer seasonal sales. The most extensive product leaflets, containing 32 pages, included special offers also connected with the Christmas holiday at home and the celebration of the anniversary of the company´s operation on the Slovak market. The seasonality was manifested mainly in the inclusion of garden furniture in the company's offer, in the period from March to August 2019.

REFERENCES

1. Cimler, P.; Zadražilová, D.; et al. (2007): *Retail management*. Praha, Management Press, p.148.
2. Jesenský, D; et al. (2018): *Marketingová komunikace v místě prodeje*. Praha, Grada Publishing, p.58.
3. Kita, P. (2013): *Obchodná prevádzka*. Bratislava, EKONÓM, pp. 41-43.
4. Kratochvíl, O.; Matušíková, I. (2015): *Metodika zpracování bakalářské práce I*. Evropský polytechnický institute, p.23.
5. Kusá, A.; Fašiang, T.; Grešková, P. (2017): *Úloha marketingovej komunikácie v oblasti procesu tvorby hodnoty zákazníka v maloobchode*. Trnava, UCM, p.51.
6. Olšanská, Z.; et al. (2006): *Tovaroznalectvo II*. Bratislava, SPN, pp. 127-128.
7. Zamazalová, M. (2009): *Marketing obchodní firmy*. Praha, Grada Publishing, pp.191 -198.
8. ***: *Distribučná.sk* (2018):
   URL: https://www.distribucna.sk/
9. ***: *GfK Consumer Reporter* (2018):
   URL:https://www.gfk.com/fileadmin/user_upload/country_one_pager/SK/documents/201 8/181101_GfK_Newsletter_ConsumerPanel_03-2018_skfin.pdf.pdf
10. ***:JYSK style guide: JYSK´s different photo types (2020)
    URL: https://jyskblueline.com/jysk-style-guide
11. ***: Kvalita a záruka (2020)
    URL: https://jysk.sk/guide/kvalita-zaruka
12. ***: Odkladal, M. (2019): *V nakupovaní zlacneného tovaru sme predbehli Čechov*.
    URL: https://www.aktuality.sk/clanok/607360/v-nakupovani-zlacneneho-tovaru-sme-predbehli-cechov/
13. ***:Produktová fotografia (2020)
    URL: https://www.canon.sk/get-inspired/stories/product-photo/
14. ***:Rožánek, F. (2016): *Tajemství letáků: Dražší zboží propagují černovlásky.*
    URL: https://mam.cz/marketing/c1-65621870-osoby-v-reklamnich-letacich-analyza-2016
15. ***:Slováci dajú 6 prc. Svojich peňazí na zariaďovanie domácností (2020)
    URL:https://abc-byvanie.sk/byvanie/byvanie-ceny-financovanie/slovaci-daju-6-perc-svojich-penazi-na-zariadovanie-domacnosti/
16. ***: Skupina Jysk (2020)
    URL: https://jysk.sk/o-jysku
17. ***:Zisk Jysku na Slovensku opäť prevýšil desať miliónov eur, tržby siete rastú (2020)
    URL:https://ekonomika.sme.sk/c/22350260/zisk-jysku-na-slovensku-opat-prevysil-10-milionov-eur-trzby-siete-rastu.html

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THE EUROPEAN FURNITURE INDUSTRY: MARKET, DESIGN AND TRENDS

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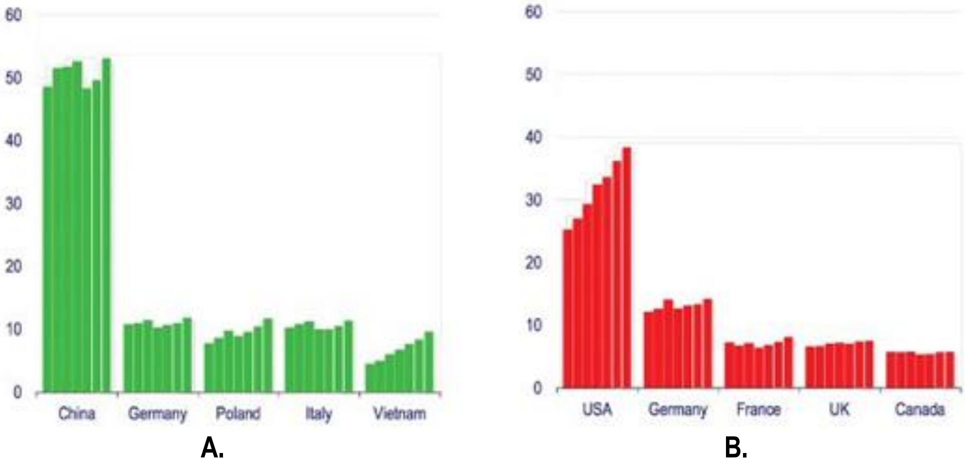
Abstract: The European furniture sector is the second biggest market and production center after Asia. It has upgraded its policy to export-oriented structure and has focused on innovative use of materials, quality, and design in last decade. These changes include restructuring, technological advances, and business model innovations.. Although Asian furniture market is the leader of the global furniture industry, the European furniture industry is the pioneer of the new designs, environmental approach, use of sustainable natural material, high value-added furniture production and high-technology. Europe furniture industry produce about the quarter of global furniture production. The competitive strategies of the European furniture companies are innovation, environmental approach, reduced lead times, export into emerging markets, and communication strategy. In this study, EU furniture market outlook, the most common problems of the European furniture industry, design studies, and recent trends were reviewed.
Keywords: furniture, market, design, trends, wood

1. INTRODUCTION

The total value of global furniture trade in 2018 was around US$149 billion, 4% up on the previous year and building on a 6% increase in 2017. CSIL expect the world furniture trade to continue to grow by 4% in 2019. The Centre for Industrial Studies (CSIL) reported that Asian countries became more dominant in the global furniture market, followed by the European market on the world. The European furniture market has 44% of global furniture import and 41% of global furniture export. According to the CSIL report, the EU furniture industry employs about one million workers (most of them are skilled workers), in 121.500 production companies, mostly consist of small and micro level companies. Similarly, the global furniture sector comprised of low and middle level income countries, which meet 55% of the global furniture production. In a recent market report of the CSIL, global furniture consumption was increased by 3.2% in 2019. In particular, the fastest growing in the global furniture production has been observed in Asia and Pacific counties. The biggest global furniture producer is China, and it has 39% of total furniture production. The major furniture exporting and importing countries are shown in Figure 1. Between 2009 and 2018 years, the amount of the furniture production in Asia and Pacific increased more than twice while the changes in other regions were comparatively minor.



A. **B.**

Figure 1. A: Major furniture exporting countries. B: Major furniture importing countries (CSIL 2019).

The production cost is one of the most important considerations in the furniture production in the Western Europe. The cost-pressure on the furniture production in Western Europe is one of the reasons of some MDF plants that moved to Eastern Europe to take advantages of lower labour cost, expertise, and infrastructure in furniture production in Eastern Europe. The relatively low labour cost in Eastern Europe enhanced with the advanced manufacturing technology ensures a great competitive situation for suppliers of value-added wood products to the European furniture industry.

1.1. Problems

The most common problems faced by European furniture industries are as follows:

- Market globalization negatively affects the European furniture sector. Especially, Asian countries such as Vietnam, China are competitive markets due to very low labor cost- low raw material prices
- Furniture industry mainly comprised of medium and small scale factories, and they are managed by their owners. The corporate management system should be encouraged. The factories should employ forest industry engineers. The companies should update their management system based on the governance and reporting models
- Many furniture sub-sectors are adversely affected by investment stagnation
- Diffuculties for loans and credits for financial support of required investments
- Unsatisfactory marketing strategy and unsufficient commercial structure to deal with global market
- Disruption of retail distribution system which negatively affect the value chain efficiency. This results in higher product prices for customers
- The goverments should protect intellectual property rights
- Increasing raw material prices such as wood, leather, plastics, etc.

1.2. Strategies

Major competitive strategies of European Union for furniture production;

- **Innovation**: Innovative furnitre design, 3D-modeling apparatus, efficiently using of internet and e-business market to obtain new market segments, environmentally friend materials used in furniture production suh as recycled materials, sustainable materials
- **Environmental (green) approach for competitive advantage**: Life Cycle Assessment (LCA) for furniture products; Ecolabel as differentiator
- **Reduced lead times:** Information and communication technology, e-business tools, such as Supply Chain Management systems
- **Entering into emerging markets and developing countries:** especially in South America, Russia, Brazil, China and India, where the number of luxury buyers is increasing)
- **Communication strategy beyond advertising**: the sponsorship of activities, conferences and campaigns, undertaken by local professional bodies. Trade fairs, web-site advertising, magazines, newsletters and TV programme.

The essential values guiding to the European Furniture Group (EFG) for their Works (EFG 2013);

Flexibility – Each customer is unique and interior design is based on the individiual requirements of customers

Inspiring – The furniture companies are inspired by new innovations and innovative use of materials. They follow the latest market trends for interior solutions.

Sustainability – Use of environmentally friendly matertialsi sustainable materials, recycled materials and responsibility in socio-cultural, and economic issues.

Curious – The furniture companies continuously looking for solutions to their customers in wonder

1.3. Key factors

Nowadays, interior design is considered by furniture companies to maintain healthy office maintaining a healthy office environment. Four important key factors affecting interior design are given below (EFG 2013);
Efficiency of space. The room space enables more people without crowding the room and
Productivity. Many activies can be carried out in the office, with less effort by adapting the interior design to fit specific tasks and activities.
Motivation. An office with a modern way of working is attractive to both current and future employees.
Image. The interior design of a workplace tells the story of the company and its brand and is a direct reflection of the company culture.

European furnitre companies compete with many emerging countries having significant advantages such as lower labour costs, known and accessible technologies, and import facilitating factors. European companies have revised their business model into a new one based on the added value created for the consumer. Customer behaviors such as preferences and life style has been shifted to the busines model of furniture producers Tradition business model versus to business model based on value generation is given in Table 1.

Table 1. Tradition business model versus to business model based on value generation (UEA 2013)

Traditional business model	Business model based on value generation
Oriented to the furniture production	Oriented to the consumer
Based on the traditional value chain: supplier - manufacturer – retailer and based on the individual capabilities and resources of the companies	Operative efficiency search, improving the inter-cluster cooperation
Local and national activity approach	Global approach of the activity
Company size as a problem	Flexible organizations to apply (strategy, organization, resources and capabilities, knowledge and technologies)

1.4. Recent furniture design trends in Europe

The demand for the organic shaped furnitures in European countries has increased in last decade. The organic shapes, slim and thin furniture designs, innovative use of materials, can be observed in many home and office furniture. In particular, the sector is restructuring and moving towards more efficient, sustainable, and innovative production. Recently, environmentally friendly bio-based materials and the innovative design are combined, which has been attractive to the customers. Many people changed their work life due to coronavirus pandemic. Home-office trend has rapidly increased in Europe and this significantly affects the furniture desing.

The number of senior citizens is rapidly increasing, which consequently signifies an increase in the number of people having difficulties to process information. Elderly persons experience a greater degree of risk whilst performing daily tasks in their living ambients. Manufacturers should design furniture systems that would allow for implementation adapted for special needs and should inform buyers more about the significance of an adequately furnished ambients, heeding the needs of advanced age. In spite of the initial high costs for technology, in the long run investment will reduce public expenditures for the social and medical care of elderly.

Anotherrecent trend in European countries is the change in the design of kitchen furniture. Families have spent more time in the kitchen and this affects the customer behavior. Kitchen has become one of the most important rooms for social life at home.

Thanks to increasing digitalisation, more and more smart devices are available for both domestic settings and offices; *intelligent speakers and a table, sofa and wardrobe with smart functions, etc*. Developing concepts of smart high-tech furniture for the home that is operated via apps or voice control is relatively new and gives us commplitly new opportunities for designing innovative ambients.

2. CONCLUSIONS

The furniture industry in EU is a labour-intensive and very dynamic sector dominated by small and medium-sized enterprises and especially by micro firms. EU furniture manufacturers have a very good reputation worldwide thanks to their capacity for new designs and responsiveness to new demands. The furniture industry is able to combine new technologies and innovation with cultural heritage and style, and provides jobs for highly skilled workers, which is very important nowadays.

European furniture industry is the heart of the design and innovative materials used in the production of the furniture on the World. Especially, Italy is the frontier of the innovative design in Europe. Although European furniture industry has major competitive strategies such as innovation, environmental approach, reduced lead times, the industry is still faced some common problems such as market globalization and Unsatisfactory marketing strategy. When the tradition business model is changed to business model based on value generation, the European furniture industry will develope in near future.

REFERENCES

1. EFG European Furniture Group Ltd (2020): *Furniture Market Report*. Haydock WA11 , 9UX http://www.efgoffice.co.uk/en/Contact.
2. European Furniture Manufacturers Federation (UEA). (2013): *Furniture Industry İn Restructuring: Systems & Tools*, Belgium.
3. The Centre for Industrial Studies (CSIL). (2019): CSIL Processing Of United Nations. Milano, Italy.

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THE COMPETITIVENESS OF THE WOOD-BASED SECTOR IN POLAND IN THE ECONOMIC CRISIS CONDITIONS

Wanat, L., Sarniak, L., Mikołajczak, E.

Abstract: The study attempts to identify the main factors of competitiveness of the Polish wood-based sector, based on the example of wood industry companies (primary wood processing) and companies providing forestry services (in terms of obtaining wood raw material and its logistics). Competitiveness factors and their impact on the industry were examined in the conditions of the economic crisis resulting from the global pandemic. The study was conducted in the first quarter of 2020, using individual in-depth interviews (IDI), of an expert nature. They were made on a purposely selected group of enterprises selected proportionally for locations corresponding to the structure of the Regional Directorates of State Forests in Poland. As a consequence, it was noticed that the structure of factors shaping the potential and competitive position is changing, the role of resource criteria is weakening, the importance of qualitative criteria is growing, including in particular coopetition, building relationships and industry cooperation networks.
Keywords: forestry, wood-based industry, competitiveness factors, pandemic economic crisis, Poland

1. INTRODUCTION

In 2020, we have found ourselves in an emergency, our current world has stopped. Paradoxically, we have just rediscovered in quarantine that forests perform in the culture and economy of many countries the necessary functions that are integrally connected with each other. There are at least three of them: natural (also called conservational or ecological), social (including cultural) and productive (economic). It is only from this observation that the real situation of each economic activity in forestry is real, especially in conditions of permanent threat of a pandemic. The forester and entrepreneur in the wood industry cannot ignore the symbiosis of economic, ecological, industrial conditions, as well as increasingly significant social and behavioral conditions. Hans Carl von Carlowitz [10] believed that rational economic activity in forestry should be based on obtaining only the amount of industrial wood that can be restored through adequate forest renewal. In this way, the idea of "Sustained Yield Forestry" paved the way for a career in sustainable development theory [1]. Or maybe you need something more than just mathematical and even mythical "balance" in economics? Is there a compromise that would allow the coexistence of many different market participants, taking into account the specific, individual development ability, the starting point of which was the "resource" competitive potential? In the first half of 2020, the Polish forest and wood sector found itself in a completely new perspective. They asked how companies from traditional forestry to advanced wood processing should behave in the face of the threat of complete freezing and then a widespread crisis [9]. How will the sector market change if it is exposed to irregular and asymmetrical factors? What will be the "new" wood market, and therefore what "new" competitiveness?

The starting point for the designed research is the current state of forestry and wood-based sector in Poland. In Poland, over 45 million cubic meters of wood are obtained annually. Only the wood sector employs almost 350 thousand people, and therefore roughly 3% of the total employed in the economy. The wood-based industry produces over 2.5 percent Poland's GDP, and also 11% of value added in manufacturing [3]. It is worth emphasizing that the majority of timber harvesting companies (forest services), followed by elemental wood processing companies (sawmills) and furniture manufacturers belong to the group of micro, small and medium enterprises. Finally, the Polish wood industry is almost entirely based on domestic wood resources harvested from Polish forests. In addition, the Polish forestry and wood sector is characterized by atypical market organization [8]. It is an institutional structure based on the natural monopoly of the State Forests (the dominant state property of wood resources). Thus, the domestic wood market cannot be programmed "classically" by the dominance of market competitiveness [2, 5]. Here, the space for "new" competitiveness and development factors opens up [7]. These factors should be sought by science and practice, especially in the face of the threat of a prolonged economic crisis.

2. PURPOSE OF THE RESEARCH, MATERIAL AND METHODS

In the study of key competitiveness factors in the qualitative dimension, referring to aspects including the potential, position and competitive strategy of enterprises, the need to reduce uncertainty was also taken into account. At the same time, risk reduction allows you to identify those competitiveness factors that can determine not only the development of the sector in question, but even its existence. Forest- and wood-based sector in Poland found itself in a situation of necessity to choose adequate anti-crisis strategies. No one underestimates the serious long-term threat of a global pandemic.

2.1. Purpose and scope of research

The aim of the study was to identify the most important factors shaping the competitiveness of selected entities of the Polish sector based on wood, on the example of elemental wood processing companies (commonly known as sawmills) and forest services companies (directly responsible for obtaining wood raw material and its logistics) [11]. Therefore, an attempt was made to determine competitiveness factors and indicate their impact on the industry in the conditions of the economic crisis (scope of research). The degree of similarity of the previously selected factors for both subsectors was verified: elemental wood processing and forest services. In addition, attempts were made to indicate the answer to the question of how the factors identified affect the competitiveness of the entities surveyed, depending on their size.

The research was conducted in the first quarter of 2020 (time range), using the method of individual in-depth interviews (IDI), having an expert character [12], on a purposely selected group of wood industry enterprises and companies providing forest services (subject scope), selected proportionally for locations corresponding to the structure of 17 Regional Directorates State Forests in Poland (spatial scope) [15].

2.2. Research scenario

The designed research scenario was divided into four stages, referring to the hierarchical analysis model. In the first stage, already at the time referring to expert analysis, among many factors of the industry's competitiveness, a targeted selection of eight key factors was made, to which experts from the wood-based sector gave the highest weight. The scheme of the next steps of the research process is illustrated in Figure 1.

In the selection of factors, the (subjective scope) of the wood industry enterprises and forest services companies were taken into account. The following factors were distinguished: (1) location of the enterprise; (2) company size; (3) production profile; (4) history of cooperation in the forest-wood value chain (supplier of raw material - forest services - wood processing); (5) flexibility of production profile and ability to change; (6) investment potential; (7) financial result and (8) diversifying the sales market. The set of eight factors was further considered consistently in the course of comparative analysis.

Then, a deliberate selection was made of a group of business entities, with representatives of whom were subsequently conducted in-depth interviews. Therefore, the subjective scope of the study covered 101 enterprises, including 52 wood industry enterprises and 49 companies providing forestry services. The examined entities were diversified in terms of size: 21 micro enterprises (up to 9 employees);47 small enterprises (from 10 to 49 employees); 21 medium-sized enterprises (from 50 to 249 employees) and 12 large enterprises (over 250 employees). The location of enterprises was varied, almost full proportional share was obtained for each of the 17 Regional Directorates of State Forests in Poland, in which two enterprises of the wood and forest services subsector had their headquarters (the participation of 6 entities / thus 3 for the subsector / from each region). The only exception was the regional management in Łódź, where one of the invited entities refused to participate in the study due to epidemic conditions. The other assumptions of the research scenario were met, and therefore the study was carried out.

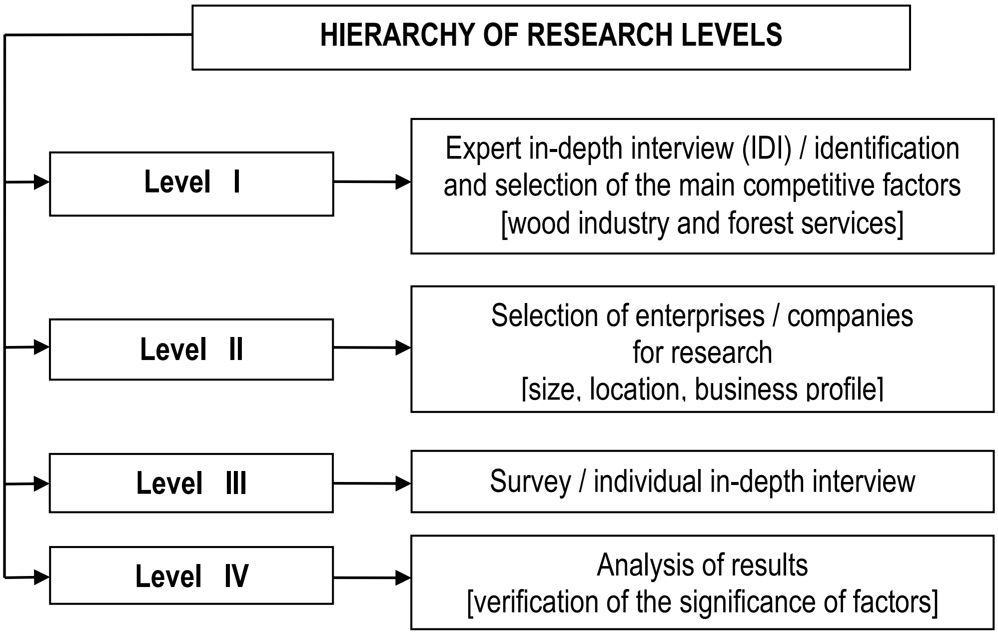

Figure 1. Visualization of the author's research scenario
Source: Own elaboration

3. COMPLETION OF RESEARCH AND RESULTS

The designed study was carried out based on the diagnostic survey method. Individual in-depth interviews (IDI) were conducted with professional representatives of the surveyed enterprises. Experts pointed out the relationships between individual pairs of factors whose impact on the competitiveness of enterprises was identified earlier (level I). The relationships between the examined factors were determined using the Saaty method [4, 6]. The answers were ordered and then a ranking of factors was prepared for each of the subsectors surveyed [14]. Then, the results were aggregated including all surveyed entities (level IV). Table 1 shows the "ranking of competitiveness factors significance of wood industry companies" (WIC ranking).

Table 1. Ranking of significance of selected competitiveness factors of wood industry area

Competitiveness factors	Wood industry companies (WIC)				
	Micro	Small	Medium	Large	All
Company / business location	6	8	8	8	8
Company size	8	7	6	7	7
Production / business profile	7	6	7	6	6
History of cooperation in the value chain	3	1	1	1	1
Production / business profile flexibility and ability to change	4	5	2	3	5
Investment potential	1	2	3	2	2
Financial result	5	4	4	4	3-4
Diversification of the sales market	2	3	5	5	3-4

Source: Own elaboration

In the same way a ranking of factors for forest services enterprises was built. In turn, in table 2 you can find "ranking of significance of selected competitiveness factors of forest services companies" (FSC ranking).

The study was conducted taking into account the specifics and separateness of subsectors: wood industry enterprises and forestry services companies. Micro, small, medium and large enterprises were identified in each of the above groups. Based on the obtained expert responses (as part of individual in-depth interviews), a ranking of the significance of factors affecting the competitiveness of the surveyed enterprises was constructed. Numeric values were assigned to individual factors, from 1 to 8, respectively, depending on the level of significance. The lower the value of the indicator, the greater its impact on the competitiveness of the surveyed enterprise. On the other hand, high values of the indicator inform about the opposite situation, i.e. about the correspondingly smaller significance of the examined factors.

Table 2. Ranking of significance of selected competitiveness factors of forest services area

Competitiveness factors	Forest services companies (FSC)				
	Micro	Small	Medium	Large	All
Company / business location	7	8	7	7	8
Company size	8	7	8	8	7
Production / business profile	5	5	6	5	5
History of cooperation in the value chain	1	1	1	1	1
Production / business profile flexibility and ability to change	3	3	2	3	4
Investment potential	4	2	3	2	3
Financial result	2	4	4	4	2
Diversification of the sales market	6	6	5	6	6

Source: Own elaboration

The aggregated results were logically verified, mathematically ranked and discussed using comparative and descriptive analysis tools.

4. CONCLUSIONS

The collected opinions of experts - real market actors, coded within hierarchical scales, allow the following conclusions to be drawn:

1) The leading factor that can determine the competitiveness of the wood industry enterprises (WIC) and forest service companies (FSC), turns out to be the history of cooperation in the forest-wood value chain (supply of wood raw material - forest services - woodworking). the location of the enterprise and its size are the least important factors.

2) Diversification of the sales market is much more important for wood industry enterprises than for forest service companies whose recipient market is relatively stabilized, limited by barriers to entry into the industry.

3) An important, very interesting observation confirms that the size of the enterprise does not have a strong impact on the significance of factors, and therefore also does not prejudge the competitive position of enterprises in crisis conditions.

Is a new industry competitiveness model being shaped under crisis conditions? It cannot be ruled out that it may be based on: the ability to plan development in the territorial dimension, on integration and building cooperation in the process of supplying raw materials, services and products [13], and as a consequence on the pursuit of economic efficiency not only and not so much through resources, but through building long-term, multidirectional relationships.

REFERENCES

1. Chudobiecki J., Wanat L. (2015). *Industrial symbiosis and green business parks in the wood-based sector in Poland*. [In:] Wood Processing and Furniture Manufacturing Challenges on the World Market; Chobanova, R., (ed)., pp. 221-228.
2. Chudobiecki J., Potkański T., Wanat L. (2016): *Intermunicipal and intersectoral coope-ration as a tool of supporting local economic development: selected examples from the forest and wood-based sector in Poland*. [In:] Proceedings of the 9th International Scientific Conference on "The Path Forward for Wood Products: A Global Perspective", Baton Rouge, LA, USA, 5–8 October 2016; WoodEMA: Zagreb, Croatia, pp. 187-195.
3. Czemko B., Wilińska A., Biernacka J., Krzosek S. (2017). *Polish wood industry and its economic importance. Part 1*. Annals of Warsaw University of Life Sciences - SGGW Forestry and Wood Technology, (97), 101-107.
4. Hwang C.L., Yoon K., (1981): *Multiple Attribute Decision Making*. In: Lecture Notes in Economics and Mathematical Systems 186. Springer-Verlag, Berlin.
5. Kusiak, W., Mikołajczak, E., Wanat, L. (2018): *Institutional and Industrial Symbiosis Case Study of Cooperation for Development in Forestry and Wood-Based Sector*. [In:] Increasing the use of wood in the global bio-economy. Glavonjic B. (ed.), September 26th-28th, 2018, University of Belgrade, Belgrade, Serbia, pp. 388-399.
6. Łuczak A. (2016). *Wielokryterialne metody ilościowe w diagnozowaniu i modelowaniu rozwoju lokalnego*. Poznań: Wydawnictwo Uniwersytetu Przyrodniczego w Poznaniu.
7. Mikołajczak E., Wanat L., Styma-Sarniak K., Czarnecki R., Topczewska A. (2020): *The Prospects to Applying the Best Practices Model as One of the Pillars of Business Management in the Wood Market*, [in:] D. Jelačić (ed.) Management Aspects in Forestry and Forest Based Industries, WoodEMA ia., Zagreb, pp. 125-136.
8. Paluš H., Parobek J., Vlosky R.P., Motik D., Oblak L., Jošt, M., ... & Wanat L. (2018): *The status of chain-of-custody certification in the countries of Central and South Europe*. European Journal of Wood and Wood Products 76(2): pp. 699-710, https://doi.org/10.1007/s00107-017-1261-0.
9. Potkański, T., Wanat, L., Chudobiecki, J. (2011): *Leadership in time of crisis or crisis of leadership? Implications for regional development*. Intercathedra, 4(27).
10. Von Carlowitz, H. C. (1713): *Sylvicultura Oeconomica*. Leipzig: Braun.
11. Wanat L., Mikołajczak E., Chudobiecki J. (2018): *The Value and Profitability of Converting Sawmill Wood By-Products to Paper Production and Energy Generation: The Case of Poland.* [In:] *Pulp and Paper Processing*. IntechOpen, 109. http://dx.doi.org/10.5772/intechopen.80044.
12. Wanat L., Mikołajczak E., Sarniak Ł., Czarnecki R., Topczewska A. (2020): *Application of Analytic Hierarchy Process (AHP) Algorithm to Optimize Business Model for the Kitchen Furniture Market*, [in:] D. Jelačić (ed.) Management Aspects in Forestry and Forest Based Industries, WoodEMA ia., Zagreb, pp. 111-124.
13. Wanat L., Potkański T., Chudobiecki J., Mikołajczak E., Mydlarz K. (2018): *Intersectoral and Intermunicipal Cooperation as a Tool for Supporting Local Economic Development: Prospects for the Forest and Wood-Based Sector in Poland.* Forests 9 (9), 531, 1; https://doi.org/10.3390/f9090531.
14. Wysocki F. (2010): *Metody taksonomiczne w rozpoznawaniu typów ekonomicznych rolnictwa i obszarów wiejskich*. Poznań: Wydawnictwo Uniwersytetu Przyrodniczego w Poznaniu, 108.
15. ***Statistical Yearbook of Forestry 2019. Central Statistical Office (GUS 2019). Warsaw.

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DIRECTIONS OF DEVELOPMENT OF THE FURNITURE INDUSTRY IN POLAND BASED ON TREND ANALYSIS AND MARKET TRENDS

Stasiak - Betlejewska, R., Grzegorzewska, E.

Abstract: Furniture industry contributed to the success of Polish exports. Furniture industry is the second industry among industrial processing industries in terms of net export value that constitutes a significant part of the Polish economy. The furniture sector is also one of the largest employers in Poland. A key element in creating a development strategy for the furniture industry is the analysis of the market environment in relation to the analysis of the resources and capabilities of enterprises. The article analyses trends in consumer behaviour, global macroeconomic trends affecting the furniture market, as well as analyses the value of consumption on the global furniture market. The analysis results in recommendations for furniture industry companies.
Keywords: furniture industry, development, export, import

1. INTRODUCTION

Furniture imports in 2017 amounted to EUR 206.5 billion. China is the world leader in terms of furniture exports, which in 2017 had a market share of 37%, in 2017 exporting furniture worth nearly EUR 78.8 billion. The United States is a world leader with a market share of 28.8%. In 2017, they purchased furniture worth nearly EUR 59.5 billion. The value of global furniture demand in 2018 amounted to USD 458 billion (EUR 402.6 billion *), which accounted for over 97% of global production and increased from USD 455 billion in 2015. The value of furniture produced in the EU was over 106.7 EUR billion in 2017 [Polski Fundusz Rozwoju 2017]

The largest furniture manufacturers in the EU are Italy and Germany, which together generated over 43% of production. Almost 126.5 thousand are involved in the production of furniture. companies (according to Eurostat data for 2017). Most furniture manufacturers are located in Italy and Poland. The value of EU furniture exports was EUR 80.8 billion in 2017. The share of% of all EU countries in global exports was 38.0%. The value of furniture imported by EU countries was EUR 78.2 billion in 2017. The share of% of all EU countries in global imports amounted to 37.9%. The value of furniture demand in the EU was over EUR 101.3 billion in 2017. Germany, France, the UK Britain and Italy consume over 68% of furniture sold in the EU.

Poland is a significant furniture manufacturer, in 2017 it produced furniture worth over EUR 10.1 billion. Poland has a 9.5% share in furniture production in the EU, which made it possible to reach the 3rd position in terms of the value of furniture produced in the EU in 2017. In 2013-2017, furniture exports from Poland increased by over 43.5% from 7.9 EUR billion to EUR 11.4 billion. In the years 2013–2017, furniture imports from Poland increased by over 81.2% from EUR 1.6 billion to EUR 2.8 billion. Poland is 18th among the largest furniture importers in the world with a share of 1.2%. The value of furniture demand in Poland amounted to EUR 1.6 billion in 2017. Poland consumes over 1.6% of furniture sold in the EU. The value of furniture produced in the world in 2018 amounted to USD 469 billion (EUR 412.24 billion *) according to the Centre for Industrial Studies (CSIL) report. World furniture production is concentrated in the Asia-Pacific region, which accounts for over 54% of production [PKO B 2019]

In the years 2003–2012 a dynamic increase in furniture production in the world was observed, when an average annual increase of 5.5% was recorded. The main driving force behind the increase in furniture production in the world over recent years has been the increase in furniture consumption in the USA. After 2012, the production dynamics slowed down, the average annual growth in the years 2012 - 2018 amounted to 2.2%.

At the beginning of the 21st century, China emerged as the world leader in furniture production. During this period, their share in world production increased from 10% (2 producer in 2003) to 39% (1 position in 2018). The strengthening of China's position is mainly due to relocation by Western companies from Taiwan, Hong Kong and Singapore of production to China, where qualified and cheap labour is available. In addition, the Chinese government has carried out a number of measures to stimulate the export of furniture, such as: lowering customs duties and taxes on the import of raw materials for furniture production, and granting VAT rebates for furniture exports.

Furniture production in EU countries is characterized by a high level of concentration - the 10 largest producer countries account for over 83.1% of EU production, and the two leaders - Germany and Italy jointly generate 42.8% of production. Poland is a significant furniture manufacturer. In 2017, it produced furniture worth over EUR 10.1 billion, which allowed it to reach the third position and market share of 9.5% [PKO BP 2019].

As of 2017, 126,507 furniture companies were registered in the EU. Over 109,000 are registered in the 10 largest producer countries. companies, 78.6% of furniture manufacturing companies in the EU. Poland is the largest employer in the EU in terms of the number of people employed in the furniture manufacturing industry - giving a job to 189.1 thousand employees. The 24.9% increase in furniture demand in 2013–2017 is mainly due to the increase in demand in Germany, Great Britain and Italy. Germany is the largest furniture consumer in the EU - with a share of around 26%. In the largest markets of Western Europe, where wealthy societies operate, the frequency of buying new furniture is much higher than in countries with less wealth (CEE countries).

According to Eurostat data, in the years 2008–2017 the increase in household expenditure on furniture, equipment, rugs and other floor coverings in the EU amounted to 9.4%.

China is the world leader in furniture exports, which in 2017 exported furniture worth almost EUR 78.8 billion, reaching a market share of 37.1%. The top 10 industry exporters accounted for 73.7% of global exports in 2017. Poland's share in global exports increased in the years 2013 - 2017 from 4.6% to 5.4%.

In the years 2013 - 2017, global imports of the furniture industry recorded a 33.6% increase from EUR 154.6 billion to EUR 206.5 billion. The world leader in furniture import is the United States, which in 2017 purchased furniture worth over EUR 59.5 billion, achieving a market share of 28.8%. The 10 largest importers in the industry accounted for 64.6% of global imports in 2017. Poland's share in global imports increased in the years 2013 - 2017 from 1.0% to 1.4%.

2. POLISH FURNITURE INDUSTRY MARKET

The value of furniture produced in Poland sold in 2016 amounted to PLN 42 billion. Poland is the fourth largest furniture exporter in the world, only China, Germany and Italy are ahead of us. It is important that companies with native capital are primarily responsible for the furniture industry in our country. According to Eurostat, the value of furniture industry production in Poland in 2017 amounted to EUR 10.1 billion and has recorded a growth of 38.5% since 2013, which is mainly driven by production for export. The Polish furniture market has been steadily growing for many years, which allowed it to reach the sixth position in the world among the largest furniture manufacturers.

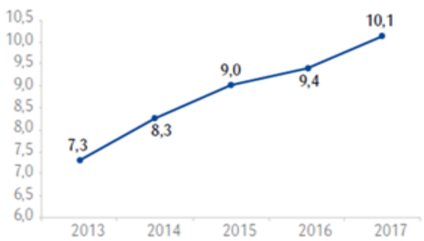

Figure 2. Value of furniture industry production in Poland (EUR billion).

Figure 3. Number of companies in the furniture industry in Poland 2013 - 2017.

In 1937, there were 36 bent furniture factories in Poland, employing approximately 122 people on average. Generally, however, then craft enterprises, and therefore small-scale production, dominated.

After the war, in 1952, following a wave of tendencies to centralize all branches of the economy, an organization was created to bring together entities from the furniture industry - the Central Board of the Furniture Industry with headquarters in Poznań. During the establishment of CZPM, it was associated 43 furniture companies. In 1960, its name was changed to the Furniture Industry Union, and in 1981 to the "MEBLE" Association.

In the years 1991–1999 an economic transformation took place in the Polish furniture industry. Foreign investors have entered the market and have purchased a significant part of state-owned enterprises from the industry (German companies SCHIEDER, STEINHOFF and KLOSE, HARTMANN, PAJDI). We also invested with us from the US fund - SCHOONER CAPITAL CORP. However, it is important that some of the plants were taken over by Polish entrepreneurs - for example, FORTE bought the plants in Ostrów Mazowiecka and Suwałki at that time. In total, at the beginning of the 90s a number of Polish furniture companies were established: FORTE (1992), Nowy Styl (1992), Black Red White (1991), VOX (1990). We can observe signs that Poland is becoming a powerhouse of the furniture industry on a global scale for several years. If Poles made $ 147 million in furniture exports in 1989, it was as much as $ 9 billion in 2011. In 2015, Poland was already the 4th largest furniture exporter in the world, second only to Italy, Germany and the Chinese. The main recipient of our furniture is Germany (about 36% of exports) [Stankiewicz 2016].

Furniture industry contributed to the success of Polish exports. Furniture manufacturers have achieved the second position among the branches of industry in terms of net exports, just after the producers of parts and accessories for motor vehicles. The favourable balance of furniture making in foreign trade consists of a high level of export combined with low import intensity. In terms of gross exports, i.e. the value of exports not reduced by the value of imports carried out by a given industry, Polish furniture ranks fifth among Polish industries.

Exports of the furniture industry from Poland in 2013 - 2017 increased by 43.5% from EUR 7.9 billion to EUR 11.4 billion, and imports by 81.2% from EUR 1.6 billion to EUR 2.8 billion . The main export directions for Polish producers are EU countries. Germany has been the largest recipient for many years, to which nearly 34.1% of Polish furniture industry exports went to 2017. The next three recipients are the Czech Republic, Great Britain and France, which purchased a total of 20.0% of products exported by Poland.

Sales of medium and large furniture manufacturers employing over 49 employees, give about 1.5 to 2% of GDP annually. The furniture industry recorded a slowdown in the years 2009 - 2012, but from 2013 a positive sales dynamics has been observed, which is a derivative of the improvement in the economic situation on foreign markets and the replacement of the Russian market with other export directions. According to Eurostat data, there were a total of over 16,000 registered in Poland at the end of 2015. furniture manufacturing companies, which was the second largest number in the entire European Union [PAP 2018].

The average work efficiency in the Polish furniture industry without taking into account labour costs is lower than the EU average, but after taking into account labour costs places Polish furniture in third place behind Bulgaria and Great Britain. Maintaining a high position and increase productivity Polish furniture companies with rising wage costs and shrinking resources of human capital will require the implementation of new business models and increased investment.

The drivers of the furniture industry development [Polski Fundusz Rozwoju 2017]:

1. Automation and robotization of production. This development model is a response to the globalization of distribution and limited resources of human capital. It assumes gaining competitive advantages due to the effect of scale, but requires investment in modern solutions for automatic inter-operational transport, implementation of lean production solutions, the use of autonomous and collaborative robots, and IT coupling of all stages of production.
2. Consolidation, mergers and acquisitions. Fragmentation of the furniture industry weakens the negotiating position both in relation to suppliers and recipients of furniture who form strong organizations. Vertical consolidation on both sides of the production process will result in process optimization, which with shrinking margins is an opportunity to remain competitive. The activity on the market of mergers and acquisitions of foreign entities - producers and distributors - is beneficial for enterprises due to the expansion of the customer base and strengthening of own brands. Similarly, integration into materials and production accessories can be beneficial.

3. Material, functional and design innovations. Achieving higher profitability requires intensive producers to stand out in a highly competitive global market. This can be achieved through material innovations (e.g. in the field of lighter plate materials, cheaper decorative materials, etc.), development of functional innovations (e.g. relaxers, integration with the Internet and digital systems, etc.) or through the development of design innovations. In this development model, it is necessary to increase expenditure on R&D and cooperation with interdisciplinary project teams.
4. Services for individual customers. Services such as personalization (dimensions, functional layout, colour selection) and delivery directly to home using e-commerce is more valuable to customers than buying a product from a store shelf. Taking into account the additional costs associated with traditional trade, the field for generating higher margins is opening up. In this case, new competences should be implemented in companies related to the operation of e-commerce platforms, selection of offers for online sales and related optimization of logistics processes, as well as IT integration of supply, production and trade.

3. TRENDS IN THE CONSUMPTION OF THE MAIN FURNITURE SEGMENTS IN THE WORLD

The value of consumption on the global furniture market in 2017 amounted to more than 370 billion dollars. It is expected that in the next 5 years its value will increase by 12%. Furniture used at home constitutes as much as 96% of the entire furniture market, garden furniture is only 4%. 32% of all consumer spending on furniture is spent on bedroom furniture, 21% on seating furniture, 15% on kitchen furniture and 11% on living room furniture. Home furnishings stores are the most important furniture sales channel. However, the most dynamically developing channel is the Internet. Home furnishings stores have a 57% share in the value of all furniture sold in the world. The next channel in terms of the value of furniture sales are DIY and DIY stores, having almost 10%, this channel has recorded negative growth dynamics over the past 5 years. Internet sales had an 8% share in the total value of furniture sales in 2017. For over 10 years, this channel has been growing dynamically, in the period from 2006 to 2017 the value of furniture sales on the Internet increased by over 300% [PARP 2019].

Western Europe is still the largest furniture market in the world, but over the past 10 years its value has dropped by 15% from 139 to almost USD 120 billion. The largest decreases in furniture consumption were recorded in 2009, 2012 and 2015. The year 2017 brought a slight 1.5% increase, whose dynamics, according to forecasts, will continue until 2022. North America is the second market in furniture consumption in the world, recording from 2009 a continuous annual increase on level 1%. Forecasts indicate that its dynamics will increase to almost 2% annually in the coming years.

Home furnishings stores have almost 70% share in furniture sales in Western Europe. The exception is the British market, in which the share of this channel is only 42%. This is due to the highest share of online sales in Western Europe (14%) and the share of non-food specialized stores (20%). The fastest growing sales channel in Western Europe is the internet (+ 300% compared to 2006, whose average share in this region in 2017 is 7%).

Home furnishings stores have a 63% share in furniture sales in Eastern Europe, of which the largest in Poland is 85%. The exception is the Ukrainian market, in which the share of this channel is only 43%. This is due to the highest share in DIY store furniture sales in Eastern Europe reaching as much as 32%. The share in online furniture sales is the highest in Russia, in 2017 it was 9%.

Over the years, Germany has been the undisputed leader and key partner for Polish furniture manufacturers, despite the fact that their share in the total value of Polish furniture exports decreased in 2017 to 35.5%.

The countries to which the export of Polish furniture is significant and to which it has grown dynamically over the past 10 years are: the Czech Republic, the Netherlands and the USA. China is the most dynamically developing export market for Polish furniture. The value of exports in 2017 compared to 2006 increased practically from 4 to 140 million euros. Other dynamically growing markets with a significant export value include Romania, Finland, Portugal, the Czech Republic, Hungary and the Netherlands [Rogala, 2020].

4. CONCLUSION

Consumers in the coming years will increasingly look for personalized furniture suited to small apartment areas. They will also require producers to have an ethical and transparent product development and delivery process, as well as social and environmental responsibility.

One of the additional factors of the dynamic growth of Polish furniture exports in the years after the crisis in 2008 is probably the fact that many consumers in developed countries, including Germany, began to look for products of good quality and at the same time more economical. A threat to the Polish furniture industry, which perfectly responded to the above needs, is that with the reversal of the downward trend in furniture consumption in 2017, more and more consumers are starting to look for brand products, higher quality and in more expensive price segments than those offered by Polish manufacturers.

The Polish furniture industry in the area of export faces two key challenges: maintaining the current level and dynamics of furniture sales to Western European countries based on orders of purchase groups and the development of furniture sales according to own design and under the own brands of the manufacturer, which requires more control in the area distribution of products to the end customer and a much greater involvement in marketing activities on foreign markets.

It is also important to place greater emphasis on the development of own design and innovation in the area of multifunctional solutions offered subsequently in furniture under its own logo. Combining these activities with the strategy of extending the product offer upwards, by creating product lines in the higher price segment. It is also important to develop omnichannel strategies that maximize the potential of the internet (e-commerce, social media, etc.) in reaching the final consumer in selected markets. Including the "click and collect" option, minimizing the need for own sales points.

REFERENCES

1. Rogala, B. (2020): *Rynek meblarski w Polsce ma się świetnie. Mamy szansę stać się liderem wśród europejskich eksporterów*, URL https://300gospodarka.pl/news/rynek-meblarski-w-polsce-ma-sie-swietnie-mamy-szanse-stac-sie-liderem-wsrod-europejskich-eksporterow
2. PAP (2018): Strzelecki: *Polska jest 4. eksporterem mebli na świecie*, Puls Biznesu, 20.05.2018.
3. PARP, Grupa PFR, (2019): *Analiza tendencji i trendów rynkowych w perspektywie najbliższych 5 lat mających wpływ na rozwój branży meblarskiej*, Warszawa.
4. PKO BP, (2019): *BRANŻA MEBLARSKA. Wzrost znaczenia polskich producentów na świecie*, Departament Strategii i Analiz Międzynarodowych, Warszawa
5. Polski Fundusz Rozwoju (2017): *Raport specjalny. Polskie Meble. Inwestycje dla Polski*, Warszawa.
6. Stankiewicz, A. (2016): *Dlaczego polska branża meblarska jest potęgą w skali świata?*, URL https://wspieramrozwoj.pl/artykul/168/polska-branza-meblarska

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SUSTAINABLE CONSUMPTION PATTERNS – THE CASE FROM SLOVAKIA

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Abstract: The main objective of the paper was to reveal consumption patterns among Slovak inhabitants and identify the factors that influence those patterns. The survey examined the following dimensions of consumers' behavior: Environmental concern, Perceived consumer effectiveness, Environmental activism, Green purchase intentions and Green buying behavior. The non-probability sampling method was used – a snowball sampling technique. Data from the buyers of consumer goods were collected from January to February 2018. The final sample consisted of 1061 completed questionnaires from the Slovak consumers aged over 18. Finally, we draw the conclusions for more sustainable consumption models.
Keywords: consumption patterns, green buying behaviour, consumer

1. INTRODUCTION

Over the past years we are witnessing significant changes in economy and environment. The rising production possibilities of the companies and over consumption of consumers, have strong impact on environment as: global warming, air pollution and environmental damage (Chen and Chai, 2010). That's why the economic growth, which is based on green path development, is needed (Lis and Wanat, 2014). Nevertheless, putting the grow at the centre of human economic activity posed the business in a role of "bad guy" responsible for the degradation of (not only human) environment (Kaputa et al., 2020). Recent shift of economic concept is represented by the effort to move from linear to circular economy. Each consumer has a different level of knowledge, preferences and needs. However, some common characteristics can be identified as consumer consumption patterns. This identification might help companies to understand green consumer better, and adjust product offer more effectively, with greater impact on profitability as well as on environmental performance.

2. CONCEPTUAL BACKGROUND

2.1. Environmental attitude, concern and knowledge

We can find different terms in academic papers, when talking about the pro-environmental behaviour. Some authors use term "environmentally responsible behaviour" or "ecologically conscious consumer behaviour". Stern (2000, p. 408) defines pro-environmental behaviour as "behaviour that has positive impact on the availability of materials or energy". Gupta (2017) who made narrative review on more than a hundred academic papers, prefers term "responsible consumption behaviour". He identified seven interdisciplinary determinants, which were used in numerous studies. In this study we aimed on the last one: Environmental determinants: knowledge and concern might be positively related to environmental citizenship behaviour, environmental activism and green purchase intentions as was proved in the previous studies (Alibeli, 2011; Lee, 2017; Gupta, 2017).

As mentioned above, consumer behaviour can be affected by different factors and determinants. The consumer individual values, opinions and believes about environment are defined as "environmental attitude" (Alibeli and Johnson, 2009). Environmental believes and values enlarged by information received through media, school or personal experience are known as "environmental knowledge". It is what people know about environment (Mostafa, 2007) environmental problems and their solutions (Apaydin, 2017). If the consumer decides to actively and consciously think and process his environmental values believes and knowledge, we talk about the "environmental concern". It is people attentiveness about environmental problems and their active attitude to solve them (Alibeli and Johnson, 2009).

There are also studies that do not confirm statement that ecological concern, attitude and knowledge lead into environmentally active behaviour. "Previous studies showed mixed results" (Lee, 2017, p.4). This is explained by two factors. Frist one is social dilemma (Picket-Baker and Ozaki, 2008) were a member of the group has to choose between group benefits and self-interest. Second factor is perceived consumer's efficacy/effectiveness (PCE). It is one's perception, that his effort will make a difference in solution of given problem (Ellen, 1991) and believe, that "ones' effort in the marketplace can influence the marketplace behaviour of others consumers and organizations" (Leary, 2014, p.1954).

2.2. Green behaviour

Ecological attitude, knowledge, and concern can be reflected in consumer's behaviour: consumer's non-economical and economical everyday actions. Apaydin (2017) characterized this behaviour as "green behaviour" and divided it into the three dimensions: i) green activism, ii) green habits, and iii) green purchase behaviour.

Non economical consumer's actions might be present in two areas – green activism and green habits. Green activism is characterized by scholars as being involved in political and social area – "actively involved in environmental organizations" (Stern, 2000). Green habits "are opposed to green buying behaviour" (Apaydin, 20017, p.97) and describe it as a behaviour, when one intentionally reduces the impact of his/her own actions on environment (Kollmuss and Agyeman, 2002).

Economical consumers' actions responsible towards environment is demonstrated by green buying behaviour. Purchase intention is a part of this process defined as the antecedents that stimulate motivation to buy a product (Hawking, 2012). Consumer green purchase intention can be significant factor and predictor of green buying behaviour (Chan, 2001; Albakyrak, 2013). If the consumers are intentionally buying product or services, that are environmentally beneficial, we can talk about green buying behaviour (Kollmus and Agyeman, 2002).

Consumers consumption and buying patterns are changing. Some empirical studies have shown that consumers tend to choose green product more often (Sony and Ferguson, 2017). But other studies have indicated that there are differences between consumer's attitudes, and real time green buying behaviour. There are different levels of environmental consciousness among consumer segments which can be manifest like: True Greens, Potential Greens, and Browns (Josi and Rahman, 2015; Apaydin, 2017). Consumer's buying patterns can be affected by consumer value dimensions and green brands purchase costs (Papista, 2017). Other studies showed that consumers differ in perceived consumer effectiveness and environmental actions (Prokeinova, 2015).

This led us to search for the current patterns of green consumer behaviour in Slovakia. The results could enrich the theoretical knowledge about green consumer segments and help marketing practitioners to aim more precisely on segments.

3. MATERIALS AND METHODS

Data from the buyers of consumer goods were collected from January to February 2018. We collected and analysed 1061 questionnaires from Slovak consumers aged over 18. An electronic form of the questionnaire was distributed to respondents via e-mails and social networks in Slovakia. The non-probability sampling method was used – a snowball sampling technique. The survey examined the following dimensions of consumers' behaviour: Environmental concern (EC), Perceived consumer effectiveness (PCE), Environmental activism (EA), Green purchase intentions (GPI) and Green buying behaviour (GBB). The questionnaire consisted of 20 questions: six for EC, four for PCE, two for EA, three for GPI and 5 for GBB. These questions were measured on a scale: from 1 (definitely yes), 2 (yes), 3 (neither yes nor no/indifferent), 4 (no) and 5 (definitely no). To evaluate the results, we used modes.

3. RESULTS AND DISCUSION

Table 1 represents the results for dimensions from the questionnaire. The worst results are for dimension Environmental activism (two questions – modes are "absolutely not"). Most of the respondents are not very active in this area and they also claim it openly. We can say they are not proactive e.g. they strongly denied the participation on eco-activities or in eco-organizations (Q11 - "I know about environmental issues and problems, but I do not actively involve (active participation e.g. in eco-events)"). According to Benda-Prokeinova (2015) Slovak consumers do not boycott unsustainable product frequently, the "boycott" we consider as proactive action of environmental activism in Slovak conditions (culture, history etc.).

Table 1. Results for dimensions

Sample	Environmental concern	Perceived consumer effectiveness	Environmental activism	Green purchase intentions	Green buying behaviour
Mode	1	2	5	1	1

The second worst dimension was Perceived consumer effectiveness (PCE) which Leary (2014, p. 1954) describes as the belief that "ones' effort in the marketplace can influence the marketplace behaviour of other consumers and organizations". Most respondents claim that they perceived their effectiveness but not strongly. Only one strong agreement was captured in this dimension - Q 10 – "I can contribute to solving environmental problems, through my personal decisions about purchasing eco products". Based on the above mentioned two dimensions, we can conclude that respondents act individually on the market rather than being a member of a "eco group". Rypakova, Stefanikova and Moravcikova (2015) linked it to the Slovak history as stated that previous political regime (1948 – 1989 – socialistic regime) could affect present patterns of purchasing behaviour of the Slovak population (e.g. some Slovaks finally want to enjoy what they could not before), strong stimuli to behave sustainably is the economic reason.

Environmental concern – on the one hand, most of the respondents think that environmental problems are greatly exaggerated by eco-organizations or proponents and on the other hand, they are worried about the live of future generations because of a possible environmental disaster (if we will be continuously ignoring environmental problems). Respondents also claim that responsible for solving such problems are states/governments and business entities. Most of them also mentioned that they have their personal problems and that's why they do not care about such issues.

We might conclude from these answers that the respondents have some ecological knowledge but they are not active (environmental activism). They are aware of possible threats coming from ecological problems, but they do not admit it sensitively enough comparing to attitudes of ecological movements' groups and environmental NGOs. Respondents put the primary responsibility for the environmental problems solution to the state/governments and corporations. Possible reason of such an attitude could lie in the fact that they can solve such societal problems only as an official group led by someone and at the same time socially recognized (e.g. by state). This result corresponds to the result from the PCE dimension. Where respondents are seen more as those who can contribute to the solution but are not seen as those who design, implement and control the solution.

As was mentioned above, GPI can be considered as a predictor of green buying behaviour (Chan, 2001; Albakyrak, 2013). Respondents claimed positive intentions in two questions of this dimension. Only one question has neutral answer (Mode = 3). As for dimension Green buying behaviour with five questions, only two of them have neutral answers (Mode = 3): "I only buy environmentally friendly products" and "I am avoiding buying products from companies acting unethically (e.g. the ones which are acting environmentally inappropriate, the ones which abuse workers, or use children labour).

4. CONCLUSION

Consumption patterns of the Slovak population are affected by culture, recent trends and overall awareness. Respondents revealed fair intentions related to environment, but there is a gap between buying intentions and buying behaviour.

They are aware of significant influence of their consumption on environment, but they are not convinced of the power to change it. They called the governments and business entities to be responsible for this change. We can speculate, that the issue is to trust the institutions. To overcome the problem with the "gap" and with the "trust", we advise to educate people about environmental problems as well as about sustainable solutions. This is not just a role of school system, but also task for companies to adopt environmental strategies and programmes. Companies should provide customers with innovative possibilities to participate on global change in consumption patterns through local (sometimes small) actions. Loučanová et al. (2017) stated that innovation activities of the company are basic premise of commercial success and sustainable development in the conditions of market economy. We see commercial success in mutual cooperation among official authorities, citizens (consumers) and business entities with the same main goal – sustainable development of the whole society. "It is possible to conclude that innovation activities in wood processing industry as a part of forestry-wood chain in Slovakia will move towards the innovations of processing technologies" (Loučanová et al., 2017, p. 9). Recently, it is necessary to shift innovating processes also to other areas of the company. Forest-based industry operates with an excellent sustainable raw material, easy recognized by consumers as environmentally friendly. So, it is wonderful opportunity be a leader in sustainable production as an advocate of environmental performance.

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REFERENCES

1. Albayrak, T., Aksoy, S., Caber, M. (2013): *The effect of environmental concern and scepticism on green purechse beaviour*. Mark. Intell. Plan. 2013, 31, pp.29-37.
2. Alibeli, M. Johnoson, Ch. (2009): *Environmental Concern: A cross national Analysis*, Journal of International and Cross Cultural Studies, Vol. 3, Issue1, pp.1-8.
3. Alibeli, M., White, N. R. (2011). *The Structure of Environmental Concern*. International Journal of Business and Social Science, Vol.2 No.4, 2011, pp 1-8.
4. Apaydin, F., Szczepaniak, M. (2017): *Analyzing the profile and purchase intentions of green consumers in Poland.* In: Ekonomika 2017. Vol 96 (1). (2017). ISSN2424-6166. pp. 93 -112.
5. Chan, R. Y. K. (2001): *Determinants of Chinese consumers green purchase behaviour.* Psychol. Mark. 2001,18, 389 -431.
6. Chen, T. B., & Chai, L.T. (2010): *Attitude towards the environment and green products: Consumers perspective.* Management science and engineering, 4(2), pp. 27-39.
7. Ellen, P., Wiener, J., Cobb-Walgren, C. (1991): *The Role of Perceived Consumer Effectiveness in Motivating Environmentally Conscious Behaviours.* In: Journal of Public Policy & Marketing. 10 (2). 102-117.
8. Gupta, K., Singh, N. (2017): *"Characterizing and Profiling Global Segments of Responsible Consumers – A Narrative Review."* In: Journal of Technology Management for Growing Economies (Chitkara University, India), Vol. 8, No. 1, pp. 7-39.
9. Hawking, D. I., Mothersbaugh, D. L. (2012): *Consumer Behaviour: Building Marketing Strategy*, 11th Ed.; McGraw Hill: New York, NY, USA, 2013; ISBN 0077645553, 978-00764557.
10. Joshi, Y.; Rahman, Z. (2015): *Factors Affecting Green Purchase Behaviour and Future Research Directions.* In: International Strategic Management Review 3. (2015). pp. 129-143.
11. Kaputa, V., Lapin, K., Leregger, F., Gekic, H. (2020): Economic Dimensions of Environmental Citizenship. Chapter in book: *Conceptualizing Environmental Citizenship for 21st Century Education*. Springer International Publishing. Editors: Hadjichambis, Andreas Ch. et al. ISBN 978-3-030-20248-4. DOI: 10.1007/978-3-030-20249-1.
12. Kollmuss, A., Agyeman, J. (2002): *Mind the Gap: Why do people act environmentally and what are the barriers to pro-environmental behaviour?* In: Environmental Education Research, 8:3, 239-260.

13. Leary, R., Vann, R., Mittelstaedt, J., Murphy, P., Sherry, J. (2014): *Changing the marketplace one behaviour at a time: Perceived marketplace influence and sustainable consumption*. In Journal of Business Research. 67. 1953–1958.
14. Lee, Y. K. (2017): *A Comparative Study of Green Purchase Intention between Korean and Chinese Consumers: The Moderating Role of Collectivism.* In: Sustainability 2017, 9, 1930.
15. Lis, W. Wanat, L. (2014): *Competitiveness Vs. Green Economy? Confronting Traditional and „Green"Indicators of the Competitive Position of the Forest – and Wood based Industry in Poland. Position and Role of the forest based sector in the green economy:* proceeding of scientific papers. - Zagreb: international Association for Economics and Management in Wood Processing and Furniture Manufacturing – WoodEMA, p.76-82.
16. Loučanová, E.; Paluš, H.; Dzian. M. (2017): *A Course of Innovations in Wood Processing Industry within the Forestry-Wood Chain in Slovakia: A Q Methodology Study to Identify Future Orientation in the Sector*. In: Forests 2017, 8, 210.
17. Rypakova, M; Stefanikova, Ľ.; Moravcikova, K. (2017): *Suggestion of green customer segmentation in 867 Slovakia.* In: Procedia Econ. and Financ. 2015, 26, 359-366.
18. Papista, E., Chrysochou, P., Krystallis, A., Dimitriadis, S., (2017): *Types of value and cost in consumer-green brands relationship and loyalty behaviour.* In: Journal of Consumer Behaviour, 17, pp.101-113.
19. Pickett-Baker, J., Ozaki, R. (2008): *Pro-environmental products: Marketing influence on consumer purchase decision.* In: Journal of Consumer Marketing. 25. 281-293.
20. Prokeinova, R. B. (2018): *Sustainable Consumption Patterns in Visegrad Region: Slovak Report. 1st ed.* [ebook] Nitra: Visegrad Fund, 2015, 25. Available at: http://www.k48.p.lodz.pl/ecomarket/en,reports-to-940 download.html [Accessed June 2nd, 2018].
21. Sony, A., Ferguson, D. (2017): *Unlocking consumers' environmental value orientations and green lifestyle behaviors. A key for developing green offerings in Thailand.* Asia-Pacific Journal of Business Administration. 9. 37-53. 10.1108/APJBA-03-2016-0030.
22. Stern, P. (2000): *Toward a Coherent Theory of Environmentally Significant Behaviour.* In: Journal of Social Issues. 56. 407-424.

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CONSUMER BUYING BEHAVIOR FOR WOOD HOME FURNITURE

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Abstract: Many consumers see their home and furniture as an extension of themselves. In addition, today, even if functionally not needed, furniture is a status symbol and is often considered a permanent investment. The decision to buy something is very often based on personal needs, desires, values and personal experiences. This paper will explore how customers make the decision to purchase wood furniture and wood products for interior use and which product features influence their choice.
Keywords: furniture; wood products market; purchase decision

1. INTRODUCTION

The most important goals of marketing is to satisfy desires and needs of the target group of consumers (Kotler, 1999). In order to succeed, marketing experts must know consumers' desires, thoughts and attitudes and how to fulfill that needs. When buying everyday supplies such as, groceries and hygiene supplies, process of making a purchase decision is not lengthy considering it is a consumer good that usually does not have a high price, so consumers make a decision on the spot or while compiling a shopping list. On the other hand, furniture is durable, expensive and is not bought often, so it requires longer consideration of options before making a purchase. Therefore, furniture purchase planning is approached step by step and intentionally (Ponder, 2013). Consumers do not approach furniture purchase superficially considering they are building their living space with that furniture and also by cause of belief that furniture they equip their home with reflects the image of themselves. Further, the furniture purchase is connected with family and friends with whom the furniture will be shared, so this process also has an emotional impact on the consumer (Ponder, 2013). While choosing the furniture, consumers tend to focus their attention on different characteristics of the furniture at different levels; some will consider the quality of the product most important, while for the others the design and appearance of the product will be crucial. As consumers' tastes are different, different options need to be offered to them in order to encourage them to make a purchase. This is where marketing comes in order to direct consumers to make a purchase in a certain chain of stores or from a certain manufacturer. While some consumers will be loyal to one specific manufacturer, for others will the information and the ease of finding information be crucial for making a decision. In that case, manufacturer/retailer's website and employees working in the store will be crucial factor. Consumers, therefore, differ according to desires, interests, lifestyle and other characteristics. These characteristics influence consumer behavior while making a purchase decision. This paper will examine how consumers make a purchase decision, whether they are willing to sacrifice time and put more effort into saving money, and which characteristics they pay the most attention to while purchasing furniture.

The aim of this paper is to examine the furniture and wood products for interior design market and find out how consumers make purchasing decision, or, in other words, what precedes the purchase and payment of the product. It will be examined which channels are used by consumers while researching information, are they used at all, or is the purchase decision made immediately after the need for the product is realized. Furthermore, the goal is to find out which product characteristics influence the final purchase decision.

2. THEORETICAL BACKGROUND

Understanding consumer behavior involves learning about how individuals, groups and organizations select, purchase, use and dispose of products, services, ideas and experiences to meet their wants and needs (Kotler, 1999). Marketing experts, in order to be successful in their field, must understand the desires and needs of consumers, which is not an easy task since consumers tend to make reckless purchasing decisions (Oblak et al., 2017). Consumer behavior is influenced by cultural, social, personal and psychological factors (Kotler, 1999). Each of these factors has a major impact on the purchasing decision, so it is difficult to define and assess the exact consumer behavior that precedes the purchase itself.

2.1. Consumer behavior

Personal factors influencing consumer behavior include age and life cycle stage, occupation, economic opportunities, lifestyle, personality and self-image (Kotler, 1999). Changing some of these factors also affects the change in the way of thinking and making decisions (Rani, 2014). For this reason, it is important for marketing managers to recognize the group of people who consume their products and adapt new products and services to them (Kotler, 1999). Throughout its existence, a person will be influenced by a number of factors - family, friends, environment and society (Rani, 2014). Consequently, marketing needs to be adapted to the geographical area, the demographic characteristics of the inhabitants and their cultural factors. Social factors greatly influence consumer behavior, either directly or indirectly. The greatest influence on an individual is exerted by his family which shapes him in a social, psychological and political sense. Different types of groups affect the individual, each in a different way. The reference group is the one to which the individual belongs and which indirectly affects his behavior. An individual would like to belong to an aspiration group, and dissociative group does not respond to him because of behavior or attitudes (Kotler, 1999). Social status represents people at the same level of income and position in society (Solomun et al., 2013), and it, together with the position in the family and work, influences a person's behavior, in general, but also specifically in his consumer behavior. For instance, someone who is employed as a director will be expected to dress a certain way to meet social norms. That means that a person's position in the family, at work and in society represents his role in society and it dictates his attitudes and activities in line with the expectations of the surroundings (Rani, 2014). Consumer behavior of each individual is influenced by psychological factors: motivation, perception, learning, beliefs and attitudes. Each individual has many needs at all times, and motivation subconsciously drives the consumer to satisfy the need when it becomes strong enough (Kotler, 1999).

2.2. Making a purchase decision

The buying process begins long before the purchase and payment of the product and lasts for a certain period after (Liker, 2016). The process of making a purchase decision begins with recognizing the need or problem of the consumer. The need can be driven by internal (actual need for furniture) or external incentives (after seeing advertising) (Kotler, 1999). Particularly, when buying furniture, it is about lack of furniture needed for everyday use, the dilapidation of existing furniture or the desire to refresh the living space by changing the interior design (Lihra and Graf, 2007). In addition, the need for new furniture arises with changes in consumer life such as change of marital status, the purchase of real estate, family expansion or retirement (Ponder, 2013). When it comes to other interior design elements, such as decorations, curtains, scents for the living space etc., it is about the desire to improve the living space, and not about the items necessary for everyday life. The beginning of the decision-making process also depends on gender, women discover the need for new furniture earlier and more often than men (Lihra and Graf, 2007, Oblak et al., 2017), but the responsibility for finding and purchasing furniture is more often taken by men, while couples with children in some cases leave the choice of furniture to the child (Ponder, 2013). After realizing the need for furniture, the next stage of making the purchase decision is to search for information. In some cases, consumers research information about furniture even though they do not need it (Ponder, 2013). Since today's consumers want to find out as much information as possible before making a purchase decision, sellers and manufacturers are forced to work on marketing continuously in order to meet customer requirements and make purchasing easier (Liker, 2016). Furniture sellers and manufacturers should offer channels for information researching tailored to consumers in order to attract them to decide to purchase their product (Lihra and Graf, 2007). Third phase of purchase decision making process, the evaluation of alternative options, involves examining and comparing products by their characteristics such as price, quality, brand etc. (Alok, 2014). Each of the options found is now a set of different characteristics that meet consumers' needs in different ways. At this stage, the consumer reduces the number of different options to just one, so although he knows what characteristics he wants his furniture to have, he may have to sacrifice some of them to pay a lower price and similar, and it all depends on consumers priorities. While deciding on a product, advice can also come from the spouse, child or parents, especially when it comes to valuable and durable products (Ahamad and Chandra Sekhar, 2014). Research conducted by Kaputa et al. (2018) shows that consumers from Croatia choose furniture primarily according to its quality and price, followed by safety, environmental characteristics and manufacturer's guarantee, while the smallest role is played by the brand and country of origin of the product, while the survey conducted in 2020 (Oblak et al., 2020) shows that buyers from the same area will choose for solid wood furniture rather than wood panels or other materials.

2.3. Smart purchasing

While making a purchase decision, the consumer has at his disposal various channels through which he can research the offer of the desired products on the market, as well as information about them. Factors influencing the choice of channels for product information research are: the risk that the channel provides, the intention to search and compare prices, the effort required to search and evaluate and the delivery time of the product (Alok, 2014). Smart purchasing is a term that denotes the combination of these channels when making a purchase decision, and the ability to make a purchase decision in this way makes the consumer more satisfied, ensuring a strong tie between seller and consumer (Flavián et al., 2019). If the consumer decides to research the information about the product on the seller's website, and eventually makes a purchase in the store, it is *web rooming*. In contrast, *showrooming* is used when the consumer physically browses the product in the store and makes a purchase online (Krstić, 2017). How the consumer will research the product before making a purchase decision depends on how much effort and time he is willing to invest in the process. As a result of saving of effort and time, consumers more often opt for *webrooming* (Flavián et al., 2019). In addition to the websites of sellers and manufacturers, customers also get information about products through social networks. This is especially accurate for younger customers who spend more time online (Voramontri and Klieb, 2018). On the other hand, consumers are more confident that they have made the right decision if they apply showrooming channel combination (Flavián et al., 2019). In addition, online shopping often offers benefits such as free shipping or a discount (for example if the consumer subscribe to the newsletter). A combination of on-site channels is also possible, which means that consumers in stores browse products and at the same time explore online alternative options and prices at other sellers (Valek, 2018).

3. MATERIALS AND METHODS

3.1. Survey questionnaire

The sample frames were 400 wood products and furniture consumers. Based on research objectives, a questionnaire was developed and pre-tested with a sub-sample of selected respondents. Questions were formed based on the available literature. On-line surveys by using "*Google Forms*" tool were conducted. The questionnaire, as an appropriate method of data collection, was chosen because the costs of this method of data collection are financially acceptable (Dillman, 2000) and also allows the collection of data from a wide geographical area (Zahs and Baker, 2007).

Certain statements in the questionnaire were measured using the Five-point Likert scale, so that ranges from 1 to 5 were given to individual statements of individual variables, where 1 stands for 'extremely disagree' or 'irrelevant', and 5 denotes 'extremely agree' or 'very important', i.e. respondents determined the degree of satisfaction or meaning they attach to individual statements. Furthermore, some of the questions are defined by multiple statements, as it has been determined that a particular variable / element will be better described by applying multiple statements rather than just a single one (Thorndike, 1967; Churchill, 1979; Lewis-Beck et al., 2004). The survey questionnaire consists of 4 parts, starting with questions related to demographic characteristics such as gender, age, county of residence, number of household members and household income, followed by questions on the frequency of furniture purchases in the past year, which together make the first part of the questionnaire. This is followed by questions about purchase planning where the respondent is asked to define the intensity of researching product information and planning the purchase, or whether he plans to purchase furniture at all. The last part is composed of questions related to the characteristics of the furniture.

The snowball method was used to sample the subjects. Sampling with this method starts from a certain number of respondents in the target population who meet the criteria to enter the sample, and in this case it is the age that must be greater than or equal to 18 years. Sharing the survey questionnaire with acquaintances and friends who meet the criteria increases the number of samples and this chain is repeated until the required number of samples is collected (Baćak, 2006).

The media through which the survey questionnaire was dispatched was the Internet, and respondents shared the questionnaire via e-mail and social networks. The reason for this is the possibility of free sharing, which does not require much effort, so this option has increased the number of shares and in such way the reach of respondents was greater, and the sample in demographic terms is very diverse. In addition, sharing questionnaires in that way facilitates data analysis since all responses are in digital form (Ponder, 2013).

Data from the survey questionnaires were uploaded into a *Microsoft Excel* spreadsheet (database). Statistical analysis was performed using the statistical program *SPSS Statistics* 17.0.

4. RESULTS

4.1 Respodent profile

Of 400 respondents, 68,25% were female and 31,75% were male. Both, age and education were classified into four categories. As shown in Table 1, most of the respondents (39%) were between 36 and 64 years old, followed by age group 26 to 36 years old (38%), while 20,5% were people between 18 and 24 years old. Only 2,5% of employees were people older than 65. Further, based on the 400 respondents educational structure was obtained. More than half (52,5%) were people with graduate degree, followed by respondents who have high school education (39%). Of total number of respondents, 6,8% were graduate people with completed Master's degrees or Ph.D., while only 1,8% were people with elementary school education.

Table 2. Respondents gender, education and age structure

Gender (%)		Education level (%)		Age groups (%)	
Male	68,25	Elementary school	1,8	18 - 24 years old	20,5
		High school	39	25 - 36 years old	38
Female	31,75	Graduate degree	52,5	36 - 64 years old	39
		M.s./Ph.D.	6,8	older than 65	2,5

Furthermore, the largest number of respondents were from Karlovac County (51.5%), followed by the City of Zagreb (14.75%) and Zagreb County (10.25%), respectively. Of the total number of respondents, 4% of respondents live abroad, and the remaining 19.5% of respondents come from other parts of Croatia.

4.2. Frequency of furniture buying activities

To show how often people buy furniture or just think about buying it, questions about the frequency of thinking about the need for furniture and buying furniture in the past year were asked. The answers are shown in Table 2.

Previous researches (Lihra and Graf, 2007; Oblak et al., 2017) have shown that women are more likely to recognize the need for furniture than men. If the frequency of thinking about buying furniture and the purchase of furniture itself is put in relation to gender, the example of this particular research does not show any rule according to which a certain gender would more or less think about purchasing furniture or purchasing furniture. Specifically, 19.78% of women stated that they have thought about buying furniture more than 10 times in the past year while the number of men stating same thing is slightly lower and it amounts to 15.75% of the total number of surveyed men. On the other hand, 6% of men have bought furniture more than 10 times in the past year, which is a higher than number of female respondents (4%) who have purchased furniture more than 10 times in the past year.

Table 3. Frequency of furniture purchases

	In the past year, how many times have you…			
	…thought about purchasing furniture?		…purchased furniture?	
	number	fr (%)	number	fr (%)
not once	25	6,3	110	27,5
1 - 2 times	132	33,0	193	48,3
3 - 5 times	131	32,8	66	16,5
6 - 10 times	38	9,5	14	3,5
more than 10 times	74	18,5	17	4,3
∑	400	100,00	400	100,00

4.3. Furniture purchase planning

Furniture purchase planning is a process that begins with recognizing the need for furniture, and varies from customer to customer. As many as 16.5% of respondents do not plan to buy at all, and most respondents study all the possibilities in detail before making a purchase decision (61.5%) (Figure 1).

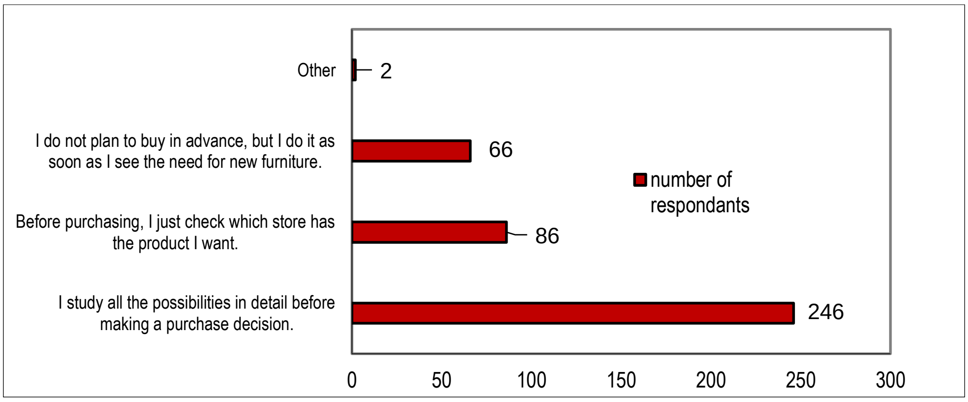

Figure 3. Activities that precede the decision to purchase furniture (n=400)

When conducting information about the product (Figure 2), the largest number of respondents use media such as television, newspapers and the Internet (55%), while as many as 38.5% said they believe the experiences of friends or acquaintances. Detailed research on the product is conducted by 29% of respondents, and only 19% of them decide to consult with experts before buying furniture. 11% of respondents do not collect product information before making a purchase decision.

When it comes to the place where respondents most often buy furniture, by far the largest number of respondents (55%) opt for large department stores (Figure 3). Due to their own ideas or requirements, or the need for custom-made furniture, 19% of respondents decide to purchase furniture in person from a furniture manufacturer. In small furniture showrooms 18% of respondents purchase furniture, and only 6.5% of respondents order furniture online. Customers also choose to combine these options, which mainly depends on the purpose of the furniture.

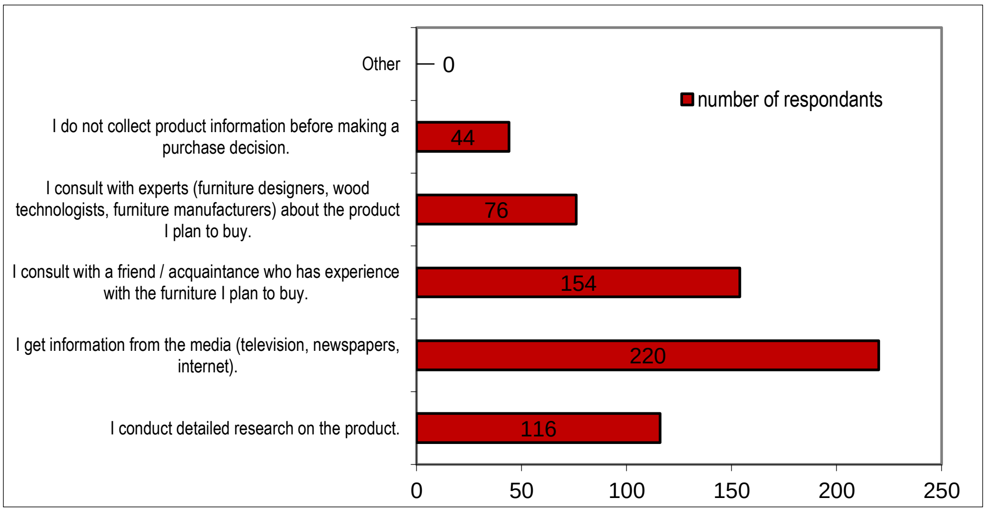

Figure 4. Method of collecting information (n=400)

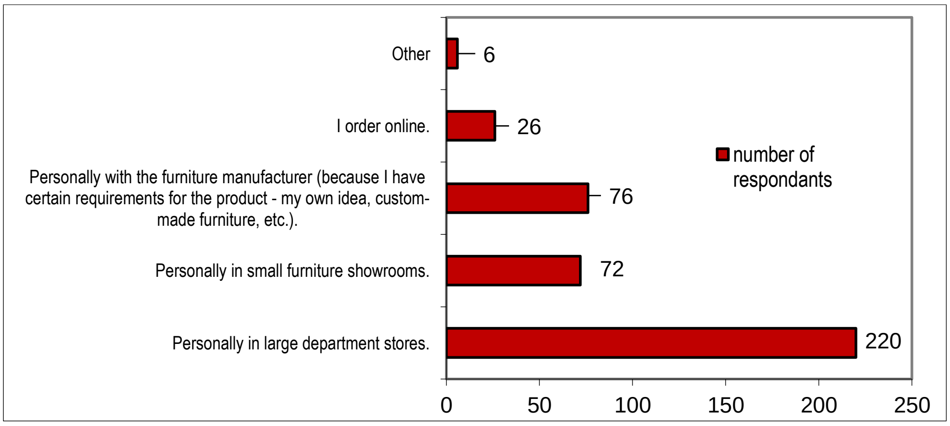

Figure 5. Where do you most often buy furniture?

When comparing products from different manufacturers, before making a purchase decision, most respondents compare two or three manufacturers they trust the most (46.25%). When asked "At what level do you compare the same products from different manufacturers before making a purchase decision", a slightly smaller number (46%) try to compare several different manufacturers before making a purchase decision, and only 7.5% of respondents remain loyal to one manufacturer (Figure 4).

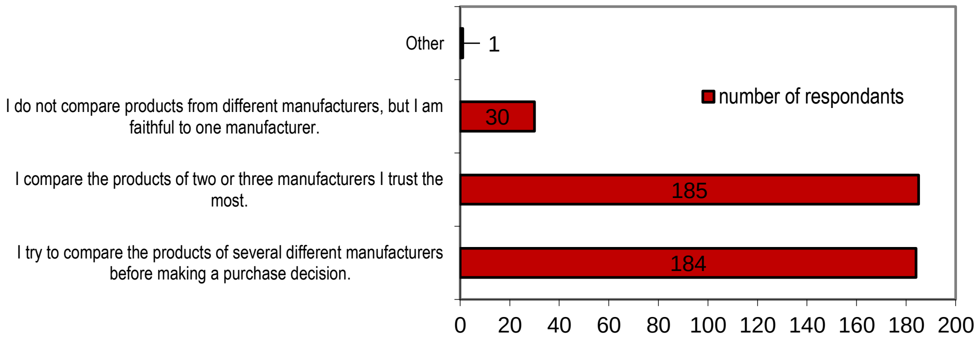

Figure 6. Comparison of different manufacturers (n=400)

4.4. Saving effort, time and money & product characteristics

Figure 5 shows the results of the question related to the collection of information, and it can be seen that respondents collect as much information as possible before going shopping, only 5% of respondents say that this does not apply to them at all.

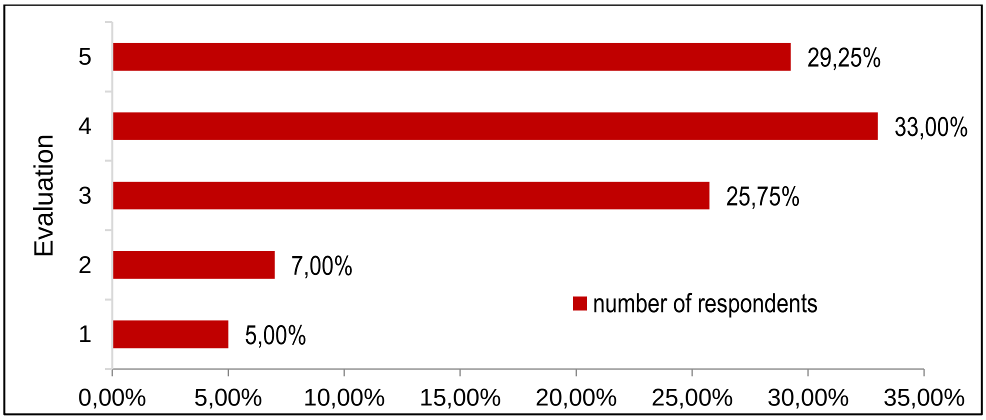

Figure 7. I gather as much information as possible before I decide to buy

When it comes to saving effort or money, as many as 33% of respondents were neither committed to saving effort nor saving money (Figure 6). In this case, a score of 5 indicates an effort to save money, while a score of 1 indicates that the respondent is not ready to make an effort to save, or indicates a saving of effort. However, a total of 54% of respondents rated this statement with a score of 4 and 5, so it can be concluded that they are still willing to make more efforts to find cheaper options than money when buying furniture.

However, the importance of saving effort, time, and money, no significant difference between the grades assigned to men and women was found. Exception was in the case of cleaning and maintenance, which was assessed by female respondents with an average score of 4.4, and male respondents by 3.97.

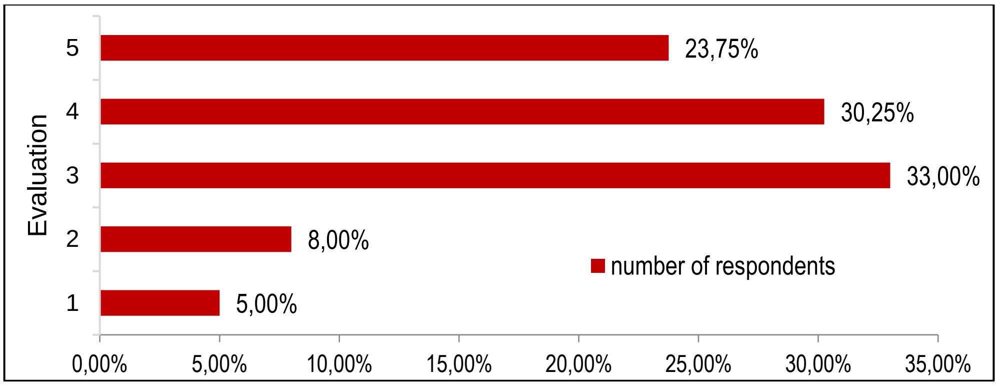

Figure 8. I will make more effort to buy the product at a lower price

5. CONCLUSIONS

Nowadays, in a time when a digital digital technology is extremely presented all around us people are becoming more and more depended on it. Following this statement it is logically to impose that most of shopping activities like wood produces and furniture purchase also take place on-line on the Internet. Additionally, another reason for people buying more and more on-line is the way of life in which people are more and more preoccupied with work and obligations, so they have less and less time for other activities, so online shopping seems like a great way to save time.

Online retailers are also aware of this, so they often offer special discounts or benefits such as free shipping. Survey conducted as part of this work showed that the manufacturer's website and sellers are the most common choice of consumers when researching product information, but also they further prefer the personal purchase of furniture, whether in large or small department stores or at a furniture manufacturer, before making an online purchase. In other words, the way of shopping which respondents practice is *webrooming*. This allows them to compare the same or similar products from different manufacturers before making a purchase decision, without investing too much effort or time. When comparing product characteristics, at the most respondents pay their attention to the appearance, quality of materials and finishing and functionality, while at least to the brand recognition of the manufacturer. To keep up with the times, furniture manufacturers and sellers are forced offer as much information as possible about the products they make and / or sell in order to were competitive in the market. Future wood furniture consumer are young generations, who are growing up in an age when almost everyone the household has a computer and internet access … which are even schooled through the internet, so if furniture manufactures and sellers want to survive in that market they definitely must adjust to the combination of off-line and on-line buying process without any exceptions.

REFERENCES (alphabetical order)

1. Ahamad, S., Chandra Sekhar, N. D., 2014: Family members role in purchase decision making, Abhinav International Monthly Rrfereed Journal of Research in Management & Technology, 3(8), 22-27.
2. Alok, G., Bo-chiuan, S., Zhiping, W., 2014: An empirical study of consumer switching from traditional to elecrtonic channel: A purchase decision process perspective, International Journal of Electronic Commerce, 8:3, 131-161, DOI: 10.1080/10864415.2004.11044302.
3. Baćak, V., 2006: Uzorkovanje upravljano ispitanicima: novi pristup uzorkovanju skrivenih populacija, Filozofski fakultet Sveučilišta u Zagrebu
4. Churchill, Jr. G. A., 1979: A paradigm for developing better measures of marketing constructs. Journal of Marketing Research, 16(1):64-73
5. Dillman, D. A., 2000: Mail and Internet Surveys – the Tailored Design Method. John Wiley & Sons, Inc. New York, USA.

6. Flavián, C., Gurrea, R., Orús, C., 2019: Combining channels to make smart purchases: The role of webrooming and showrooming, University of Zaragoza, Zaragoza, Spain.
7. Kaputa, V., Pirc Barčić, A., Mat'ová, H., Motik, D., 2018: Consumer preferences for wooden furniture in Croatia and Slovakia, BioResources 13(3), 6280-6299.
8. Kotler, P., 1999: Marketing management: the millennium edition, Upper Saddle River, NJ: Prentice Hall.
9. Krstić, N., 2017: Digitalni marketing: Pojmovnik, Fakultet za medije i komunikacije, Beograd, Srbija.
10. Lewis-Beck, M. S., Bryman, A., Liao, T. F., 2004: Encyclopedia of Social Science Resource Methods. SAGE Publications.
11. Lihra, T., Graf, R., 2007: Multi-channel communication and consumer choice in the household furniture buying process, Direct Marketing: An International Journal, 1(3), 146-160.
12. Liker, B., Zadnik Stirn, L., Gornik Bučar, D., Hrovatin, J., 2016: Examination of decision factors in the process of buying kitchen furniture using conjoint analysis, Drvna industrija, 67 (2), 141-147.
13. Oblak, L., Glavonjić, B., Pirc Barčić, A., Bizjak Govedil, T., Grošelj, P., 2020: Preferences of different target groups of consumers in case of furniture purchase, Drvna industrija, 71 (1), 79-89.
14. Oblak, L., Pirc Barčić, A., Klarić, K., Kitek Kuzman, M., Grošelj, P., 2017: Evaluation of factors in buying decision process of furniture consumers by applying AHP method, Drvna industrija, 68 (5), 37-43.
15. Ponder, N., 2013: Consumer attitudes and buying behaviour for home furniture, Business Law College of Business, Mississippi State.
16. Rani, P., 2014: Factors influencing consumer behaviour, International journal of current research and academic review, 2(9), 52-61.
17. Thorndike, R. L., 1967: The analysis and selection if test items. Editors: D. Jackson, S. Messick, Problems in human assessment, 201-206, McGaw Hill, New York.
18. Valek, M., 2018: Marketinški trendovi: Utjecaj digitala na odluke u prodajnom prostoru, dostupno na www.jatrgovac.com (accessed 03/2020.).
19. Zahs, D., R. Baker, 2007: Telephone and Mail Surveys: Advantages and Disadvantages of Each. Market Strategies, Inc.

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THE IMPORTANCE OF POLISH FURNITURE INDUSTRY EXPORT FOR SELECTED EU COUNTRIES

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Abstract: The important position of the Polish furniture industry in comparison to the European Union countries is confirmed by its significant production and export potential, in particular towards countries classified as new members of the Community. For years, Poland has occupied a leading position in the global and European ranking of furniture exporters. Thus, the main purpose of the article was to determine the importance of Polish foreign trade in furniture industry products for selected countries, which are the major markets for these products. The research covered the years from 2009 to 2017. The main sources of research material were the the International Trade Center database, as well as Statistical Yearbooks of Foreign Trade of the Central Statistical Office in Poland. The trends in the export and import value of Polish furniture were presented and interpreted. The article shows also a ranking of EU countries that belong to the main importers of the Polish furniture industry. In addition, the manuscript presents the structure of the export value of individual categories of Polish furniture.
Keywords: furniture, export, foreign trade, EU countries

1. INTRODUCTION

Foreign trade is an important stimulator of economic growth. New theories of trade emphasize the positive impact of trade liberalization on economic growth with increasing frequency. It contributes to specialization in those sectors of the economy which are characterized by high economies of scale, which, in turn, implies an improvement in an efficient allocation of resources and long-term productivity (Dowrick, Golley 2004; Bond et al. 2005). Furthermore, what is often emphasized is the role of dissemination of knowledge and new technologies in the processes related to the flow of goods and services between countries (Grossman, Helpman 1990; Riviera-Batiz, Romer 1991; Barro, Sala-i-Martin 1997). The positive dependency between trade openness and economic growth has been confirmed by, among others, Chang et al. 2009; Dollar, Kraay 2004; Frankel, Romer, 1999; Freund, Bolaky 2008; Katircioglu et al. 2007.

In Poland, one of the industries exhibiting a strong pro-export character is the furniture industry, which has demonstrated a clearly positive foreign trade balance for years. Every year, approximately 90% of the furniture production value goes to the foreign market (Grzegorzewska, Stasiak-Betlejewska 2014; Grzegorzewska, Więckowska 2016). This means that the external demand and the economic situation in the countries classified as Poland's largest partners in this respect are of great importance for Polish furniture manufacturers. Thus, the principal goal of the study was to assess the importance of the export carried out by the Polish furniture industry to the EU countries which constitute important furniture markets for Poland.

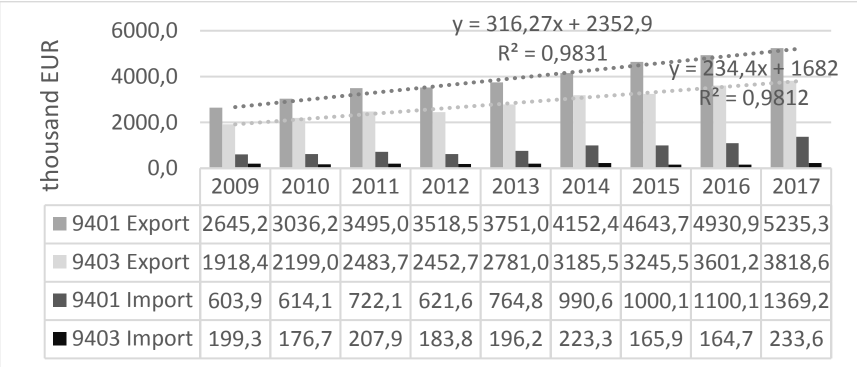
2. METODOLOGY

The database of the International Trade Center was the primary source of research material. The analyses were carried out while taking into account the CN Classification and pertained to the period of 2009-2017. The research covered two categories of products included in CN 94 class, whose export represents a significant share in the export of the Polish furniture industry, namely: 9401 – Seats, whether or not convertible into beds, and parts thereof, n.e.s. (excluding medical, surgical, dental or veterinary of heading 9402), including: 940161 - Upholstered seats, with wooden frames (excluding convertible into beds); 940169 - Seats, with wooden frames (excluding upholstered); 940171 - Upholstered seats, with metal frames (excluding seats for aircraft or motor vehicles, swivel seats with variable height adjustments and medical, dental or surgical furniture); 940179 - Seats, with metal frames (excluding upholstered, swivel seats with variable height adjustments and medical, dental or surgical furniture); 940190 - Parts of seats, n.e.s. and 9403 – Furniture and parts thereof, n.e.s. (excluding seats and medical, surgical, dental or veterinary furniture), including: 940330 - Wooden furniture for offices (excluding seats); 940340 -

Wooden furniture for kitchens (excluding seats); 940350 - Wooden furniture for bedrooms (excluding seats); 940360 - Wooden furniture (excluding for offices, kitchens and bedrooms, and seats).

3. RESULTS

The research shows that the export value of the Polish furniture industry has increased significantly in recent years. Over the years 2009–2017, the value of class 9401 furniture (seats, whether or not convertible into beds, and parts thereof) continued to rise systematically, reaching a twofold increase from EUR 2.6 billion to 5.2 billion (Chart 1). A similar increase could be observed in the case of class 9403 furniture (from EUR 1.9 billion to 3.8 billion). The value of furniture that reached the Polish market from abroad was substantially lower than the value of the exported furniture belonging to particular classes of CN Classification, which contributed to a clearly positive trade balance in the furniture industry.



	2009	2010	2011	2012	2013	2014	2015	2016	2017
9401 Export	2645,2	3036,2	3495,0	3518,5	3751,0	4152,4	4643,7	4930,9	5235,3
9403 Export	1918,4	2199,0	2483,7	2452,7	2781,0	3185,5	3245,5	3601,2	3818,6
9401 Import	603,9	614,1	722,1	621,6	764,8	990,6	1000,1	1100,1	1369,2
9403 Import	199,3	176,7	207,9	183,8	196,2	223,3	165,9	164,7	233,6

Fig.1 The value of the export carried out by the Polish furniture industry according to the selected classes from CN Classification (Source: elaborated on the basis of the International Trade Center database).

What results from the data presented in Tables 1 and 2 is that the main recipient of Polish furniture is Germany. This country was ranked first among Polish furniture importers in all categories of furniture industry products selected. Over the years 2009–2017, the value of class 9401 furniture delivered to the German market increased from EUR 1.2 billion to nearly 2.0 billion. At the beginning of the analysed period, 20% (940169 – seats, with wooden frames, excluding upholstered) to 50% (940161 – upholstered seats, with wooden frames, excluding convertible into beds) of class 9401 furniture was exported to Germany.

Table 1. The value of Polish furniture export according to CN class 9401

Itemisation	Export				Share in world export			
	2009 thous. EUR	2017 thous. EUR	D* %	V** %	2009 %	2017 %	DF*** p.p.	V %
9401– Seats, whether or not convertible into beds, and parts thereof, n.e.s.								
World	2645.2	5235.3	197.9	22.2	100.0	100.0	0.0	0.0
Germany	1202.5	1954.6	162.5	16.3	45.5	37.3	-8.1	6.4
Czech Republic	206.7	607.6	293.9	44.9	7.8	11.6	3.8	23.3
United Kingdom	125.4	410.1	327.2	35.3	4.7	7.8	3.1	19.2
Netherlands	134.0	382.1	285.0	35.8	5.1	7.3	2.2	14.1
France	236.7	307.7	130.0	8.1	8.9	5.9	-3.1	15.8
940161- Upholstered seats, with wooden frames (excluding convertible into beds)								
World	1052.9	1760.7	167.2	17.4	100.0	100.0	0.0	0.0
Germany	541.2	771.7	142.6	11.5	51.4	43.8	-7.6	6.2
Netherlands	102.5	195.1	190.3	22.8	9.7	11.1	1.3	6.1
United Kingdom	28.9	144.5	500.5	50.4	2.7	8.2	5.5	36.3

France	85.7	111.9	130.5	11.9	8.1	6.4	-1.8	11.5
Sweden	61.2	86.9	142.0	21.1	5.8	4.9	-0.9	9.8
940169 - Seats, with wooden frames (excluding upholstered)								
World	27.3	62.1	227.3	29.3	100.0	100.0	0.0	0.0
Germany	5.5	9.0	164.6	27.3	20.0	14.5	-5.5	14.3
United Kingdom	3.2	5.5	172.0	23.5	11.7	8.9	-2.8	12.1
Czech Republic	2.3	4.2	183.0	20.2	8.3	6.7	-1.6	14.7
France	1.2	3.2	275.9	46.5	4.2	5.1	0.9	23.2
Hungary	1.6	3.0	180.6	26.7	6.0	4.8	-1.2	20.0
940171- Upholstered seats, with metal frames…								
World	47.5	167.4	352.1	40.7	100.0	100.0	0.0	0.0
Germany	11.9	45.0	377.0	49.8	25.1	26.9	1.8	11.8
Netherlands	5.8	23.7	409.2	38.8	12.2	14.1	2.0	12.4
Denmark	2.6	16.7	643.5	59.0	5.5	10.0	4.5	23.2
Sweden	3.9	9.5	243.9	25.5	8.2	5.7	-2.5	20.0
France	3.7	8.2	222.0	25.8	7.7	4.9	-2.9	20.5
940190 - Upholstered seats, with metal frames								
World	1080.4	2161.0	200.0	21.9	100.0	100.0	0.0	0.0
Germany	443.8	728.6	164.2	16.4	41.1	33.7	-7.4	8.3
Czech Republic	152.5	506.5	332.1	52.0	14.1	23.4	9.3	31.0
United Kingdom	80.7	216.3	268.1	30.1	7.5	10.0	2.5	17.2
Slovakia	39.1	100.1	256.2	34.9	3.6	4.6	1.0	17.2
France	97.0	56.9	58.6	24.4	8.9	2.6	-6.3	43.9

D* - dynamics; V** - coefficient of variation; DF*** - difference.

Sources: own elaboration based on International Trade Centre database.

Table 2. The value of the Polish furniture export according to CN class 9403

Itemisation	Export				Share in export			
	2009 thous. EUR	2017 thous. EUR	D %	V %	2009 %	2017 %	DF p.p.	V %
9403 - Furniture and parts thereof, n.e.s.								
World	1918.4	3818.6	199.1	22.7	100.0	100.0	0.0	0.0
Germany	553.2	1239.3	224.0	26.8	28.8	32.5	3.6	5.9
France	169.9	224.1	131.9	10.1	8.9	5.9	-3.0	18.3
United Kingdom	111.3	247.2	222.1	32.0	5.8	6.5	0.7	11.3
Czech Republic	119.6	156.7	131.0	14.2	6.2	4.1	-2.1	16.7
Sweden	71.2	165.0	231.8	26.7	3.7	4.3	0.6	6.7
940330 - Wooden furniture for offices (excluding seats)								
World	71.0	129.2	181.9	17.0	100.0	100.0	0.0	0.0
Germany	16.4	34.7	211.8	31.1	23.1	26.9	3.8	21.0
France	6.4	4.9	75.6	48.3	9.1	3.8	-5.3	55.1
Netherlands	5.8	8.8	150.3	26.9	8.2	6.8	-1.4	20.2
UK	4.5	12.5	275.8	29.7	6.4	9.7	3.3	17.9
Sweden	4.1	9.8	240.8	23.7	5.7	7.6	1.9	12.7
940340 - Wooden furniture for kitchens (excluding seats)								
World	56.9	68.9	121.1	16.6	100.0	100.0	0.0	0.0
Germany	10.8	14.2	132.0	33.9	18.9	20.6	1.7	19.7
Czech Republic	13.0	8.6	66.0	13.9	22.9	12.5	-10.4	25.7
France	3.5	7.2	207.4	28.4	6.1	10.5	4.4	27.6
Slovakia	2.3	4.4	186.8	27.7	4.1	6.3	2.2	17.6
United Kingdom	1.4	2.1	147.2	44.8	2.5	3.0	0.5	32.4
940350 - Wooden furniture for bedrooms (excluding seats)								
World	241.2	587.6	243.6	29.6	100.0	100.0	0.0	0.0

Germany	63.4	197.9	312.1	39.0	26.3	33.7	7.4	10.3
France	21.7	29.7	136.7	16.7	9.0	5.0	-4.0	20.2
UK	16.2	42.6	263.0	37.8	6.7	7.2	0.5	12.5
Belgium	9.9	15.1	152.3	16.6	4.1	2.6	-1.5	26.1
Netherlands	6.6	13.7	206.1	33.5	2.7	2.3	-0.4	11.0
940360 - Wooden furniture (excluding for offices, kitchens and bedrooms, and seats)								
World	1056.0	1874.2	177.5	18.9	100.0	100.0	0.0	0.0
Germany	338.7	637.6	188.3	20.3	32.1	34.7	1.9	4.6
UK	61.4	119.4	194.4	26.3	5.8	5.8	0.6	10.6
France	80.7	99.5	123.3	10.0	7.6	5.6	-2.3	16.2
Czech Republic	55.2	86.7	157.1	20.2	5.2	4.7	-0.6	10.4
Spain	10.2	54.4	535.3	42.5	1.0	3.8	1.9	31.4

Sources: own elaboration based on International Trade Centre database.

Over the period in question, the importance of the German recipients of Polish furniture products belonging to class 9401 decreased slightly, however, this country still maintained the first position in the developed ranking of EU countries. It is worth noting that a clear growth dynamics in the export value of the Seats category (whether or not convertible into beds, and parts thereof, n.e.s.) was noted in Great Britain (327.2%), Czech Republic (293.9%) and the Netherlands (285.0%), which led to the increased importance of these countries for the export of the Polish furniture industry. In addition, the highest coefficient of variation in the value of export was recorded in the case of the Czech Republic and Great Britain, testifying to the degree of diversity of the examined feature over the period of 2009–2017. When it comes to the class 9401 furniture, the value of this coefficient was 23.3% and 19.2% respectively. The Netherlands was also ranked high among the Polish furniture buyers. Alongside Germany, this country was the main exporter of upholstered seats with wooden frames (excluding convertible into beds) and upholstered seats with metal frames. On the other hand, the Czech Republic was one of the major recipients of parts of seats. At the end of the period analysed, more than 23% of the value of this product class was absorbed by this country. Furthermore, the most significant Polish partners in the area of the foreign trade in seats included France, Denmark and Sweden.

As pointed out by the data in Table 2, Germany was also the main recipient of class 9403 furniture – Furniture and parts thereof, n.e.s. (excluding seats). In 2009, from 18.9% (940340 – wooden furniture for kitchens, excluding seats) to 32.1% (940360 – wooden furniture, excluding for offices, kitchens and bedrooms, and seats) of the value of the Polish furniture export went to German importers. In addition, during the analysed period, the importance of Germany as the main recipient of furniture and parts excluding seats increased – the share of this country in this respect rose by 3.6 p.p. to 32.5%. In 2017, more than one-third of the value of wooden bedroom furniture and other wooden furniture (excluding for offices, kitchens and bedrooms, and seats) were products intended for the German market. Except Germany, France was another important importer of wooden furniture for offices, kitchens and bedrooms. However, the diminishing role of this country as a recipient of wooden furniture for offices and bedrooms should also be noted. On the other hand, a visible growth dynamics in the value of Polish furniture export to Great Britain was recorded. In particular, this referred to wooden office furniture (275.8%), wooden bedroom furniture (263.0%) and other wooden furniture (193.4%). This situation led to the increased importance of Great Britain as a recipient of these categories of wooden furniture. The Netherlands, Sweden, Belgium and Spain should also be indicated as the most important recipients of wooden furniture excluding seats (class 9403). Among the new EU Member States, special attention should be devoted to the Czech Republic, as it proved an important recipient of wooden furniture for the kitchen and other wooden furniture excluding seats.

4. CONCLUSIONS

Poland is one of the most important furniture producers and exporters in the EU. The value of the export of the Polish furniture industry has increased significantly in recent years. The conclusion from the research indicates that the main recipient of Polish furniture is Germany. This country was ranked first among Polish furniture importers in all categories of furniture industry products selected for the analysis, however, in some of those categories, the importance of German recipients has slightly decreased. Germany played a special role in the import of wooden bedroom furniture and other wooden furniture (excluding for offices, kitchens and bedrooms, and seats). France was an significant importer of wooden furniture for offices, kitchens and bedrooms. The Netherlands, Sweden, Belgium and Spain should also be listed as significant recipients of wooden furniture. Furthermore, the Czech Republic should be mentioned as an important trade partner in furniture trade among the new EU members.

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REFERENCES

1. Barro, R.J.; Sala-i-Martin, X. (1997): *Technological Diffusion, Convergence and Growth*. Journal of Economic Growth 2: pp. 1-26.
2. Bond, E.W.; Jones, R.W.; Ping, W. (2005): *Economic Takeoffs in a Dynamic Process of Globalization*. Review of International Economics 13: pp. 1-19.
3. Chang, R.; Kaltani, L.; Loayza, N.V. (2009): *Openness can be good for growth: The role of policy complementarities*. Journal of Development Economics 90: pp. 33-49.
4. Dollar, D.; Krayy, P. (2004): *Trade. Growth and Poverty*. Economic Journal 114: pp. 22-49.
5. Dowrick, S.; Golley J. (2004): *Openness and growth: Who benefits?* Oxford Review of Economic Policy 20: pp. 38-56.
6. Frankel, J.A.; Romer, D. (1999): *Does trade cause growth?* American Economic Review 89(3): pp. 379–399.
7. Freund, C.; Bolaky, B. (2008): *Trade, regulations, and income*. Journal of Development Economics 87(2): pp. 309-321.
8. Grossman, G.M.; Helpman, E. (1990): *Comparative advantage and long-run growth*. American Economic Review 80: pp.796-815.
9. Grzegorzewska, E.; Stasiak-Betlejewska, R. (2014): *The influence of global crisis on financial liquidity and changes in corporate debt of the furniture sector in Poland*. Drvna Industrija 65(4): pp. 315-322.
10. Grzegorzewska, E.; Więckowska, M. (2016): *Selected aspects of innovation in the furniture industry - empirical research findings*. Drewno: prace naukowe, doniesienia, komunikaty 59(198): pp. 147-161.
11. Katircioglu, S.T.; Kahyalar, N.; Benar, H. (2007): *Financial development, trade and growth triangle: the case of India*. International Journal of Social Economics 34: pp. 586-598.
12. Rivera-Batiz, L.A.; Romer, P.M. (1991): *International trade with endogenous technological change*. European Economic Review 35: pp. 971-1001.
13. ***: International Trade Centre; URL: https://www.trademap.org

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THE ROLE OF CHINA IN SUSTAINABLE MARKET SUPPLY OF THE EU WITH WOOD WINDOWS AND DOORS

Petrović, S.

Abstract: According to relevant data on annual demand for wood doors and windows, the EU market can be considered one of the largest in the world. Although production in the EU satisfies most of the market needs, significant amount of wood doors and windows are imported from non-EU countries every year. Among these, China distinguishes itself from other member countries, as one of the EU's most significant foreign trade partners for most categories of wood products. For this reason, the paper represents the analysis of the role of China in the EU market supply with wood doors and windows. Except for the products listed above, the paper also deals with the role of China in the EU market supply with PVC and aluminum doors and windows. The reason for expending the research is that these products represent the biggest competition to wood windows and doors. Special attention was paid to the relevant European technical standards, which specify the values of particular properties of windows and doors.
Key words: windows, doors, EU market, China, supply

1. INTRODUCTION

Doors and windows are made of wood, PVC, metal, aluminium, as well as a combination of some of these materials. Over the period 2014-2017, at the EU market, the consumption value of doors and windows made of aluminium showed highest growth, followed by metal, while the production of PVC was stagnant (Global Wood 2019). In the same period, the consumption value of wood doors and windows showed the lowest growth rate of only 4.0% (Global Wood 2019). However, the share of the consumption value of wood doors and windows in the consumption value of doors and windows made from all type materials in the EU, was 29.0% in 2018, while the share of aluminium was 28.0%, PVC 27%, and metal 16% (Global Wood 2019).

In 2018, the EU production value of wood doors reached €7.0 billion. The largest producers were Germany, with a production value of €1,35 billion, Italy with €940 million, Great Britain with €810 million, France with €640 million, Spain €580 million and Poland with €560 million (Fordaq 2018). Same year, the import value of the EU from non-EU countries reached €352.2 million (Eurostat 2020). The use of engineered wood instead of solid wood represents a new trend in the production of wood doors. In this way, it is possible to ensure greater product stability, longer life cycle and higher energy efficiency (Fordaq 2019). Another novelty is a greater use of composite materials in the doors production (Fordaq 2019). In addition, greater use of tropical hardwoods is being considered, for production high performance doors at competitive prices (Fordaq 2019).

In 2018, the EU production of wood windows reached €6.14 billion (Global Wood 2019). The largest producers were Italy with €1.46 billion, Germany with €850 million, Poland with €740 million, France with €500 million and Sweden with €440 million (Fordaq 2018). The import value of the EU from non-EU countries was €36.2 million (Eurostat 2020). In order to meet the strict requirements stipulated by technical and environmental standards, as well as to extend a product's lyfe cycle, engineered wood is increasingly used in the manucaturing of wood windows (Global Wood 2019).

In Western Europe in 2019, the share of metal windows in the total consumption value of windows was 36.8%, followed by PVC (29.4%), wood-aluminium (15.3%), wood (14.0%), PVC and aluminium (3.7%) (Global Wood 2019). In Eastern Europe, the best-selling were PVC windows, followed by the metal ones, while the consumption of combined wood-aluminium windows is expected to increase in the following period.

Door and window consumption, mostly depend on the construction of new facilities and to a lesser extent on the repair of the old ones. The recession, faced by EU countries over the past decade, has significantly affected the extent of constraction activites and reduced the number of newly built facilities. However, in order to influence to construction sector and at the same time reduce heat losses, some of the EU countries implemented appropriate measures on facilities provided for particular purpose. Austria is one of these countries, which has launched several programs with a budget of €100 million. The funds were intended for the replacement of old windows and exterior doors on residential and commercial bulidings older then 20 years (Petrovic 2014).

The choice of materials used for doors and windows production may depend on the purpose of the facilities. Metal doors and windows, are most frequently used in non-residential buildings, unlike doors and windows from other materials.

1.1. Technical standards and appropriate labels for doors and windows

The quality of windows and exterior doors is affected by a large number of external and internal factors. External factors include air temperature, wind, rain, solar radiation, noise, forced opening and fire. Internal factors include temperature and its changes in the facilities, humidity and fire. To determine the quality of doors and windows the following are tested: mechanical strength and stability, thermal and sound insulation, light and air permeability, water and wind sealing, thermal insulation, noise protection, space comfort, burglary safety, ease of handling and durability of function. The quality of doors and windows at the EU market is specified by technical standards (EN) prescribed by the European Committe for Standardization (CEN). Technical standards for these products are classified in the category CEN/TC 33: Doors, windows, shutters, building hardware and curtain walling (CEN 2020). In addition to EN, there are ISO standards, prescribed by the International Organization for Standardization. ISO technical standards relating to doors and windows are classified in the category ISO/TC 162: Doors, windows and curtain walling (ISO 2020).

Based on the requirements specified in the relevant EN technical standards for windows and external doors, the EU has issued appropriate Directives (EuroWindoor 2014). If windows and external doors are produced in accordance with the requirements prescribed in the relevant EU Directives, their producers can affix the CE mark to them. This means that the CE mark is not a certification mark, a quality mark, or an eco label. The CE mark for windows and doors is necessary for free trade in these products at the EU market. Otherwise, customs office may stop the entry of the products in the EU, or they may be withdrawn from the market.

PVC doors and windows placed on the market of the Great Britain and Ireland, are classified based on energy efficiency, into energy classes in the range A^{++} to E. PVC windows and doors in class A, A^{+} and A^{++} are considered energy positive. Energy rating is an energy balance of positive contributions from solar gain minus the negative factors of thermal heat loss and air leakage (BFRC 2020).

In recent years, VinylPlus certification has been presented at the EU market. The result of the voluntary sheme is the VinylPlus Product Label, which confirms the positive social, economic and environmental impact of PVC products (VinylPlus 2020). It helps customers find high-performance and the most sustainable PVC windows and doors on the market.

In the Nordic countries market, windows and external doors manufactured of wood, aluminium, metal and PVC are subject to Nordic eco-certification, which is awarded the Swan eco label. The requirements these products need to meet in order to be awarded the eco label, are specified in the instruction, version 4.11., which is valid until 2023 (Nordic Swan Ecolabelling 2020).

2. METHODS AND MATERIAL

For the purpose of research on the selected topic, the following general scientific methods were used: content analysis method (to analyze the content of technical standards and appropriate marks), functional analysis (to determine the connections and relationships among the analyzed variables), comparative analysis (to compare analyzed variables in the different time periods), genetic analysis (for the reasons that caused the trend of certain variable for a certain period of time).

The analysis of the EU market supply with wood doors and windows was done by using of the Eurostat database. The period 2007-2019 was chosen for the analysis, which is explained by the following. The period 2007-2008, is the period before the beginning of the recession in the EU, and it was characterized by corresponding supply chain trend on this market. It was followed by a period of recession in the EU, which was characterized by a different supply chain trend. Finally, there was a period of stabilization of the EU market with a new supply chain trend. The analysis of the supply chain trend on the

EU market with wood doors and windows from China, aimed to determine current situation, and show whether China maintained, lost or strengthened its role over the analyzed period.

Also the aim was to determine the variables that affect the EU import of wood doors and windows from China. For this purpose, four simple econometric models were created. Four hypotheses have been set up, namely that the EU's supply of wood doors and windows from China is affected by: the import of aluminium doors and windows from China, the import of wood doors and windows from Germany and Poland, as well as the number of housing starts in Great Britain. Data from Eurostat and Trading economics databases were used to create the economic models. The Statistics software package was used for creating models. Regression models were created for each of the selected variable in linear, power, and exponential functions. The coefficient of determination (R^2) was used to select the function, e.i. its highest obtained value. The coefficient of determination shows the extent to which a certain econometric model explains the variations of the dependent variable (Glavonjić, Petrović 2009). The correlation coefficient (R) was used to determine the strength of the correlations between the two analyzed variables. Econometric models were formed by using a reliability coefficient of 0.95, which means that the significance level was 0.05.

3. RESULTS AND DISCUSSION

3.1. EU market supply with wood doors and windows from China

In 2019, the import value of wood doors and windows to the EU from non-EU countries was worth €413.4 million, with 91.5% share of doors, and 8.5% share of windows (Eurostat 2020). The import value of wood doors and windows from China, over the period 2007-2019, varied between ¼ and 1/3 of the total value of wood doors and windows supply from non-EU countries. More precisely, its share rose from 22.6% (2007) to 35.3% (2014), and then fell to 25.0% (2019) (Chart 1). These shares are significantly lower compared to shares of the import value of wooden hangers and wooden upholstered chairs to the EU from China, over the period 2007-2018 (Petrovic 2018, 2019).

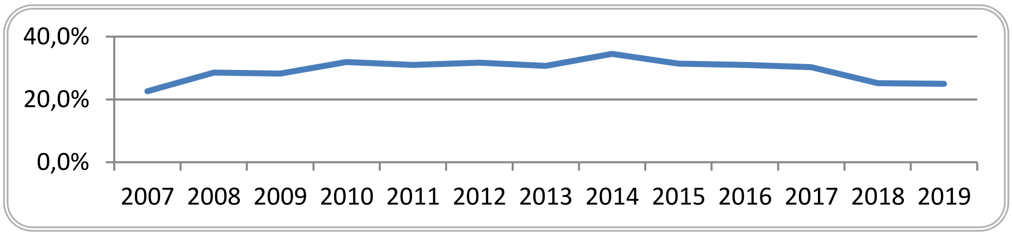

Chart 1. The share of China in import value of wood doors and windows to the EU from non-EU countries in the period 2007-2019 (Source: original)

The import value of wood doors and windows to the EU from China increased from €96.6 million in 2007, to €103.2 million in 2019 (Eurostat 2020). The record value of €120.9 million was achieved in 2008, and the following year, in 2009, the lowest value of €87.3 million was recorded (Eurostat 2020). Over the analyzed period, the average annual growth rate of the import value of wood doors and windows to the EU from China was 0.5%.

China is more significant for the EU market supply with wood doors, than with wood windows. The import value of wood doors increased from €91.0 million in 2007, to €101.8 million in 2019 (Eurostat 2020). A record import value of €115.9 million was achieved 2008, and the lowest of €83.3 million in 2009 (Eurostat 2020). Over the period 2007-2019, the import value was growing by average annual growth rate of 0.9%.

Over the period 2007-2019, in the import value of wood doors to the EU from non-EU countries, the China's share ranged from 25.1% (2007) to 35.3% (2014) (Chart 2).

The EU mostly imports hardwood doors from China, followed by coniferous wood, whereas the import of doors from tropical wood is minor (Graph 3). The import of doors from hardwood had a very unstable trend over the analyzed period, with high decline rates, especially over the period of recession and followed by the recovery period.

With an average annual growth rate of 0.5%, the import value of hardwood doors, increased from €71.9 million in 2007 to €76.3 million in 2019 (Eurostat 2020). The lowest value of import of €70.5 million was recorded in 2009, and the highest of €101.4 million in 2008 (Eurostat 2020). The average annual growth rate of the import value of coniferous wood doors was slightly higher and amounted to 2.9%. The import value of this type of product increased from €18.0 million in 2007 to €25.3 million in 2019 (Eurostat 2020). In contrast to the previously analyzed, the import value of tropical wood doors has fell drastically, from €1.1 million in 2007 to €161,000 in 2019 (Eurostat 2020).

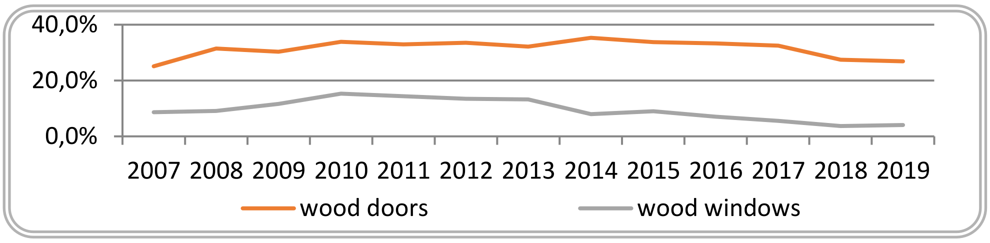

Chart 2. The share of China in import value of wood doors and windows to the EU from non-EU countries in the period 2007-2019 (Source: original)

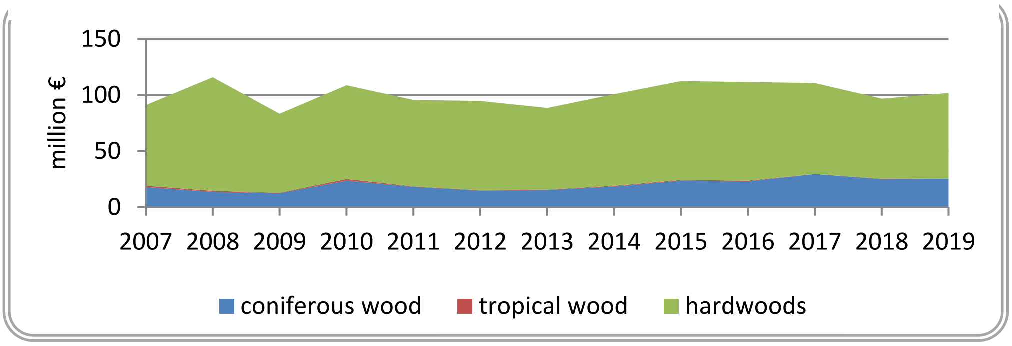

Chart 3. The import value of doors from differente type of wood to the EU from China in the period 2007-2019 (Source: Eurostat 2020)

China has no greater importance in supplying of the EU market with wood windows, and it further declined over the analyzed period. Over the period 2007-2019, the EU import from China, was ranging from 3.7% (2018) to 15.3% (2010) of the import value from non-EU countries (Eurostat 2020).

With an average annual decline rate of 10.7%, over the period 2007-2019, the import value of wood windows from China to the EU decreased from €5.6 million to €1.4 million (Eurostat 2020) (Chart 3). A record level of imports of €5.9 million was realized in 2010, and the lowest of €1.3 million in 2018 (Eurostat 2020).

The EU mostly imports coniferous wood windows from China, followed by hardwood windows, while the import of tropical wood windows is symbolic (Chart 4). In 2019, the import value of coniferous wood windows decreased to €0.2 million, while for hardwood it increased to €1.3 million, and from tropical ones it amounted to a simbolic €1,500.

After the analysis of the wood doors and windows import was conducted, it was extended to the same PVC and aluminium products. The results of the extended research showed that, over the period 2007-2019, the import value of PVC doors and windows to the EU from China increased to €15.3 million, and of aluminium to €75.3 million (Eurostat 2020). The average annual growth rate for these products over the analyzed period was 7.6%. In the same period, the import value of aluminium doors and windows continued to grow by average annual growth rate of 12.8%. The last years of the analized period are especially important for these products, considering the fact that their total import value in 2019 increased by 134.0% compared to 2017. Such intensive growth over the period 2017-2019, could contribute to the decrease in the import of wood doors and windows in the same period (Chart 5).

In 2007, the share of wood doors and windows in the import value of doors and windows to the EU from China was 80.1%, followed by aluminium 14.7%, and of PVC 5.2%. In 2019, shares were in the ratio of 53.3%:38.8%:7.9%.

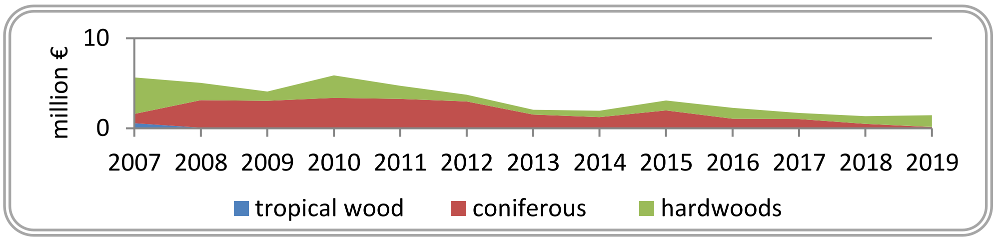

Chart 4. The import value of wood windows to the EU from China in the period 2007-2019 (Source: Eurostat 2020)

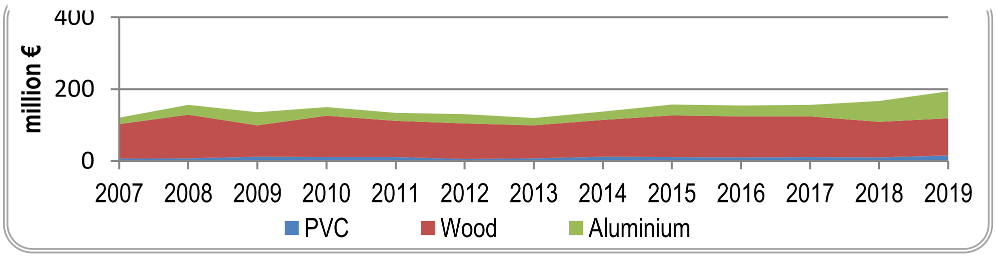

Chart 5. The import value of doors and windows of PVC, wood and aluminium to the EU from China in the period 2007-2019 (Eurostat 2020)
(Izvor: Eurostat 2020)

3.2. The impact of selected variables to the EU supply with wood doors and windows from China

To determine what the EU's market supply of wood doors and windows from China depends on, four dependent variables were selected and than simple econometric models were created. These dependant variables are the import of aluminium doors and windows to the EU from China, the import of wood doors and windows from Germany and Poland, as well as the number of housing starts in Great Britain.

By creating the first simple econometric model, the following was determined. Linear econometric model best describes the impact of the import of aluminium doors and windows on the import of wood doors and windows to the EU from China. The model showed a weak correlation among the analyzed variables (R=0.006). Aso only 0.6% of variations, of the EU supply with wood doors and windows from China can be attributed to this variable. According to the results, the following can be concluded: althought the import of aluminium doors and windows to the EU from China increased in the period 2017-2019, it did have significant impact to the import of wood doors and windows to the EU from China. Also it should be noted that the Eurostat database does not compile special statistics for aluminium doors and windows, and the ones produced of wood and aluminium, which affects the relevance of the results obtained.

Exponential econometric model best explains the impact of the EU's market supply of wood doors and windows from Germany on their import from China. However, there is a weak correlation among the analyzed variables (R=0.10). Only 1.1% of the import variations of wood doors and windows to the EU from China can be attributed to this variable. Power econometric model best explains the influence of the import of wood doors and windows to the EU from Poland on their import from China. There is a weak correlation among the analyzed variables (R=0.26). Only 6.6% of the import variations of wood doors and windows to the EU from China can be attributed to the effect of import from Poland. Comparing the obtained results, greater influence of Poland than Germany on the import of wood doors and windows to the EU from China is evident. At the same time, Germany is the largest supplier to the EU, while Poland has grown in importance over recent years. In this regard, in order to predict future relations, it would be very useful to continue the study of dependence between imports from China and Poland. Also the research should be extended to non-EU countries, because they may prove to be bigger competitors to China.

Power econometric model best describes the impact of the number of housing starts in Great Britain on wood doors and windows import to the EU from China. There is weak correlation between the analyzed variables (R=0.19), and only 3.9% of variations in the import can be attributed to this variable. China, as a member of non-EU countrie, is the largest supplier of the Great Britain market with wood doors and windows. According to the obtained results, it is clear that China has strong competitors among suppliers to the EU market of wood doors and windows. In addition to the above, there are data obtained by the research of the EU market supply with wood doors and windows from China in the period 2007-2019, which showed stagnation in doors supply and significant reduction in windows supply.

4. CONCLUSIONS

Over the period 2007-2019, the EU import value of wood doors and windows from China varied between ¼ and 1/3 of the total import value from non-EU countries. Over the period 2007-2019, the EU import value of wood doors from China varied between from 25.1% (2007) to 35.3% (2014) of the import value from non-EU countries. Unlike wood doors, China has no greater importance in supply the EU with wood windows, and it additionally decreased over the analyzed period. In 2019, China accounted for 4.1% in the total import value of wood doors and windows to the EU from non-EU countries.

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REFERENCES

1. Glavonjić B., Petrović S. (2009): Ekonomika drvne industrije, Univerzitet u Beogradu, Šumarsku fakultet, Beograd, Republika Srbija, ISBN: 978-86-7299-162-8
2. Petrović S. (2014): Tržišni potencijali i ekonomski efekti održivog korišćenja drvnih peleta kao biogoriva u Srbiji, doktorska disertacija, Univerzitet u Beogradu, Šumarski fakultet, Beograd, Republika Srbija, http://nardus.mpn.gov.rs/bitstream/handle/123456789/4865/Disertacija454.pdf?sequence=1&isAllowed=y
3. Petrović S., Jelačić D., Bego M. (2018): Actual State of the EU28 Market of Clothes Hangers of Wood, In: Proceedings of the 11rd WoodEMA Conference "Increasing the Use of Wood in the Global Bioeconomy", Belgrade, Republic of Serbia, September 26th-28th, pp. 96-106, ISBN 978-86-7299-277-9, http://www.woodema.org
4. Petrović S., Dzinčić I. (2019): The EU 28 Market of Upholstered Wooden Chairs, In: Proceedings of the 12rd WooDEMA Conference "Digitalization and Circular Economy: Forestry and Forestry Based Industry Implications Sofia, Bulgaria, September, 11th-13th pp.303-314, ISBN 978-954-397-042-1, http://www.woodema.org
5. ***British Fenestration Rating Council (BFRC) (2020): How BFRC rainbow rating labels work, https://www.bfrc.org/ratings, London, UK, accessed on 19.06.2020.
6. EUROSTAT (2020): http://epp.eurostat.ec.europa.eu/newxtweb/setupdimselection.do, accessed on 07.04.2020.
7. ***EuroWindoor AISBL (2014): EuroWindoor Guidance Sheet, Guidance on Declaration of Performance and CE marking of windows and external pe-destrian doorsets according to the CPR, Frankfurt, Germany, https://www.eurowindoor.eu/fileadmin/redaktion_eurowindoor/miscellaneous/CE02_1412_EN.pdf, accessed on 19.06.2020.
8. ***Fordaq (2019): Stasis in EU market for wooden doors, https://www.fordaq.com/news/EU_market_wooden_doors_64509.html, accessed on 15.06.2020.
9. *** Global Wood (2019): Wood Products Prices in Europe, http://www.globalwood.org/market/timber_prices_2019/aaw20190801e.htm, accessed on 15.06.2020.
10. ***International Organization for Standardization (2020): ISO/TC 162 Doors, Windows and Curtain Walling, Geneva, Switzerland, https://www.iso.org/committee/53444.html, accessed on 19.06.2020.
11. ***Nordic Swan Ecolabelling (2020): Nordic Ecolabelling for Windows and Exterior doors, Version 4.11 • 19 March 2014 - 31 March 2023, The official ecolabel of the Nordic countries Stockholm, Sweden, http://www.nordic-ecolabel.org/product-groups/group/?productGroup Code=062 accessed on 19.06.2020,
12. ***Trading Economics (2020):United Kingdom Housing Starts, https://tradingeconomics.com accessed on: 16.06.2020.
13. *** The European Trade Association of PVC Windows Szstem Suppliers - EPPA (2018): European PVC windows brochure, https://eppa-profiles.eu/wp-content/uploads /2018/07/D175_2018_EPPA_Windows-for-Life.pdf, accessed on 07.04.2020
14. ***The European Committee for Standardization (2020): CEN/TC 33 Doors, windows, shutters, building hardware and curtain walling Brussels, Belgium, https://www.cen.eu/work/Sectors/Construction/Pages/ConstructionProducts.aspx, accessed on 19.06.2020.
15. ***VinylPlus (2020): VinylPlus Product Label, Brussels, Belgium, https://productlabel.vinylplus.eu/wp-content/uploads/2020/05/Product-Label-Brochure_April2020_Web_FINAL.pdf, accessed on 15.06.2020.

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THE NEW EFQM MODEL – THE WAY TO THE SUSTAINABILITY OF THE FORESTRY SECTOR IN THE GLOBAL ECONOMY

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Abstract: In the paper we will discuss the new EFQM model. Creating a sustainable future is one of the basic principles of excellnce. Criterion 2 of the EFQM model defines Leadership in the concept of Values in Action and Model Leadership Grow. The output will be the creation of a specific Model of Leadership grow focused on identifying values and strenghts for the measure of excellence in the forestry sector.
Keywords: EFQM model, sustainability, forestry sector, global economy

INTRODUCTION

The crisis caused by COVID-19 has tested the preparedness and resistance to unforeseen situations of small and medium-sized enterprises operating in the woodworking industry. In most cases, it confirms the saying that the paper can withstand everything, but the reality is different. Many companies are proud to be owners of various types of certificates, which declare the implemented quality management systems according to ISO 9001: 2015 standards, or certificates according to ISO 31000 standards, the integrated risk management system. The quality management system should be a guarantee of profitability, competitiveness, preparedness for situations of crisis and, last but not least, to be a guarantee of a higher standard of all activities in comparison to mediocre organizations.

We deal with the Fourth Industrial Revolution, exponential technologies in connection with artificial intelligence and robotics. However, a little attention is payed to the so-called disruption. Disruption is (according to an Accenture study from 2018) a disruption of the traditional form of a given area due to groundbreaking changes. As part of the survey, Accenture developed a Disruptability Index. This index can be used to understand what stage a company is in and why. It allows to identify risks and opportunities and consequently prepare the right strategic decisions. Only excellent organizations can exploit the potential of disruption in a global environment. For organizations to be successful, regardless of industry, size, structure, or maturity, they must create an appropriate management framework. The starting point can be self-assessment according to the EFQM model. The correct use of the EFQM model of excellence in conjunction with the RADAR methodology and basic principles ensures that all management practices are used by the organization and form a single, integrated system. This system tends to constantly improve and create an effective strategy for the organization.

1. THE BASIC PRINCIPLES OF EXCELLENCE

The basic principles of excellence in (EFQM Leading Excellence, 2017) are following:

1. Creating added value for customers;
2. Creating a sustainable future;
3. Developing the ability of the organization;
4. Using creativity and innovations;
5. Leadership with vision, inspiration and integrity;
6. Agile management;
7. Achieving success through the capabilities of employees;
8. Achieving lasting results.

The late topic seems to be the area focused on agile management. The definition of the EFQM model for agile management is as follows: " Excellent organisations are widely recognised for their ability to identify and respond effectively and efficiently to opportunities and threats" (EFQM Leading Excellence, 2017).

In practice this means the following:

- Organizations use mechanisms to identify possible changes in their external environment, transfer them to possible future scenarios for the organization
- Translate their strategies into organized processes, projects and organizational structures and ensure that changes can be implemented at a reasonable speed throughout the whole value chain.
- Develop a meaningful combination of process performance indicators and related measurement results, enabling an examination of the effectiveness and efficiency of key processes and their contribution to strategic objectives.
- Use data on current process performance and capabilities, benchmarks to encourage creativity, innovation, and improvement.
- Effectively manage change through structured project management and targeted process improvement
- Evaluate and develop a portfolio of technologies with aim to improve the agility of processes, projects and organizations.

The EFQM model is based on 9 criteria. 5 criteria are so called Enablers and 4 are Results. Enablers criteria describe what the organization actually does and how. The results are conditioned by the Enablers and express what the organization achieves. Each criterion is made up of sub-criteria. The sub-criteria identify in more detail what will be assessed within the individual requirements for quality and excellence (EFQM Leading Excellence, 2017).

The use of the EFQM model could be also beneficial for small and medium-sized enterprises operating in wood processing industry. Therefore, in this study, some sub-criteria which could be connected to the flexibility to adapt to change are submitted to more detailed characteristic. We have in mind both expected and unexpected changes.

Immediately in the first precondition, Leadership in the sub-criteria is declared:

1e) Leaders ensure the flexibility of an organisation and the efficient management of changes

The assessment then takes into account whether leaders in excellent organizations are flexible, whether they demonstrate their ability to make correct and timely decisions based on available information, previous experience and knowledge, or whether they take into account the "People, Planet, Profit" aspect (Elkington, 2018) in balancing conflicting requirements, whether they seek to support and involve all relevant stakeholders in the changes needed to ensure the sustainable success of the organization, whether they efficiently manage changes through structured project management and targeted improvement process, test and improve the most promising ideas, allocate resources for their implementation within a reasonable time frame.

In the second precondition, **the Strategy is under sub-criterion 2a)** the emphasis is on identification, analysis and external indicators such as e.g. trends in the global and local economy, market and other societies that may affect the organization while anticipating the long-term and short-term global and local impacts of changes in relevant political, legal, regulatory and compliance requirements. They also use mechanisms to detect changes in their external environment and interpret them into possible future scenarios for the organization.

The precondition about **Employees in part 3a)** Employee plans support the strategy of the organization, focuses attention on the alignment of employee plans with the strategy, organizational structure, new technologies and key processes, and rapid change is expected, resp. adapting the organizational structure to support the achievement of strategic objectives.

Another prerequisite criterion is the **Partnerships and Resources criterion**. An important message of this criterion is that excellent organizations provide and monitor access to relevant information and knowledge for workers and external users, while ensuring security and intellectual property protection, creating networks of mutual learning and cooperation to identify opportunities for creativity, innovation and improvement, creating approaches to involve relevant stakeholders and use their collective knowledge to generate ideas and innovate.

In criterion no. 5 Processes, products and services, an area of excellence is considered where processes are designed and managed to optimize value for stakeholders - sub-criterion 5a) and where products and services are developed with an objective to create optimal value for customers - sub-criterion 5b).

The Result criteria directly measure and monitor the needs and expectations of customers, employees, society and also focus on economic results as an important indicator of sustainable prosperity.

At the beginning of this paper, we mentioned that the EFQM model uses the so-called RADAR methodology.

RADAR is an acronym and based on EFQM Leading Excellence (2017) stands for the following words:

R- Results – which the organization wants to achieve as part of its strategy

A – Approaches – these are approaches to how to plan and develop an integrated set so that it achieves the desired results today and in the future.

D – Deploy – application of systematic methods to ensure the implementation of results

Assess and Refine – assessment and improvement of applied approaches based on monitoring and analysis of achieved results and ongoing learning

Parts of RADAR cards divide each element into several attributes:

Table 1. Analysis of Enablers (RADAR methodology) (2)

Elements	Attributes	Auxiliary Explanation
Approach	Appropriateness	Approaches have a clear rationale, based on the relevant needs of stakeholders and are process-based
	Integrated	The approaches support the strategy and are linked to other relevant approaches
Application	Implemented	Approaches are implemented in the relevant areas and on time. The application is structured and allows flexibility and agility of the organization.
	Structured	
Assessment and Improvement	Learning and Creativity	Learning and creativity are used to generate opportunities for improvement or innovations.
	Improvement and Innovations	Measurement, learning, and creativity outputs are used to assess, prioritize and implement improvements and innovations.

Table 2. Analysis of Results (2)

Elements	Attributes	Auxiliary Explanation
Relevance and Applicability	Scope and Relevance	A comprehensive set of results is identified, including key results that demonstrate the organisation's performance in terms of strategy, objectives and needs and the expectations of relevant stakeholders.
	Integrity	The results are suitable at the time, reliable and accurate.
	Segmentation	The results are appropriately disaggregated to provide a meaningful view of the organization.
Performance	Trends	Positive trends or sustainable good performance for a period minimum 3 years.
	Objectives	For the key results need to be set and consistently achieved appropriate objectives which are in line with strategic goals.
	Comparisons	Relevant external comparisons are made in line with the strategic objectives and are favorable to key results.
	Trust	There is confidence that performance levels will continue to be sustainable in the future through an understanding of relationships and causes and effects.

Table 3. RADAR Card for the Criteria of Enablers (2):

Approach	Auxiliary Explanation	Cannot be proved	Limited ability to prove	Can be proved	Can be fully proved	Recognised as a global model
Appropriateness	Approaches have a clear rationale, based on the relevant needs of stakeholders and are process-based.					
Integrated	The approaches support the strategy and are linked to other relevant approaches.					
Application	Auxiliary Explanation	Cannot be proved	Limited ability to prove	Can be proved	Can be fully proved	Recognised as a global model
Implemented	Approaches are implemented in the relevant areas and on time.					
Structured	The application is structured and allows flexibility and agility of the organization.					
Assessment and Improvement	Auxiliary Explanation	Cannot be proved	Limited ability to prove	Can be proved	Can be fully proved	Recognised as a global model
Measurement	The effectiveness and efficiency of approaches and their application are appropriately measured.					
Learning and Creativity	Learning and creativity are used to generate opportunities for improvement or innovations.					
Improvement and Innovations	Measurement, learning and creativity outputs are used to assess, prioritize and implement improvements and innovations.					
Scale		0%	25 %	50%	75%	100%
Overall Score						

Table 4. RADAR Card for the Criteria of Results (2)

Relevance and Applicability	Auxiliary Explanation	Cannot be proved	Limited ability to prove	Can be proved	Can be fully proved	Recognised as a global model
Scope and Relevance	A comprehensive set of results is identified, including key results that demonstrate the organisation's performance in terms of strategy, objectives and needs and the expectations of relevant stakeholders.					
Integrity	The results are suitable at the time, reliable and accurate.					
Segmentation	The results are appropriately disaggregated to provide a meaningful view of the organization.					

Relevance and Applicability	Auxiliary Explanation	Cannot be proved	Limited ability to prove	Can be proved	Can be fully proved	Recognised as a global model
Trends	Positive trends or sustainable good performance for a period minimum 3 years.					
Objectives	For the key results need to be set and consistently achieved appropriate objectives which are in line with strategic goals.					
Comparisons	Relevant external comparisons are made in line with the strategic objectives and are favorable to key results.					
Trust	There is confidence that performance levels will continue to be sustainable in the future through an understanding of relationships and causes and effects.					
Scale		0%	25%	50%	75 %	100%
Overall Score						

2. PRACTICAL APPLICATION OF THE EVALUATION FRAMEWORK OF THE RADAR METHODOLOGY FOR COMPARISON OF TWO ORGANIZATIONS IN THE WOODWORKING INDUSTRY

For the practical application of the evaluation framework of the RADAR methodology, we selected two organisations which produce furniture. We focused only on the result criteria. Based on the survey, we developed a RADAR card for each organization and defined their position within the specific industry in which they do business. Before we evaluate our survey, we briefly characterize the selected organizations:

IKEA Industry Slovakia, s.r.o. with a seat in Malacky

The overall purpose of the Inter IKEA Group is to ensure the continuous improvement, development, expansion and longevity of the IKEA concept. It consists of three main activities: franchising, scope and supply, and industry.

The three main companies are working together to build a stronger franchise system. Building even better IKEA offer together with retailers and suppliers based on existing and new strengths in our value chain. The aim is also to provide franchisees with the best possible conditions for the implementation and operation of the IKEA concept and to create a strong platform for future expansion and growth.

There exist many IKEA companies around the world. All IKEA franchises are independent of the Inter IKEA Group. A large group of franchisees is owned and managed by the INGKA Group. Inter IKEA Group and INGKA Group have the same founder and a common history and heritage, they have been operating under different owners and management since the 1980s.

The industry produces approximately 10-12% of the total IKEA assortment, with the main focus on furniture. Its activities are carried out through approximately 40 production units, which include forestry, sawmill and the production of board material, wooden components, and finished furniture. It is the largest manufacturer of wooden furniture in the world.

DECODOM, s.r.o. with a seat in Topoľčany

The main trend in furniture solutions is to provide a universal sollutions in the field of design and material and customer individuality – i.e. to furnish all housing in one place and from one manufacturer. The production of Decodom is also subordinated to this goal and customer requirements. Already at the time of proposal of new furniture model there are considered other accessories to be delivered, e.g. coffee table, regals, shelves, and likewise. They try to enable the customer to buy a furniture from their offer to every room in one place and thus to avoid customers to look for desired accessory at their competition.

Table 5. RADAR Card for the Criteria of Results IKEA Industry Slovakia, s.r.o. with the seat in Malacky (own elaboration)

Relevance and Applicability	Auxiliary Explanation	Cannot be proved	Limited ability to prove	Can be proved	Can be fully proved	Recognised as a global model
Scope and Relevance	A comprehensive set of results is identified, including key results that demonstrate the organisation's performance in terms of strategy, objectives and needs and the expectations of relevant stakeholders.				**X**	
Integrity	The results are suitable at the time, reliable and accurate.				**X**	
Segmentation	The results are appropriately disaggregated to provide a meaningful view of the organization.				**X**	
Relevance and Applicability	Auxiliary Explanation	Cannot be proved	Limited ability to prove	Can be proved	Can be fully proved	Recognised as a global model
Trends	Positive trends or sustainable good performance for a period minimum 3 years.					**X**
Objectives	For the key results need to be set and consistently achieved appropriate objectives which are in line with strategic goals.					**X**
Comparisons	Relevant external comparisons are made in line with the strategic objectives and are favorable to key results.					**X**
Trust	There is confidence that performance levels will continue to be sustainable in the future through an understanding of relationships and causes and effects.					**X**
Scale		0%	25%	50%	75 %	100%
Overall Score					3 x 75%	4 x 100%

Table 6. RADAR Card for the Criteria of Results DECODOM, s.r.o. with the seat in Topoľčany (own elaboration)

Relevance and Applicability	Auxiliary Explanation	Cannot be proved	Limited ability to prove	Can be proved	Can be fully proved	Recognised as a global model
Scope and Relevance	A comprehensive set of results is identified, including key results that demonstrate the organisation's performance in terms of strategy, objectives and needs and the expectations of relevant stakeholders.			**X**		

Integrity	The results are suitable at the time, reliable and accurate.				**X**	
Segmentation	The results are appropriately disaggregated to provide a meaningful view of the organization.				**X**	
Relevance and Applicability	Auxiliary Explanation	Cannot be proved	Limited ability to prove	Can be proved	Can be fully proved	Recognised as a global model
Trends	Positive trends or sustainable good performance for a period minimum 3 years.				**X**	
Objectives	For the key results need to be set and consistently achieved appropriate objectives which are in line with strategic goals.					**X**
Comparisons	Relevant external comparisons are made in line with the strategic objectives and are favorable to key results.					**X**
Trust	There is confidence that performance levels will continue to be sustainable in the future through an understanding of relationships and causes and effects.					**X**
Scale		0%	25%	50%	75 %	100%
Overall Score				1 x 50%	3 x 75%	3 x 100%

The RADAR rating is more complex as the individual sub-criteria are scored separately and the basic principle for scoring is that if the organization improves over time, its score against the model will increase. In addition, point weights are assigned to each of the nine criteria to calculate the total number of points awarded. In general, each sub-criterion has the same weight within the criterion. For example, each of the 5 sub-criteria of the Leadership criterion has a share of 20% out of 100 points. However, there are exceptions. Sub-criterion 6a) occupies 75% of the points allocated to criterion 6, while sub-criterion 6b) occupies 25%. Sub-criterion 7a) occupies 75% of the points allocated to criterion 7, while sub-criterion 7b) occupies 25%. The total score that can be achieved is from 0 to 1000 points.

In this paper, it was not possible to score each sub-criterion separately, so we used a summary output, the result of which is as follows.

The company **IKEA Industry Slovakia, s.r.o. with its seat in Malacky**, is part of a strong franchise system and the IKEA brand is recognized worldwide and we can assume partnership orientation. In terms of agility, the organization is able to adapt quickly to effective change and can adapt in a timely manner to a new threat or opportunity. Production is focused on the so-called value benefits, which means a very good distinctive value of products and services from customers. Part of the strategy is the practical transfer of ideas into new products, services, processes, systems and social interactions.

From this point of view, IKEA Industry can be considered an excellent organization with a global reach.

The company **DECODOM, s.r.o. based in Topoľčany**, is rather locally oriented and its strategy is strongly oriented towards traditions and a management system that is focused on the management of processes and systems improvement. The company uses intellectual capital, which is an intangible asset of the organization and its strengths are diversity, educational networks, the opinion of stakeholders about the organization and, last but not least, top management, i.e. people who coordinate and balance the interests and activities of all who are in contact with the organisation.

From this point of view, it is possible to consider the DECODOM company as an excellent organization with local scope.

CONCLUSION

In conclusion, we could say that both of the above organizations, without claiming to the completeness of the input information in this paper, are in a way excellent and if they can sustain their results in the future, we can consider them excellent organizations. Why is it necessary the use, resp. implementation of the EFQM Model by organizations? There may exist several reasons, but the most important is that excellent organizations are constantly adding value to customers and can anticipate and meet needs, expectations and opportunities. They compare their performance with relevant benchmarks and learn from the strengths, continuously monitor and evaluate their customers' experiences and perceptions, and respond to any feedback. The experts from practice reproach several shortcomings to the EFQM model. Like other models, it passes through certain development stages and the innovation of the model is not always fortunate and sufficiently understandable. Nevertheless, it can be used as a benchmark for excellent organizations in the woodworking industry.

REFERENCES

1. Elkington, J. (2018): *"25 Years Ago I Coined the Phrase "Triple Bottom Line." Here's Why It's Time to Rethink It": From Harvard Business Review.* Harvard Business Publishing, Brighton
2. Česká spoločnosť pre kvalitu. (2020): *EFQM Leading Excellence: From Časopis Perspektívy Kvality.2. vyd.* Česká spoločnosť pre kvalitu, Praha
3. ***: Decodom website (2020): O nás: Výroba v Topoľčanoch. URL: https://www.decodom.sk/clanky/o-nas-1/vyroba-v-topolcanoch-1
4. ***: Inter Ikea Group (2020): Our Business in Brief. URL: https://www.inter.ikea.com/en/about-us/business-in-brief/index.html
5. Model excelence EFQM. Praha.Česká společnosť pro jakost. Brussels: EFQM, 2012. ISBN 978-90-5236-698-2
6. Fišerová, Danuše.Fórum EFQM 2019. Perspektivy kvality. 2019, č.4, 40-41. ISSN 1805-6857 (print)
7. Vaníček, M.: Disrupce doby globální. In: Perspektivy kvality. 2020, č. 2, ČSJ, ISSN 1805-496X (online)
8. https://knowledge.ckgsb.edu.cn/219/1 globalization/us-china-decoupling/

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SUSTAINABLE DEVELOPMENT GOAL INDUSTRY AND INNOVATION: CHALLENGE FOR WOOD-PROCESSING INDUSTRY IN SLOVAKIA

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Abstract: Sustainable development goals (SDGs) present a transformation force of Agenda 2030 for sustainable development. The Agenda 2030 established by the United Nations is the most comprehensive set of global priorities for achieving sustainable development. One of the SDGs is a goal Industry and innovation. Wood-processing industry has play an important role in this issue with a high potential for ensuring own sustainability and competitiveness, as well as possibility of contributing to the fulfillment of SDGs. Aim of the paper was to provide insight into the situation in the field of wood-processing industry in Slovakia and to analyze selected indicators of SDG with emphasis on innovation activities, research and development spending and others. In order to obtain the necessary data, the data from Eurostat and Statistical Office of the Slovak Republic was used. Results define some dominant features and also significant challenges and opportunities that this industry faces.
Keywords: sustainable development, innovation, wood-processing industry

1. INTRODUCTION

The basis of sustainable development, generally accepted in the report of the World Commission on Environment and Development, points to the unceasing need to shape the economic development of society in a way that respects the resources of the planet and social justice (Mensah, Casadevall, 2019). It could be seen that the basis of this concept "meeting the needs of present generations without compromising the ability to meet the needs of future generations" (Our Common Future, 1987) is perceived as an issue of the global direction of humanity. However, a proactive approach by the business sector is also needed.

The transformation force of Agenda 2030 represents 17 sustainable development goals (SDGs). The mission of these goals is to stimulate actions on the next 15 years to achieve a set of important social and environmental priorities worldwide (United Nations, 2015; Sachs, 2012). These goals represent a wide range of areas, from more generally oriented: poverty, hunger, peace, good health, clean water, energy, sustainable cities, to the goals more industry or business oriented as innovation, decent work and economic growth, sustainable production and consumption, quality education, gender equality or climate action. In general, the SDGs represent a challenge for enterprises. The Agenda 2030 says that "private business activity, investment and innovation are major drivers of productivity, inclusive economic growth and job creation. We acknowledge the diversity of the private sector, ranging from micro enterprises to cooperatives to multinationals. We call upon all business to apply their creativity and innovation to solving sustainable development challenges" (United Nations, 2015).

The forest and timber sector are contributing to the SDGs in many ways. It could be mainly by providing low-carbon, bio-based solutions that are renewable and recyclable (World Business Council for Sustainable Development, 2019). Moreover, from the point of view of wood-processing industry it is necessary to support the development of sectors with higher value added, especially those with a negative trade balance (Green Report, 2019). 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). However, most foreign companies investing in Slovakia has 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). 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). Wood-processing industry 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). According to Walz et al. (2017) reaching the SDGs needs innovations, whereas the high importance of green issues also reflects the high pressure to reduce the environmental burden in every country and industry. Furthermore, the need for environmental innovations and the build-up of life-supporting infrastructure go hand in hand.

The Government of the Slovak Republic consider the sustainable development as one of the basic pillars of the knowledge society (Ministry of Economy SR). Aim of the paper is to provide insight into the situation in the field of wood-processing industry in Slovakia and to analyze selected indicators of SDG with emphasis on innovation activities, research and development spending and others.

2. MATERIALS AND METHODS

Within the primary architecture of the paper we pay attention to analyze selected indicators of SDG 9 – Industry and innovation: 1) at national level of country; 2) at level of wood-processing industry. In order to obtain the necessary data, the database from Eurostat and Statistical Office of the Slovak Republic (SOSR) was used. We compare the indicator of gross domestic expenditure on R&D with data of the V4 countries and the EU average. We analyze the selected indicators (Table 1) in terms of individual data availability. The enterprises of wood-processing industry are divided according to SK NACE: 16 – Manufacture of wood and of products of wood and cork, except furniture, manufacture of articles of straw and plaiting materials, 17 – Manufacture of paper and paper products, and 31 – Manufacture of furniture.

Table 1. Selected analysed indicators

Indicator	Level	Goal linking	Source
Gross domestic expenditure on R&D	national	scientific research	Eurostat
Innovation expenditures in business	sector	development & innovation	SOSR
Type of innovation activity	sector	development & innovation	SOSR
Barriers of innovation activity	sector	development & innovation	SOSR

These data were processed using an analytical-synthetic method, mainly descriptive statistics through the MS Excel and software STATISTICA 12. At the end of the paper we define some dominant features and significant challenges and opportunities that this industry faces.

3. RESULTS AND DISCUSSION

Except for some multinational enterprises operating in the Slovak Republic, no significant investments were made in the modernization of processing technologies. The wood-processing sector is forced to respond to changes in demand in the European market, through the implementation of innovations and changes in the structure of production (Green Report, 2019). Despite the positive development of economic indicators (Table 2) and the growth in the volume of domestic wood processing, there was no significant increase in the competitiveness of most wood processing enterprises and growth in added value. It is the producing of added value that is a negative and a weakness of the Slovak wood-processing industry.

Table 2. Economic characteristics of wood-processing (Source: National Forest Centre, 2020)

Wood-processing industry (mil. €)	2016	2017	2018
Turnover	3 023	2 984	3 129
Costs	2 830	2 802	2 960
Profit/loss before taxation	193	182	169
Average number of employees	22 446	23 407	23 434

Economic indicators of the wood-processing industry were reflected in the improvement of some parameters compared to the previous year. Turnover increased by 6.6% to the level of 3,129 mil. €, costs increased by 5.6% and employment are slightly increased to 23,434 jobs. The profit/loss before tax decreased by 7.1% to 169 mil. €.

From the national level point of view, within the goal Industry and innovation we analyzed the indicator that measures gross domestic expenditure on R&D of the business sector as a percentage of the GDP. From the Figure 1 is evident that values of this indicator are in V4 countries below the average of EU.

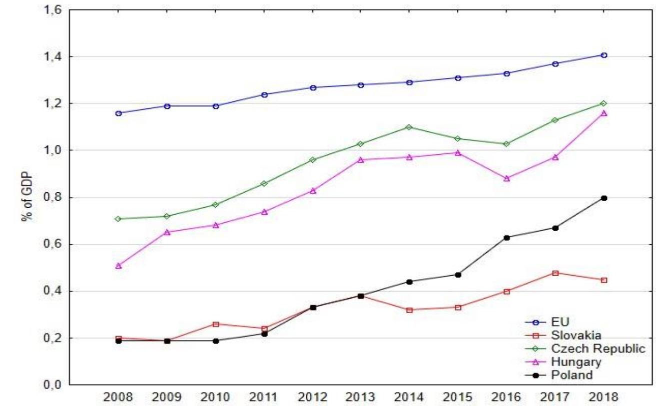

Figure 1. Gross domestic expenditure on R&D *(Based on Eurostat data)*

While the average value of the expenditures of R&D by the enterprise sector in 2018 in the EU is 1.41% of GDP (which represents an increase of 0.04 percentage points compared to previous year) and still has a slightly increasing tendency, in case of V4 countries is only 0.90 % of GDP (2018). Slovakia lags behind the other V4 countries and its values are relatively low (2017 it is 0.48%), while in 2018 they fell to 0.45%.

The analysis through indicators of the innovative activity of wood-processing enterprises brings a different perspective. According to SOSR (2018) enterprises with innovation activity are those, that introduced new or significantly improved products to the market or introduced a new or significantly improved process within the enterprise. Further abandoned or on-going innovation activities are also included to this group of enterprises.

Table 3. A general data related to innovation of enterprises (Source: SOSR, 2018)

Enterprises		Wood	Pulp, paper	Furniture
Enterprises with innovation activity	Total	38 (20.65%)	18 (30.00%)	42 (31.34%)
Total innovation expenditures	in thous. €	6 397	1 167	2 828
	% of total turnover for all enterprises	0.94	0.09	0.35
	% of total turnover for all innovation active enterprises	2.35	0.15	0.55
Turnover (thous. €)	innovation activity	272 454	782 372	512 281
Turnover (thous. €)	without innovation activity	406 249	573 738	304 424

In terms of indicators related to the innovation at the level of wood-processing industry (Table 3) it is clear that most enterprises with innovative activity are located in the furniture production sector (31.34%) while enterprises implement both technological and non-technological innovations. Enterprises with innovaion activity from manufacture of pulp and paper represent 30% of enteprises and their focus is on both technological and non-technological innovations. Nearly 21% enterprises with innovation activity recorded manufacturing of wood with predominantly technological innovation. A smaller percentage of enterprises in the industry is only in case of manufacture of textiles, clothing and leather (16.70%), repair and installation of machinery (19.80%), and other manufacturing (17.00%).

In 2016, the most expenditures on innovation are realized by wood processing enterprises (6,397 thousand €), while it represents 2.35% of the total turnover for all innovation active enterprises. This is followed by furniture manufacturing enterprises (2,828 thousand €), which represents 0.55% of total turnover for all innovation active enterprises. In the case of paper manufacturing enterprises, total expenditure is 1,167 thousand € (0.15% of total turnover). The most expenditures heads to the acquisition of machinery, equipment, software and builds. In case of furniture enterprises, higher revenues are achieved by innovative enterprises. From the point of view of other fields of industry, it represents relatively low values. We are aware that the wood-processing industry is characteristic by a low-technology technology sector but this industry has a several opportunities for improvement. On the other hand, there exist some barriers which prevent the implementation of innovation activities (Figure 2).

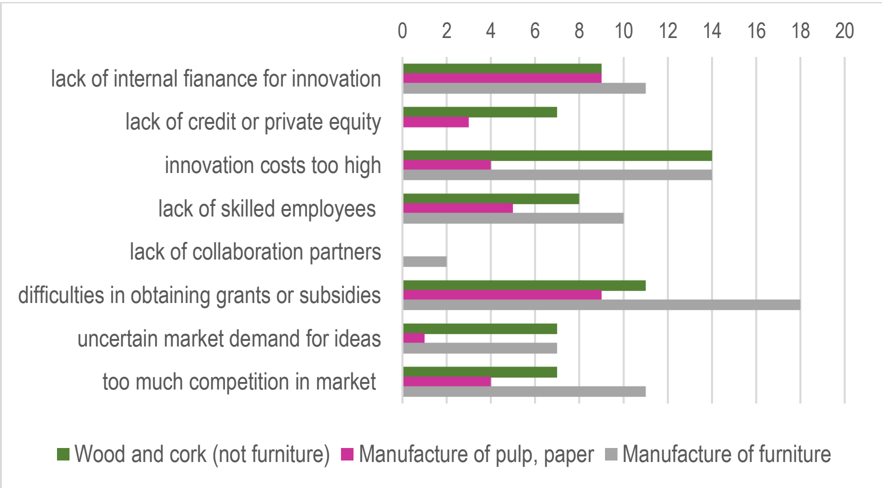

Figure 2. Factors hampering innovation activities (Based on SOSR, 2018)

The wood-processing enterprises identified the innovation costs as the biggest barrier to realization innovative activities. In the field of paper and pulp industries the enterprises marked the difficulties in obtaining government grants or subsidies, and it is the same in furniture enterprises. Other factors were the lack of internal finance, lack of skilled employees, or too much competition in the market.

The wood-processing industry is typical of its features. It may seem that there has been far too little innovation in some fields of wood-processing industry and decreasing the share on market. This trend could be caused by replacing of wood by plastics and aluminum. The wood-processing industry still fight with the lower value added of its production. Changes in investment could solve this problem, increasing productivity which could ultimately lead to increased competitiveness of the sector. Technological developments must be adapted and further developed to comply with the increasingly demanding consumer sectors. Strategies of these enterprises are still more oriented on improving existing products whereas enterprises could focus their strategies more on customer specific solutions or reaching new customer groups or new products. Further it is needed to be included bio-based solutions and improving partnership as a significant source of innovation through value chain based on cooperation. 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).

An interesting finding is the position of Slovakia in the SDG index. Slovakia ranked 23rd out of 157 countries in 2017, and the worst results were achieved in meeting goal 9 - industry, innovation, where the

Slovak Republic lags behind in expenditures on science and research, but also in other parameter (Pontis, 2018). The improvements in this area are debatable due to the current situation marked by the Covid-19 pandemic. It has caused many problems on the part of producers as well as processors of wood raw material, and the fall in the sale of wood automatically means shortfalls in sales. The wood sector is already feeling the impact, people are stopping buying furniture products. There is an optimistic assumption of a slight increase in autumn 2020 or in the second half of 2021 (LESmedium, 2020).

The paper has some limitations: the possibilities of analysis of more indicators related to innovation on national or sector level, processing of currently unavailable current data, more up-to-date data concerning innovation activity and the possibility of comparison with V4 countries.

4. CONCLUSION

The issue of SDGs can be described as phenomenally complex. We can conclude that for Slovakia the fulfillment of SDGs is still a challenge. 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. The main priority for the development of the forestry and timber sector should be the modernization of technology in order to increase the efficiency of production, which would increase the competitiveness of DSP companies. Investing in R&D and innovation are essential for long-term economic development and prosperity as they foster economic growth, job creation, labor productivity and resource efficiency. At the national level Slovakia lags behind not only the EU average but also V4 countries and its values are relatively low. Moreover the amount of innovative expenditures and innovative activity are at the low level.

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REFERENCES

1. European Commission (2019): *2019 Innovation Scoreboards: The innovation performance of the EU and its regions is increasing.* URL: https://ec.europa.eu/commission/presscorner/detail/en/QANDA_19_2998
2. Eurostat. *Gross domestic expenditure on R&D by enterprise sector.* URL: https://ec.europa.eu/eurostat/databrowser/view/sdg_09_10/default/table?lang=en
3. Eurostat: *SDG 9 Industry, innovation and infrastructure*. URL: https://ec.europa.eu/eurostat/web/sdi/industry-innovation-and-infrastructure
4. Green Report (2019): *Report on forestry in the Slovak Republic for 2018*. The Ministry of Agriculture and Rural Development of the Slovak Republic, National Forestry Center. URL: https://www.mpsr.sk/zelena-sprava-2019/123---14927/
5. LESmedium (2020): *The effects of the corona crisis will be serious. The virus is also a memento.* URL: http://www.lesmedium.sk/aktualne/anketa-dopady-koronakrizy-budu-vazne-virus-je-aj-mementom
6. Mensah, J.; Casadevall, S. R. (2019): *Sustainable development: Meaning, history, principles, pillars, and implications for human action: Literature review*. Cogent Social Sciences 5 (1): pp.5-6.
7. Merková M., Drábek J., and Polách, J. (2011): Impact of Investment on Labour Productivity Growth in Wood Processing Industry in Slovak Republic. Finance and the Performance of Firms in Science, Education and Practice. Zlín, 2011, p.324-332.
8. Merková, M. and Drábek, J. (2010): Effects and benefits of foreign direct investment for the development of wood-processing industry. In: Wood processing and furniture manufacturing: present conditions, opportunities and new challenges. Vyhne, Slovakia. 2010. pp. 125-133.
9. Merková, M., Drábek, J. and Jelačić, D. (2012): Determinants of Effects of Foreign Direct Investment in Terms of Slovak Republic and Wood-Processing Industry of Slovakia. *Drvna industrija* 63, 129-142. doi:10.5552/drind.2012.1136

10. Ministry of Economy of the Slovak Republic. *Strategies and policy*. URL: https://www.mhsr.sk/inovacie/strategie-a-politiky
11. National Forest Centre (2020). *Economic indicators of wood-processing industry.* URL: https://gis.nlcsk.org/IBULH/SpracDrev/DSP
12. Our common future (1987): *Report of the World Commission on Environment and Development.* URL: https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf
13. Pontis (2018): *Sustainable Development Goals 2017 - how is Slovakia doing?* URL: https://www.nadaciapontis.sk/novinky/ciele-udrzatelneho-rozvoja-2017-ako-si-vedie-slovensko/
14. Sachs, J. D. (2012): From millennium development goals to sustainable development goals. *The Lancet* 379 (9832): pp. 2206-2211.
15. Statistical Office of the Slovak Republic (2018): *Innovation activity of enterprises in the Slovak Republic 2014-2016.*
16. United Nations (2015): *Transforming our world: Agenda 2030 for sustainable development.* A/RES/70/1. URL: https://sustainabledevelopment.un.org/post2015/transformingourworld/publication
17. Walz, R.; Pfaff, M.; Marscheider-Weidemann, F.; Glöser-Chahoud, S. (2017): Innovations for reaching the green sustainable development goals – where will they come from? *International Economics and Economic Policy* 14: pp. 449-480.
18. World Business Council for Sustainable Development (2019): *Forest sector. SDG Roadmap.* URL: https://docs.wbcsd.org/2019/07/WBCSD_Forest_Sector_SDG_Roadmap.pdf

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EVALUATION OF THE INNOVATION ACTIVITY OF THE WOOD PROCESSING INDUSTRY AS SUSTAINABLE INDUSTRY

Olšiaková, M., Loučanová, E., Šupín, M.

Abstract: The paper is aimed at the evaluation of the innovation activity of the wood processing industry in Slovakia. The situation is assessed from the point of view of innovation activity concentrating on three areas: wood and cork (not furniture), manufacture of pulp, paper and furniture manufacture. Within the Forest-Wood-Chains, the sustainability concept has developed from a narrow concentration on sustainable wood production. Wood is supposed to be the primary raw material in the wood processing industry. It is considered to be a material with environmental nature. It is necessary to determine the innovation activity and performance of wood-processing industry of Slovakia and its favourable and critical areas through the analysis which is followed by the comparison of selected periods. Subsequently, the results of the analysis point to the state of innovation activity of wood processing industry in Slovakia compared to other industries.
Key words: innovation, innovation activity, wood processing industry.

1. INTRODUCTION

The concept of sustainability in the forest sector has developed from a limited concentration on sustainable wood production to a much wider evaluation of environmental, social, and economic sustainability for all value chains. Forest-Wood-Chains are understood as chains of production processes (e.g. harvesting–transport–industrial processing), which are associated with wood products. Sustainability is determined by analysing environmental, economic, and social sustainability indicators for all production processes. Lindner et al. (2010) states that the forest-wood-chains sustainability is presented as the less intensive management system with natural regeneration and motor–manual harvesting shows higher carbon storage and slightly less energy use. It creates more employment and higher labour costs, but the average rate of accidents is also higher.

Sustainability has been the main idea in forestry for many years. The forest management is aimed to organise timber harvesting schedule with regard to the forest growth potential to maintain a continuous flow of timber production. In the twentieth century we recorded a change, specifically the multiple use of forest resources was replaced by the narrow focus on timber production that used to be a management objective. Consequently, there were included multi-dimensional aspects of sustainability in forest management. After entering into the 21st century, the idea sustainability has been spread and economic sectors of Forest-Wood Chains have become its part (Päivinen, Lindner, 2006).

Innovation activities are one of the elementary preconditions for the company´s success based on the sustainable development within the market economy. These activities are a significant dynamic factor of each company. They also create an important link between the present and future of each company. Schumpeter (1939) defines innovation as creating a new production function representing application of new ideas into the production process. Some authors (OECD and Kotsemir, Abroskin, 2017, Očkajová et al, 2019, Olšiaková et al. 2017) characterise innovations as one of the factors influencing economic changes. Radical innovations create significant changes in the world; sequential innovations present the change process.

Innovations can take many forms, such as introduction of a new product, process innovations, opening of a new market, development of new sources of inputs supply and changes in industrial organization.

If an enterprise considers increasing its investments, implementing new innovations and competitiveness, it should search all available sources and mainly use all factors that support innovation processes.

Innovation process is strongly associated with predictions in innovative process. The statement or prophecy about future state of investigated object is systematically derived by the prognosis. It means that innovation in innovative process will be applied under specific conditions in a specific period. The prognosis is primarily aimed at estimates of market changes, customers' requirements and needs, competition development, market capacity development, changes in disposable incomes and macroeconomic parameters (Loučanová, 2016; Straka, 2013; Štofková, 2013; Havierniková, 2012).

From the point of view of the National program for the utilization of wood potential in the Slovak Republic (Ministry of Agriculture of the SR, 2016) wood processing industry reports insufficient competitiveness on domestic and mainly on foreign markets. The reason rests in the lack of own financial resources for innovations. It mainly concerns small and medium-sized wood processing companies. This economic unstable situation causes problems in preparation of innovation and their implementation that leads to lowered competitiveness. It is consequently reflected in many difficulties.

Most of domestic wood processing companies attempt to use the direct entry to foreign markets. Their products are often sold as semi-finished or low value production to subsequently processing companies.

Parobek et al. (2016) indicates that the comparative advantages are changing with the stage of wood products processing. In particular, they decline with the increasing value added products. The stage of wood processing also influences the trade specialisation. Slovakia is inter-industry country specialised on the raw material stage and the stage of semi-finished mechanical wood products with low added value (e. g. sawnwood). Slovak trade changes in specialisation with the industry with the increasing added value of the products (Loučanová et al. 2017; Šupín 2009; Parobek et al. 2014; 2015).

There were not recorded any important changes in customers´ behaviour towards wood as a material. Therefore it is recommended to keep the existing position and implement innovative strategic business models that emphasize wood as a material and its quality compared to substitute materials (Olšiaková et al., 2016; Loučanová et al., 2014).

The purpose of these models rests in defining expectations and needs of customers taking into account their environmental as well as other reflections (Paluš et al., 2014; Paluš et al. 2011). Thus they identify the specific product characteristics taking into account the customers´ requirements.

The elements specification is an important impulse to identify trends and to determine consecutive procedures, improvements and innovations for selected products (Loučanová et al., 2014) when applying the quality management systems with the objective to ensure a higher efficiency in the whole sector (Gejdoš, 2016).

The study results by Kaputa et al. (2016) validate that foreign competition is considered to be the most substantial obstacle for the Slovak exporters of wood products. To succeed in foreign surroundings they have to invest in promotional activities. They also have to deal with limited access to capital. Another problem rests in an absence of the strategic development of the whole forest sector that would provide more effective problems solutions resulting from the industry structure transformation as well as problems connected with business relations within the supply chain which is influenced by a number of above mentioned factors and cyclical changes in wood prices.

As it is stated by Klenk and Wyatt (2015) and Šterbová et al. (2016) the strategy in the forest sector should fixate on mobilisation of knowledge. It leads to innovation that means a level of engagement with partners. It is rather creative and transformative than informative and cooperative. In the long term, it should establish new ways for innovation for all types of wood in this sector.

The aim of the paper is the assessment of the innovation activity of the wood processing industry in the Slovakia.

2. METHODOLOGY

The analytical-synthetic method presents an elementary approach to process the innovation activity issue of the wood processing industry valuation. In the paper we analyse the issue within the individual parts of the wood processing industry through the researched features and processes analysis. The results that we have obtained describe the innovation activity of wood processing enterprises in several respects, identifying the basic causalities and coherences. The results of the research are partial findings and conclusions, which are combined through a synthesis into a unified whole of the examined issue.

3. RESULT AND DISCUSSION

Companies with innovation activities are those that have launched new or radically improved products or introduced new or significantly improved processes in the company or introduced organizational or marketing innovations. We can also include here those companies that have unfinished or suspended innovation activities.

28.7 % of enterprises were active in innovations in the Slovak Republic in the monitored period review. 30.7 % comes from industry and selected services (except construction). Enterprises from the industrial sector had higher innovation ability (32.7 %) than in the service sector (28.4 %).

The proportion of enterprises with innovation activity varied and ranged from 16.7 % to 66.7 % in individual sectors of economic activity. It reached the average 32.7 % in industry and 28.4 % in services (Statistical Office of the Slovak Republic*,* 2018; 2020*)*.

The wood processing industry's innovation activity in terms of furniture production is 31.3 %, paper and paper products 30 % and wood processing 20.7 %. The average value of innovation activity in the wood processing industry is 27.33 % in complex. This value does not reach the average of the innovation activity of enterprises in Slovakia, so we can state that it is below average.

Compared to the previous monitored period, it has decreased by 6.7 % in furniture production, by 3 % in wood, pulp, paper and paper products, but it has increased by 5.90 % in wood processing.

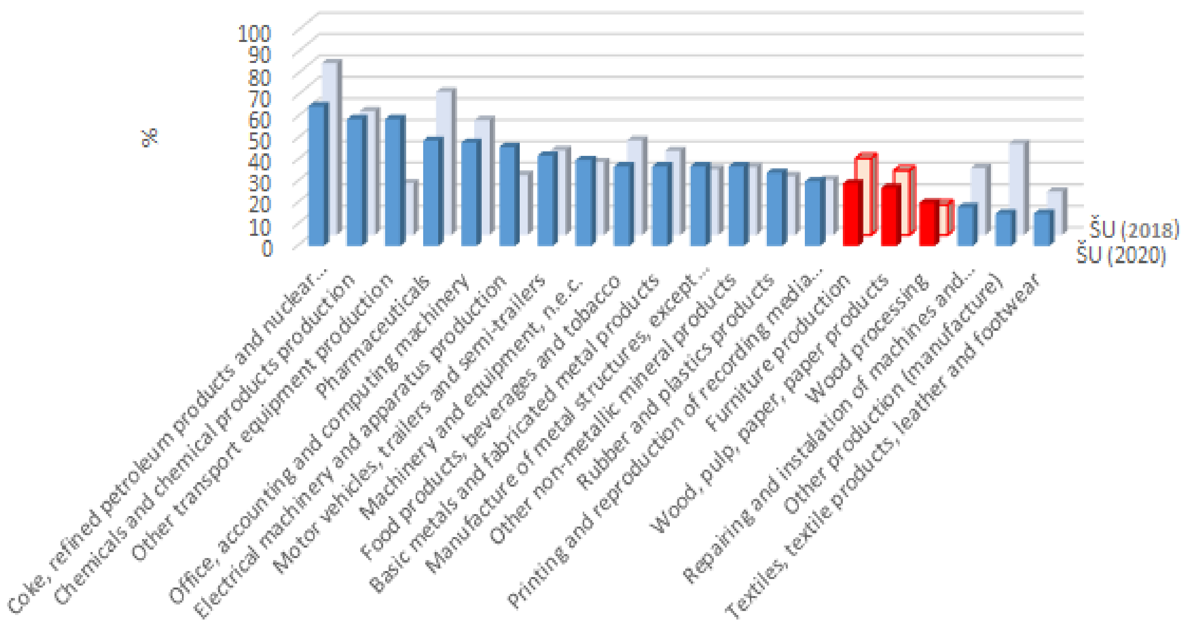

Figure 1 The share of enterprises with innovation activity from the total number of enterprises in industry Source: Statistical Office of the Slovak Republic (2018); Statistical Office of the Slovak Republic (2020)

From the point of view of statistics, the greatest burden within innovation activities is in the machinery and equipment acquirement, followed by internal research and development, etc. Expenditures on other innovations activities present the lowest burden in terms of expenditures for innovation activities (seen Figure 1) (Statistical Office of the Slovak Republic*, 2018; 2020)*.

Compared to the previous monitored period more innovation expenditures were used in the area of acquisition of machinery and equipment, but less in the area of acquisition of external knowledge.

Below-average innovation activity in the wood processing industry is mainly caused by a lack of own financial resources for innovation, especially in small and medium-sized processing enterprises. This economically unstable situation causes complications in the processes of innovations preparation and implementation and finally it leads to drecrease competitiveness. Thus, most of domestic wood processing is facing difficulties in direct access to foreign markets and their production is often sold as semi-finished or low-value products for follow-up processing companies.

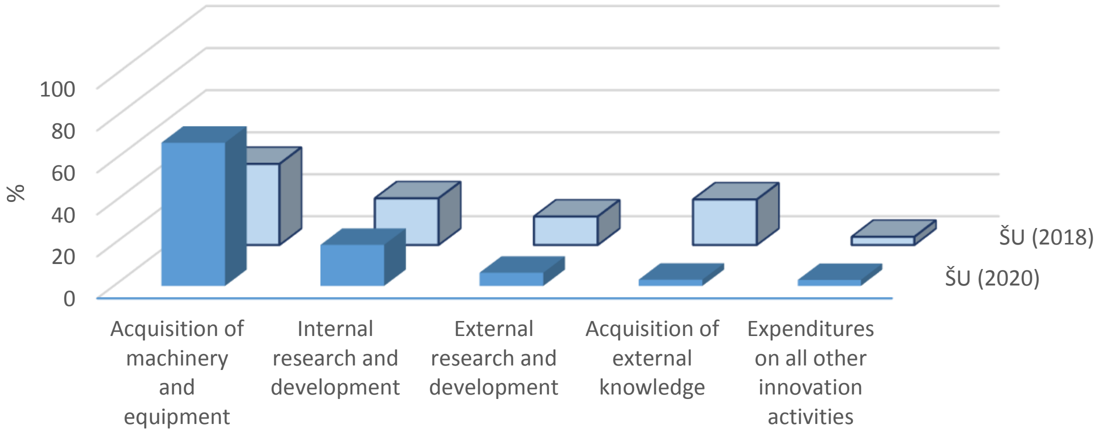

Figure 2 The structure of expenditures on innovation in industry
Source: Statistical Office of the Slovak Republic (2018); Statistical Office of the Slovak Republic (2020)

CONCLUSION

Innovation activities create a significant component strongly influencing the success of the enterprise on the market regardless of which sector the enterprise belongs to. The paper is aimed at the assessment of the innovation activity in the Slovak wood processing industry. Results from our study point to below average innovation activity in the wood processing industry which is caused mainly by financial reasons for innovations. It should be noted that wood processing has slightly improved in the area of innovation activity compared to furniture and pulp and paper manufacturing. The problems result in decreased competitiveness of Slovak wood processing companies in foreign markets. One of possible ways to solve this problem is to create partnerships between small and medium sized enterprises for more efficient obtaining of financial resources for innovation activities, resulting in higher competitiveness of these enterprises abroad because external cooperation in innovation activities has decreased.

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REFERENCES

1. Gejdoš, P. (2016): *Analysis of performance improvement of wood processing companies in Slovakia and the Czech Republic through the implementation of quality management systems*. In: Acta Facultatis Xylologiae 2016, 58 (1), pp. 113-124.
2. Havierniková, K. (2012): *Selected aspects of clusters initiatives in the field of industry in the Slovak Republic*. In Proceedings of 21st International Conference on Metallurgy and Materials (METAL 2012), pp. 1838-1845.
3. Kalamárová, M., Parobek, J., Loučanová, E., Trebuňa, P. (2014): *Competitiveness evaluation of the slovak forest industry.* In: Proc. 7th Int. Scientific Conf. of Int. Assoc. for Economics and Management in Wood Processing and Furniture Manufacturing (WoodEMA), Zvolen, pp. 58-62.
4. Kaputa, v., Paluš, h. (2014):. *Architects and wood as a construction material: a case of Slovakia.* In: Position and role of the forest based sector in the green economy : proceedings of scientific papers. Zagreb - WoodEMA, 2014, pp. 63-68.
5. Kaputa, v., Šupín, M. (2010): *Consumer preferences for furniture.* In: Wood processing and furniture manufacturing : present conditions, opportunities and new challenges. - Zvolen : Technical University in Zvolen, 2010. pp. 81-90.
6. Kaputa, V.; Paluš, H.; Vlosky, R. P. (2016): Barriers for wood processing companies to enter foreign markets: a case study in Slovakia. European journal of wood and wood products, 2016, 74 (1), pp. 109-122.
7. Klenk, N.L.; Wyatt, S. (2015): *The design and management of multi-stakeholder research networks to maximize knowledge mobilization and innovation opportunities in the forest sector.* In: Forest Policy and Economics, 61, pp. 77–86.
8. Lindner, M.; Suominen, T.; Palosuo, T.; Garcia-Gonzalo, J.; Verweij, P.; Zudin, S.; Päivinen, R. (2010): *ToSIA—A tool for sustainability impact assessment of forest-wood-chains.* In: Ecological modelling 221(18), pp. 2197-2205.
9. Loučanová, E. (2016): *Inovačné analýzy a stratégie*. Technical University in Zvolen, Zvolen, Slovakia, 2016; p. 149.
10. Loučanová, E., Paluš, H., Dzian, M. (2017): *A course of innovations in wood processing industry within the forestry-wood chain in Slovakia: A Q methodology study to identify future orientation in the sector*. In: Forests, 8(6).
11. Loucanova, E., Parobek, J., Kalamarova, M., Palus, H., Lenoch, J. (2015): *Eco-innovation performance of Slovakia*. In: Procedia Economics and Finance, 26, pp. 920-924.
12. Loučanová, E.; Kalamárová, M.; Parobek, J. (2014): *The competitiveness of wood products from the perspective of used material.* In: Acta Facultatis Xylologiae 2014, 57 (2), pp. 155-163.
13. Loučanová, E.; Parobek, J. Paluš, H. (2014): *Identification of Slovak customers' requirements for storage furniture based on the KANO mode*l. In: Acta Facultatis Xylologiae 2014, 56 (1), pp. 109-117.
14. Očkajová, A., Barcík, Š., Kučerka, M., Koleda, P., Korčok, M., Vyhnáliková, Z. (2019*): Wood Dust Granular Analysis in the Sanding Process of Thermally Modified Wood versus its Density*. In BioResources 14 (4), pp. 8559-8572.
15. Olsiakova, M. et al. (2017): *Application of new trends of marketing communication as a competitiveness tool in furniture industry*. In: More wood, better management, increasing effectiveness: starting points and perspective, pp. 5-10.
16. Olšiaková, M.; Loučanová, E.; Paluš, H. (2016): *Monitoring changes in consumer requirements for wood products in terms of consumer behavior*. In: Acta Facultatis Xylologiae 2016, 58 (1), pp. 137-149.
17. Päivinen, R.; Lindner, M. (2006): *Assessment of sustainability of forest-wood chains*. European Forest Institute.
18. Paluš, H. et al. (2011): *End users´ preferences for joinery products and furniture*. In: Intercathedra 27/2, pp. 58-61.
19. Palus, H. et al. (2015): Contracts and risk management of innovation process of forestry services contractors in Slovakia. In: Reports of forestry research - Zpravy lesnickeho vyzkumu 60(1), pp. 8-13.
20. Paluš, H., Kaputa, V. (2009). *Survey of attitudes towards forest and chain of custody certification in the Slovak Republic.* In. Drewno: prace naukowe, doniesienia, komunikaty, 52, pp. 65-81.
21. Paluš, H.; Mat'ová, H.; Križanová, A.; Parobek, J. (2014): *A survey of awareness of forest certification schemes labels on wood and paper products.* In: Acta Facultatis Xylologiae, 56 (1), pp. 129-138.
22. Parobek, J. et al. (2014): *Analysis of wood flows in Slovakia*. In: BioResources 2014, 9 (4), pp. 6453-6462.
23. Parobek, J., Loučanová, E., Kalamárová, M., Šupín, M., Štofková, K. R. (2015): *Customer window quadrant as a tool for tracking customer satisfaction on the furniture market*. In: Procedia Economics and Finance 34, pp. 493-499.
24. Parobek, J.; Paluš, H.; Loučanová, E.; Kalamárová, M. Glavonić, B. (2016): *Competitiveness of central european countries in the EU forest products market with the emphasis on Slovakia*. In: Acta Facultatis Xylologiae, 58 (1), pp. 125-136.

25. Shumpeter, J. A. (1939): Business Cycle: A *Theoretical, Historical, and Statistical Analysis of the Capitalist Process*, McGraw-Hill, New Youk, USA,1939; p. 1095.
26. Statistical Office of the Slovak Republic (2018): *Inovačná aktivita podnikov v Slovenskej republike 2012 – 2014*. Ústredie ŠÚ SR, 2020.
27. Statistical Office of the Slovak Republic (2020): *Inovačná aktivita podnikov v Slovenskej republike 2014 – 2016*. Ústredie ŠÚ SR, 2020.
28. Štěrbová, M., Loučanová, E., Paluš, H., Ivan, Ľ., Šálka, J. (2016): *Innovation strategy in Slovak forest contractor firms—A SWOT analysis*. In: Forests, 7(6).
29. Štofková, J. et al. (2017): *Possibilities of using E-learning system of education at universities*. In: Proceedings of the 11th International Technology, Education and Development Conference, Valencia, Spain, pp. 5-8.
30. Štofková, K. (2013): *Sieťové podnikanie*. In: Manažment a sieťové podnikanie vo vedomostnej ekonomike. Žilina: Žilinská univerzita, p. 25-60.
31. Straka M. (2013): *Logistika distribúcie, Ako efektívne dostať výrobok na trh*, Bratislava, EPOS 2013, 400 p.
32. Šupín, M. (2009): *Megatrendy vo vývoji svetového hospodárstva a možnosti Slovenskej republiky zmäkčiť dôsledky hospodárskej krízy*. In: Marketing a obchod 2009 : vplyv hospodárkej krízy na marketing a obchod, pp. 5-8.
33. Šupín, M. (2014): *The impact of the global recession on wood processing industry and wood products trade and the road to recovery.* In: Position and role of the forest based sector in the green economy, 159.
34. Šupín, M. et al. (2019): Sustainable bioenergy policy for the period after 2020. In: Digitalisation and circular economy, 315.
35. *** Kotsemir, M.; Abroskin , A. (2017): *Innovation concepts and typology – an evolutionary discussion*. URL: https://www.hse.ru/pubs/share/direct/document/76780100.
36. *** Ministry of Agriculture of the SR (2016): *Proposal of the national program for the utilization of wood potential in the Slovak Republic 2016.* URL: ww.mpsr.sk/download.php?fID=7417
37. *** OECD (2017): *Oslo Manuals. The measurement of scientific and technological activities*. URL: https://www.oecd.org/sti/inno/2367580.pdf
38. *** OECD. (2019): *Oslo Manuals. Guidelines for Collecting and Interpreting Innovation Data, 3rd edition*. URL: https://www.oecd-ilibrary.org/docserver/9789264013100-en.pdf?expires=1559824060&id=id&accname=guest&checksum=9528F043A991195ED5A02E07DDD439EA

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IMPACTS OF BUSINESS INFORMATION SYSTEMS APPLICATION TO PRODUCTION AND BUSINESS MANAGEMENT IN THE SERBIAN WOOD INDUSTRY COMPANIES

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Abstract: The research subject in this paper is Business Information Systems (BIS) used in wood industry companies of the Republic of Serbia. The main objective of this paper is to research the impact of BIS application in various production and business management processes in wood industry companies of the Republic of Serbia. An additional objective is to determine production and business management processes that are the most improved by BIS application in the companies where the research was conducted. This paper aims to imply to these companies the advantages of BIS application in production and business management, as well as the business improvement that can be achieved by their application. The research was conducted on a sample of the 100 largest companies in the wood industry of the Republic of Serbia, according to the criterion business income in the year 2016. The research results show that BIS application in wood industry companies has the most significant positive impact on the inventory management process. Of the total number of surveyed companies, the most significant number of companies considers that the BIS application has a large positive impact on this management process. Also, many companies consider that the implementation of BIS has an enormously positive impact on the financial management process. Increasing the efficiency of the inventory and financial management process contributes in reducing the number of days of working capital in the stock of reproductive material, reducing the level of debts, as well as increasing liquidity and efficiency of capital management.
Keywords*:* Business Information System, Wood Industry, Production Management, Business Management, Republic of Serbia

1. INTRODUCTION

The results of the conducted research related to the Business Information Systems (BIS) application in the wood industry companies of the Republic of Serbia indicate that a very small percentage of these companies apply BIS in their business. The 100 largest wood industry companies of the Republic of Serbia were selected according to the criterion business income in the year 2016 (SBRA, 2017). According to the research results presented in the paper Rajković et al. (2020), only 12 (12 [%]) companies use some of BIS and only 3 (3 [%]) companies plan to implement BIS in the next 18 months. The same research results indicated that BIS application in micro and small enterprises, as the most represented categories of wood industry companies of the Republic of Serbia, is very rare. Only 2 (16.67 [%]) companies of all surveyed companies that own BIS belong to small enterprises. The number of micro enterprises that own BIS is 0 (0 [%]). The same paper presents the research results on BIS application in the wood industry companies from a different area, i.e., the presence of BIS in companies in the area C16 (wood processing and products of wood, cork, straw and willow, except furniture) and area C31 (furniture production). The results of this research indicate that out of the total number of companies that apply BIS, 9 (75 [%]) companies belong to area C31 and 3 (25 [%]) companies belong to area C16.

Although they are one of the important elements of the economy, the wood industry companies of the Republic of Serbia also face several problems in doing business. Some of them are production milling, unrecognition of products of this industry on the world market and insufficient visibility of companies from this industry on the domestic and foreign markets. According to Kalem et al. (2019), only 62 (62 [%]) wood industry companies of the Republic of Serbia have a website. This is a relatively small percentage, given that the survey was conducted on a sample of the 100 largest companies in this field in the Republic of Serbia. Also, it can be assumed that in a larger sample, the percentage of companies that have a website would be significantly lower. The reason for this is that the companies that would be observed as a sample, in that case, would belong to the group of small and micro enterprises based on criteria business income, number of employees, market share and market distribution.

In addition to the above, one of the main problems these companies face is the low level or lack of applications of systems for production and business management. The production and business management are based on information, i.e., the process of receiving, transferring and processing data, where this processing provides information for the management decision (Lečić-Cvetković & Atanasov, 2015). Based on this, it can be concluded that quality, timely and in the correct form of information presents the basis for successful production and business management. The lack of information related to internal processes and external impacts that affect a company's business can be defined as one of the fundamental problems of a large number of wood industry companies of the Republic of Serbia.

To remain one of the pillars of the Republic of Serbia's economy in the future, wood industry companies must implement a system for production and business management. Applying this system, these companies can increase the surplus in foreign trade, increase the number of employees and remaining competitive with international companies that operate in the market of the Republic of Serbia. One of the prerequisites for the production and business management systems implementation is the application of BIS that provides receiving, transferring and processing large amounts of data that occur in everyday business in various processes. Also, it includes data processing and data creation for quality management decisions.

2. AIM AND METHODOLOGY

The main objective of this paper is to present the research results to perceive the effectiveness of BIS in various processes of production and business management in the wood industry companies of the Republic of Serbia. The methodology used in this paper was basic methodological methods, i.e., the use of analysis, synthesis and generalization. These methods were used in the data analysis, where data were collected by surveying the 100 largest companies in the Republic of Serbia's wood industry. During the survey, companies were questioned about BIS impact on a particular production or business management process. Each question was answered with values on the Likert scale from one to five, where a value *one* indicates that the BIS application has no positive impact on a particular production or business management process. In contrast, a value *five* indicates an extremely high positive impact of BIS application on a specific production or business management process. Based on the collected data, analyses were performed and appropriate conclusions.

3. APPLICATION OF BUSINESS SYSTEMS IN PRODUCTION AND BUSINESS MANAGEMENT

According to the authors (Krenczyk & Jagodzinski, 2015), "in modern companies integrated information systems supporting management processes are used extensively at different levels (strategic to operational), including the area of production planning where most often offered solutions are the systems belonging to Enterprise Systems (ES) class, from Manufacturing Resource Planning (MPR) to Enterprise Resource Planning (ERP) and complementary solutions-Customer Relationship Management (CRM), Product Data Management Systems (PDM) or Manufacturing Execution System (MES)".

ERP systems, as one type of BIS, present a business system for the development of different business functions. According to this solution, it is possible to record and control all activities in a company and coordinate with all business documents, resource management, etc. The application of ERP systems in everyday business brings many benefits. With the successful implementation and correct usage of ERP, the best business results appear. One of the advantages is integrating all of the business processes at the level of the entire company. Thereby the quality division of needed work is implemented, reflecting the division of responsibilities, better monitoring and control of business processes. "Being one of the information technologies, ERP offers a structure that reconstructs processes of enterprises and represents a crucial tool for corporations to manage the flow of both inside and outside processes of the firm" (Acar et al., 2017). "ERP systems can be a very important knowledge repository for each manufacturing enterprise which data registered in an ERP database could be first transformed into information, and after interpretation, into knowledge about products and processes" (Klos, 2016). "The way an ERP system gets implemented also depends on a vital question that "What" needs to be implemented" (Nagpal et a., 2015).

4. RESULTS AND DISCUSSION

The first question of the survey was to assess the impact of BIS application in the procurement process management. Based on the results of the research presented in Figure 1, it was determined that out of a total of 12 companies that apply BIS in their production and business management, 2 (16.67 [%]) companies consider that BIS application has an extremely high positive impact on improving the procurement process management, 5 (41.67 [%]) companies believe that this has a significant positive impact on the procurement process management and 3 (25 [%]) companies consider that BIS application has a visible impact on the procurement process management. The number of companies that consider that BIS application has an extremely small positive impact on the procurement process management is 1 (8.33 [%]), and also the same number of companies consider that the BIS application has no positive impact on the procurement process management. The obtained results on this question indicate that the companies perceive a significant percentage of the advantages achieved by BIS application in the procurement process management, i.e., that BIS facilitates their business activities and exchange of information with their stakeholders and suppliers.

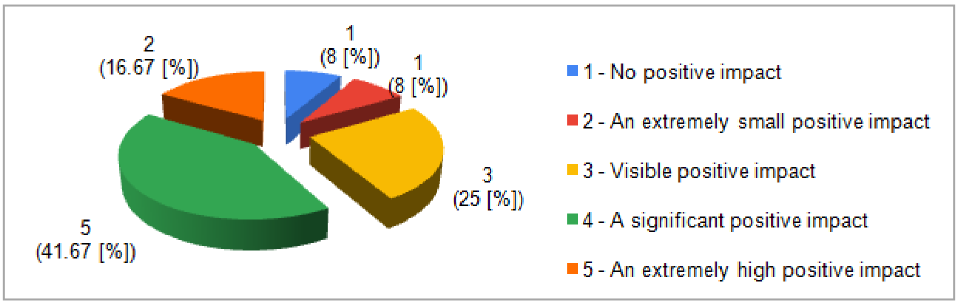

Figure 1. The impact of BIS application on the procurement process management

The next question was related to the impact of BIS application on the inventory management process. Based on the research results shown in Figure 2, it can be concluded that out of a total of 12 companies that apply BIS, 8 (66.67 [%]) companies consider that BIS application has an extremely high positive impact on inventory management process, while 2 (16.67 [%]) companies consider that BIS has a significant positive impact on this process. Also, 1 company (8.33 [%]) considers that the impact of BIS application on the inventory management process is of medium importance. The number of companies that consider that the BIS application has no positive impact on the inventory management process is 1 (8.33 [%]). Based on the research results, it can be concluded that companies perceive the advantages of BIS application on the inventory management process. The reason for that conclusion is that the inventory management process is an internal process, companies do not have the problem of information and data exchange with other companies. Also, the improvement of this process significantly contributes to the reduction of inventories and increases companies' working capital, which makes companies extremely satisfied with BIS application in the inventory management process.

The next question was related to the impact of BIS application on the financial management process. Figure 3 shows the research results on this question. These research results show that 6 (50 [%]) companies consider that BIS application has an extremely high positive impact on the financial management process, while 5 (41.67 [%]) companies consider that this impact is significant. Thus, a total of 11 (91.67 [%]) companies consider that BIS application has an extremely high positive or a significant positive impact on the financial management process, while only 1 company (8.33 [%]) considers that BIS application does not influence to the financial management process. The research results can be considered unusual because the more significant number of surveyed companies had specialized accounting programs that facilitated the financial management process, even before BIS installation.

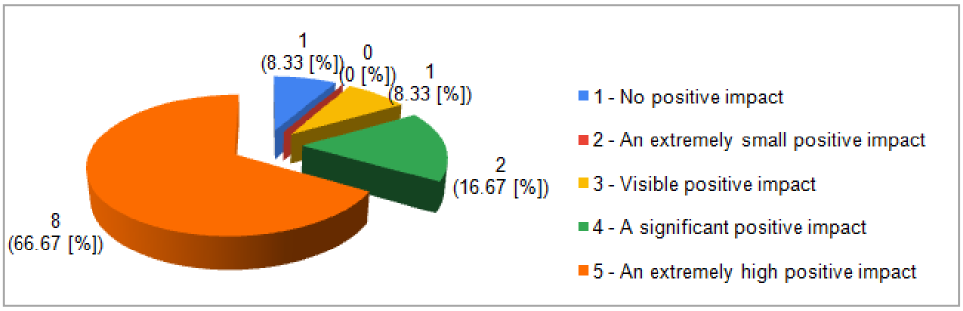

Figure 2. The impact of BIS application on the inventory management process

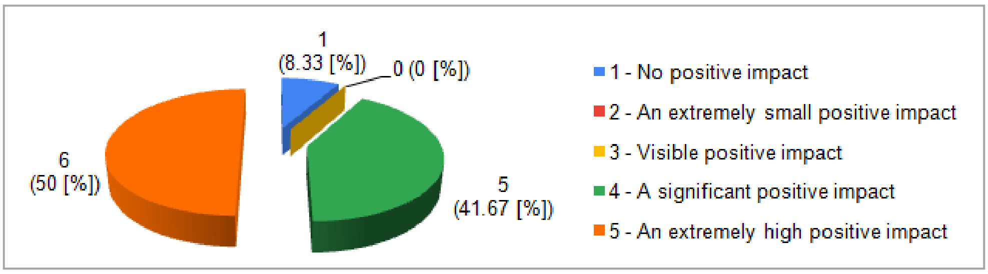

Figure 3. The impact of BIS application on the financial management process

5. CONCLUSION

Based on the presented research results, it can be concluded that the BIS application has a positive impact on observed production and business processes management. Also, many companies do not use all the benefits of BIS in their business. BIS application in production and business management has the most significant impact on the financial management process. A total of 11 (91.67 [%]) companies indicated that BIS application had an extremely high positive or significantly positive impact in this management process, that contributes to reducing the level of debts, as well as increasing liquidity and efficiency of capital management. Another process on that BIS application has an extremely positive impact is inventory management. A total of 10 (83.33 [%]) companies consider that the implementation of BIS has an extremely positive or positive impact on this management process. This result can be considered expected because one of the fundamental purposes of BIS is to improve the inventory management process as one of the main internal processes in production company. Unexpected results of the research are that 2 (16.67 [%]) companies considered that the BIS application has an extremely small positive impact on procurement process management or that it has no positive impact on it. Insufficient business activities of these companies with their stakeholders and suppliers are one of the reasons that a certain number of these companies are not extremely satisfied or just satisfied with BIS application in this process management. This problem does not provide the possibility of applying all the advantages of applying BIS in these management processes.

The direction of further research of the authors of this paper would be the same research conducts on the same number of companies in this field in the countries in the region and a comparative analysis with the research results presented in this paper. Based on these results, can be indicated the similarities and differences in these studies in different countries of the region, which would lead to new conclusions and recommendations to the wood industry companies of the Republic of Serbia, in order to improve their production and business management by BIS application.

REFERENCES

1. Acar, M. F.; Zaim, S.; Isik, M.; Calisir, F. (2017): *Relationships Among ERP, Supply Chain Orientation and Operational Performance.* Benchmarking: An International Journal: pp. 1291-1308.
2. Kalem, M.; Rajković, T.; Lazarević, A.; Lečić-Cvetković, D. (2019)*: Application of Internet in Serbian Wood Industry*. In: Proceedings of the 12th Conference of Business and Science SPIN '19 "Lean Transformation and Digitalization of the Serbian Industry". Republic of Serbia. November, 2019. 243-249.
3. Kłos, S. (2016): *A Model of an ERP-Based Knowledge Management System for Engineer-to-Order Enterprises*. In: Proceedings of the *International Conference on Information and Software Technologies*, Communications in Computer and Information Science, Vol. 639. 42-52.
4. Krenczyk, D.; Jagodzinski, M. (2015): *ERP, APS and Simulation Systems Integration to Support Production Planning and Scheduling*. In: Proceedings of the 10th International Conference on Soft Computing Models in Industrial and Environmental Applications, Advances in Intelligent Systems and Computing, Vol. 368. 451-461.
5. Lečić-Cvetković, D.; Atanasov N. (2015): *Production and Services Management* (in Serbian: *Upravljanje proizvodnjom i pružanjem usluga*). Republic of Serbia, Belgrade: Faculty of Organizational Sciences.
6. Nagpal, S.; Khatri, S. K.; Kumar, A. (2015): *Comparative Study of ERP Implementation Strategies*. 2015 Long Island Systems, Applications and Technology, IEEE: pp. 1-9.
7. Rajković, T.; Kalem, M.; Lečić-Cvetković, D. (2020): *Application of Business Information Systems in Serbian Wood Industry*. In: Proceedings of the 17th International Symposium SymOrg 2020 "Business and Artificial Intelligence". Republic of Serbia, 2020.
8. ***:The Serbian Business Registers Agency (SBRA) (2017): *Republic of Serbia: 2017.*
9. URL: https://apr.gov.rs/

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CONTEMPORARY CHALLENGES FOR THE SUSTAINABLE PRODUCTION AND SUPPLY OF WOODEN PALLETS IN BULGARIA

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Abstract: The report focuses on the nature of the production of wooden pallets in Bulgaria, as part of the wood processing industry. The production of wooden pallets is a business organized in small and medium-sized companies in semi-automatic and automatic technologies. An important problem of the modern supply of wooden pallets is the achievement of free exchange of certified Euro pallets and quality assurance through control. The report analyzes the contribution of wooden pallets to the forest industry and logistics related to existing management strategies. The report focuses on meeting the quality requirements of the product and its contribution to improving economic performance.
Keywords: pallets, wooden pallets, supply chain, packaging, wooden packaging, logistics

1. INTRODUCTION

With the development of international trade in goods, more and more goods are present in various markets around the world. The globalization of the markets and the expansion of the range of goods sold on the international markets are factors that influence the intensity of the development of transport and the conditions for their storage. Looking at business activities such as logistics and warehousing, it can be emphasized that wooden pallets have influenced international trade in goods effectively. As one of the key components of the warehousing and transport environment, pallets have helped to improve trade. Although the pallet as a product has evolved over time, its main purpose remains the same: to facilitate the rapid movement and storage of goods, to reduce product damage, to minimize the risk of injury to workers. With the use of pallets, customers have the opportunity to more easily operate and process their goods.

The article analyses, on the one hand, the role of pallets in logistics activities to ensure the protection of goods during storage and transport, the challenges facing the industry for the production of wooden pallets in the European Union and Bulgaria and business opportunities, on the other. Emphasis is placed on the quality requirements for the production of wooden pallets. The economic, social and environmental contribution of wooden pallets to the industry and the management of the supply chain of goods are studied.

2. WOODEN PALLETS AS PACKAGING IN THE INTERNATIONAL EXCHANGE OF GOODS AND QUALITY REQUIREMENTS

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). According to their functional purpose, the packaging can be divided into three groups: Commercial packaging (primary); Group packaging (secondary); Transport packaging(tertiary).

At present, in international trade in goods, several normative documents are regulating the import and export of goods and their accompanying packaging, both between EU countries and in EU trade with third countries. The expansion of trade requires the unification and harmonization of the quality and type of transport packaging with which goods are linked to the trade process. Regulatory requirements in Bulgaria combine many criteria, such as those related to the quality of packaging, safety and protection of the packaged product, hygiene and transport requirements. Ensuring the quality of raw materials and finished products are inextricably linked to the availability of standards (Fras, Olsztynska, & Scholz, 2018).

Regardless of the voluntary nature of the standards, their application guarantees economic efficiency of enterprises, the application of scientific achievements, production and supply of quality products, maintaining market positions, increasing customer satisfaction (Marinova & Stoykova, 2019) (Marinova, Stoykova, 2019). The standards present the relevant criteria for the assessment of packaging according to Directive 94/62 /EC and the method of declaring conformity.

When placed on the market, the packaging of goods must have a minimum weight and volume to the extent necessary to fulfil its main consumer property - to ensure the safety and hygiene of the packaged product. According to Sowa (Sowa, 2012), 90% of all products produced in the world require the use of appropriate protective functions. In the process of designing, manufacturing and distributing packaging, it is possible to use reusable packaging to minimize their impact on the environment as generated waste.

Reusable packaging is considered to be a more effective option for reducing the impact of packaging volume and energy while preventing production emissions to the environment. To this end, the maximum use of reusable and recyclable packaging is required (Sowa, 2012). The use of reusable packaging improves logistics and transport activities and reduces the consumption of natural resources. Wood is still considered to be the most environmentally friendly packaging material and has ample opportunities to use more active forms of wood packaging (Nosáľová, Loučanová, & Parobek, 2018). It is estimated that at least 20% of plastic packaging can be replaced by reusable ones (Reuse, Rethinking Packaging, 2019).

Modern European society strives to implement measures to protect the environment, and policies and technologies should promote sustainable resource consumption to ensure sustainable development in the long run (Marinova, 2019). The growing demand for timber and timber products in the world, the reduction of forest areas and the problems in the management of the forest sector have raised serious questions of concern. The emphasis in recent years has been on reducing the amount of packaging material per unit volume, as well as the gradual transition from recycling of materials to reusable packaging. These trends can be reported as positive because they allow more value to be maintained (Coelho, Corona, ten Klooster, & Worrell, 2020).

In terms of regulations in Bulgaria, pallets are considered as reusable transport packaging. The main materials from which the pallets are made are wood, plastic, metal, composite and paper. Globally, according to a study by the Freedonia group (2020) (https://www.freedoniagroup.com/World-Pallets.html), wooden pallets are the most common type of pallets, accounting for 92% of unit demand and 83% of sales in value terms in 2019. International Standards for Phytosanitary Measures Number 15 (ISPM 15) address wooden packaging material is considered to be wood or a wood product used to support, protect or transport goods (International Standart for Phitosanitary Measure, 2002). The use of pallets as a wood packaging material is associated with the unification of the structure, size and material from which the packaging is made. Based on the performed analysis, the regularities between the price of the pallets and the conditions ensuring security and lifespan of the package, which is used repeatedly, are derived (Jiang, Wang, Xu, & Cai, 2012).

Wooden pallets as wooden packaging material must meet many requirements - technological, legal, quality. To meet these requirements, systems for production monitoring, marking, supervision, licensing have been developed (Fras, Olsztynska, & Scholz, 2018). The EPAL pallet system (https://www.epal-pallets.org) operates within the European Union to ensure reliability in the production and use of wooden pallets. The licensing system for the production and repair of wooden packaging in the European Union is mainly used in Euro-pallet, based on standards for wooden flat pallets.

The organization started working in 1995 as an international pallet organization EPAL (European Pallet Association. Currently, the organization has 20 national committees and representative offices and cooperates with three audit firms. The volume of EPAL pallet production is constantly growing. According to the association, in 2018, 121.8 million EPAL freight carriers were produced and repaired, which is 5.2% more than in 2017, including 93.9 million new flat pallets, and 27, 5 million flat pallets have been repaired and it is estimated that more than 500 million EPAL pallets are currently in circulation.

The EPAL system is essentially based on the guidelines of the harmonized standard EN 13698, which includes the requirements for flat reusable flat wooden pallets measuring 800 mm x 1200 mm, used for transport, storage, handling and interchangeability. To ensure the quality of its products and services, EPAL works with independent audit organizations, logistics organizations and key pallet users.

The main proposals of the EPAL system are to achieve security and quality assurance of pallets. Therefore, only licensed companies can produce pallets and mark them in accordance with the instructions of the system. Marked euro pallets with the EPAL mark allow identifying its manufacturer and the legal origin of the product. EPAL also licenses pallet repair companies, manufacturers of pallet components, as well as nails and equipment used for pallet production. The EPAL system enables the exchange of over 500 million pallets traded worldwide, market access for over 1,600 production operators, uniform quality standards worldwide, standardized pallet sizes throughout the supply chain, transparency of costs, the more neutral balance of CO2, optimal transport routes of goods, etc. After 2013, a pallet quality assessment system based on the new ECL EPAL Pallet Assessment Cards is implemented. According to EPAL, the association's pallets are made of sustainably grown and carbon-neutral wood, can be repaired and reduce transport distances due to their high level of accessibility.

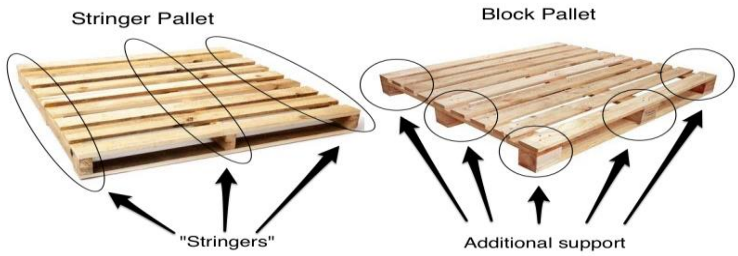

Figure 1. Basic types of wooden pallets

In the world modern logistics practice, there are two main types of wooden pallets: “stringer” and “block” pallets (Figure 1). Stringer pallets have three long pieces of wood ("stringer") that support the sides and middle of the parallel wooden boards. These are usually two-way pallets, as a forklift can only pick them up in two different ways. The block pallets are supported by wooden blocks on the sides and middle of each edge. Block pallets, better known as 4-pointed pallets because they have the same orientation, no matter how they are transported, are typically used for heavier shipments as they provide more support for the platform.

Although there are no uniform international standards for the size of wooden pallets, the (ISO, 2003)International Organization for Standardization (ISO) defines six standard sizes of wooden pallets, shown in Table 1. The most common pallet size used in Europe is the EUR pallet, with dimensions 1000x1200x144mm. Usually, wooden pallets are designed to be accessible from all four sides. Depending on the loading requirements of the pallet, the weight of the EUR pallet can range from 20 to 35 kg.

Table 1. ISO-determined sizes of Euro pallets used in different regions

ISO Pallet Dimensions (mm)	***Regions Commonly Used***	***Euro Pallet Type***	***Euro Pallet Dimensions (mm)***
1016 × 1219	North America	EUR, EUR 1	800 × 1200
1000 × 1200	Europe and Asia	EUR 2	1200 × 1000
1165 × 1165	Australia	EUR 3	1000 × 1200
1067 × 1067	North America, Europe, Asia	EUR 6	800 × 600
1100 × 1100	Asia	Quarter size	600 × 400
800 × 1200	Europe	Eighth size	400 × 300

The productivity and strength of wooden pallets can be affected by several of factors, including the weight that the wood can carry and the ability to bend. Other factors for the efficiency of pallets are pressure strength, resistance, defects in the wood, resistance to rot and others (PALLETS, UNIFORM STANDARD FOR WOOD, 2014). To achieve safety and reduce the risk of introduction and spread of quarantine pests in wooden pallets used in international trade and produced from raw wood, they need to be treated and marked according to the International Standard for Phytosanitary Measures Number 15 (ISPM 15, 2013). The requirements of the standard also apply to recycled wooden pallets.

The scope of the ISPM 15 includes the requirements for repair and reuse of wood packaging material, its thermal treatment and marking. 182 countries around the world are committed to complying with the requirements of the ISPM 15, which prevents the entry of wood pests into foreign ecosystems and ensures greater safety of transported goods.

The control for compliance with the requirements of the ISPM 15 in case of import in Bulgaria of goods transported by wooden pallets is carried out by the Bulgarian Food Safety Agency at the border inspection phytosanitary points, in the customs organizations on the territory of the country or in the places approved for phytosanitary inspections. In the event of non-compliance with the requirements of the ISPM 15 and depending on the severity of the non-compliance, inspectors may detain the goods until the non-compliance is remedied, prescribe re-treatment or destruction. The control for compliance with the requirements of the ISPM 15 for export from Bulgaria is carried out in the places where the vehicle is loaded or in the customs organizations.

3. CONTRIBUTION OF THE PRODUCTION AND SUPPLY OF WOODEN PALLETS TO INDUSTRY AND LOGISTICS

The ability and efficiency of the supply chain depend not only on the type of method of storing or transporting the product but also on the ways in which goods are packaged by which the product arrives at the consignee. Wooden pallets make a significant contribution to both the logistics of goods and the wood processing industry. This section will examine some economic, technological and environmental challenges of using wooden pallets for the economy.

3.1. Economic challenges of wooden pallets for the industry

The wood based industry is key for the manufacturing sector in the EU and generated 142.7 billion value-added in 2016, respectively 7.5% of the value-added of the manufacturing sector (Eurostat, 2019). In 2017, 429 thousand enterprises operated in the EU wood processing industry, mainly in small and medium-sized companies, as 39.7% of the industry is enterprises for processing wood and wood products. The employed in the sector are 3.3 million (10.8% of the employed in production). The contribution of the wood processing industry to the EU economy is great and plays an important role in the creation of the gross product (Nováková, Pauliková, & Canet, 2019).

According to National Statistical Institute of Bulgaria data, in 2018 in the wood processing industry of Bulgaria 1237 companies operated, with 13 thousand employees. The gross value added of the sector is EUR 334 million, which is about 4.2% of the value-added in industrial production. Most employed in the wood processing sector are in the Southwest and South-Central regions.

Globally, over the past decade, the production and consumption of wooden pallets have left a significant impact on economic growth, especially in developing countries such as the United States, Canada, and the EU. According to a study and forecasts of the Freedonia group (2020) (https://www.freedoniagroup.com/World-Pallets.html), the expected global demand for pallets will grow by about 3.7-3.8% per year, reaching 208 billion units in 2024. The pallet market is estimated at about $ 52.5 billion. The world market is dominated by block pallets compatible with automatic systems. They are distinguished by their ease of operation and good load capacity. Stringer pallets predominate in developed markets, while block pallets are preferred in emerging markets. The development of the pallet market will grow, despite the slowdown in worldwide sales due to COVID-19. The most dynamic markets are expected to be Asia-Pacific, with forecasts in 2024 to reach 40%. In the North American and EU markets, available pallet stocks will hamper opportunities for higher sales. The lower price of wooden pallets will continue to define them as a leading product over metal and plastic. The growth of regional demand for pallets will be supported by the development of industries and logistics systems in developing countries.

E-commerce will further increase the need for storage pallets. India and China are expected to determine global demand for pallets in the coming years.

According to FEFPEB (the European Federation of Wooden Pallet and Packaging Manufacturers, https://www.fefpeb.eu), the EU produces about 100 million cubic meters of timber, with over 25 million cubic meters of timber each year they are used for pallets and wooden packaging. The average lifespan of a wooden pallet is between 5-7 years, with a high percentage of wooden pallets being recycled and recovered.

According to the United Nations, Economic and Social Council (UN, 2016), the production of pallets and wooden packaging is fragmented in Europe, with a large number of small and medium-sized enterprises operating. There is a tendency for production to gradually shift to Eastern European countries, where costs are lower. Pallet production in Western Europe is becoming increasingly automated, with the industry incorporating more robotics into production and repair. The sector has consolidated in recent years with fewer and larger companies, and several of the larger groups have begun to operate internationally. Production for all major wood packaging products in Europe increased from 2012 to 2014, with a total value of $ 11.1 billion in 2014. In descending order, the main producers of flat pallets in Europe are France, Poland and Germany, with production growing at the highest rate in Poland. According to the European Federation of Wood Packaging Manufacturers (FEFPEB), the number of pallets produced increased from 339 million units in 2006, to 371 million units in 2010, to 401 million units in 2013 and almost 500 million in 2018.

According to FEFPEB (the European Federation of Wooden Pallet and Packaging Manufacturers, https://www.fefpeb.eu), the number of pallets heat-treated according to the International Phytosanitary Standards № 15 is increasing due to the spread of some pests (eg pine nematodes, etc.). In the Scandinavian countries, almost 100% of softwood is heat-treated and dried. In other countries, pallets are made from pre-cut raw wood and heat treatment is carried out after installation.

A total of 73.6 million EPAL pallets were produced in 2015, compared to 67 million in 2012. As expected, 23.9 million units were repaired in 2015, compared to 22.4 million units in 2014.

Pallet prices have been relatively stable in recent years, although commodity prices have fluctuated. The main factor for the changes in prices was the changes in the prices of raw materials and the accumulation of stocks.

Pallets and wooden packaging are mainly supplied with goods, but there is also some trade in empty pallets and wooden packaging, mainly in Europe. As the production of pallets is developing intensively in the countries of Eastern Europe, the main exporters of flat pallets are Poland, Germany, the Czech Republic and Latvia. Western European countries are finding it increasingly difficult to compete with Eastern European prices at lower costs. The main importers of pallets in the EU continue to be Germany, France, Belgium and the Netherlands. The production and trade of pallets are mainly within the EU.

In Bulgaria, the production of wooden pallets is organized in about 1000 smaller and medium-sized companies, but there are also operators on the market with a larger production capacity. The production of wooden pallets is promising for Bulgaria, given the lower production costs compared to Western European countries. Proof of this is the increased export of pallets from the country to 129 thousand tons in 2016. The production of pallets is a business that can be organized for the implementation of various technological solutions, according to the size of the company. In small family businesses, the production of pallets can be carried out by manual assembly of pallets or by applying semi-automatic lines. In medium and large enterprises, production opportunities are increasing. The semi-automatic production line allows producing 1.5 pallets in one minute and is serviced by two operators and one forklift and 2 nailing machines at 5 pallets per minute. Such a line can be served by 4-6 people and produces up to 90 pallets per hour. Automated and robotic lines for the production of wooden pallets can produce up to 650 pallets per hour. They are served by 5-6 operators and 2-3 loaders. The profitability of the production of wooden pallets is determined mainly by the price of raw materials and the volume of production. With the right organization of production, the pallet business can be very profitable. It is accepted that the return on investment in semi-automated production is within two to three years, while the payback period for automated lines for the production of pallets can be within three to four years.

3.2. Technical challenges of wooden pallets for industry and logistics

In recent years, logistics has developed extremely dynamically in the context of the development of international trade, as the usefulness of the logistics service is associated with the implementation of customer satisfaction to maintain the quality of transported goods (Stefanova, 2019). Pallets are a critical component of logistics infrastructure. In the United States, about 2 billion pallets are used annually to transport raw materials and goods, in the EU about 500 million, and in China about 1.2 billion, with solid wood pallets accounting for 90-95% of the market and are the most common. Plastic pallets are about 4-6% of the total pallets, and their purpose is for specific industries (pharmaceutical). In the structure of the pallets, flat pallets predominate.

The issue of the contribution of wooden pallets to logistics is closely linked to existing pallet management strategies. In practice, there are three pallet management strategies (Ernst, 2019) (Roy, Carrano, Pazour, & Gupta, 2016):

1) Single use expendable pallets strategy - ownership of a pallet is transferred with the load it carries. In this case, the pallets are not returned to the distributor or the manufacturer. Such pallets are usually wooden and are chosen for lower costs. After their use, such pallets are used briefly and collected in landfills. In terms of cost, this is the most expensive strategy.

2) Buy-sell strategy - pallets are sold to customers and subsequently, he manages them. Once the pallet reaches the end of its useful life, their owner recycles them. The activities of repair, proper disposal and sorting are the responsibility of the buyer of the goods.

3) Leased pallet pooling strategy - in which the customer leases the pallets from the distribution company and agrees to manage them further in the supply chain, using them back down the chain or recycling them. This strategy is cheaper in terms of costs.

The challenge in choosing a specific pallet management strategy is to choose from the most efficient option from an economic, technical or environmental point of view (Bilbao, Carrano, Hewitt, & Thorn, 2011). From the point of view of costs, it is necessary to analyze the type of material, the method of production and use, life expectancy, the nature of the product, the possibilities for ensuring safety, etc.

In technological terms, the steps in the chain of production and delivery of wooden pallets are presented in Figure 2 (adapted from Sanchez Gomez, L.S.) (Sanchez Gomez, 2011). The production process begins with logging, and then the logs are sent for processing. The timber is processed into parts for pallets and edged according to the type of pallet, after which the pallet is assembled. The finished pallets follow their purpose and are sent to distributors of goods or directly to end-users.

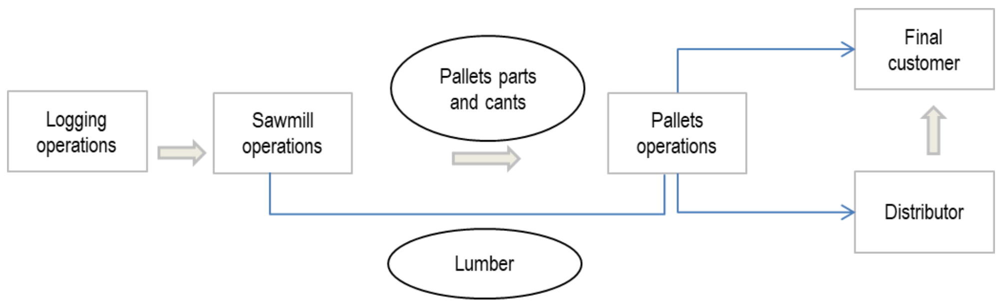

Figure 2. Stages of the supply chain of wooden pallets

Surveys of the American magazine "Modern material handling" (https://www.mmh.com) in 2016 (October) and 2019 (September) on the state of the pallet industry in the United States revealed some important problems and challenges for the industry and logistics. According to the 2016 study, the most significant factor for pallet users was the purchase price (61%), strength (56%), durability (54%) and reusability (44%). When buying wooden pallets, 65% prefer used pallets and 54% prefer new pallets. Regarding the use of wooden pallets, 46% of respondents use the same number as the previous year, and 42% use more than the previous year. Only 12% use fewer pallets than the previous year. Regarding pallet management strategies, only 7% of respondents use pallet rental companies. According to the 2018 survey on pallet storage and handling, only 23% use automated palletizing equipment, and the majority of companies continue to use manual pallet storage and handling systems.

The increased desire to automate the supply chain creates prospects for the growth of smart pallets. The use of pallets with microchip RF identification allows easier tracking of goods in the supply chain and improves inventory management. According to Persistent Market Research (https://www.persistencemarketresearch.com), the Global Market Study on Pallets: Smart and Recyclable Pallets to Trend Through 2029 report expects increased worldwide demand for smart pallets over the next decade due to growing supply chain automation.

3.3. Environmental benefits of wooden pallets

Assessing the application of environmental principles in the production and supply of wooden pallets, it can be argued that this product is made entirely in compliance with the highest environmental criteria. Wooden pallets fit very well into the circular economy. Pallet manufacturers and users are expanding their pallet repair and recycling programs. Damaged wooden pallets are easy to repair and suitable for a new use, and their strong parts can be used to repair worn pallets. Waste from recycled pallets is a good raw material for animal bedding, for the production of furniture or paper, which increases the lifespan of the wood. Also, reusable pallets are heat-treated, which reduces the need for pesticides. Wooden pallets have much greater environmental advantages over plastic pallets, mainly because they are easier to recycle, although they wear out more and are more resistant to pests. According to FEFPEB, recent studies in France and Spain have shown that bacteria have a higher survival rate on plastic than on pine or poplar wood (UN, 2016). At the same time, the production of plastic pallets consumes five times more energy, emits more greenhouse gas emissions and is more difficult to recycle (Bilbao, Carrano, Hewitt, & Thorn, 2011). Plastic pallets have been found to have a greater impact on climate change than wooden pallets, and wooden pallets have a negative carbon footprint (Deviatkin, Khan, Ernst, & & Horttanainen, 2019).

According to FEFPEB, 108 billion kg CO_2 are stored in pallets circulating in the EU. It is a misconception that the use of wood for pallets leads to deforestation. Although wooden pallets are also made from new wood, much of the unattractive wood unsuitable for furniture and construction is used for the production of wooden pallets.

Although the wooden pallet sector uses forest resources (which are renewable), it fits well into the EU's action plan for the transition to a sustainable, low-carbon and competitive economy. Given the EU's proposal to recycle 65% of packaging by 2025 and 75% to 30%, the importance of wood as reusable packaging is growing.

4. CONCLUSION

In conclusion, the following conclusions and summaries can be made: 1) In the coming years, wooden pallets will continue to have a positive effect on international trade by improving the operation and handling of goods. 2) The requirements for guaranteeing the quality and safety of the goods subject to trade are increasing and wooden pallets can meet these challenges. 3) The market of wooden pallets is dynamically developing and Bulgarian producers can take advantage of the favourable opportunities they have to produce at lower costs. 4) The contribution of wooden pallets for logistics solutions for delivery and for inventory management in warehouses is in the direction of increasing automation in the supply chain. 5) The environmental benefits of using wooden pallets are great and they fit very well into modern EU policy for the development of a sustainable and low-carbon economy.

REFERENCES

1. Bilbao, A., Carrano, A., Hewitt, M., & Thorn, B. (2011). On the environmental impacts of pallet management operations. Management Research Review, 34(11), 1222–1236.

2. Coelho, P., Corona, B., ten Klooster, R., & Worrell, E. (2020). Sustainability of reusable packaging – Current situation and trends. Resources, Conservation & Recycling: X, 100037, 1-11.
3. Deviatkin, I., Khan, M., Ernst, E., & & Horttanainen, M. (2019). Wooden and Plastic Pallets: A Review of Life Cycle Assessment (LCA) Studies. Sustainability, 11(20, 5750).
4. Ernst, E. (2019). An Environmental and Economic Evaluation of Construction and Demolition Waste based Wood-Composite Pallets and Virgin Wood Pallets. Master thesis. School of Science and Engineering at Reykjavík University.
5. Eurostat. (2019). Agriculture, Forestry and Fishery Statistics. Luxembourg: Publications Office of the European Union.
6. Fras, J., Olsztynska, I., & Scholz, S. (2018). Standardization and certification of the wooden packaging in international trade. Research in Logistics and Production, 8(1), 25-37.
7. Jiang, C., Wang, Y., Xu, J., & Cai, L. (2012). CAE analysis and optimization desigh for mutual flat wooden pallets. Applied Mechanics and Materials, 200, 556-570.
8. Marinova, V. (2019). Izsledvane kachestvoto na recikliran karton za transportni opakovki. Izvestiya, Spisanie na Ikonomicheski universitet - Varna, 63(4), 369-384.
9. Marinova, V., & Stoykova, T. (2019). Rolya na standartite za kachestvoto na recikliranata hartiya. Kachestvo, kontol i ekspertiza na stokite (pp. 70-78). Varna: Nauka i ikonomika (bg).
10. Naredba za opakovkite i otpadatsite ot opakovki (bg). (2012).
11. Nosáľová, M., Loučanová, E., & Parobek, J. (2018). Perseption of intelligent and active packaging with regard to packaging from wood-based materials. 11th International Scientific Conference WoodEMA 2018 "Increasing the use of wood in the global bio-economy" (pp. 9-17). Belgrade, Republic of Serbia: University of Belgrade – Faculty of Forestry.
12. Nováková, R., Pauliková, A., & Canet, N. (2019). The process of indexing working comfort factors in organizations. 12th International Scientific Conference WoodEMA 2019, DIGITALISATION AND CIRCULAR ECONOMY: forestry and forestry based industry implications (pp. 269-276). Sofia: Union of scientist of Bulgaria.
13. Roy, D., Carrano, A., Pazour, J., & Gupta, A. (2016). Cost-effective pallet management strategies. Transportation Research Part E: Logistics and Transportation Review, 93, 358-371.
14. Sanchez Gomez, L. S. (2011). Identifying Success Factors In The Wood Pallet Supply Chain. Master Thesis. Blacksburg, Virginia, USA: Virginia Polytechnic Institute and State University.
15. Sowa, M. (2012). The role of packaging in streamlining material flows from the producer to the consumer. Scientific Letters of the University of Szczecin No. 739, Problems of Transport and Logistics(17), 171–184.
16. Stefanova, M. (2019). Vazdeistvie na logistikata varhu ikonomikata. Kachestvo, kontol i ekspertiza na stokite (pp. 79-90). Varna: Nauka i ikonomika (bg).
17. UN, E. a. (2016). Trends and perspectives for pallets and wooden packaging. Geneva: Economic Commission for Europe, Committee on Forest and the Forest Industry.
18. ISO. (2003). ISO 6780 - Flat pallets for intercontinental materials handing - Principal dimensions and tolerances. International Organization for Standartization.
19. (2002). International Standart for Phitosanitary Measure. Rome: FAO.
20. (2013). ISPM 15. Rome: FAO.
21. (2014). PALLETS, UNIFORM STANDARD FOR WOOD. Alexandria, VA. USA: National Wooden Pallet and Container Association.
22. (2019). Reuse, Rethinking Packaging. Isle of Wight, UK: Ellen MacArthur Foundation, New Plastics Economy. Retrieved from https://www.ellenmacarthurfoundation.org/publications/reuse

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PATIENTS' ATTITUDES TO TREATMENT BASED ON ACTIVE ELEMENTS FROM TREE EXTRACTS AS ECOLOGICAL INNOVATION

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Abstract: Sustainable development is a way of developing human society that harmonizes economic and social progress with the full-valued preservation of the environment. The ambition of sustainable development is to improve the quality of the environment and the health of the population, to simplify the system and to maintain non-intervention at the highest level of protected areas, sustainable timber harvesting, support of the circular economy and incentive system for waste charges and other activities associated under the concept of eco-innovation. Eco-innovations seek to make significant and demonstrable progress towards a sustainable development by reducing environmental impacts, strengthening resistance to environmental pressures, or making more efficient and responsible use of natural resources. Therefore, the aim of this paper is to find out the attitudes of patients with alopecia to their disease and treatment using active compounds from tree extracts through the Kano model. The results identify the attitudes of patients with the disease to the treatment with the aim of more effective approach to patients in terms of satisfying their needs and adaptation, respectively ecological innovation of products used to treat this disease by using natural resources compared to existing alternatives, supporting the idea of sustainability. From the point of view of patients suffering from this disease, treatments based on active compounds from tree extracts are an essential element of their treatment and their deficit represents potential on the market from an economic, natural and social point of view.
Keywords: Innovation, eco-innovation, Kano model, customers' requirements, alopecia, active elements from tree extracts

1. INTRODUCTION

Competition in the market causes a continual contest for customer favour, which accelerates technological progress and innovation in all areas to meet customer demands. From a microeconomic point of view, customer satisfaction can be understood as one of the factors reflected in the evaluation of products competitiveness. It means that the basic prerequisite for the success of businesses on the market is to create such competitive products that are able to meet the maximum volume of customer needs. This represents product portfolio management and its innovations do not exempt eco-innovations.

Eco-innovation (synonymous for "sustainability innovation") is a special category of innovation that generates the effects needed for environmental protection (respectively sustainable development ensuring).

Nowadays a strong emphasis is placed on sustainable development. Innovation management associated with the whole innovation process and corporate social responsibility when applying environmental protection creates an environmental management system which is established on three pillars - environmental performance of a product, innovation quality for customer and added value of the product supporting this development (James, 1997; Jeck, 2018; Loučanová, 2016, Madudová et al., 2018, Šterbová et al, 2016).

The product quality, which increases the customer's standards through innovation, is reflected mainly in the increasing comfort of the customer, his safety and reliability of the innovated product. On the contrary, taking into account the environmental impact there are monitored descending effects on climate changes, resource efficiency throughout the life cycle of an innovated product from research and development to its ecological disposal (Loučanová, 2016; Kalamárová et al, 2014, Loučanová et al. 2014; Straka, 2013; Štofková, 2013; Kaputa et al, 2016; Paluš et al. 2011).

All these innovative activities are a prerequisite for the commercial success of a business for the sustainable development of its operating regarding market economy conditions, so they are connected to the commercial part of the innovation process, i.e. diffusion of eco-innovation in the market. Then ecological innovations represent an important dynamic factor of each industries (Loučanová, 2016) and even in medicine.

The pharmaceutical industry invests in research and development more of its profits than other sectors. The value of the innovative pharmaceutical industry is enormous, but it does not only rest in the world's largest scientific and research base. Innovative pharmaceutical companies bring additional benefits to national economies. Innovative ways of treatment allow patients to live longer and more productive life. New therapies bring people longer and better life. Investments in medical innovation also have a significant impact on patients' quality of life. Innovative methods within the diseases treatment often use natural ingredients (AIFP, 2020).

Attitudes towards lifestyle and health are developed in several models of consumer segmentation in terms of their attitudes and behavior towards sustainability and environmental issues, such as the LOHAS (Lifestyles Of

Health And Sustainability) model. Therefore developmental tendencies for the issue of examining the attitudes of patients of the selected type of disease and towards treatment with the use of preparations based on active elements from tree extracts are current topics of research. Allopecia is also an actual topic because it is increasingly common in younger age groups of patients.

Alopecia is a non-infectious disease that results in hair and pubes loss. Hair loss afflicts more than 50 % of the world's population.

Genes are the main responsible factor causing the loss of hair growt of men. Hormones, stress, age, diseases, unhealthy lifestyle, inappropriate hair products (containing SLS and parabens) as well as haircuts are the factors influencing the hair loss of women. Alopecia is a limited hair loss that is divided by doctors into scarred and non-scarred. The chance of hair growth returning is lower in alopecia with scarring (Palovčíková, 2015; Expert team NANOGEN, 2016).

Mentioned factors can cause an activation of T cell-mediated autoimmune disease that targets hair follicles (Goh et al., 2002; Ikeda, 1965; Tan et al., 2002; Xiao et al. 2006; Nanda et al., 2002). It affects both genders the same way, the disease can occur at the beginning of life or later in adulthood (Safavi et al., 1995). The disease has several subtypes ranging from one or more local spots of hair loss to complete hair loss on the head or on the overall scalp and body (Sundberg et al., 2003).

Alopecia occurs in men as well as women, with the difference that a complete baldness never occurs in women. In men, it usually begins in the corners; later the hair begins to recede from the forehead and gradually forms a bald spot on the scalp. In women, alopecia has a different course - the hair is gradually thinner, shorter, loses color until the hair follicle completely disappears and the skin between the hair begins to shine through. At the age of sixty-five, half to three quarters of women suffer from hair loss (Palovčíková, 2015). Androgenic alopecia affects almost 30 % of men before the age of 30 years and 50 % over the age of 50 years. 40 % of women over the age of 50 also suffer from it (Expert team NANOGEN, 2016). It is caused by viral infections or inflammation, or bacterial or fungal infections, cancer or mechanical and physical damage (Odborný tím Vypadavanie vlasov, 2016). If alopecia occurs repeatedly in specific places by tension or pressure, we talk about traumatic alopecia, which is caused by inappropriate headgears as well as ornaments, improperly performed cosmetic procedures and massages (Palovčíková, 2015). As it is demonstrated by the studies of Martinez-Mir et al. (2007), at present complex multigenetic peculiarities resulting from hereditary predisposition are risk factors for alopecia. Also studies by McDonagh (2002) and Goh et al. (2006) state that most cases of alopecia have a positive family case history.

Treatment of alopecia is divided into supportive, local and surgical treatment. Topical treatment includes the use of vitamins, trace elements, amino acids with sulfur content and suitable shampoos for deep cleansing of the scalp. Surgical treatment is also recommended for long-term disabilities (Expert team Vypadavanie vlasov, 2016). However, a study by Padmavathy and Anbarashan (2013) showed a positive effect of herbal, tree and shrub extracts in alopecia. Specifically in the case of trees, these were extracts from fruits, leaves, resins, etc., whose extracts represent an important antioxidant (it protects the body from the effects of free radicals), plays a role in the synthesis of collagen or helps prevent hair breakage. It is also important in the regeneration of nails or skin (Expert team Revalid, 2016).

The aim of the paper is to find out how patients with this disease perceive it and as well as how they perceive the positive effects of trees, which represent the wealth of our country, as according to Enviroportál (2016) the area of forest land in Slovakia is currently 41.2 % of the total area of the state. Therefore, the aim of this paper is to use the Kano model to determine the attitudes of patients with alopecia to their disease and treatment, in which tree extracts are used.

2. METHODOLOGY

The evaluation of the attitudes of patients with alopecia to their disease and treatment, in which tree extracts are used, is identified through the Kano model, taking into account the satisfaction of respondents in terms of problems perception associated with this disease. The examination of determined parameters is based on the data obtained by the pre-survey. Following the pre-survey, the basic attributes are identified and at the same time the specific problems of patients suffering from this disease are selected. The evaluation of attitudes to the integration of patients with alopecia into society will be determined on the basis of the specific requirements of this target group through a model of nonlinear and asymmetric dependence between their importance and satisfaction with the attributes of their integration into society.

The methodological procedure for identifying specific patient requirements is based on the elementary steps of the Kano model, which monitors the dependence between the importance of individual properties of selected attributes and patient satisfaction. As a first step, the basic requirements of patients that they meet in everyday life when integrating into society are identified. The data are obtained by the method of patients´ questioning in various regions of the Slovak Republic. This method identifies the criteria that patients consider in their integration into society in everyday life. Regarding their answers there are established requirements for selected attributes which are the object of the research. The pre-survey generates the basic attributes (future variables in the Kano model) associated with the integration of patients into society.

Based on the achieved results, a Kano questionnaire is created. It formulats a positive and negative question (statement) on the generated attributes identified from the pre-survey to detect patients' reactions in the Likert scale (strong agreement, partial agreement, neutral attitude, partial disagreement, strong disagreement).

A questionning is applied as the main method of identifying the specific needs of patients suffering from alopecia. It presents a versatile method for obtaining and collecting primary data on the activities and attitudes of patients with alopecia. The analysis is aimed to determine the opinion of patients, their knowledge and experiences, as well as ways of behaving in the integration of patients suffering from alopecia into society.

After the questionning by the Kano questionnaire we a database of obtained data was created. For each value the individual answers to the positively and negatively asked question (statement) are evaluated separately by cross rule of the KANO model, which specifies the requirements of the selected products. This approach classifies the individual monitored quantities into requirements: must-be (M), one-dimensional (O), attractive (A), reverse (R), indifferent (I) or questionable (Q).

The individual categories of product requirements that affect the satisfaction of patients can be characterized according to Chen et al. (2010) and Loučanová (2016) as follows:

Must-be requirements (M) are considered by patients to be natural and they are automatically expected. They can be marked as primary, resp. basic and therefore patients deal with them only in case of non-compliance. Their identification is of fundamental importance because their fulfillment is reflected in patient´s satisfaction. Patients immediately realize their deficit and non-fulfillment and they are dissatisfied. Finally, this situation reflects in their maximum dissatisfaction.

One-dimensional requirements (O) represent those attributes of the product, the fulfillment of which leads to satisfaction and, in the case of their non-fulfillment, to patient dissatisfaction. It means, the higher the level of compliance with these requirements, the more sattisfied patients are, but patients do not automatically expect them compared to must-be requirements. There is a direct linear dependance between meeting these requirements and patients´ satisfaction.

Attractive requirements (A) are those that have an obvious influence on patients´ satisfaction, because patients do not expect these requirements. If they are not met, it will not result in patients´ dissatisfaction.

Some literature (Ducák et al. 2006, Ullah et al. 2011, Loučanová, 2016) calls reverse requirements (R) as exactly opposite. They represent attributes where patients react in contradictory ways.

Requirements that do not affect patients (I) are also called indifferent requirements. These attributes are not critical for patients and their fulfillment or non-fulfillment does not influence their contentment (satisfaction) or discomfort (dissatisfaction). They are also insignificant from the point of view of product competitiveness.

In addition to the above categories of product requirements, the Kano model also identifies the so-called controversial, resp. questionable requirements (Q). They express a controversial result, which is related either to incorrectly formulated questions or lack of understanding of the question by patients.

Categorized requirements of patients for selected attributes are then expressed in percentages, where the category with the highest percentage identifies the specific category of the observed variable of the given attribute. The percentage expression of the identified specific category (requirement with a maximum value) represents its share of all monitored requirements for the analyzed value of the given attribute.

3. RESULT AND DISCUSSION

Before the implementation of the Kano model, there were identified the attributes observed in the survey within the Kano model, which were generated on the basis of a pre-survey monitoring what patients with alopecia consider and use in the treatment of their disease. We chose problems and treatment as identification components. We included a feeling of unattractiveness and a mental slump among the subcategories of problems.We have included contraception, special preparations, vitamins and food supplements, careful hair handling, diets (gluten-free, low-carbohydrate, etc.), socialization and others among the subcategories of treatment.

The most common problem with alopecia is considered to be a mental shock (90 %). A less problem is considered to be the feeling of unattractiveness (60 %). Socialization helps people with alopecia the most of all during the treatment (90 %). In addition to socializing, various special preparations (69 %), vitamins (50 %), contraception (19 %) and other means (19 %) are used. Very few people with alopecia try to handle their hair carefully (10 %).

Based on the identified attributes monitored by customers (patients) with alopecia, a Kano questionnaire was created and subsequently applied. This questionnaire was completed by 211 respondents suffering from alopecia and treated for this disease. They were addressed personally and electronically within groups of patients with this disease. At a confidence interval 95 % and an acceptable margin of errors (7 %) the minimum sample of respondents was calculated (196). The survey results are relevant because the required number of respondents participating the survey was met.

Based on the collected data, we can conclude the following results. Seventy-three respondents identified the psychological impact of alopecia as a reverse (also known as the opposite) requirement, which represents attributes where patients react contradictory. They also consider weekends with family or meeting people with similar problems to be a reverse requirement within the treatment of alopecia, respectively its psychological impact. On the other hand, many respondents consider weekends spent with family to be an attractive requirement that has an obvious effect on patient satisfaction. A lot of respondents also consider wearing a wig to be a reverse requirement.

Most respondents include special preparations based on active ingredients from tree extracts among must-be requirements in the treatment of alopecia. Respondents consider them natural and automatically expected. Reimbursement of contraception and wigs is considered by most respondents to be an attractive requirement. Reimbursement of special foods is also an attractive requirement for many respondents, which has an obvious effect on patients´ satisfaction, because it is a requirement that patients do not expect. Satisfaction associated with partial financial compensation for medical devices is considered by most respondents to be a requirement that does not influence patients.

From the point of view of age categories, the given results are different, as with increasing age of men, the disease does not influence them so much compared to men at a younger age. Regarding women, this perception is still the same and negative. In younger age groups, this perception is negative regardless of gender.

The results clearly point to the fact that patients with alopecia consider preparations based on active ingredients from tree extracts in the treatment of their disease as mandatory. In alopecia, there are used Cocos nucifera L (Oil from endosperm-antiseptic), Juglans regia L., Juglands nigra L. (list of plants), Pyrus malus L. (list of plants), Quillaja saponaria L. (list of plants),Santalum album L. (list of plants), Acacia concinna (list of plants), Azadirachta indica (list of plants), Betula pendula (list of plants), Cedrus atlantica L. (list of plants), Eucalyptus sp. (list of plants), Emblica officinalis (list of plants), etc (Jain and Das, 2016; Padmavathy and Anbarashan, 2013). These trees, resp. and extracts from their fruits and leaves belong to the active elements of medicaments to improve skin health, which is the basis for healthy hair growth.

As the study by Padmavathy and Anbarashan (2013) points out, agriculture, including forestry and the related wood processing industry, is a very dynamic sector all over the world and involves human needs and supports important living systems. Nevertheless, these sectors must also meet economic objectives, such as profitability, but at the same time not forget about ecological integrity and the offer of ecosystem services. This requires a comprehensive system of research and management approach to geographical scaling, supporting the stabilization and regeneration of plants and forests that important and unique for medical purposes. However, even in Slovakia, these values have not been explored, yet. Therefore, within the current forest policy documents and generally binding legislation in the field of forestry (as stated in the Zelená správa, 2016) it is necessary to think about this potential, which is still very little used, namely afforestation of forest areas or creation of forest plantations with woody species which parts, resp. components (leaves, fruits or extracts) are useful in medicine and they present active elements in a number of medicaments. Juglans regia L., Juglans nigra L., Betula pendula L. and Pyrus malus L. (Malus domestica Borkh) are suitable in European climatic conditions in the case of leaf extracts using. The creation of areas using forested extracts for medical purposes, forestry and the wood processing industry will then have a synergistic effect in terms of increasing productivity and complex efficiency.

To eliminate this situation, it is necessary to support ecological management processes that partially miss in conventional management and promote biodiversity in the organic system (Mader et al., 2002; Raupp et al. 2006; Nakhro and Dkhar, 2010, Olšiaková et al, 2017, Loučanová et al. 2017). These plants (i.e. medicinal plants but also trees and their parts, from which extracts are used in medicine) are extremely important and play an important role in terms of biodiversity, but also the economy of the territory. These statements from various studies also confirm the results of our study, which point to the fact that patients consider treatment with products based on active elements from tree extracts to be mandatory and natural in their expectations. Such treatment is of fundamental importance to them, mainly because their fulfillment will be reflected in patient satisfaction. Patients immediately realize their deficit and non-fulfillment and are dissatisfied, which represents potential from an economic point of view.

Therefore, within the issue of putting this innovation into practice, it is important not only to focus on the segment of customers (patients), but also on the segment managing and supporting biodiversity in the organic system to support the development of this idea. This study is a pilot survey of this issue, pointing to the possibilities of eco-innovation presenting a potential synergistic effect in increasing productivity and complex efficiency.

CONCLUSION

The results clearly point to the fact that patients with alopecia consider it mandatory to use preparations based on active elements from tree extracts in the treatment of their disease. In the future, this represents a business opportunity, as it is necessary to eliminate the state of conventional management and support biodiversity in the organic system and at the same time the economy of the territory. From the point of view of patients suffering from this disease, treatment preparations based on the active elements of tree extracts represent an essential part of their treatment and their deficit represents a potential in the market from an economic point of view. To support the development of this idea, it is appropriate to focus on the segment of patients requiring treatment based on active elements from tree extracts as natural (compulsory, expected) and at the same time to manage and support biodiversity in the organic system to support the development of this idea.

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REFERENCES

1. Červenková, E.; Chrappová, M. (2017): Postoje pacientov vybraného druhu ochorenia ku liečbe s využitím prípravkov založených na aktívnych zložkách z výťažkov stromov. In ŠVOČ 58. Zvolen : Technical University in Zvolen, 2017. pp. 688-702.
2. Chen, LS. et al. (2010): *C Kano Model : a Novel Approach for Discovering ttractive Quality Elements*. In: Total Quality Management 21 (11): pp. 1189-1214.
3. Ducák, S.; Naščáková, J.; Malák, M. (2006): *Návrh systému merania spokojnosti zákazníkov Kano modelom*. In: Transfer inovácií 9: pp. 137-139.
4. Goh, C. et al. (2006): *Profile of 513 patients with alopecia areata: associations of diseasesub types with atopy, autoimmunedisease and positive family history.* In: J Eur AcadDermatolVenereol 20: pp. 1055–1060.
5. Ikeda, T. (1965): *A new classificationofalopeciaareata. In:* Dermatologica 31: pp.. 421–445.
6. Jain,P.K., Das, D.E.B.A.J.Y.O.T.I.(2016):*The wonder of herbs to treat-Alopecia*.In:Innov JMed Sci 4(5):pp. 1-6.
7. James, P. (1997): *The Sustainability Circle: a new tool for product development and design*. In: Journal of Sustainable Product Design 2: pp. 52-57.
8. Jeck, T. (2018): *Ecological Innovation on* Slovakia: Current State, Development and Policy. In: Životné prostredie 52 (3): pp. 131 – 139.
9. Kalamárová, M. et al. (2014): *Competitiveness evaluation of the Slovak forest industry*. In:Position and role of the forest based sector in the green economy: proceedings of scientific papers, pp. 58-62.
10. Kaputa, V.; Paluš, H.; Vlosky, R. P. (2016): *Barriers for wood processing companies to enter foreign markets: a case study in Slovakia*. In: European journal of wood and wood products, 2016, 74 (1): pp., 109-122.

11. Kožuchová, Z. (2015): Androgenetickáalopécia a súčasné možnosti liečby Dermatol. prax,9 (4): s. 147–149.
12. Loučanová, E. (2016): *Inovačné analýzy a stratégie*. Zvolen: Technická univerzita vo Zvolene, 149 s
13. Loučanová, E. et al. (2017). *A course of innovations in wood processing industry within the forestry-wood chain in Slovakia: A Q methodology study to identify future orientation in the sector*. In: Forests, 8(6), 210.
14. Loučanová, E., Parobek, J., Paluš, H. (2014): *Identifikácia požiadaviek slovenských zákazníkov na úložný nábytok na základe modelu KANO*. In Acta Facultatis Xylologiae Zvolen, 56 (1): pp:. 109-117.
15. Mader, P. et al. (2002): *Soil Fertility and Biodiversity in Organic Farming*. In: Nature. 296: pp.1694-1697.
16. Madudova, E., Čorejová, T., Valica, M. (2018): *Economic sustainability in a wider context: Case study of considerable ICT sector sub-divisions.* In: Sustainability, 10(7).
17. Martinez-Mir, A. et al. (2007): *Genome wides canforlinkagerevealsevidenceofseveralsusceptibilitylocifor alopecia areata.* In:Am J Hum Genet,80: pp. 316–328.
18. Mcdonagh, A.J.; Tazi-Ahnini, R. (2002): *Epidemiology and genetics of alopecia areata*. In: Clin Exp Dermatol 27: pp.. 405–409.
19. Nakhro, N.; Dkhar, MS. (2010): *Impact of organic and inorganic fertilizers on microbial populations and biomass carbon in paddy field soil.* In: Journal Agron. 9: pp.102-110.
20. Nanda, A. et al. (2002): *Alopecia areata in children: a clinical profile.* In: Pediatr Dermatol,19, 482–485.
21. Olsiakova, M. et al. (2017): *Application of new trends of marketing communication as a competitiveness tool in furniture industry*. In: More wood, better management, increasing effectiveness: starting points and perspective.
22. Padmavathy A., Anbarashan. M. (2013): *Ethnobiology of unconcernedfloras in organic and inorganic agriculturalfields-Bahour, Puducherry-India.* In Journal of Medicinal Plants Researc 7(44), pp. 3254-3262.
23. Paluš, H. et al. (2011): *End users´ preferences for joinery products and furniture*. In: Intercathedra 27/2, 58-61.
24. Raupp, J. et al. (2006): *Long-term field experiments in organic farming*. Verlag Dr. HJ Köster.
25. Richterová, K. et al. (2004):. *Marketingový výskum*. Bratislava: Ekonóm 2004. 380 p.
26. Safavi, K. H.; Muller, S. A.; Suman, J. V.; Moshell, N. A.; Melton III, L. J. (1995): *Incidenceofalopeciaareata in OlmstedCounty, Minnesota, 1975-1989,* In: MayoClin Proc 70, pp. 628–633.
27. Štěrbová, M., Loučanová, E., Paluš, H., Ivan, Ľ., Šálka, J. (2016): *Innovation strategy in Slovak forest contractor firms—A SWOT analysis.* In: Forests, 7(6), 118.
28. Štofková, K. (2013): *Sieťové podnikanie.* In Manažment a sieťové podnikanie vo vedomostnej ekonomike. Žilina: Žilinská univerzita, pp. 25-60.
29. Straka M. (2013): *Logistika distribúcie, Ako efektívne dostať výrobok na trh*, Bratislava, EPOS 2013, 400 p.
30. Sundberg, J. P.; Boggess, D.; Silva, K.A.; Mcelwee, K.J.; King, L.E.; Li, R. (2003): *Major locus on mousechromosome 17 and minorlocus on chromosome 9 are linkedwithalopeciaareata in C3H/HeJ mice*. In: Journal Invest Dermatol 120, pp. 771–775.
31. Tan, E.; Tay, Y.K.; Goh, C.L.; CHin Giam, Y. (2002): *Thepattern and profile ofalopeciaareata in Singapore–a study of 219*, In: AsiansInt J Dermatol 41, pp. 748–753.
32. Ullah, S. A. M. M.; Tamaki, J. (2011): *Analysisof Kano-model-based customer needs for product development*. In Systems Engineering. 14 (2): pp. 154–172.
33. Xiao, F.L.; Yang, S.; Liu, J.B.;. He, P.P.; Yang, J.; Y. Cui, Y. (2006): *Theepidemiologyofchildhoodalopeciaareata in China: a study of 226 patients*, In: PediatrDermatol, 23: pp. 13–18.
34. ***AIFP, (2020) URL: https://www.aifp.sk/sk/inovacie-hodnota-inovacii/
35. ***Enviroportál, (2016): URL: ttps://www.enviroportal.sk/indicator/detail?id=701&print=yes
36. ***EXPERT TEAM NANOGEN (2016): URL: https://nanogen.sk/alopecia-areata/
37. ***EXPERT TEAM REVALID (2016): URL: https://vypadavanievlasov.net/revalid/
38. ***EXPERT TEAM VYPADAVANIE VLASOV (2016): URL: https://vypadavanievlasov.net/
39. ***Jakasi, (2015): *Co je cílený marketing (koncentrovaný a diferencovaný*? URL: http://www.jakasi.cz/co-je-cileny-marketing-koncentrovany-a-diferencovany/
40. ***Palovčíková, M. (2015): *Strata vlasov nie je vždy genetická: Kedy treba vyhľadať lekára?* URL: http://www.pluska.sk/izdravie/liecba/strata-vlasov-nie-je-vzdy-geneticka-kedy-treba-vyhladat-lekara.html
41. ***Zelená správa (2016): URL: http://www.mpsr.sk/index.php?navID=123&id=10995.

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SATISFACTION WITH UNIVERSITY INFORMATION SYSTEM

Kaputa, V., Maťová, H., Triznová, M., Šupín, M., Kalamárová, P.

Abstract: The paper deals with the overall satisfaction with university information system (UIS) which creates communication and data transfer environment for user of four faculties aimed at issues of forest, wood, environment and technics. The system was evaluated by its clients - over four hundreds of students and over hundred of lecturers at the Technical University in Zvolen (also known as TUZVO). Users expressed their satisfaction join survey via online questionnaire. Evaluated was capacity, functionality, safety, stability, utilisation in the pandemic time, and other components of the information system structure. Open questions brought us many valuable suggestions and enable a deeper view to the attitudes, expectations and needs of university system clients. Findings will serve as supporting information for managerial decisions (e.g. to launch a university system application for cell-phones/mobile devices) and as a tool to improve the UIS construction and functionality.
Keywords: information system, university, users' satisfaction

1. INTRODUCTION

Data not put in the order create a bulky bundle of information. A struggle to find the proper one often takes enormous amount of time what individuals usually do not have or do not willing to devote. Natural human effort is to develop a system based on a rational structure which make the work with data and/or information much effective (considering time and costs mainly). Thus, if one speaks about the information system, it should be a tool allowing to work easier. The objective of this study was to evaluate the satisfaction of the university information system users.

Information systems are built on data, but data themselves are streams of raw facts (Laudon and Laudon, 2012) and are irrelevant itself. They reflect objective reality and certain events without reference to surrounding events (Šujanová et al., 2007). The sense of data processing is to interpret them and create information. Each information is a set of data, but it is not true vice versa. By information we mean data that have been shaped into a form that is meaningful and useful to human beings. Such understanding of information by Laudon and Laudon (2012) led into the definition of an information system as a set of interrelated components that collect (or retrieve), process, store, and distribute information to support decision making and control in an organization.

Research was conducted among the users of university information system at the Technical university in Zvolen, Slovakia. The TUZVO is a modern higher education institution providing education in all three levels of studies within the European Higher Education and Research Area. In the higher education system in Slovakia, the TUZVO has a unique specialisation within a focus on the spheres of forest – wood – ecology – environment with an appropriate expansion in other technical, natural, security, economics as well as design spheres (tuzvo.sk, 2020). TUZVO has four faculties: Faculty of Wood Sciences and Technology, Faculty of Forestry, Faculty of Technology, and Faculty, Faculty of Ecology and Environmental Sciences. Revealing the satisfaction with the UIS utilisation, all the university teaching staff and the students of TUZVO were included to the target group of respondents.

2. MATERIALS AND METHODS

The design and construction of the questionnaire survey as the primary research tool was the basic precondition to fulfil the objective of the study. Two different groups of users were determinate to recognize broader aspects of usefulness of university information system (UIS). The first group were students as the clients of university and lecturers (university employees) created the second surveyed group. There were 2 forms of the questionnaires, each for certain group respondents. They were asked to evaluate capacity, functionality, safety, stability, utilisation during the pandemic time, and other components of the information system structure. Eight question were standard (the same) for both groups while the group of lecturers had two more specific questions concerning pedagogical aspects of the UIS utilisation and the group of students had one more question concerning their interest about a mobile application of the UIS. In the sample of students, we gathered identification data regarding the level of study and the faculty affiliation. The answers were constructed using the 5-points Likert-type scale (1-completely disagree, 5-completely agree).

Census was done among all the students (N = 2353) as well as among all the lecturers (N = 237) of the Technical University in Zvolen (Source of data: TU Zvolen, 2020). Link related to the electronic form of the questionnaire was distributed using TUZVO's university information system. We have reached 429 completed forms from the students (18.2% response rate) and unexpected 125 completed forms from the lecturers (52.7% response rate).

Frequency and contingency analyses were used to treat the data. Satisfaction of the relevant group of the UIS users was expressed using simple calculation:

$$Satisfaction = \frac{Number\ of\ received\ points}{Max.\ possible\ number\ of\ points}\ x\ 100\ [\%] \qquad (1)$$

Calculation in case of students:
Max. possible number of points = 5 x 9 x 429 (5 as the marginal positive assessment through the Likert-type scale x Number of evaluated items x Number of respondents)

Calculation in case of lecturers:
Max. possible number of points = 5 x 10 x 125 (5 as the marginal positive assessment through the Likert-type scale x Number of evaluated items x Number of respondents).

3. RESULTS

There is a strong demand for mobile application among the sample of students – over 73% of them would welcome such a way to enter the UIS. Most of students considered the system as stable (over 64%) and safety (almost 60%). On the other hand, the possibility of online teaching is perceived as not sufficient by 36% and capacity of data (means mailbox) was blamed by over 35% of the students' sample. There is relevant share of users (almost 30%) considering the UIS as user unfriendly from other devices (cell-phone, tablet).

Table 1 Satisfaction of the UIS users: students (n = 429) and lecturers (n = 125)

	Unsatisfied (%)		**Indifferent (%)**		**Satisfied (%)**	
	Lecturer	Student	Lecturer	Student	Lecturer	Student
Sufficient data capacity	35.2	50.8	13.6	18.2	51.2	31.0
UIS is stable	8.8	16.6	12	19.3	79.2	64.1
Just in time problem solving	17.6	14.9	24.8	43.1	57.6	42.0
User friendly on all devices	29.6	30.8	39.2	13.1	31.2	56.2
UIS saves time	13.6	19.6	24	24.2	62.4	56.2
UIS makes communication easy	26.4	29.1	22.4	17.5	51.2	53.4
UIS functions makes work	8.8	NA	9.6	NA	81.6	NA
UIS interlinks units, reduce	28.8	NA	39.2	NA	32	NA
UIS is safety	8.8	12.4	46.4	28.0	44.8	59.7
Possibility of online teaching	36	36.1	33.6	33.6	30.4	30.3
Demand for smartphone app	NA	13.5	NA	13.1	NA	73.4

NA – not applied

Majority of the lecturers claimed that the UIS functions (e.g. e-index, term of exam, study records) makes work effective (over 81%). Simultaneously over 79% consider the system for stable and time saving (over 62%). On the other hand, 36% of the unsatisfied lecturers pointed at the issue of online teaching. Such tools offered by the UIS were rarely used before as face-to-face teaching and examining was practiced usually. Higher demand for such tools during the pandemic time showed user friendliness. Results distributed more or less equally those whose were (over 30%) or were not (36%) satisfied and those with an indifferent attitude (over 33%). There was a possibility to express own remarks on the survey topic. Old-fashioned style, non-actual data, insufficient capacity of the mailbox as well as the document server belong to the shortages of the UIS mostly mentioned by lecturers. Minority of the users stated that the system is not good designed and the orientation in the UIS is opaque. Lecturers also mentioned that the Czech language mutation of the UIS should be removed. Such remarks relate to the fact that some Czech terms still appear in the official Slovak version.

4. CONCLUSION

Reflexing the data received from the questionnaires, the calculation of satisfaction could be done (Table 2, Calculation 2 and 3). The results showed similar level of satisfaction comparing both groups of respondents. Lecturers' level achieved level of 68.1% of satisfaction while the sample of students expressed 67.7% – slightly lower level of satisfaction.

Table 2 Calculation of satisfaction

	Students (n =	**Lecturers** (n =
Number of received points	13 061	4 259
Maximum possible number of	19 305	6 250

$$Satisfaction\ of\ lecturers = \frac{4259}{6250}\ x\ 100 = 68.1\% \quad (2)$$

$$Satisfaction\ of\ students = \frac{13061}{19305}\ x\ 100 = 67.7\% \quad (3)$$

Capacity of mailbox is the Achilles' heel of the UIS and complicates mutual communication to long. Administrative staff must send e-mails warning students to clear their mailboxes and watch the capacity. It is disturbing concernig the fact that this generation grew up in a digital world (Kaputa et al., 2017). High demand of students for the smartphone application will be probably solved soon as the process to launch the application has started already. Less important, but still mentioned is old-fashioned design and system opacity.

Based on sufficient obtained number of responses in the group of lecturers (response rate 52.7%) the results can be considered as representative. Findings revealed that attention of management must be aimed at the possibility of online teaching. Recent pandemic period unexpectedly tested readiness of the teaching staff to utilise such functions and components of the UIS (project teaching, e-learning, testing). Most of lecturers switch to another platform and discovered online teaching using the possibilities offered by Office (Microsoft) 365. Others took advantage from wide portfolio of platforms that allowed them to reach the students. Overall, the UIS received respectable assessment by both the groups of users.

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REFERENCES

1. Kaputa, V., Triznová, M., Maťová, H. (2017): *Is paper still attractive for generation Y?* In Marketing identity: online rules, Trnava. 2017. ISBN 978-80-8105-918-6. p. 108-115.

2. Laudon K. C., Laudon, J. P. (2012): *Management Information Systems*, Twelfth edition, Prentice-Hall, 2012. ISBN 13: 978-0-13-214285-4.
3. Šujanová, J., Rešetová, K., Výboch, J. (2007): *Informačný manažment*. Bratislava: Slovenská technická univerzita v Bratislave. 216 s. ISBN 978-80-227-2602-3.
4. TU Zvolen. 2020. Final Report / Výročná správa o činnosti Technickej univerzity vo Zvolene za rok 2019. R-3593/2020.
5. tuzvo.sk. (2020): Mission of TUZVO [online]. Available at: https://www.tuzvo.sk/en/mission

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SELECTED ASPECTS OF THE TRANSITION TO THE ON-LINE STUDY PROCESS DURING THE PANDEMIC, CASE: BIOTECHNICAL FACULTY

Kropivšek, J., Jošt, M., Oblak, L., Zupančič, A.

Abstract: Due to measures and restrictions taken by many governments around the world for preventing the spread of the Covid-19 virus and thus the pandemic, many higher education institutions have been closed for a long time. In order not to stop the study process completely, university and faculty management had to make sure that most of the study activities were carried out regardless of the new situation. Digitalization of these activities or moving most of them to cloud platforms that allow distance learning has become one of their priorities. Despite all the already established digital solutions in the implementation of the study process, such as standard e-classrooms, many obstacles and challenges have arisen when migrating practically all study activities to the online environment. The technological challenges can be relatively easily solved, while organizational and legal issues are more complex. The research, which was carried out after the first wave of "forced" digitalization of study at the Biotechnical Faculty in the first half of 2020, shows very interesting results, among which is the rapid adaptation of all stakeholders in the study process to the new situation. Moreover, many opportunities have emerged that will undoubtedly affect the implementation of the pedagogical process in the future.
Keywords: on-line study, digitalization, higher education, Covid-19, Slovenia

1. INTRODUCTION

Due to measures and restrictions taken by many governments around the world, including Slovenia, for preventing the spread of the Covid-19 virus and thus the pandemic, many higher education institutions have been closed at the beginning of March 2020. Higher education institutions had to adapt to the new situation fast and promptly. In order not to stop the study process completely, university and faculty management had to make sure that most of the study activities were carried out regardless of the new situation. The situation was quite similar all over the world (Zhu & Liu, 2020; Jandrić, 2020). Faculties and universities responded quickly and immediately started to move their classes on-line. Moving on-line can enable the flexibility of teaching and learning anywhere, anytime, but the speed with which this move to online is expected to happen is unprecedented and staggering (Hodges, 2020). It is always a very stressful transformation, especially if it has to be done in the rush. In contrast to experiences that are planned from the beginning and designed to be on-line, so-called emergency remote teaching, is a temporary shift of instructional delivery to an alternate delivery mode due to crisis circumstances and that's why this is not real on-line teaching (Hodges, 2020).

Nevertheless, all this means a real historical move in the field of higher education and demands joint efforts from faculty, staff, and students in equal measure. Digitalization of most activities and moving them to cloud platforms that allow distance learning has become one of the priorities. Also worldwide, a huge rise of e-learning in 2020 is emerging (Gonzalez De Villaumbrosia, 2020). Regardless of the fact that the digital transformation of the study process is one of the priorities for the development of digital society at the European level and many initiatives have been developed for this purpose (European Commission, 2017; 2020a; 2020b), practice is still poor. At the level of the Biotechnical Faculty, it was found in 2018 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 the use of on-line examination tools, lecture videos, social networks and tools in the clouds (Kropivšek, 2018). Despite all the already established digital solutions in the implementation of the study process, such as standard e-classrooms, many obstacles and challenges have arisen when migrating practically all study activities to the on-line environment.

The research, which was carried out after the first wave of "forced" digitalization of study at the Biotechnical Faculty in the first half of 2020, shows very interesting results, among which is the rapid adaptation of all stakeholders in the study process to the new situation. Moreover, many opportunities have emerged that will undoubtedly affect the implementation of the pedagogical process in the future, after returning to a "normal" state.

The aim of the research was to examine the selected directions of the transition to the on-line implementation of the pedagogical process at the Biotechnical Faculty due to pandemic-related measures on both technological (use of e-classroom and other platforms for remote work) and organizational (management, response, etc.) point of view.

2. METHODS

2.1 Students' questionnaire

Two weeks after the faculty shutdown and the transition to distance learning, a survey was conducted among students, the purpose of which was to gain insight into students' opinions regarding the new on-line study. It was carried out by the Student Council of the Biotechnical Faculty (Študentski svet BF, 2020). An open-source application was used for creating, conducting, and analyzing the on-line survey. The survey was sent to all 2085 active students at the Biotechnical Faculty and was accessible online between 27 March and 3 April 2020. It was completed by 572 students, which means a 27 % response rate. The survey was anonymous and consisted of 6 questions, four of them were closed type questions in the shape of a five-point Likert scale with one possible answer, and two questions were open.

Data were further analyzed based on a frequency distribution, which is a tabular summary of data showing the number (frequency) of observations in each of several non-overlapping categories or classes (Anderson et al., 2015; Košmelj, 2007). The frequency of a class j is marked as fj. For comparison of frequencies of different classes, a relative frequency is used. This means that the frequency of a class equals the fraction or proportion of observations belonging to a class. It is normally presented by percentage frequency distribution, fj.% :

$$\boldsymbol{f_j}\% = \frac{\boldsymbol{f_j}}{\boldsymbol{N}} * \mathbf{100} \qquad \text{Eq. 1}$$

Where is: f_j is the frequency of a class *j*, and *N* is the number of observations.

2.2 Review of measures during the epidemic

Review and qualitative analysis of internal documents and activities, which deal with and are related to on-line study during the epidemic at both, University of Ljubljana and Biotechnical Faculty.

2.3 Log-in analysis in the e-classroom and the survey about its use

First, to check the actual use of the e-classroom, in our case the Moodle platform, by users, the logs of all activities were analyzed for the recent and past academic years; data for the previous year were collected on 16 June 2019 and for the recent year on 17 June 2020, in both cases for the whole academic year. The sample included 855 subjects taught at the faculty. Special attention was paid to group data in comparable groups of activities and frequency calculations (see above: equation 1), as well as the proportion in order to compare these data with each other.

Next, an online survey was conducted to check the use of e-classroom and videoconferencing platforms amongst pedagogical workers at Biotechnical Faculty. For creating and conducting the online survey the Moodle module "Feedback" was used. The survey was anonymous and was sent to all 388 pedagogical workers (316 internal and 72 external) on teacher and/or assistant position. 225 of them clicked the link to the survey and 177 of them answered all the questions, which means a 46 % response rate. The survey was accessible online between 10 and 24 June 2020. The survey consisted of 83 questions; most of them were the closed type with one possible answer, and in most cases in the shape of a five-point Likert scale. Data were further analyzed in Microsoft Excel 2016 based on a frequency distribution.

3. RESULTS

3.1 Analysis of students' opinion

From a survey among students conducted one month after the introduction of a part-time online study, one of the main findings was that students responded and adapted quickly to the change. The majority of students (91%) liked distance study about the same or even more than the conventional way of study and just about one-tenth of the students were not satisfied with a new form of study. More than four-fifths (around 80%) of students didn't report any problems with joining distance learning, while the biggest problem for others was a poor internet connection. This is, we assume the result of above-average internet network occupancy and cannot be eliminated in an easy and fast way. In rare cases (4%), the problem is also the availability of appropriate hardware (camera, microphone, and/or computer) and a lack of internet connection. At the same time, this is the biggest obstacle of distance study as it doesn't provide equal opportunities for all students and causes exclusion.

According to our research were students bothered the most by two facts in particular. The first one was, they didn't like that lecturers were using different video-conferencing programs (Webex Meetings, Zoom, MS Teams, GoToMeeting, etc.), which caused confusion among students. The second and much bigger challenge for students was high pressure, which was physical on the one hand as students spent much more time in front of the computer screen and also physiological on the other hand since they had to process a lot of study materials by their own. Despite video-conferencing, they had to write final reports and were given a greater number of seminars. In addition, they had more on-line exams during the epidemic than they would have in normal conditions. They reported pain in their backs and aching eyes since they spent up to 14h per day in front of computers. More than half of students (62%) reported spending more or much more time for distance study than normal (Figure 1).

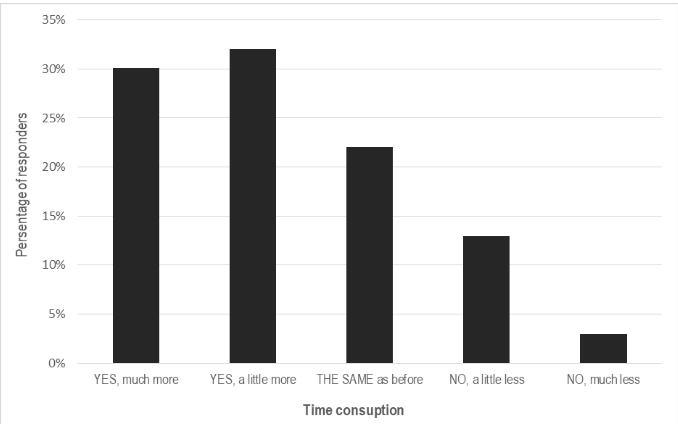

Figure 1: Answer on the question "Do you spend more time on distance study than on traditional way of study?" (N = 572)

3.2 Review of measures during the epidemic

In the period of epidemic and faculty shut down, many measures were taken at both, the university and faculty level, to facilitate the new situation and above that enabling all stakeholders to carry out the pedagogical process from their homes.

Table 1. Review of measures taken during the epidemic related to on-line studies at both University of Ljubljana and Biotechnical Faculty level

GROUP OF MEASURES	MEASURE	WHO	LEVEL	FOR WHOM	PERIOD
Instructions and protocols	Instructions for basic and advanced use of the e-classroom (Moodle)	IT support	Faculty	Students and pedagogical staff	2 years before epidemics
	Instructions for using various on-line videoconferencing platforms	IT support	Faculty	Students and pedagogical staff	At the beginning of the epidemic
	Guidelines for distance work and study (several documents)	Faculty management	Faculty	Students and pedagogical staff	At the beginning and during the first wave of the epidemic
	Protocols for conducting on-line examination (several documents)	University and faculty management/ IT support	University and faculty	Students and pedagogical staff	During the first wave of the epidemic
GROUP OF MEASURES	**MEASURE**	**WHO**	**LEVEL**	**FOR WHOM**	**PERIOD**
Webinars	Basic use of the Moodle platform	IT support	Faculty	Pedagogical staff	Before the epidemic and during the first wave of the epidemic
	Advance use of the Moodle platform with a focus on quizzes and grades	IT support	Faculty	Pedagogical staff	Before the epidemic and during the first wave of the epidemic
	Use of on-line video-conferencing platforms for distance work	IT support	Faculty	Pedagogical staff	Before the epidemic and during the first wave of the epidemic
	Implementation of on-line examination – presentation of the protocol and workshop	IT support	Faculty	Pedagogical staff	During the first wave of the epidemic
Physical assistance	Organization of distributed pedagogical and technical assistance	IT support	Faculty	Students and pedagogical staff	During the first wave of the epidemic

Table 1 shows how many measures were taken at the faculty to facilitate and ensure a more organised transition to distance work and study. Support was provided to both students and pedagogical workers in various forms. Certain measures were initiated by the university, where a particularly important role was played by the team within the Digital UL project (2018), in which many events related to the digitalization of studies in the last 3 years were organized. Numerous instructions and protocols served primarily to create a framework in which students and pedagogical workers worked in a more organized and competent manner. During the implementation, however, it turned out that due to the remote work, the virtual implementation of many workshops in the form of webinars was very appropriate. The participation and response rate of employees was exceptional, e.g. almost 70% of all pedagogical staff at the faculty attended the workshops on the topic of conducting on-line examination. Physical assistance is at faculty organized in a distributed manner. During the remote work, this kind of help was mostly implemented as telephone consulting or assistance via platforms that allows e.g. sharing a desktop. Technical assistance was also available to students for solving their, mostly technical problems.

3.3 Use of e-classroom and other platforms for distance work and study

At the end of the second semester of the academic year 2019/2020 at least one activity was recorded in 565 subjects out of a total of 855 subjects taught at the faculty, which represents around two-thirds of all subjects (66.1%). Among these subjects as many as three quarters also used advanced modules such as quizzes, questionnaires, and assignments. The year before, at the end of the academic year 2018/2019, the share of active subjects as well as the use of advanced modules was much lower (41% subjects with recorded activity in 2018/2019, among them 45% with advanced modules). The number of activities of pedagogical workers in the e-classroom has in academic year 2019/2020 increased significantly (Figure 2). Especially big increase is seen in March and April 2020, at the beginning of the epidemic and the faculty shutdown.

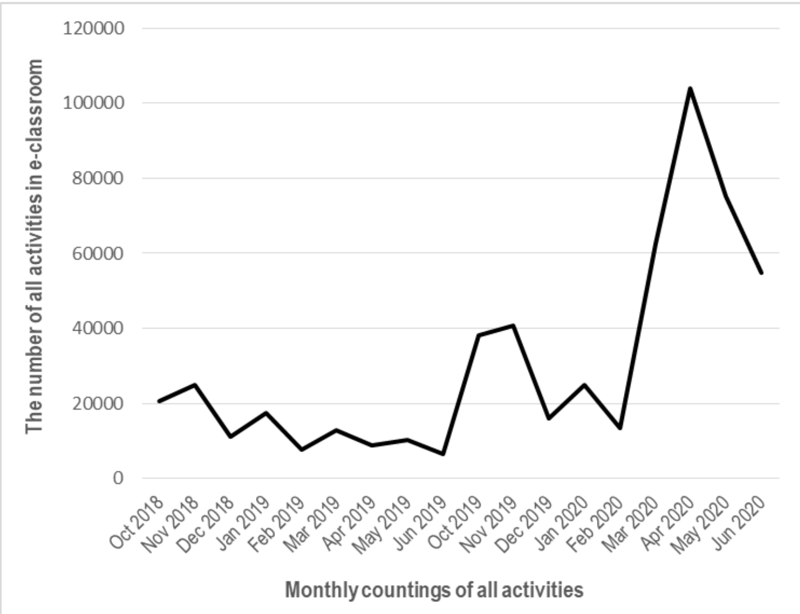

Figure 2. Number of activities in the e-classroom by months for the period between October 2018 and June 2020

A more detailed analysis of the use of the e-classroom shows that in the recent academic year 2019/2020 compared to the previous academic year 2018/2019 the number of subjects using advanced modules has increased significantly (Figure 3). We observed increasing use of modules “File”, intended for pedagogical workers to upload all kinds of study material (index = 150) and “Assignment”, intended for students to upload documents with final reports, seminars, etc. (index = 232). Particularly has increased the usage of quizzes in e-classroom, which was the basic platform for on-line examination during the epidemic (index = 1147). Module “Forum” is not displayed in Figure 3 since it is installed by default in all subjects.

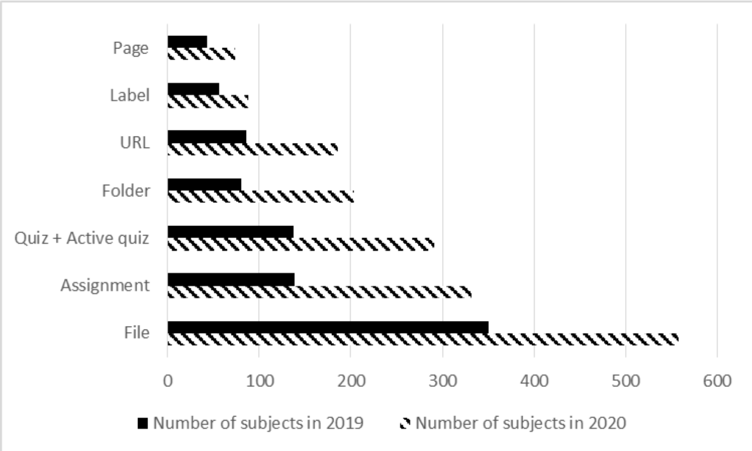

Figure 3. Number of subjects using different modules in the e-classroom (n=855)

In the recent academic year 2019/2020, the module »File« was used in almost two-thirds of all subjects (65.15%), “Assignment” in around 39%, and in a quarter of subjects were used quizzes, folders, and URLs (Figure 3). Modules “Tag” and “Page” were used in the fewest subjects. Other modules are present in less than 5% of all subjects and are therefore not shown in Figure 3.

Although the use of e-classroom at Biotechnical Faculty has increased in comparison to the last year, it still offers many opportunities to pedagogical workers in the future to explore and use various modules as upgrades of the existing study process. These are mainly in the module “Assignment”, which enables the orderly uploading of various students' protocols and seminars, and in the module “Quiz”, which enables real-time on-line examination.

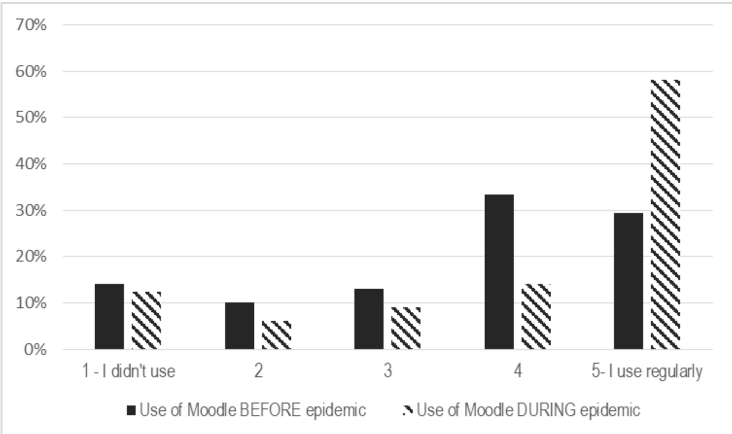

Figure 4. Use of e-classroom before and during the epidemic (n = 177)

Based on the analysis of pedagogical staff at Biotechnical Faculty, we can conclude, that the use of e-classroom has increased significantly (Figure 4) in the academic year 2019/2020. In particular, the share of those who regularly used the e-classroom increased to almost 60% of all respondents. This share increased mostly because of reduced shares of those users of e-classroom who used it already before the epidemic, but less regularly and/or on a smaller scale. However, there are still more than a tenth of those pedagogical workers, who despite the situation, all the support activities and recommendations from management, still don’t use e-classroom.

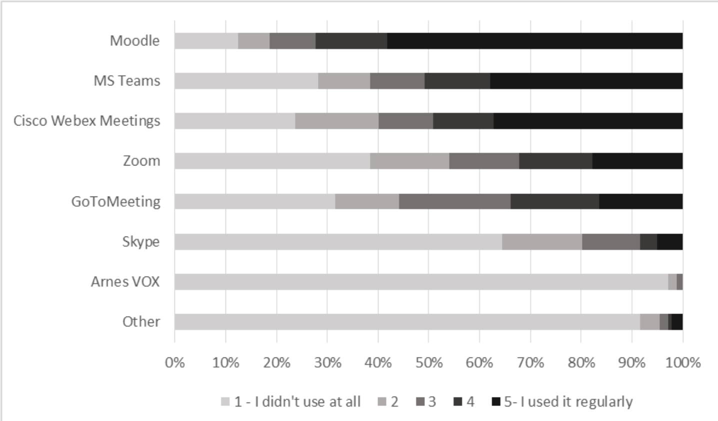

Figure 5. Use of different videoconferencing platforms during distance work (n = 177).

In the same study, we also checked, how much and which videoconferencing platforms were used by pedagogical workers during the epidemic (Figure 5). Next to e-classroom Moodle, which was used by around 80% pedagogical workers, MS Teams and Cisco Webex Meetings prevailed (both by more than 60%), which were simultaneously supported by internal technical support. Other platforms were used by a minority of pedagogical workers.

4. DISCUSSION AND CONCLUSION

Extraordinary conditions in the business environment cause many twists and above all many changes in the basic conditions and ways of working. In such situations, the quick response of the management of companies and/or institutions, the state of infrastructure, and especially the competencies of employee and their adaptability to new conditions are extremely important. The same is true for educational institutions, including the Biotechnical Faculty of the University of Ljubljana. In fact, the emergency caused by the Covid-19 pandemic and the measures associated with it, in particular the closure of institutions, required rapid and dramatic change. As part of this research, we confirmed the importance of the rapid response of the faculty management and the willingness of employees and students to adapt to the new situation. It turned out how important within this transition was previously established e-classroom with a considerable number of active users, appropriate IT infrastructure, good organization of the IT service at the faculty and proactive operation, as well as satisfactory digital literacy of all, pedagogical workers and students. With our research, we confirmed the successful transition to a new way of teaching and studying, which is reflected in many formal frameworks that were established during this time, the successful transition to the implementation of distance pedagogical work, which is reflected in increased use of e-classroom and videoconferencing platforms and the satisfaction and responses from students who are "costumers" in the pedagogical process.

During this time, many ad-hoc purchases of small value videoconferencing equipment were made, as well as providing certain services, especially those that enable distance work. A very important role in this had IT support, which also had to move from the physical to the virtual environment and helped all participants in the process with webinars and remote access.

In fact, the pandemic is not over yet. Therefore, it is necessary to find out what we have done well and make further improvements to the parts which were not properly arranged and need to be fixed as soon as possible. Based on the research, we can conclude that especially curricula and internal acts need to be changed, internal workshops should be provided permanently and thorough investments in long-term hardware and software for distance work purposes should be carried out. In this context are meant licenses for video-conferencing platforms and hardware for equipping some of the classrooms at the faculty, which will in near future reduce exclusion of both pedagogical workers and students due to lack of technology in their homes. The latest was also the biggest problem of the transition to on-line study. Otherwise, technological challenges were relatively quickly and easily resolved, whereas more complex problems were related to organizational and legal aspects, especially on a personal level. This includes the acquisition of digital competencies. Further research should be conducted in this direction.

Even after the end of the pandemic, the implementation of the pedagogical process will never return to the situation before the pandemic. Good things will remain and complement the traditional implementation of the pedagogical process, which will thus become even more adapted to the new trend in the development of the digital society.

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REFERENCES

1. Anderson, D. R., Sweeney, D. J., Williams T. A. (2015): Essentials of Modern Business Statistics with Microsoft Excel. 6th Edition. Cengage Learning.
2. Digitalna UL (2018): Uporaba IKT v študijskem procesu. Interno poročilo projekta »Digitalna UL – z inovativno rabo IKT do odličnosti«. Ljubljana, Univerza v Ljubljani.
3. Gonzalez De Villaumbrosia, C. (2020): The Rise Of E-Learning In 2020. Forbes, https://www.forbes.com/sites/forbesbusinesscouncil/2020/05/26/the-rise-of-e-learning-in-2020/#24150f487610 (26.5.2020)
4. Hodges, C., Moore, S., Lockee, B., Trust, T., Bond, A. (2020): The Difference Between Emergency Remote Teaching and Online Learning. Published: Friday, March 27, 2020, EDUCAUSE Review. https://er.educause.edu/articles/2020/3/the-difference-between-emergency-remote-teaching-and-online-learning
5. Jandrić, P. (2020): Postdigital research in the time of Covid-19. Postdigital Science and Education, 2, 233– 238. https://doi.org/10.1007/s42438-020-00113-8.
6. Košmelj, K. (2007): Uporabna statistika. Ljubljana, Biotehniška fakulteta.
7. Kropivšek, J. (2018): Konceptualni model digitalizacije izobraževanja: Primer visokošolskega izobraževanja v lesarstvu v Sloveniji. Les/Wood, 67(2), 63-74. https://doi.org/10.26614/les-wood.2018.v67n02a06
8. Študentski svet BF (2020): Evalvacija študija na daljavo. Ljubljana, Univerza v Ljubljani 14 p.
9. Zhu, X., Liu, J. (2020): Education in and After Covid-19: Immediate Responses and Long-Term Visions. Postdigital Science and Education, 2, on-line. https://doi.org/10.1007/s42438-020-00126-3
10. ***: European Commission (2020a): Digital competence framework for educators.
    URL: https://ec.europa.eu/jrc/en/digcompedu.
11. ***: European Commission (2020b): DigCompOrg Framework.
    URL: https://ec.europa.eu/jrc/en/digcomporg/framework
12. ***: European Commission (2017a): Digital education plan.
    URL: https://ec.europa.eu/education/sites/education/files/factsheet-digital-education-action-plan.pdf.

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THE ALLOCATION OF INVESTMENTS AND THEIR EVALUATION IN ENTERPRISES OF THE WOOD-PROCESSING INDUSTRY

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Abstract: The aim of this paper is to present not only theoretical background from domestic and foreign sources with focus on investment, allocation of investments, methods of investment evaluation, but also presentation of research results of these areas in enterprises of the wood-processing industry in Slovakia. The questionnaire research was carried out in enterprises of the wood-processing industry, divided into woodworking, furniture and pulp and paper-making enterprises. The main objective of the research was to determine the allocation of investments in specific areas such as technology, renewal of production facilities, research and development, software and licenses, but also financial investment in relation to the Return on equity (ROE) indicator. In the processing of research results were used classical methods of research work such as analysis, synthesis, comparison, descriptive statistics, and pivot tables.
Keywords: investment, investment allocation, investment evaluation methods, wood-processing industry

1. INTRODUCTION

Today, there are many ways in which enterprises can secure their investment strategy to be competitive. Strategic investment decision-making is of great importance for every enterprises, because it affects its future prosperity and has an impact on the long-term development of the enterprises. Future revenues and costs of the enterprises are influenced by the decision of the enterprises in which area it directs its investments, or in the renewal, expansion and development of technologies, production facilities or buildings. Equally important is the allocation to research and development, financial investment in the purchase of long-term loan securities and equity securities, but also the direction of investment in software and licenses. The investment activity of the company is a necessary determinant, which leads to increased efficiency and ultimately to ensuring the prosperity and successful development of the enterprises. The investment activity and its financing by the enterprises is characterized by the fact that the decision on the implementation of the investments must take into account the long-term time horizon and the resulting degree of risk. Investments are capital-intensive operations and are closely related to the application of new technologies, new products, and some investments even have serious consequences for infrastructure, ecology and mean the emergence of induced investments. These specifics determine the different requirements for the investment evaluation methods used (Valach, 2010). The aim of investment decision-making is to select projects that will contribute to the growth of the market value of the enterprises. In order to evaluate individual investment options, it is necessary to assess the effects and possibilities of implementing investment plans based on these options. In the decision-making phase, non-WPI enterprises analyze the various investment options in terms of the possibilities, needs and implications of these proposals in order to set out the criteria and methods for their evaluation.

2. MATERIAL AND METHODS

2.1. Investments, their allocation and evaluation methods

There are several perspectives on the concept of investment. However, the essence of the investments is the same and is based on a relationship where the output must be greater than the finance spent. According to the author Synek et al. (2015) it is possible to define the term investment from a macroeconomic point of view as capital assets, which consist of goods and are not intended for direct consumption, but for use in the production of consumer goods or capital goods. Zámečník et al. (2007) define investment as an economic activity in which entities, such as the state, enterprise or individual, give up their current consumption with the intention of increasing the production of goods in the future. According to the team of authors Drábek, Merková and Polách (2012), investments from the macroeconomic concept have two basic tasks, namely: they represent a significant and relatively unstable expenditure component. Sudden and unplanned changes in investment can significantly affect aggregate demand, which ultimately has an impact on employment (demand side). The second task is to support economic growth in the long run (offer side), as investments is aimed at accumulating capital and raising fixed capital. Globally, the same is true of corporate investments as it is of the macroeconomic concept of investments. The basis is that these are goods that are not intended for direct consumption but for the future production of goods, so it is also a deferred benefit for the future. For example, the author Skálová (2005) defines corporate investments as a tool that leads to the creation of a portfolio of assets, while the invested capital must be adequately valued, and thus must ensure the subsequent development of the enterprises and the progress of its value in the market. An investment can be simply defined as a present commitment of money or other resources, and this commitment implies the expectation of future benefits (Bodi et al., 2009).

Drábek (2001) presents the allocation of investments at the enterprise level to three groups:

- The first group is capital investments, which can be used to create or expand production capacity in the enterprise.
- The second group consists of financial investments, the purpose of which is to obtain income in the form of finance, which can be mainly interest, dividends or profit.
- The third group consists of intangible investments that are used to purchase know-how, such as expenditure on scientific and research purposes and more.

Static methods are considered basic methods, the main task of which is to eliminate completely unsuitable projects. The aim of their use in pre-selection is to exclude from further evaluation investment projects that could not be accepted in terms of strategy and goals of a particular company, even before the money was spent to develop detailed analyses of their capabilities (Scholleová, 2009). According to the authors Synek and Kislingerová (2015) and Drábek et al. (2012), static methods include the average profitability and payback period of the project.

Dynamic - discount methods for evaluating the effectiveness of investments already consider the influence of the time factor and thus have a higher explanatory power than static methods. One of the most important of these is the Net present value method, which is the basis of all dynamic methods. The profitability index is closely related to the net present value of the investment project. It is a relative indicator that expresses the ratio of expected discounted cash receipts from the project to initial capital expenditures (Valach, 2010, Drábek et al. 2012). The internal rate of return is defined as such a discount rate at which the present value of cash flows equals the input capital expenditure (Synek and Kislingerová, 2015). The Economic value added indicator is understood as the net income from the operating activities of the company reduced by the cost of capital (Maříková and Mařík, 2001).

The method of commercial viability of the project documents the viability of the project, which means that the revenues generated by the project are sufficient to cover the expenses in cash, states Polách et al. (2012). According to Drury (2012), the turning point analysis reflects the relationship between changes in output and the resulting changes in costs, revenues and profits. In investment controlling, the most common controlling methods Net Present Value, Internal Rate of Return, Discount Economic Value Added are used in the evaluation of investment projects, states Scholleová (2009). Authors Rajnoha (2008) and Varcholová et al. (2007) agree that financial indicators provide a quick and inexpensive picture of a company's financial performance.

2.2. Methods

This publication is part of the research project VEGA 1/0286/16 - Change Management Based on a Process Approach. Relevant data and information on industrial enterprises in the Slovak Republic were obtained through an online research questionnaire and a direct controlled interview with managers of randomly selected enterprises. This publication is part of the research project VEGA 1/0286/16 - Change Management Based on a Process Approach. Questionnaires were sent to 2,525 enterprises in selected sectors of industrial Slovakia. The research was conducted on a research sample of 524 enterprises. The sample was relevant, had sufficient explanatory power, which was also verified by selected mathematical-statistical methods. According to the calculation of the minimum sample of statistical research, this was a representative sample with a 99% confidence level and a 4% standard deviation. Methods of analysis, synthesis, and pivot tables were used to evaluate the obtained data.

3. RESULTS

Partial results of the research focused on the allocation of investments were obtained from a questionnaire survey in 82 surveyed enterprises in the wood processing industry. The surveyed enterprises were divided into wood working enterprises in the number of 60, furniture enterprises in the number of 18 and pulp and paper enterprises in the number of 4. Allocation of investments was in production technologies, machines and equipment, investments in constructions, investments in research and development, financial investments, investment in employees and intangible investment in software and licenses. The allocation of investments was examined in connection with the level of the return on equity ROE, which expresses how much net profit per currency unit of invested capital.

Table 1. Analysis of allocation investments in woodworking enterprises

Allocation investments	The value of the ROE indicator						SUM	Relative frequency
	ROE < 0	0% - 2%	2% - 4%	4% - 7%	7% - 10%	Over 10 %		
Investments in manufacturing technology, machinery and equipment	2 3.3 %	10 16.7%	6 10.0 %	18 30.0 %	8 13.3 %	0 0.0 %	44	73.3 %
Investments in building	0 0.0 %	2 3.3 %	1 1.7 %	0 0.0 %	1 1.7 %	0 0.0 %	4	6.7 %
Investments in research and development	0 0.0 %	2 3,3 %	0 0.0 %	2 3.3 %	1 1.7%	0 0.0%	5	8.3 %
Financial investments	0 0.0 %	1 1.7 %	0 0.0 %	2 3.3%	0 0.0%	2 3.3%	5	8.3 %
Investments in employees	0 0.0 %	1 1.7 %	0 0.0 %	0 0.0%	0 0.0%	0 0.0%	1	1.7 %
Investment intangible (software, licenses)	0 0.0 %	0 0.0 %	0 0.0 %	1 1.7 %	0 0.0 %	0 0.0 %	1	1.7%
SUM	2	16	7	23	10	2	60	100.0 %

As we can see in Table 1, out of 60 wood working enterprises, the highest percentage of investments was recorded in production technologies, machinery and equipment in 30.0% of enterprises in the category with ROE from 4% to 7%. This was followed by 16.7% of enterprises with ROE from 0% to 2%, 13.3% of enterprises with ROE from 7% to 10%. In the ROE category, from 2% to 4%, 10% of enterprises invested in production technologies, machinery and equipment. Enterprises with ROE < 0 invested only in production technologies, machinery and equipment, while enterprises with ROE over 10% focused only on financial investment. Wood working enterprises classified in the ROE category from 0% - 2% in relative numbers to 3.3% invested in constructions and in science and research, 1.7% of enterprises in each area invested funds in financial investments and investments in employees. Based on the results obtained, we can state that 77.3% of wood working enterprises in all ROE categories except the category over 10% invested in production technologies, machinery and equipment. The second most numerous area of investment allocation was in research and development and in financial investments, which was stated by 8.3% of monitored wood working enterprises in both areas. The third most numerous area of investment direction was investment in construction in 6.7% of enterprises. The last areas of investment direction were investments in employees and in intangible investments. Investing in both areas only

1.7% of enterprises. The second most numerous area of investment allocation was in research and development and in financial investments, which was stated by 8.3% of monitored wood working enterprises in both areas. The third most numerous area of investment direction was investment in construction in 6.7% of enterprises. The last areas of investment direction were investments in employees and in intangible investments. Only 1.7% of enterprises invested in both areas.

Table 2. Analysis of allocation investments in furniture enterprises

Allocation investments	The value of the ROE indicator						SUM	Relative frequency
	ROE < 0	0% - 2%	2% - 4%	4% - 7%	7% - 10%	Over 10 %		
Investments in manufacturing technology, machinery and equipment	2 11.1 %	3 16.7 %	3 16.7 %	3 16.7 %	1 5.6%	0 0.0 %	12	66.7 %
Financial investments	1 5.6 %	1 5.6 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	2	11.1 %
Investments in employees	0 0.0 %	1 5.6 %	0 0.0 %	0 0.0 %	0 11.1 %	0 0.0 %	1	16.7 %
Investment intangible (software, licenses)	1 5.6 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	1	5.6 %
SUM	4	5	3	3	3	0	18	100.0 %

The results of the research of furniture enterprises showed in Table 2 that 66.7% of enterprises in all ROE categories except over 10% allocated their investments in technologies, machinery and equipment. Furniture enterprises with ROE < 0 and from 0% to 4% directed investments to financial investments, 5.6% of enterprises in each ROE category. Investments in employees were confirmed by 5.6% of enterprises in the ROE category from 0% to 2% and in the ROE category from 7% to 10% by 11.1% of enterprises. 5.6% of enterprises with ROE < 0 invested in intangible investments. From the above results, we can state that the majority of up to 66.7% of furniture enterprises focused their investments mainly on investments in technology, machinery and equipment. In the range from 11.1 to 16.7% of enterprises allocated investments in employees and in the area of financial investments.

Given the small sample of pulp and paper companies and the fact that there are few enterprises of this type in Slovakia, we can say that the surveyed enterprises with a ROE of 2% to 4% and over 10% invested in technology, machinery and equipment, in financial investments and in the area of intangible investments. Investments in construction, personnel, science and research and in science and research were not mentioned in the questionnaire replies.

CONCLUSION

One of the goals of the research presented in this work was to determine the allocation of investments in enterprises in the wood processing industry in Slovakia. The benefit of the research was the finding that in the enterprises of the wood processing industry, the allocation of investments is focused primarily on investments in technologies, machinery and equipment. Financial investment, investment in research and development and investment in buildings were found in all categories of enterprises on a smaller scale. A negligible number was made up of enterprises that invested in employees and in intangible investments, which can be considered a negative trend, which does not support increasing the competitiveness of enterprises. Dynamic methods should be considered as key methods in the evaluation of investment projects, which take into account the action of a significant factor and thus the time factor, which acts to change the value of money. Equally important factors in the evaluation of investment projects is the consideration of project risks such as business, market, economic, social and other, which also need to be properly identified, evaluated and take into account their impact on the economic results of the enterprises. We can determine the investment decision-making of a enterprise as one of the key factors of a enterprise's success.

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REFERENCES

1. Bodie, Z., Kane A., Marcus, A. J. (2009). Investments. McGraw-Hill/Irwin, Boston.
2. Drábek, J. (2001). Business investment. Sabo brothers, Zvolen, p.170.
3. Drábek, J., Merková, M., Polách, J. (2012) Real and financial investments.C. H. Beck, Praha, p. 263.
4. Drury, C. (2012). Management and cost accounting. 8th ed. Andover, Hampshire: Cengage Learning, p.783.
5. Maříková, P., Mařík. M. (2001). Modern methods of performance evaluation and business valuation: economic added value. Ekopress, Prague, p. 487.
6. Polách, J., Drábek, J., Merková, M., Polách, J. jr. (2012). Real and financial investments. C. H. Beck, Prague, p. 280.
7. Rajnoha, R. et al. (2013). Measuring and managing business performance, Technical University in Zvolen, p.313.
8. Scholleová, H. (2009). Investment controlling: how to evaluate investment plans and manage corporate investments. Grada, Prague, p.285.
9. Skálová, P. (2005). Business economics 1. University of West Bohemia, Plzeň.
10. Synek, M., Kislingerová, E. (2015). Business economics. C.H. Beck, Prague, p. 526.
11. Valach, J. (2010). Investment decisions and long-term financing, Ekopress, Prague.
12. Varcholová, T. et al. (2007). Measuring business performance, Ekonom, p. 167.
13. Zámečník, R., Tučková, Z., Hromková., Ľ. (2007). Business Economics II. Tomas Bata University in Zlín, p.194.

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THE CLASH OF JOHN MAYNARD KEYNES AND MILTON FRIEDMAN ECONOMIC PERSPECTIVES - DEVELOPMENT DILEMMAS OF THE WOOD-BASED SECTOR IN POLAND IN TIME OF CRISIS

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Abstract: Entities participating in the wood-based sector in Poland have to adapt to the special organization of the industry-based wood market, where institutional regulations intertwine with elements of free market regulations. Also in such conditions, an optimal strategy for the development of the industry is sought, especially in times of crisis. Such an attempt was made in this paper, referring to the most frequently discussed theoretical approaches to mesoeconomics, referring to the theories of John Maynard Keynes and Milton Friedman, stereotypically considered to be contradictory or even mutually exclusive. As a result of the analysis, however, it turned out that the verified views are more complementary than opposing, and the Polish wood-based sector is looking for its own, individual development strategy, drawing on the achievements of both eminent economists.
Keywords: wood-based sector, wood market, Keynes, Friedman, mesoeconomics, Poland

1. INTRODUCTION

Who is interested at least a little bit in the main directions of creating economic policy, and would like to apply them in practice to the regulation of selected economies or industries, cannot ignore the proposals, first put forward by John Maynard Keynes on the one hand, and by Milton Friedman on the other hand, continued then by the students of both eminent professors of economics [1, 2]. Nor would it be an exaggeration to describe the juxtaposition of these two separate proposals by the term "collision" or “clash”. At first glance, an attempt to reconcile the views of both professors seems to be an impossible mission. Is it really? Therefore, it may seem a somewhat crazy idea, or to put it carefully, very simplified, to apply Keynes' and Friedman's market perspective to the meseconomic realities of a specific, but specific industry that creates the wood market in Poland. The madness of the proposed approach weakens a bit when we move to the economic realities with which the world has not yet dealt with on such a scale. A kind of freezing, or at least a significant slowdown in the global market (locally known as "lockdown") has become a fact because of the real epidemic threat. The Polish forestry and wood sector is also in a completely new situation. Therefore, questions are raised as to how entities participating in the wood market should behave. This market has been subjected to irregular and asymmetric factors. Will these conditions, therefore, "balance" or "integrate" the wood-based market? Or maybe a completely "new" wood market will be created? For these reasons, this paper attempts to answer the question which of the economic proposals, which path or strategy, Keynes's or Friedman's, could be used as a directional one in the process of programming the development of the wood market in Poland? For this purpose, reference was made, although to a limited extent of necessity, to an opinion poll, i.e. an expert, individual in-depth interview (IDI), conducted on the background of the theoretical concepts of both eminent economists.

2. INDUSTRY PERSPECTIVE - THE POLISH WOOD MARKET

The Polish forestry and wood-based sector has a specific market organization [6, 8]. It is an institutional, rather than a market, "libertarian" structure. It is based on the natural monopoly of the Polish Forest Holding "State Forests", the dominant owner of forest resources in Poland. There is also a specific model of wood sales in which only some selected aspects are subject to market laws. However, this does not change the situation that this relatively distinct sector reflects a specific value chain (Figure 1) [7]. It is a "sector" of the economy, from raw material forestry (stump wood management), forest services (wood harvesting and transport), to industrial wood processing and its reuse. Each of the elements, links in this chain, forms a model of the circular economy sector [9, 13]. It is an integral model, referring to the concept of sustainability by Hans von Carlovitz [11], connecting the blocks of the chain the more strongly, the more they are oriented not only towards the forest and the natural environment, but above all towards man [12].

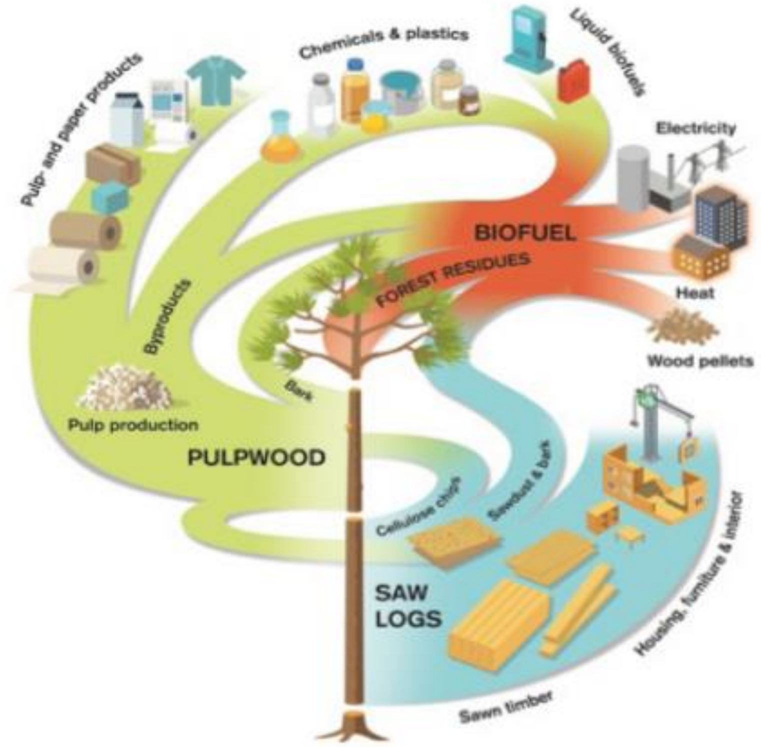

Figure 1. The primary segment of the forest-wood value chain. Sub-sector meso-orientation: blue-green-red. Source: Figure based on the graphic concept by Meskin and Borkowski [7] (p. 30).

The wood market in Poland reflects the condition of the entire industry, and more specifically the situation of forestry and the wood industry. The wood-based sector employs, together with complementary industries, over 350,000 people. It creates, depending on the calculation method, from 2 to 3 percent of Poland's GDP [14]. In addition, the Polish wood industry relies almost entirely on domestic resources of wood raw material, less often on imports. In such circumstances, the wood market cannot be programmed with "classical" methods only. Therefore, an economic model is sought that would be largely adequate to the actual competitive ability of the wood sector [8, 10, 13]. However, this ability should be determined not so much by the "institutional market", but by the real, community of entities creating demand and supply. Thus, the "clash" of the title requires at least an attempt to find a solution to the "dispute".

3. THEORETICAL PERSPECTIVE - KEYNES OR FRIEDMAN MESOMODEL?

Each of the economic models, separately for John Maynard Keynes and Milton Friedman, has been considered separately at the level of general theory [1, 2]. In this perspective, an attempt was made to "adapt" theoretical assumptions to the "meso" level, reflecting the relative distinctiveness of the industry, as an independent economic system ("meso"), which is the industry. Then, in a qualitative study, theoretical preferences were identified that are closest to the practice of the Polish wood market.

The originality of Keynes' economic views is reflected in his most important work: “The General Theory of Employment, Interest and Money” [5]. Keynes' theory is characterized by the following features:
- advantage of macroeconomic analysis over microeconomic one;
- preferences for the demand approach (the impact of investments on the growth of effective demand);
- advantage of short-term analysis over long-term one (need to see quick effects);
- dominance of static analysis (successive dynamization of research by Keynes' students);
- the cause-effect nature of the dependence of economic measures (in others it is rather functional);
- crises as a feature of the capitalist economy (rejection of the Say market law);
- society is not a simple sum of individuals; an individual behaves differently in the economy than a society, so the behavior of an individual cannot be generalized as a whole;

- recognizing the importance of researching the human – thing – human relationship (departure from subjectivism);
- general equilibrium (still understood as the balance between global demand and global supply), is not always a desired state for the economy (depression phase);
- acceptance of state intervention in the economy, negation of the "invisible hand" of the market;
- pragmatism in formulating recommendations for economic policy, especially in times of crisis;
- universal theory, applicable to any market economy.

In turn, analyzing the achievements of Milton Friedman as a supporter of free market domination [3, 4], it may seem that he is a staunch opponent of J.M. Keynes' interventionist concepts [1, 5]. Meanwhile, it is not so obvious. Milton Friedman's most important views include:

- monetarism and preferences for the quantitative theory of money as a theory of money demand;
- recognition of the impact of the quantity of money on the functioning of the economy in the short term and on prices in the long term; money supply as the main element of the policy determining global demand;
- "destructive influence of inflation" "inflation is always and everywhere a monetary phenomenon", "inflation is a disease that is easy to cause, harder to treat" [3, 4];
- the key importance of an independent monetary policy, the ineffectiveness of administrative reduction of inflation;
- formulation of the theory of consumption (as opposed to Keynes's claim that consumption is a function of current income); for people's consumption decisions are determined, as Friedman noted, not only by current income, but also by expected future income;
- the development (independently of Phelps) of the long-run Phillips curve, which shows that in the long run there is no trade-off between unemployment and inflation, because market players are able to adjust their behavior and program prices [4];
- the need to limit the role of the state in the economy, which, however, does not apply to state control over the banking system and monetary policy;
- modern methodological approach in economic sciences;
- priority for the free market wherever possible [3, 4].

Therefore, paradoxically, after a thorough analysis of the main elements of the theory of both professors, one can see their complementarity more than their opposition or collision [1, 2]. A clash is a certain stereotype in which Keynes and Friedman are seen as determined opponents. How does this relate to economic mesopolitics on the wood market?

4. IDEA. METHOD AND RESULTS OF THE QUALITATIVE TEST

Taking into account the presence of stereotypes rather than the actual economic views of Keynes and Friedman, a qualitative study was designed, attempting to verify the hypothesis that in the conditions of a crisis in a particular industry market, such as the wood market, the participants will seek their own sectoral strategy rather than encourage move towards traditional market (Friedman) or institutional (Keynes) approaches.

For this purpose, in the first half of 2020 (time range), a group of typical wood industry enterprises (subjective scope) was selected to obtain primary data. The companies were selected intentionally and proportionally according to their location. Efforts were made to make it a relatively even distribution, adequate for the territorial structure of the 17 Regional Directorates of State Forests in Poland (spatial scope). The research used the technique of individual in-depth interviews (IDI) as part of a diagnostic survey. Responses were collected from professional representatives of the management of the wood industry, participating in making market decisions. The respondents were previously acquainted with the basics of economic theories of J. M. Keynes and M. Friedman. As a result of the expert analysis (based on IDI), five economic policy strategies were selected that could be possibly used by the wood market entities: Keynesian strategy (S1), post-Keynesian (institutional) strategy (S2), individual / neutral strategy (own strategy for the industry) (S3), post-Friedman strategy (S4) and also Friedman strategy (S5).

The matrix of five pricing strategies is considered later in the study. From the group of 101 surveyed enterprises, 52 wood industry plants from which the surveyed professional experts came were taken into account for the purposes of this analysis. The task of the experts was to indicate the relationship between individual strategies. Then the answers were sorted using the Saaty method [8, 12]. Preference ranking was made for the analyzed strategies. Individual strategies were assigned numerical values (weights), depending on the "strength of preference", and converted to percentage points.

Table 1. Preferences for the selection of the optimal strategy for the development of wood market in Poland in the conditions of the economic crisis

Place / Wood Market Development Strategy	Keynes Strategy	Post-Keynes Institutional Strategy	Individual Strategy	Post-Friedman Market Strategy	Friedman Strategy
Place I	5,6%	19,8%	53,4%	18,3%	2,9%
Place II	3,8%	23,2%	46,2%	23,1%	3,7%
Place III	21,2%	35,4%	0,4%	38,5%	4,5%
Place IV	11,5%	14,6%	0,0%	17,1%	56,8%
Place V	57,9%	7,0%	0,0%	3,0%	32,1%

Source: Own study

Despite the apparent polarization of the positions of experts, balancing between strategies containing a smaller or larger share of the dominant views of Keynes or Friedman, the result of the study is interesting. The optimal, preferred strategy for the wood market turned out to be an individual strategy, combining the necessary influence of institutional and free market conditions. The distribution of the "power of influence" of the identified opinions indicates the presence of complementary elements of Keynes and Friedman's economic theories in the construction of the expected individual strategy, the detailed structure of which has not been analyzed in this work. Developing an optimal strategy, although it requires building a cooperation relationship (coopetition and co-operation) [13], is probably the only possible solution, taking into account specific regulations that define the framework for the functioning of the wood-based industry in Poland.

4. CONCLUSIONS

Based on the conducted analyzes, the following conclusions were drawn:

1) The apparent contradiction of the source economic theories of J.M. Keynes and M. Friedman, looking from the mesoeconomic perspective (industry level), is not strongly confirmed. One perceives the complementarity of views rather than their opposition or "clash".

2) Referring to expert opinions, one can notice this complementarity of Keynesian elements and the Friedman approach, in the search for an optimal, but own, individual strategy for the development of the wood market in Poland, especially during the crisis.

In this context, an important challenge seems to be the continuation of mesoeconomic research in forestry and the wood-based sector, in order to identify and verify these elements of a competitive strategy for the analyzed industry, which, thanks to ex post analysis, will allow to find a recipe for the crisis, and thanks to the ability to forecast ex ante, will decide on its integral development.

REFERENCES

1. Congdon T. (2011): Money in a Free Society: Keynes, Friedman, and the New Crisis in Capitalism. Encounter Books.
2. Dostaler G. (1998): Friedman and Keynes: Divergences and Convergences. Journal of the History of Economic Thought, 5(2), 317-347.
3. Friedman M. (2018): Theory of the Consumption Function. Princeton University Press.
4. Friedman M. R. (2017): Friedman and Smith on Contracts and Conveyances of Real Property. Practising Law Institute.
5. Keynes J. M. (2018): The general theory of employment, interest, and money. Springer.
6. Kusiak W., Mikołajczak E., Wanat L. (2018): *Institutional and Industrial Symbiosis Case Study of Cooperation for Development in Forestry and Wood-Based Sector*. [In:] Increasing the use of wood in the global bio-economy. Glavonjic B. (ed.), September 26th-28th, 2018, University of Belgrade, Belgrade, Serbia, pp. 388-399.

7. Meskin A., Borkowski P. (2020): State Forests in the Baltic Sea Region: Where experience meets challenges and future opportunities, [in:] Liuhto, K. (eds.). The forest industry around the Baltic Sea region: Future challenges and opportunities, https://www.centrumbalticum.org/files/4638/BSR_Policy_Briefing_2020.pdf.
8. Mikołajczak E., Wanat L., Styma-Sarniak K., Czarnecki R., Topczewska A. (2020): *The Prospects to Applying the Best Practices Model as One of the Pillars of Business Management in the Wood Market*, [in:] D. Jelačić (ed.) Management Aspects in Forestry and Forest Based Industries, WoodEMA ia., Zagreb, pp. 125-136.
9. Paluš H., Parobek J., Vlosky R.P., Motik D., Oblak L., Jošt, M., Glavonjić B., Dudík R., Wanat L. (2018): *The status of chain-of-custody certification in the countries of Central and South Europe*. European Journal of Wood and Wood Products 76(2): pp. 699-710, https://doi.org/10.1007/s00107-017-1261-0.
10. Potkański T., Wanat L., Chudobiecki J. (2011): Leadership in time of crisis or crisis of leadership? Implications for regional development. Intercathedra, 4(27).
11. Von Carlowitz, H. C. (1713): *Sylvicultura Oeconomica*. Leipzig: Braun.
12. Wanat L., Mikołajczak E., Sarniak Ł., Czarnecki R., Topczewska A. (2020): *Application of Analytic Hierarchy Process (AHP) Algorithm to Optimize Business Model for the Kitchen Furniture Marke*t, [in:] D. Jelačić (ed.) Management Aspects in Forestry and Forest Based Industries, WoodEMA ia., Zagreb, pp. 111-124.
13. Wanat L., Potkański T., Chudobiecki J., Mikołajczak E., Mydlarz K. (2018): *Intersectoral and Intermunicipal Cooperation as a Tool for Supporting Local Economic Development: Prospects for the Forest and Wood-Based Sector in Poland.* Forests 9 (9), 531, 1; https://doi.org/10.3390/f9090531.
14. ***Statistical Yearbook of Forestry 2019. Central Statistical Office (GUS 2019). Warsaw.

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A STUDY OF INTANGIBLE ASSETS DISCLOSURE AS FACTOR FOR SUSTAINABILITY: AN EVIDENCE FROM BULGARIAN FURNITURE ENTERPRISES

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Abstract: In a constantly changing economic and political environment, textual disclosures in the financial statements of enterprises are factors used for measuring the sustainability of the micro-organization and, hence, at the macro-level throughout an industry. Main object of analysis is the disclosed information by Bulgarian furniture enterprises regarding their intangible assets. Main goal of the paper is to analyze some factors that have impact on the disclosures and to outline the published mandatory and voluntary data. Subjects of the study are published financial statements and the accompanying notes. Adopted research methods are logical, deductive and comparative methods, as well as the methods of content analysis and synthesis. The study of statistical relationships and dependencies is based on the Chi - square test. The results of the study support the development of the literature by presenting a more in-depth analysis of the level and the factors influencing the disclosure of intangible assets data by Bulgarian furniture enterprises.
Keywords: intangible assets, disclosure, furniture enterprises

1. INTRODUCTION

The idea of a knowledge-driven economy shifts the focus of the enterprises from seeking future benefits from the use of tangible assets to seeking benefits from intangible assets use. In this respect, enterprises are willing to invest large amounts to obtain and control intangible resources (Jeny, Paugam and Astolfi, 2016, p.3). Intangibles are seen as factors that determine the true value of the entity (Low and Kalafut, 2006, p. 193). Economic literature supports the idea that there is a link between the profitability of enterprises and the number of textual disclosure (Cheng and Zhao, 2018, p. 406). Disclosures are used for the purposes of financial analysis and measure the long term sustainability of the organization. The entity's disclosures could be divided into mandatory and voluntary. The mandatory is dependable on the legislative requirements of the applicable accounting standards while voluntary is any additional information beyond the mandatory one, that enterprises publish in the financial statements. Even though managers can use disclosure data as an instrument improving the market value of equity (Merkley, 2014; Nekhili et al., 2012) it could create information asymmetry (Cheng and Zhao, 2018, p. 405, p. 410) and even may lead to a leak of strategic information (Entwistle, 1999). However, voluntary disclosures are cited as an important mechanism for reducing conflicts and information asymmetry between insiders and outside shareholders (Patelli and Prencipe, 2007, p. 8). This predetermines the need for relevant and reliable information disclosure about intangible resources to financial statements users. A study of the level of digitisation and the use of digital tools by forestry sector enterprises in Bulgaria shows better performance than that on the national average (Georgieva and Popova, 2019). Such level of digitisation suggests use of various intangible assets by the companies. From all forestry industries in the country the most developed are the companies operating in the field of design, manufacturing and sales of furniture (Popova, 2019). Based on that the main author's hypothesis is that Bulgarian furniture enterprises have a significant level of disclosure of intangible assets information (internally developed and externally acquired). Main object of analysis are the content of mandatory and voluntary disclosures regarding recognition and account of intangible assets as well as factors that have impact on it. Subject of the study are the published financial statements and the accompanying notes, incl. significant accounting policies, activity reports, auditor reports, references, annexes. Primary purpose of the paper is to study some of the factors that influence disclosures as well as the practice of Bulgarian furniture enterprises regarding the published intangible asset information. In order to achieve the stated goal, the following research tasks are set: (1) to analyze the following factors that have impact on the disclosures: accounting standards; company size; profitability; external auditor; (2) to verify the compliance with the requirements of disclosure on intangible assets demanded by the Bulgarian national accounting standards (NAS) and the international accounting standards (IAS); (3) to point out some current practices of Bulgarian furniture enterprises on voluntary disclosed information about intangible assets. The applied research methods are based on the logical, deductive and comparative methods, and the methods of content analysis and synthesis of texts introduced into the legislation framework and specialized literature.

2. LITERATURE REVIEW, HYPOTHESIS DEVELOPMENT AND METHODOLOGY

According to Bulgarian Accounting Act (AA) enterprises must apply the national accounting standards. Exceptions are the enterprises listed in the law (mainly engaged in financial, pension and investment activities), as well as those that voluntarily choose to apply the IAS. Even though it is believed that all enterprises should have the same level of mandatory disclosure in compliance with the requirements of the accounting standards (Teixeira da Silva et al., 2013, p. 392), the literature provides evidences that the diversity of information disclosure regarding the intangible assets treatment leads to lack of national homogeneity. This reflects a lack of international homogeneity (Stolowy and Cazavan-Jeny, 2001). However, Bulgarian enterprises, applying NAS, lack mandatory textual disclosure or publish limited accounting information (Georgieva, 2019). Therefore, a factor of analysis is the impact of the selected accounting standards on the textual disclosure. Several studies support the idea of a positive relation between the level of disclosure and firm size. In this respect large size companies disclose more rich data compared to smaller ones. This is believed to be due to the fact that large companies have more resources and more benefits from it (Nguyen et al., 2017). However, the literature provides arguments of no relation between company size and the level of compliance with the requirements of disclosure by the accounting standards (Nakayama and Salotti, 2014, p. 278). Considering this possibility the firm size is a second factor under analysis. Companies having more profits are more ambitious and willing to share more textual data with their stakeholders. Such an idea suggests that enterprises with poor performance are trying to hide this from the shareholders by disclosing less information (Nguyen et al., 2017, p. 258). Considering this the profitability is the third factor under study. It is argued that prestigious auditor companies require a higher level of disclosure. They associate it as a factor measuring the quality of auditor's services. Because of that, auditors influence their customers to publish more information, by affecting the type, quantity and quality of the data. In this respect, the relation between the level of disclosure and independent external audit is positive (Teixeira da Silva et al. 2013). In order to analyze the outlined factors the following hypotheses are formulated:

(H1) There is a statistically significant relationship between intangible assets disclosure and the use of NAS by Bulgarian furniture enterprises.

(H2) There is a statistically significant relationship between intangible assets disclosure and the size of the furniture enterprises.

(H3) The profitability of the furniture enterprises is statistically related to the disclosure of intangible assets.

(H4) There is a statistically significant relationship between intangible assets disclosure by Bulgarian furniture enterprises and external auditors.

An analysis of the financial statements of 157 furniture enterprises are made, covering the period 2008 - 2018. The content analysis method is used to study the enterprises balance sheet figures for long-term intangible assets, as well as disclosed information about intangible assets and research activities in the notes to the annual financial statements. 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.

3. RESULTS AND DISCUSSIONS

3.1. Analyses of the factors that have impact on the intangible assets data disclosure

From all entities under analyses, around 37% report figures in the balance sheet regarding intangible assets (externally acquired) and around 3% report internal developed intangible assets that results from the development phase of the R&D process. Around 44% disclose significant accounting policies or other relevant textual data regarding their intangible assets while around 9% - regarding the R&D developed resources. Disclosure of information about assets that the entity does not currently own or control can be partly explained by the following two hypotheses. First, the company may plan to acquire such resources in near future. In order to meet the information needs of the shareholders and investors, it publishes such relevant information in advance. However, in order not to violate the materiality principle, accounting data for assets that an organization does not currently own, control and use, should not be an element of its disclosed accounting policy or textual information. Second, the entity may not have reviewed and updated its current accounting policies. This results in publishing data regarding assets that the entity no longer actually owns and it in hand can put into question the applied methodology for filling the statement. The analysis shows another feature. Around 4% of the companies that have figures regarding intangible assets (excluding R&D developed) and around 14% regarding internal developed intangible assets do not disclose any textual data regarding these kinds of resources. Around 3% of the entities publish in their activity reports that during the period they have developed or improved intangible assets but no relevant data is reported in the balance sheets or in the accounting policies and annexes. The above contradicts to the aim financial statements to be reliable, prudent, neutral, impartial, complete in all aspects and, above all, necessary for making reliable economic decisions. In terms of applicable accounting standards, around 96% of the entities under review apply NAS. None of the entities applying IAS is currently a subject to a legislative requirement to prepare their financial statements based on the International accounting standards. 50% of the companies applying IAS have foreign shareholders at the equity of the entity. In this respect, the choice of IAS is rather on a voluntary basis that can be linked to international comparability of the statements, or the enterprises were obligated to apply IAS and have not used the legislative opportunity to change their accounting base to NAS in 2016. Based on the analyzes of the collected data (see table 1) it is confirmed the existence of a weak statistical relationship between intangible asset disclosure and the use of NAS by Bulgarian furniture enterprises. 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. Based on the AA requirements, a size classification of the enterprises under review is made. From all companies in the target group 54,8% are micro, 38,9% - small, 2,5% - medium and 3,8% are large. The collected data analysis provides evidence for an average statistical relationship between the size of the entity and the intangible assets information disclosure (see table 1). Once again not all conditions for the Chi square test application are fulfilled. It should be noted that around 41% of enterprises under review do not publish any textual disclosure or significant accounting policies. Only the annual financial statements of micro-entities may consist of abridged balance sheets and income statements (AA, 2019, art. 29, para. 4). However, 80% of the organizations that have not published notes are micro- entities and the other 20% are small sized. Around 88% of the analyzed furniture companies report gross accounting profit for the year under review. Yet, there is no statistically significant relationship between the profitability and the published textual data regarding their intangible assets. A prerequisite for such a conclusion is the presented in table 1 data, which confirms the null hypothesis. Around 55% of the annual financial statements in which there are disclosures of intangible assets data are audited by an independent external auditor. When testing the fourth research hypothesis, the chi square value is calculated 30.213 and with two degrees of freedom, this statistic provides evidence of a relationship at the 0.05 level of significance. This gives us a reason to accept the existence of an average statistical relationship between the external auditor and the disclosures of intangible assets information (see table 1).

Table 1. Chi-Square tests and Symmetric measures data

Variable	Pearson Chi-Square value	Level of significance	Degree of freedom	Asymp. Sig. (2-sided)	Cramer's V value	Approx. Sig.
Accounting standards	7.956	α=0.05	n=2	.019	.225	.019
Company size	34.644	α=0.05	n=6	.000	.332	.000
Profitability	4.832	α=0.05	n=1	.089	.175	.089
External auditor	30.213	α=0.05	n=2	.000	.439	.000

Source: own calculations, n=157.

3.2. Mandatory and voluntary disclosures by Bulgarian furniture enterprises

Based on content analyses between the disclosures in the financial statements of the target group and the requirements at the NAS and IAS none of the entities fully disclose the mandatory data for intangible assets. Notable is the fact that 6% of the furniture companies only make references to the number of the used accounting standard.

Accounting policies must have individual character based on the chosen and applied principles, rules and approaches. In this respect a reference to a standard which is giving opportunity to choose between several accounting treatments (for example the amortization methods) oppose to the main goal of the disclosures to give more prudent and reliable information. From all disclosures required by NAS, 63% of the entities publish the applied approach for initial measurement of intangible assets (externally acquired), while 21% - of internally generated intangible resources. The majority of the enterprises (73%) state the used amortization method, 30% publish data on accounting subsequent expenditures and 6% regarding temporarily idle assets. Relatively low percentage (22%) of the entities disclose any impairment information. Based on the analyses of the companies applying IAS all of them publish the applicable amortization method as well as the impairment policy of the assets. Half of them disclose the methodology of assessment of the useful life of the resources, while 17% - the residual value of the assets. Additional disclosures are the applied approach for classification (41%) and types of intangible assets (17%) owned and used by the companies. More than half of the entities (52%) voluntarily publish data on materiality thresholds. Less data is given regarding the accounting policy for gains and losses when selling the assets (10%), the moment from when the amortization starts (9%), occasions when the amortization method will be changed (1,4%) as well as the used accounts in the accounting system (1,4%).

4. CONCLUSIONS

The analyses of the disclosures to the financial statements of Bulgarian furniture enterprises give us a reason to conclude that they publish limited accounting information regarding their intangible assets. The lack of disclosure is found in the statements of entities applying NAS and IAS, and in this respect does not confirm the author's hypothesis. The only reliably confirmed statistical relationship is between the published textual data and the auditors. It is notable that voluntary disclosure is richer in the audited financial statements. This supports the studies of Nguyen et al. (2017), Georgieva (2019), Teixeira da Silva et al. (2013), but does not explain the existence of missing mandatory data in the published disclosures. The analysis as well confirms that large companies publish more data compared to micro-entities. This could be explained by the legislative requirements micro-entities to be able to prepare and publish only abridged balance sheets and income statements. Even though no statistical relationship is calculated between the disclosure and profitability due to its limitation the report cannot explain why companies with good performance are disclosing less or none information. Stakeholders can negatively interpret such lack of disclosure as the companies are trying to hide something. In Bulgarian accounting practices, the development of accounting policies, as a component of the financial statements, is considered as a formal requirement and not as a significant part of the accountability. This could be explained by the fact that the focus of the national revenue agency and other government institutions is on taxation and financial control rather than on the accurate disclosures. Such neglect of the added value of the published textual information is shifted to the auditors and accountants. Even so, disclosures enrich the information environment, prevent the idea of wrong methodologies for presenting intangible assets in the financial statements and help stakeholders to make reliable economic decisions. This in hand shows that the entity is a reliable partner, which gains creditor's trust and is a base for long term sustainability of the organization. Having in mind that disclosure can lead to a leak of strategic information we believe that the risk could be minimized through timely and reliable review of the data that could be disclosed. This in hand could be a better option rather than disclosure of none or less information.

REFERENCES (alphabetical order)

1. ***: Jeny, A.; Paugam, L.; Astolfi, P. (2016): Disclosure and recognition of intangible assets: insights from purchase price allocations, Conférence Internationale de Gouvernance, Montpellier, France.
2. Accounting act (AA), promulgated SG. 95/ 2015, last. ed. and more SG. 96/ 2019.
3. Cheng, J.; Zhao, J. (2018): Research on the relationship between R&D textual disclosure and profitability. Advances in Social Science, Education and Humanities Research, vol. 281, Atlantis press, pp. 405-410.
4. Entwistle, G. (1999): Exploring the R&D disclosure environment. Accounting Horizons, 13(4): pp. 323-342.
5. Georgieva, D. (2019): Mandatory and voluntary R&D data disclosure: evidence from Bulgaria, Academy of accounting and financial studies journal, 23(5): pp. 1-8.

6. Georgieva, D.; Popova, R. (2019): Digitisation in forest industry in Bulgaria - state and perspectives, Digitalisation and circular economy: forestry and forestry based industry implications, proceedings of scientific papers, Sofia: USB & WoodEMA, pp. 181-186.
7. Low, J.; Kalafut, P.C. (2006): Niematerialna wartość firmy. Oficyna Ekonomiczna: Wolters Kluwer, Kraków.
8. Merkley, K. (2014): Narrative disclosure and earnings performance: evidence from R&D disclosures. The Accounting Review, 89(2): pp. 725–757.
9. Nakayama, W.; Salotti, B. (2014): Determining factors of the level of disclosure of information on business combinations with the entry into force of the accounting standard CPC 15. Revista Contabilidade & Finanças, 25(66): pp. 267-280.
10. Nekhili, M.; Boubaker, S.; Lakhal, F. (2012): Ownership structure, R&D voluntary disclosure and market value of firms: the French case. International Journal of Business, 17(2): pp.126–140.
11. Nguyen, L. S.; Manh, D. T.; Hong, N. T. H.; Le, Q.H. (2017): Factors affecting disclosure levels of environmental accounting information: the case of Vietnam. Accounting and Finance Research, 6(4): pp. 255-264.
12. Patelli, L.; Prencipe, A. (2007): The relationship between voluntary disclosure and independent directors in the presence of a dominant shareholder. European Accounting Review, 16(1): pp. 5–33.
13. Popova R. (2019): Innovation development of the furniture industry in Bulgaria, CBU, Book of Proceedings: pp. 256-261.
14. Stolowy, H.; Cazavan-Jeny, A. (2001): International accounting disharmony: The case of intangibles. Accounting. Auditing & Accountability Journal, 14(4): pp. 477-497.
15. Teixeira Da Silva; S., Morais, A.; Curto, J. (2013): Disclosure of R&D activities. Global Business Perspectives, 1(4): pp. 391–417.

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COMPARISON OF THE AFFORDABILITY ASSESSMENT OF REFERENCE WOODEN HOUSE OF THE CZECH REPUBLIC AND SLOVAK REPUBLIC

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Abstract: The main factors of rational decision in solving the problem of own housing can be classified as a household income, necessary living expenses and housing costs. The main aim of the article is to present the comparison analysis of the affordability assessment of reference wooden house building in selected regions of the Czech Republic and Slovak Republic, after considering this factors. The percentage share of the total average monthly costs of using the building to the total average monthly household income was selected as the Indicator of measuring affordability. On the basis of the disposable monthly income of the household after substraction the total average monthly costs and allocating the amount of the subsistence minimum, it is clear that the availability of a wooden building is economically acceptable in both cases. The total balance of disposable income of households in the region of the Czech Republic is 382.65 € higher than in the region of Slovakia.
Keywords: affordability assessment, wooden houses, cost

1. INTRODUCTION

Until recently, the availability of mortgage loans also increased interest in the construction of houses. This was due to mortgage interest rates, which reached historic lows. We can state that over the last 15 years the market share of wooden buildings in Slovakia has increased from 2% to 10% of total construction. Whether this trend will continue depends on a number of factors such as the quality of wooden buildings, availability of producers, increased knowledge of the characteristics of wooden buildings, but especially the solution of the construction sector and the economy as a whole caused by a global pandemic. Economy and especially a certain household savings regime is now becoming an important factor in buying a family house. Therefore, in the implementation of such a serious decision, it is necessary to analyze the affordability of the building for future income and try to evaluate it without emotion.

The aim of the paper is to compare the affordability of a reference wooden building based on the analysis of costs related to the acquisition, operation and other costs that arise during the use of the building in selected regions of Slovak and Czech Republic. We chose a similar case study according to Smith (2013) as an indicator of comparison and measurement of affordability. In his study, the author determines the percentage of the total average monthly cost of using the building to the total average monthly income in an Australian household. The benefit of our study should be a real evaluation of the availability of a wooden family house in the implementation of the phase house without fixture for a selected family with average net income in the region of Banská Bystrica and the region of South Moravia.

2. MATHERIAL AND METHODS

Based on the survey (Debnár and Potkány, 2016), it is possible to define the basic profile of a potential customer as a man or woman aged 26 to 40 in a family relationship with at least one child. For the needs of our analysys of the affordability assessment, a potential investor is define as a family of 3 consisting of a married couple and one child.

The reference building is a family house realized by a company operating on both markets using panel construction technology. It is a type of bungalow construction with an area of 13.24 x 9 m, which represents a usable area of 106 m^2. The purchase price of a land with an area of 700 m^2 is 60 €/m^2 in the Slovak Republic (SR) in the Banská Bystrica region in the town of Zvolen, Môťová (www.nehnutelnosti.sk). In the Czech Republic (CR) in the region of the South Moravian Region in the city of Znojmo part of Hradiště, the price of the land is 4 €/m^2 higher (www.sreality.cz). The construction will be financed by a mortgage loan. Due to the conditions of providing loans, the coverage will be set at a ratio of 30% of the investor's own resources and 70% will be external sources. The maturity of the mortgage loan is set at 30 years in both variants selected by us. The interest rate will be fixed for 5 years. An important criterion for the analysis of affordability is the household income, from which it is necessary to pay the necessary expenses. In our calculations, we considered households with average incomes in the Slovak Republic (SR) and the Czech Republic (CR) published by the Statistical Office of the Slovak Republic and the Czech Republic in 2019. Net income was recalculated according to the valid legislative guidelines of the given countries (Table 1).

Table 1. Household income in EUR (SR and ČR)

	Region of Banská Bystrica (SR)		Region of South Moravia (CR)	
	Annual income (net) in EUR	Monthly income (net) in EUR	Annual income (net) in EUR	Monthly income (net) in EUR
Man	9 816	818	12 300	1 025
Woman	8 316	693	9 984	832
In total	18 132	1 511	22 284	1 857

Source: Processed according to Statistical office of Slovak Republic and Czech statistical office

For an objective of the affordability assessment of a family wooden house construction, it is necessary to include in the evaluation process all the costs of the life cycle of housing. In our analysis, the assessment time horizon is chosen for a period of 5 years, which is one of the alternatives for fixing the mortgage interest rate. Therefore, we will not consider the costs of liquidation and in the short term, nor the full costs of maintenance and renewal, which we will replace with the item of creating a hypothetical reserve fund. The assessed costs of the reference building for the 5-year cycle include the following groups:

- investment costs (land, base plate, construction to the phase House without fixture),
- financial costs (mortgage loan repayment costs),
- operating costs (energy costs, heating, domestic water heating-heat pump technology, water consumption and other charges related to the modern use of the family house),
- ownership costs (real estate tax, municipal waste fee and real estate insurance),
- costs of the reservation fund for repairs and renewal of the facility.

3. RESULTS AND DISCUSSION

The amount of the purchase price of the reference building, including the price of the land, the base plate price and the construction of the building to the phase House without fixture, is presented in table 2. In conditions of SR it is an investment in the amount of 127,000 €. In the CR, due to the higher price of the land, the investment is 2,800 € higher. For financing, the investor considers various offers of banks. Based on the analyzed offers on the mortgage market, we selected two large banks in the Slovak and Czech markets to prepare a loan offer for the reference building. Overview loan parameters selected banks are presented table 3.

Table 2. Data about real estate and investment items of the house

Zvolen, Môťová, Region of Banská Bystrica, Slovak Republic	Land price	700 x 60 €/m^2	42 000 €
	Base plate area price	120 x 104.16 €/m^2	12 500 €
	Price of house without fixture	106 x 801.88 €/m^2	85 000 €
	Purchase price	-	127 000 €
Znojmo, Hradiště, Region of South Moravia, Czech Republic	Land price	700 x 64 €/m^2	44 800 €
	Base plate area price	120 x 104.16 €/m^2	12 500 €
	Price of house without fixture	106 x 801.88 €/m^2	85 000 €
	Purchase price	-	129 800 €

Source: Own processing

Table 3. Mortgage loan parameters

	Slovak Republic banks		Czech Republic banks	
	Slovenská sporiteľňa - A1	ČSOB A2	Česká Sporiteľňa – B1	ČSOB B2
Loan lenght	30 years		30 years	
Interest rate (5-years fixed)	1.39 %	1.35 %	2.89 %	2.79 %
RPMN	1.43 %	1.36 %	3.03 %	2.99 %

Source: Own processing according to loan offers of the respective banks

Table 4. Determining the amount of the monthly mortgage loan

Financial costs –loan installment	Slovak Republic		Czech Republic	
	A1	A2	B1	B2
Purchase price	127 000 €		129 800 €	
Savings (30 % from purchase price)	38 100 €	38 100 €	38 940 €	38 940 €
Pre - purchase costs	271 €	271 €	357 €	357 €
Bank processing fee	89 €	0 €	97 €	0 €
Own finance source	37 740 €	37 829 €	38 486 €	38 583 €
Required loan amount	89 260 €	89 171 €	91 314 €	91 217 €
Monthly payment	304.18 €	301 €	381.67 €	379.18 €

Source: Own processing

Table 4 presents a comparison of the offers of individual banks. For the purposes of further calculation, the offer of ČSOB bank was accepted, where the monthly payment (financial cost) represents 301 € in the SR and 379.18 € in the CR. A very important item that can be classified in the category of operating expenses include energy costs, heating, domestic water heating-heat pump technology, water consumption and other charges related to the modern use of the family house (internet, TV and others). These items are presented in table 5.

Table 5. Costs for upkeep and maintaining the comfort of housing (in EUR/month)

Operating costs	Slovak republic	Czech republic
Water (heat pump) + heating	55.70 €	54.55 €
Water use (3 persons)	26.25 €	29.17 €
Electric power	30 €	31.17 €
The rest costs	20 €	26 €
In total – monthly costs	131.95 €	140.89 €
In total – annual costs	1 583 €	1 690.65 €

Source: Own processing according to www.eletrina.cz and SSE

Another item is the cost of ownership. It is a real estate tax, municipal waste fee and real estate insurance. These items have been quantified according to the regulations and directives in force in each region. These represent 32.23 €/month in the case of Zvolen and 24.70 €/month in the case of Znojmo. Another necessary group of costs for the operation of a wooden building are the costs associated with the renovation of household equipment, such as household electrical appliances, furniture and the replacement of sanitary equipment. Each element has a different lifespan and importance, so it is difficult to determine the frequency of their replacement and the costs associated with it. The average frequency of replacement would be set at 10 years for appliances and 20 years for furniture. We have included such items in the so-called reserve fund for repairs and renewal. For the SR, they were set at the level 40 €/month and CR 50 €/month (table 6).

Table 6. Total monthly operating costs of housing (in EUR/month)

Cost Items	Slovak republic	Czech republic
Financial costs	301 €	379.18 €
Operating costs	131.95 €	140.89 €
Cost of ownership	32.23 €	24,70 €
Reserve fund for repairs and renewal	40 €	50 €
In total – monthly costs	505.18 €	594.77 €
In total – annual costs	6 061.70 €	7 136.81 €

Source: Own processing according to Zvolen municipal office and Znojmo municipal office (taxes and fees)

The reason for the increase in the fund in the CR is on average 10% - 15% higher prices of appliances. At the same time, we also took into account the higher net monthly household income, which is higher than the income of the SR household by 346 €/month. In contrast to the Smith study (2013), we neglected the cost of renovation. The reason is the fact that it is a new building. After taking into account all cost categories associated with the use of of a family wooden house constructio, the total average monthly costs of the household in the conditions of the selected region of the SR are at the level 505.18 € and CR 594.77 €/month.

When deciding on affordability, in addition to household income and costs items, we must also consider the special subsistence item. It was determined on the basis of legislative regulations of both countries, for the SR at the level 441.74 €/month and CR 315.5 €/month.

In view of the above facts (Table 7), we can state that a reference wooden building in the phase of the House without fixture is affordable for a family with an average income in a given regions. Both households were able to repay the mortgage loan under the conditions analyzed by us, to provide for the basic needs of all members of the household and at the same time to set aside funds for other activities as well.

Table 7. Comparison of the affordability of alternatives

	Slovak republic	Czech republic
Average cost of housing /month	505.18 €	594.77 €
Average cost of housing - % net income	33.43 %	32.02%
Monthly payment of loan- % net income	19.92 %	20.41%
Total monthly net income	1 511.0 €	1 857.0 €
Subsistence item cost in family /month	441.74 €	315.5 €
Amount for other expenses from net income	+ 564.08 €	+946.73 €

Source: Own processing

The difference between the total resulting balance of disposable household income in selected regions of CR and SR is 382.65 € in favour of Czech house.

4. CONCLUSION

Compared to a similar analysis of affordability assessment in Australia (Smith, 2013), where the result of the share of housing costs in net income was set at 50.4%, the affordability of financing a wooden house building was better in our conditions. In the conditions of the CR it is at the level 32.02% and SR 33.43%. We realize that this comparison is affected by too many factors and differences (energy prices, cost of living, credit terms, procurement and administration costs as well as equipment, comparison time), but we did not find the results of a similar analysis when trying to compare results in European countries. We would like to state that the results of the case study presented by us, based on the analyzed input data, confirm the affordability of the reference wooden building. However, the conditions of the comparison were set during 2019, even before the outbreak of the global pandemic. From the point of view of other advantages of wood-based construction and also use (short construction time, ecological-environmental aspect of the use of input materials, indoor climate), wooden construction becomes fully competitive in comparison with the classic alternative of construction in a brick house. The ability to produce wood materials in a low-energy production process and with minimal emissions, as well as the ability to store carbon over the long term, gives wood a unique advantage. This fact was confirmed in the works Bin and Parker (2012), Gustavsson et al. (2017) Buryova and Sedlak (2016) and Sedlak et al. (2019). In the context of climate and environmental protection, this will be an important criterion for assessing construction materials.

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REFERENCES

1. Buryova, D.; Sedlak. P. (2016): Wood Log House – Comprehensive Thermal Prediction and Energy Consumption Quantification. In: The path forward for wood products: a global perspective: proceedings of scientific papers. Zagreb: WoodEMA i.a. 2016. pp. 157-165. ISBN 978-0-692-76612-5.
2. Bin, G.; Parker, P. (2012): Measuring Buildings for Sustainability: Comparing the Initial and Retrofit Ecological Footprint of a Century Home – the REEP House. Applied Energy, 93: pp. 24-32.
3. Debnár, M.; Potkány, M. (2016): Potential of Wooden Houses on the Slovak Market. In: Microeconomics and Management: Current Problems; Croatian quality Managers Society. Zagreb. 2016. 60-72.
4. Gustavsson, L.; et al. (2017): Climate Change Effects of Forestry and Substitution of Carbon-Intensive Materials and Fossil Fuels. Renewable and Sustainable Energy Reviews, 67: pp. 612-624.
5. Sedlak, P.; Buryova, D.; Stefko, J. (2019): Innovative Design of the Low-cost Structural System for Wood-based Houses. In: Digitalisation and circular economy: forestry and forestry based industry implications: proceedings of scientific papers. Sofia: Union of Scientists of Bulgaria, 2019, pp. 87-92. ISBN 978-954-397-042-1.
6. Smith, P. (2013): Modelling Housing Affordability Measurement Through the Incorporation of Life Cycle Costs. International Journal of Project Organisation and Management, 5 (1-2): pp. 111–126.
7. ***. https://slovak.statistics.sk/
8. ***. https://www.czso.cz/
9. ***. https://www.elektrina.cz/
10. ***. https://www.mpsv.cz/zivotni-a-existencni-minimum-1
11. ***. https://www.sse.sk/

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SELECTED LOGISTICS TRENDS IN SLOVAK WOOD PROCESSING ENTERPRISES

Richnák, P.

Abstract: The present time necessarily requires acceptance of the ongoing Fourth Industrial Revolution. This is largely reflected in industry and every enterprises. Increased attention needs to be paid to the logistics of the wood processing industry, because implements trends in the form of new communication, information and transport technologies, methods, approaches, concepts and strategies. For this reason, enterprises of wood processing industry need to be more aware of the prevailing changes and new challenges and accordingly, determine the new direction of logistics. The main aim of the paper is to present selected logistics trends of wood processing industry on the basis of knowledge base, which consisted of study of domestic and foreign literature and to find out their application and use in Slovak wood processing enterprises.
Keywords: trends in logistics, Quick Response, Warehouse management system, Pick-by-Systems

1. INTRODUCTION

New technologies fundamentally change the way businesses operate and develop their business, bringing new challenges to IT managers. How successfully the company will adapt to the digital transformation will be directly related to its competitiveness and future market survival (Čambalíková, 2015). In today's conditions, the success and competitiveness of manufacturing enterprises requires the improvement of three basic factors, namely flexibility, quality improvement and cost reduction. Those processes and activities in the company, which show signs of inefficiency, need to be thoroughly analysed and then found and applied in an appropriate way or method to optimize them (Simanová, 2019). Nowadays, if companies want to stay at the forefront of the market and meet the needs and wishes of their customers, they need to be flexible, so they can adapt their business processes to demand (Porubanová et al., 2019).

The main idea of Quick Response is a demand captured the closest to the real time and the closest to the final consumer. Based on these information production and supply management can be planned. QR connects informational systems and logistics systems whose combination transfers correct goods to correct location at correct time (Christopher, 2016). QR is a technology, where individual parts of logistics chain share information of supplies, orders and sales with other parts. QR is similar to Just in Time, however, relationships in QR are significantly more universal and involve all parts from producer to retail store. Condition for QR implementation is an application of automatic identification on bases of barcodes and electronic data interchange – EDI. This connection excellerates information flow, decreases degree of uncertainty in decision making – supplies are monitored daily, orders are processed daily. According to studies of the USA, entire reduction of time in a chain can reach up to couple of weeks and requested goods are delivered to stores from 24 to 48 hours (Řezáč, 2009).

Warehouse is very important for every company, especially for production and retail sector, but also for the whole supply chain. Term warehouse is often mentioned in a negative context, as the cause of high costs and waste of time, without adding value to the product. "Such understanding of warehouse and warehousing process is limited and does not observe the key tasks of warehouse management, such as: reducing the warehouse cost and holding inventory, increasing efficiency, increasing accuracy, increasing productivity while achieving greater value for customers and higher levels of service quality (Richards, 2017). Different methods of order-picking, equipment or information technology could be used for improving order-picking process. It is well known that implementation of Warehouse Management System (WMS) means integration in day-to-day planning and controlling processes. This software system presents a great support to warehousing process. Before WMS companies were using Inventory Control System. But WMS has greater results in terms of functionality and optimisation routines (Moellera, 2011). Warehouse System Management works with storage positions, one-level and multi-level packaging which enables to monitor individual storage movements. In application of system management there are combined also other technologies assisting to decrease error rates and save time. There we include for example RFID, Pick by Voice, Pick by Light, conveyors and others. The sensor-based method uses a RFID tag (Jeon, 2010) laser pointer, a wireless sensors (Shen, 2015) and a laser sensor (He, 2010; Lecking, 2010) for pallet detection and location.

2. METHODOLOGY

The main objective of the scientific paper is an analysis and comparison of theoretical background dealing with trends in logistics. Based on the implementation of the survey in wood processing enterprises in Slovakia, evaluate and interpret the position and use of selected trends in logistics.

The main objective and partial objectives of the paper were achieved using several research methods. Literary research, analysis, synthesis, induction, deduction, comparison and scientific abstraction were used in the processing of the theoretical part of the paper. Descriptive statistics and graphical methods were used in the Results chapter. The object of the research was small, medium-sized and large wood processing enterprises operating in the Slovak Republic. The research tool was a questionnaire that consisted of several questions that included scale questions through which the results were well interpreted.

3. RESULTS

The survey was conducted in 34 Slovak wood processing enteprises. Of the research sample, 47.10% of enterprises from the Prešov Region participated the most. The smallest percentage of 8.8% was from the Nitra Region. Of the total number of enterprises that participated in the survey, the largest number was medium-sized enterprises with a share of 41,2%. Small enterprises were represented with a share of 32.3%. Large enterprises participated the least in the survey with a share of 26.5%. Other questions will deal with the evaluation of the use of selected logistics trends.

Based on Figure 1, we see that wood processing enterprises in Slovakia use Warehouse management system with the largest percentage of 38%. Quick Response is used by wood processing enterprises with a share of 18%. The smallest (3%) wood processing enterprises use Pick-by-Systems from logistics trends. Wood processing enterprises in Slovakia with the largest percentage (89%) do not use Picky-by-Systems. They do not use Quick Response with a share of 42%. The least (15%) wood processing enterprises in Slovakia do not use Warehouse management system.

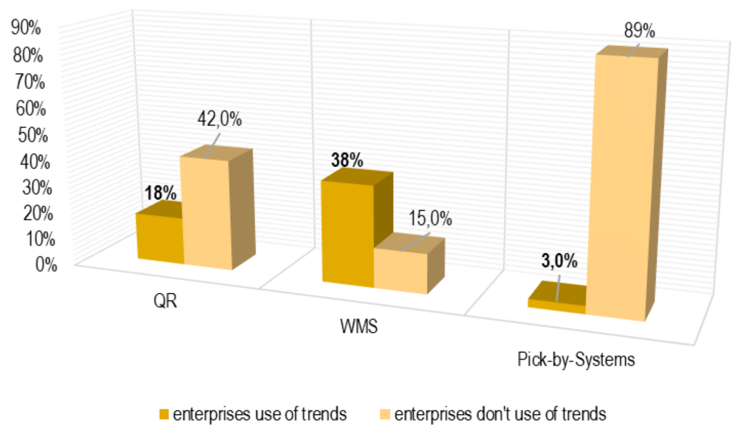

Figure 1. Using of logistics trends. Source: own research

Figure 2 shows the use of selected trends in logistics by business size. The use of Quick Response dominates in large wood processing enterprises (26.5%). Warehouse management system achieved a percentage of 23.5%. Pick-by-Systems uses the least (20.6%) of wood processing enterprises. Pick-by-Systems is the most (76.5%) use of trends in logistics among respondents. Medium-sized wood processing enterprises use Quick Response with a share of 58.8%. Warehouse management system is used by medium-sized enterprises with a share of 53%. The largest percentage (23.5%) was achieved by Warehouse management system in small enterprises. Quick response is used by wood processing enterprises with a share of 14.7%. Pick-by-Systems are used with the smallest share in small enterprises. The percentage of use of this trend was only 2.9%.

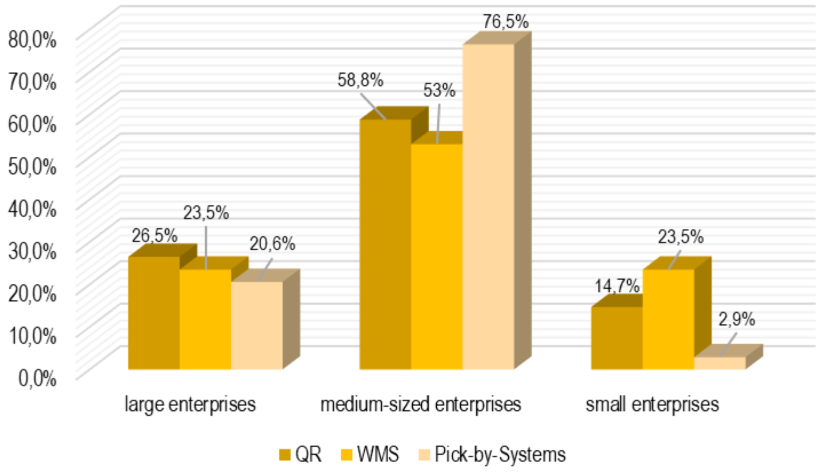

Figure 2. Using of trends in logistics according to business size. Source: own research

Figure 3 reveals, the use of selected trends in logistics according to business logistics fields. The use of Warehouse management system dominates in procurement logistics. This trend is used in this logistics with a share of 29.4%. Respondents identified the use of Quick Response in procurement logistics with a share of 5.9%. The smallest percentage (2.9%) is in the use of Pick-by-Systems in procurement logistics. In production logistics, Quick Response is used with the largest share (44.1%). Wood processing enterprises use Warehouse management system in production logistics with a share of 38.2%. The smallest percentage (35.3%) was achieved by Pick-by-Systems. The use of Pick-by-Systems dominate in distribution logistics. Percentage achieved 61.8%. Quick Response is used in distribution logistics with a 50% share. Warehouse management system is the least (32.4%) used in distribution logistics.

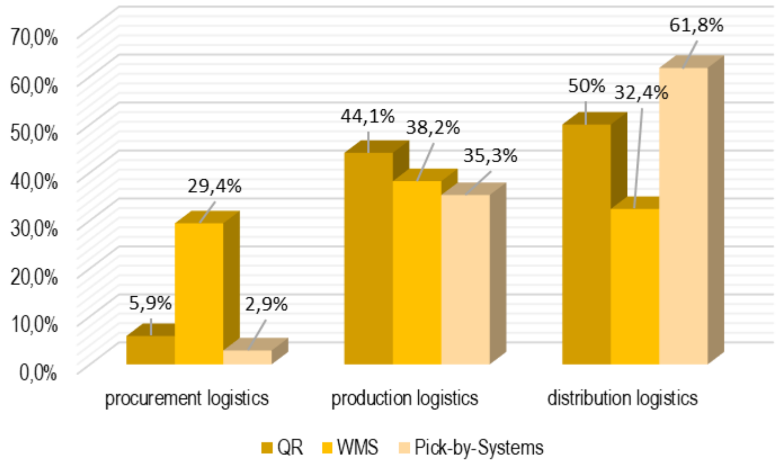

Figure 3. Using of trend in logistics according business logistics fields. Source: own research

Figure 7 shows the use of Quick Response, Warehouse management system and Pick-by-Systems in wood processing enterprises by regions in Slovakia. The radar graph was created based on the mean values. Quick Response is mostly used in enterprises in Žilina Region. The mean value achieved 3.3. Wood processing enterprises in Prešov and Trnava Regions obtained a higher mean values (3.1) in the use Quick Response. The lowest mean value (0,25) of Quick Response was recorded in Nitra Region. Warehouse management system is the most used in wood processing enterprises in Prešov Region. The mean value achieved 3.8. Bratislava Region (3.4), Žilina Region (3.24) and Košice Region (3) recorded balanced mean values. The lowest mean value (0.3) of Warehouse management system was recorded in enterprises of Nitra Region. Pick-by-Systems are the most used in enterprises in Prešov Region. The mean value achieved 1.9. The lowest mean value (0) of Pick-by-Systems was recorded in enterprises of Nitra Region.

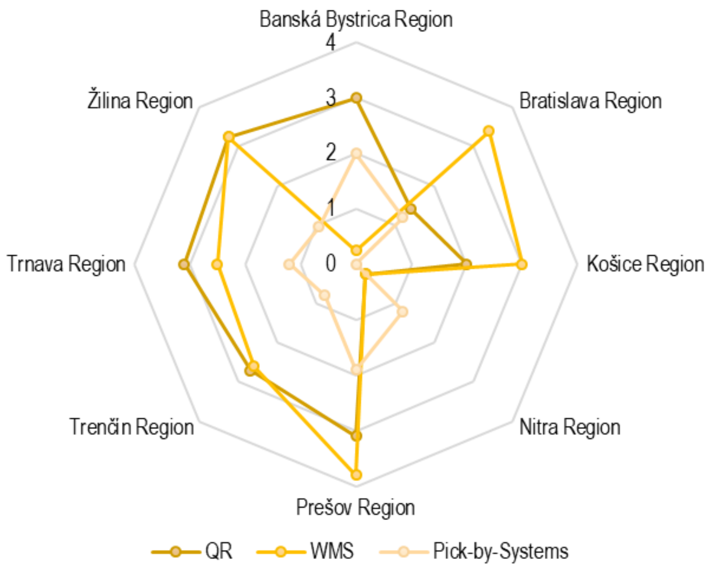

Figure 4. . Using of trends in logistics by regions of Slovakia. Source: own research

4. CONCLUSIONS

During the ongoing Fourth Industrial Revolution, significant changes and advances in logistics took place. Its position within the enterprise has changed as corporate logistics has taken on more and more activities, thus beginning to play an integral role in management of each enterprise. Globalization, economic change, the development of intelligent technologies and industrial revolutions have contributed to the new form of logistics. Based on these facts, trends in logistics have emerged and are constantly evolving.

The main objective of the scientific paper is an analysis and comparison of theoretical background dealing with trends in logistics. Based on the implementation of the survey in wood processing enterprises in Slovakia, evaluate and interpret the position and use of selected trends in logistics.

The survey was conducted in 34 Slovak wood processing enteprises. Wood processing enterprises in Slovakia use Warehouse management system with the largest percentage of 38%. The use of Quick Response dominates in large wood processing enterprises (26.5%). The use of Warehouse management system dominates in procurement logistics. This trend is used in this logistics with a share of 29.4%. In production logistics, Quick Response is used with the largest share (44.1%). The use of Pick-by-Systems dominate in distribution logistics. Percentage achieved 61.8%. Quick Response is mostly used in enterprises in Žilina Region. Warehouse management system is the most used in wood processing enterprises in Prešov Region. Pick-by-Systems are the most used in enterprises in Prešov Region.

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REFERENCES

1. Čambalíková, A. (2015) : Využitie manažérskych nástrojov Big Data Analytics a Digital Transformation. In : *Manažment informačnej bezpečnosti v malých a stredných podnikoch: Zborník vedeckých statí*. 2015. 35-41.
2. He, Z. et al. (2010): Feature-to-feature based laser scan matching for pallet recognition. In: *International Conference on Measuring Technology and Mechatronics Automation*. 2010, pp. 260–263.
3. Christopher, M. (2016): *Logistics & supply chain management*. 5th edition. Harlow: FT Prentice Hall/Pearson Education, 2016. 310 p. ISBN 978-1-08379-7.
4. Jeon, S. et al. (2010): Localization of pallets based on passive RFID tags. In: *International Conference on Information Technology*. New Generations. 2010, pp. 834–839.
5. Lecking, D. et al. (2006): Variable pallet pick-up for automatic guided vehicles in industrial environments. In: *IEEE Conference on Emerging Technologies and Factory Automation*. 2006. pp. 1169–1174.
6. Moellera, K. (2011): Increasing warehouse order picking performance by sequence optimization. *Procedia Social and Behavioral Sciences*. 2011, vol. 20, pp. 177-185. ISSN 1877-0428. https://doi.org/10.1016/j.sbspro.2011.08.023.
7. Porubanová, K., Púčková, N. (2019) : Technologické prínosy ekonomickej analýzy výrobného procesu podniku: Technological Benefits of Economic Analysis of the Production Process.In: *Nová dimenzia logistiky v štvrtej priemyselnej revolúcii v podnikoch na Slovensku: Zborník vedeckých statí*. 2019. 67-81.
8. Richards, G. (2017): *Warehouse management: a complete guide to improving efficiency and minimizing costs in the modern warehouse*. 3rd edition. London: Kogan Page, 2017. 528 p. ISBN 978-0-7494-7977-0.
9. Řezáč, J. (2009): *Moderní management*: *manažer pro 21. století*. Brno : Computer Press, 2009. 397 p. ISBN 978-80-251-1959-4.
10. Simanová, L. (2019): The application of modern methods of change management to optimize processes in wood processing industry. In: *DIGITALISATION AND CIRCULAR ECONOMY: forestry and forestry based industry implications, Paper presented at the 12th International Scientific Conference WoodEMA 2019 DIGITALISATION AND CIRCULAR ECONOMY: forestry and forestry based industry implications*, 11-13.09.2019, Varna, pp. 201-206.
11. Shen, J. et al. (2015): *A novel routing protocol providing good transmission reliability in underwater sensor networks. Journal of Internet Technology*. 2015, vol. 16, no 1, pp. 171–178. ISSN 16079264. http://jit.ndhu.edu.tw/ojs/index.php/jit/article/view/1106.

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CHANGES IN CORPORATE LOGISTICS IN THE SLOVAK WOOD PROCESSING INDUSTRY

Gubová, K.

Abstract: With the advent of digitalization, fundamental changes have begun to be felt in all areas of business. New business models, markets, ICT changes and innovations are emerging in every business area, including logistics. With innovations in logistics, every enterprise can accelerate and improve all logistics processes, from raw material purchase to product delivery, responding effectively to the growing needs of customers. Digitalization not only revolutionizes logistics changes, but also fundamentally changes the country's society and economy. The direction of the wood processing industry is also changing significantly. Digitalization is related to the ongoing Fourth Industrial Revolution, which is based on the idea of combining digitalization and automation with the use of modern technologies. Logistics in the wood processing industry in Slovakia is subject to many trends and changes due to the Fourth Industrial Revolution. The main aim of the paper is to analyse the changes in corporate logistics in the Slovak wood processing industry on the basis of an analysis of the theoretical basis of the issue and to carry out a survey in Slovak wood processing enterprises.
Keywords: digitalization, Fourth Industrial Revolution, corporate logistics, wood processing industry

1. INTRODUCTION

In today's dynamically developing world there are many economic, social, technical and political changes. Their nature and extent is determined by factors influenced by economic development and economic growth. As a result of globalization, there is a sharp increase in competition. Globalization of markets and business brings the same prerequisites for access to information, resources and technology. We see that the "world" is getting smaller and distances are minimized by information and communication technologies (Richnák, 2015). Looking at logistics as a well-known or historical concept is currently, so to speak, insufficient. We are experiencing a significant innovation shift and development in this area. Not only because the new rules and conditions, but also other facts determine and induce a different character and change, but above all that it is innovative development and globalization that open up space for progress in this area (Dupaľ et al., 2017).

The concepts of Industry 4.0 to logistics activities, Logistics is now called Logistics 4.0/Smart Logistics, since "Smart Logistics is a logistics system, which can enhance the flexibility, the adjustment to the market changes and will make the company be closer to the customer needs (Barreto et al., 2017). Pereira et al. (2018) describes Industry 4.0 as integration of Cyber-Physical Systems and Internet of Things into supply chains. The onset of digitalization in all business areas started to show major changes. New global markets, business models, advances in information and communication technologies and innovation are arising in each business area. 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. Industry 4.0 is based on the idea of linking digitization and automation using the latest technology. The basis is the Internet of Things and Services, smart devices that communicate with each other through cyber-physical systems and are independent of people (Richnák, 2019a). Maier et al. (2015) proposes that the application of Industry 4.0 technologies can lead to an innovation in supply chains and solve problems such as information asymmetry. Businesses that use e–commerce to sell goods and services are particularly sensitive to customer trust. In the event of a successful security incident and subsequent disclose of this situation, a decline in customer trust may cause significant financial losses, mainly due to a decrease in orders (Korček et al., 2018).

Industry 4.0 is represented especially by information technology representatives, telecommunication companies, new media, machinery, electro technology and industrial production and electronics. They enforce concept of intelligent factories, which are characterised by flexibility, effective utilisation of sources and materials, ergonomics and including customers into production and value making. Thoben et al. states that industry 4.0 is characterized by the Internet of Things (IoT) and Internet of Services (IoS), enabling smart factories with production systems horizontally and vertically integrated (Thoben et al., 2017).

Logistics 4.0 is a collective term for technologies and concepts of value chain organization. Within the logistics, CPS monitor physical processes, create a virtual copy of the physical world and make decentralized decisions.

Over the IoT, cyber physical system (CPS) communicate and cooperate with each other and humans in real time. Data Mining (DM) discovers knowledge to support decision-making process. Via the Internet of Service, both internal and cross-organizational services are offered and utilized by participants of the value chain (Wang, 2016).

2. RESEARCH DESIGN

The main aim of the paper is to analyse the changes in corporate logistics in the Slovak wood processing industry on the basis of an analysis of the theoretical basis of the issue and to carry out a survey in Slovak wood processing enterprises.

The information and knowledge in the paper were processed using classical and special scientific methods. The classical methods used were: analysis, synthesis, induction, deduction and comparison. Among the special methods, the method of query method, sorting and graphical methods from which clear figures were used.

The questionnaire survey was conducted in small, medium and large Slovak wood processing enterprises. When categorizing companies by size, we used the EU Commission Regulation no. 651/2014.

3. RESULTS

The survey was conducted in 42 Slovak wood processing enterprises. The largest number (47%) of respondents participated from the Žilina Region. The smallest percentage share of 7.7% was from the Bratislava Region. The largest part of the research sample was represented by medium-sized wood processing enterprises with a share of 56.8%. The smallest enterprises in the small business category had a participation percentage of 9.2%.

Changes in corporate logistics are related to the ongoing Fourth Industrial Revolution. It is changing corporate logistics due to the related digitization, augmented reality, automation and use of intelligent technologies. In figure 1 we can see how Slovak wood processing enterprises use Industry 4.0. From Figure 1 we can see that the percentages are almost identical. Slovak wood processing enterprises use Industry 4.0 with a share of 52%. Respondents with a share of 48% do not use Industry 4.0 in corporate logistics in the woodworking industry.

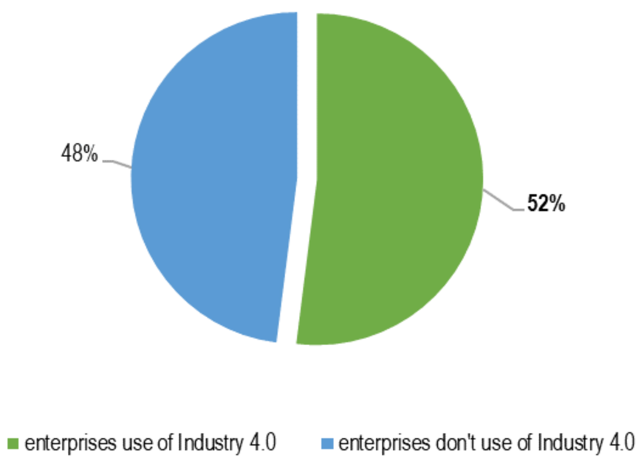

Figure 1. Use of Industry 4.0 of Slovak wood processing enterprises. Source: own processing

Figure 2 shows the use of Industry 4.0 in wood processing enterprises in Slovakia according business size. Industry 4.0 is used with the largest percentage (48.5%) by medium-sized wood processing enterprises in Slovakia. Large enterprises that use Industry 4.0 also have a high percentage (46.6%). Industry 4.0 is the least used in small wood processing enterprises in Slovakia. The average value reached 4.9%.

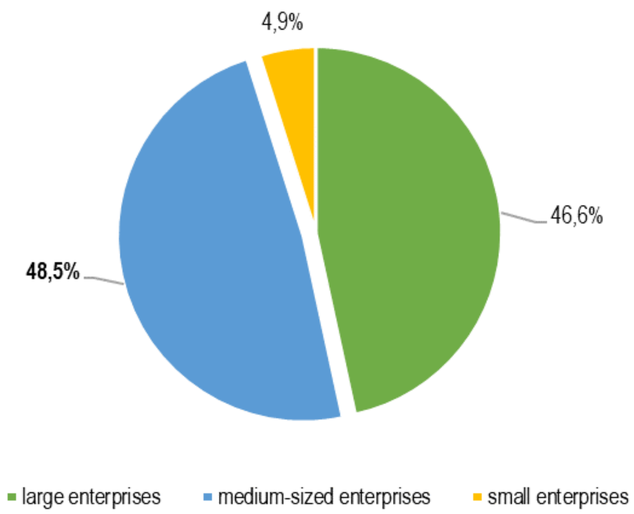

Figure 2. Use of Industry 4.0 according to business size. Source: own processing

In the next figure we can see the use of Industry 4.0 according to business logistics fields. The Fourth Industrial Revolution in the form of Industry 4.0 has the greatest impact on production logistics. Respondents identified this possibility with the largest share of 49.8%. The use of Industry 4.0 in procurement logistics and distribution logistics is almost the same. This is shown by the percentages. Slovak wood processing enterprises use Industry 4.0 in distribution logistics with a share of 27.5%. Industry 4.0 is used in procurement logistics with a share of 23%.

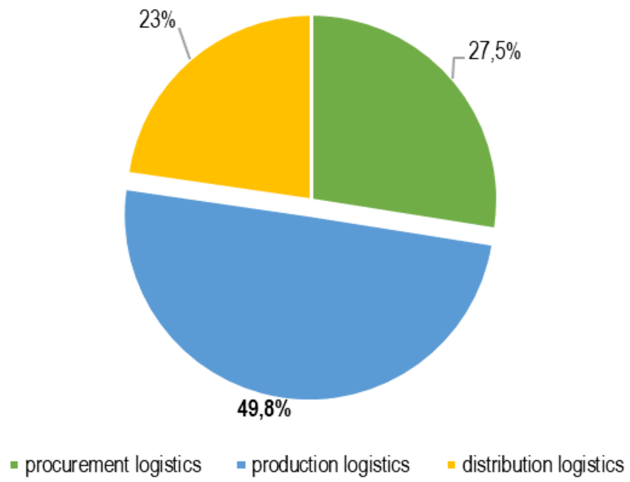

Figure 3. Use of Industry 4.0 according business logistics fields. Source: own processing

Figure 7 shows the use of Industry 4.0 in logistics processes in wood processing enterprises in Slovakia. From the figure we can see that the Fourth Industrial Revolution has the greatest impact on production. This logistics process is under the influence of Industry 4.0 with the largest percentage of 28.8%. Logistics process - storage is affected by Industry 4.0 with a share of 21.3%. Transport is under the influence of Industry 4.0 with a share of 15.6%. Respondents determined that with a share of 13.9%, the logistics process - packaging is influenced by the Fourth Industrial Revolution. Industry 4.0 is used in logistics process - inventory management with a share of 13.5%. At least the Fourth Industrial Revolution is influenced by customer service. The percentage of this logistics process reached 7%.

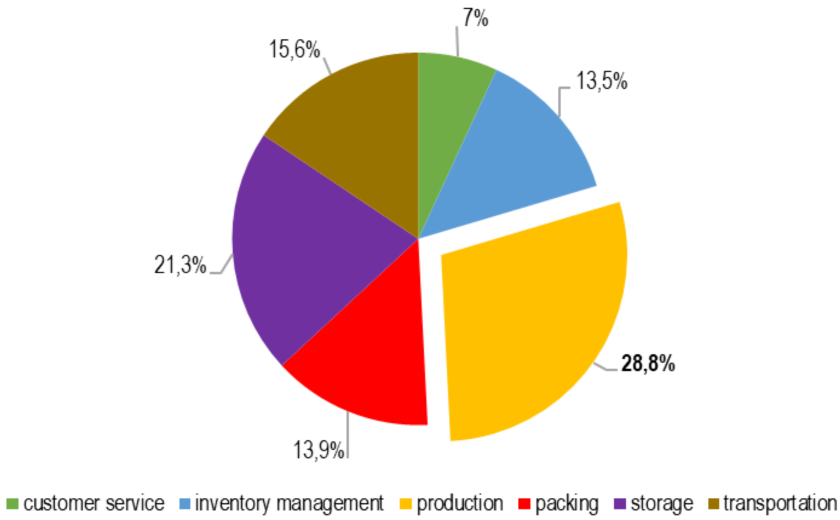

Figure 4. Use of Industry 4.0 in logistics processes. Source: own processing

4. CONCLUSIONS

The current period is marked by significant technological progress, which is also reflected in the logistics. In the context of the new economy there is a great deal of knowledge, which due to information and communication technologies is more preferred and utilized. That is why we more often speak about the phenomena such as innovation, modern logistics, supply chain management, environmental protection, flexible manufacturing technology and modern information technology (Richnák, 2016). Every enterprise has to realize that its competitive advantage in the market is not only lowering production costs and improving product quality, but also focusing on the employees themselves, so it is important to choose a logistics technology that not only increases productivity but also helps development of motivation and creativity of employees (Richnák, 2019b).

The results of a survey in Slovak wood processing enterprises show that digitization in corporate logistics is under the influence of Industry 4.0. Slovak wood processing enterprises use Industry 4.0 with a share of 52%. Industry 4.0 is used with the largest percentage (48.5%) by medium-sized wood processing enterprises in Slovakia. The Fourth Industrial Revolution in the form of Industry 4.0 has the greatest impact on production logistics. Digitization in the form of Industry 4.0 has the greatest influence on the logistics process - production.

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REFERENCES

1. Barreto, L., Amaral, A., Pereira, T. (2017): Industry 4.0 implications in logistics: an overview. *Procedia Manufacturing*. 2017, vol. 13, pp. 1245-1252. ISSN 2351-9789. https://doi.org/10.1016/j.promfg.2017.09.045.
2. Dupaľ, A., Richnák, P. (2017): Vybrané trendy a koncepcie v procesnej orientácii podnikovej logistiky. *Ekonomika a manažment: vedecký časopis Fakulty podnikového manažmentu Ekonomickej univerzity v Bratislave*. Bratislava: Fakulta podnikového manažmentu Ekonomickej univerzity v Bratislave, 2017, 14(3), 8-19. ISSN 2454-1028.
3. Korček, F., Bolek, V., Romanová, A., Richnák, P. (2018): Practicing Information Security Management System in E–Commerce. *Ad Alta: Journal Of Interdisciplinary Research*, 8(1), 207-212.
4. Maier, M. A. et al. (2015): Innovation in supply chains – solving the agency dilemma in supply networks by using industry 4.0 technologies. In: *International Journal of Communication Networks and Distributed Systems.* 2015, vol. 15, no. 2-3. ISSN 1754-3924. https://doi.org/10.1504/IJCNDS.2015.070976.

5. Pereira, A. et al. (2018): How connectivity and search for producers impact production in Industry 4.0 networks. *Brazilian Journal of Operations & Production Management*. 2018. vol. 15, no. 4, 528-534. ISSN 2237-8960. https://doi.org/10.14488/BJOPM. 2018.
6. Richnák, P. (2019a): Usage of Logistics Technologies in Slovak Enterprises. *LOGI – Scientific Journal on Transport and Logistics.* Warsaw: De Gruyter, 2019, 10(2), 94-104. ISSN 2336-3037.
7. Richnák, P. (2019b). The Current Trends in the Industry - Industry 4.0 in Slovak Enterprises. *Dokbat 2019: International Bata Conference*, 916-925.
8. Richnák, P. (2016). New development directions of logistics in an industrial company. In: *Edamba 2016: Conference Proceedings: Open Science & Open Innovation: Opportunities For Economics, Business, Management And Related Disciplines: International Scientific Conference For Doctoral Students And Post-Doctoral Scholars: University Of Economics In Bratislava*, Slovak Republic, 10 - 12 April 2016, 315-323.
9. Richnák, P. (2015): Globalization and its impact on the present concepts in company management. *Globalization And Its Socio-Economic Consequences. Part 2: Proceedings: 15Th International Scientific Conference: 7Th-8Th October 2015, Rajecke Teplice, Slovak Republic*, 608-616.
10. Thoben, K. D. et al. (2017): Industrie 4.0 and Smart Manufacturing – A Review of Research Issues and Application Examples. *International Journal of Automation Technology*. 2017, vol. 11, 4-16. ISSN 1881-7629. https://doi.org/10.20965/ijat.2017.p0004.
11. Wang, K. (2016): Logistics 4.0 Solution: New Challenges and Opportunities. In: *6th International Workshop of Advanced Manufacturing and Automation*, *10-11 November 2016.* Manchester, United Kingdom, 2016, ISBN 978-94-6252-243-5.: https://doi.org/10.2991/iwama-16.2016.13.

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A SUSTAINABLE ROUNDWOOD PRICING STRATEGY AS AN OPPORTUNITY OR A THREAT FOR THE DEVELOPMENT OF WOOD-BASED INDUSTRY IN POLAND

Mikołajczak, E., Wieruszewski, M., Wanat, L.

Abstract: The study attempts to identify an optimal pricing strategy, adequate for the basic segment of the primary wood market, i.e. the timber raw material market, and applicable in the conditions of a short- or medium-term economic crisis. Secondary quantitative data (wood prices) and qualitative data (expert preferences for price strategies) were analyzed. The research was conducted in the first half of 2020 using a comparative analysis and individual in-depth interviewing techniques. In conclusion, it was stated that in view of significant changes in prices on the primary wood market, the approach preferred by experts during the crisis is the strategy of low prices, or the tendency to reduce them relatively.
Keywords: mesoeconomics, wood-based sector, industrial policy, pandemic economic crisis, Poland

1. INTRODUCTION

The wood market consists of two complementary sectors of the economy: forestry and wood industry. The primary market in the wood-based sector is the market of roundwood. In the science of the wood market (*Holzmarktlehre*), it is sometimes assumed that the phenomena identified on the primary wood market have a significant impact on the functioning of the entire forest and wood-based sector, shaping the competitiveness of the sector and entities participating in it [5, 6]. Bearing in mind only the preliminary figures from the first half of 2020, it was noticed that the timber market in Poland is experiencing a collapse, even compared to the situation in 2008 [11, 12]. This is due not only to the reduction of transactions caused by the global pandemic, but also to the growing uncertainty of maintaining international contracts in Europe. The entire European market is characterized by an oversupply of wood raw material, as well as a collapse in prices caused by competitive imports of cheaper sawnwood from Austria, Germany and Scandinavia. At the same time, there was a clear decline in demand for wood in the markets of China and the USA, which resulted in a significant reduction in exports. The internal wood market, especially in terms of wood materials and semi-finished products, is therefore responding with a fall in prices. At the same time, the dominant Polish monopoly in the sale of roundwood, the National Forests Holding "State Forests", tries to maintain their level by regulating institutional prices. As a result, understandably, the sale of wood material is significantly decreasing. This situation will probably worsen due to the surplus production of sawnwood on the German market [10]. In such a perspective, it seems necessary to search for an optimal pricing strategy for the primary wood market in Poland, which determines not only the financial condition of "State Forests", but most of all the real situation of the wood industry plants, maintaining jobs and at least the current competitive position of the industry participants. Is it possible to find an optimal, anti-crisis pricing strategy, for entities of the wood industry?

2. MATERIAL, DATA SOURCES, METHODS AND RESEARCH SCENARIO

The starting point for the designed research was the competitive situation on the primary wood market in Poland. The forest-based value chain takes into account both the product perspective of round wood (raw wood) as well as wood materials, in particular general and special purpose lumber. The competitive situation was examined taking into account the influence of a specific factor, which is price. It is the price that is the only component of the marketing-mix model that creates the company's revenues. It should be emphasized that the remaining elements of the model generate costs. Of course, this is how the market, or rather its participants, "sees" it from the supply perspective [1, 4]. Thus, the competitive situation of the entire forest- and wood-based sector depends on the method of setting prices, on the pricing strategy, and more frankly on the pricing policy on the primary (raw material) market, especially as specific as the wood market [2, 6].

The aim of the study was an attempt to identify the optimal pricing strategy for the market of wood raw material (roundwood) in Poland, adequate for the state of short- or medium-term economic crisis. The comparative analysis was carried out on the example of primary wood processing companies. The study was divided into two main parts: price analysis in the primary wood market (Part A) and identification and selection of the optimal pricing strategy for this segment of the wood market (Part B) [9]. At the same time, an attempt was made to verify the hypothesis, which assumed that in times of crisis it is possible to apply a balanced pricing strategy on the primary wood market. As PART A, in the first half of 2020 (time range), secondary data was collected from open databases. The data was obtained from the publications of the National Forests Holding "State Forests" [9] and from industry databases [12] and Polish professional magazines (*Rynek Drzewny*, *Przemysł Drzewny*) [10, 11].

In the same period (first half of 2020), a qualitative study was also carried out under PART B. A group of typical wood industry enterprises (subjective scope) was selected and primary data was obtained. Industry entities were selected on purpose, proportionally for the location, corresponding to the territorial structure of 17 Regional Directorates of State Forests in Poland (spatial scope). Using the diagnostic survey method and the technique of individual in-depth interviews (IDI), responses were collected from professional representatives of the wood industry, participating in making real market decisions [3, 4]. As a result of the expert analysis (stage 1), five pricing strategies were selected that could be possibly used by entities participating in the sector. The experts gave the highest importance to these strategies, distinguishing the following for further verification (stage 2): low price strategy (S1), a strategy of relative price reduction (S2), neutral price strategy (S3), strategy of relative price increase (S4) and high price strategy (S5). The matrix of five pricing strategies was then included in the benchmarking exercise. Moreover, a deliberate selection of the wood market entities was made, with representatives of whom individual in-depth interviews were conducted (stage 3). From the group of 101 examined enterprises, 52 wood industry plants were taken into account for the purposes of this analysis. The location of these enterprises corresponds to the proportional spatial distribution of forestry. As a result, the obtained results were subject to discussion and descriptive analysis (stage 4), recommending the optimal strategy [4, 8].

3. RESULTS

3.1. Competitive situation - changes in the prices of roundwood and wood materials

When analyzing the competitive situation in terms of wood prices, secondary data was used, provided by the National Forests Holding "State Forests" (NFH) [9, 13]. The results were collected and aggregated on the basis of the results of timber sales, carried out in accordance with § 9 par. 1 of the Regulation No. 68 of the Director General of the State Forests of November 12, 2019 on the principles of selling wood in the NFH for the years 2020-2021 (Table 1). This regulation includes, inter alia, the results of the systemic internet auctions "*e-drewno*" in 2020. Similarly, the changes in prices of dry coniferous and hardwood, as well as special-purpose timber, including construction sawnwood and friezes (Table 2) were analyzed.

*Table 1. Changes in prices of large-sized round timber (WC0 standard**), on average in the annual period 2019-2020 (May), in relation to timber prices from 2020 (May) in EUR*

No.	Type of wood	Roundwood Assortment	Average annual price 2019-2020 m^3 in EUR*	Average monthly price in May 2020 m^3 in EUR*	Percentage change in the price of wood [%]
1.	Spruce	Oversized	55	46	-16,4%
2.	Spruce	Large-size logs	53	47	-11,3%
3.	Pine	Oversized	52	48	-7,7%
4.	Pine	Large-size logs	51	46	-9,8%
5.	Oak	Oversized	111	103	-7,2%
6.	Beech	Oversized	42	41	-7,2%

Source: Own study based on the prices provided by the State Forests

** The adopted exchange rate was EUR 1 = PLN 4.4465 on the basis of Table A of average exchange rates for foreign currencies no. 126 / A / NBP / 2020 of 2020-07-01 of the National Bank of Poland, URL: www.nbp.pl (02.07.2020); ** WC0 standard means: W - large-size, round wood with an upper diameter (thinner end) without bark from 14 cm and above; C0 - general purpose wood, quality class C.*

Table 2. Changes in prices of dry sawnwood, on average in the annual period 2019-2020 (May), in relation to wood prices from 2020 (May) in EUR

No.	Type of wood / wood species	Wood quality class // thickness [mm]	Annual average price 2019-2020 m^3 in EUR	Monthly average price May 2020 m^3 in EUR	Percentage change in sawnwood prices
1.	Spruce	3rd class // 32-50	151	184	+21,9%
2.	Spruce	I / II class	180	218	+21,1%
3.	Pine	3rd class // 32-50	162	200	+23,5%
4.	Pine	I / II class	207	270	+30,4%
5.	Oak	3rd class // 28-52	349	540	+54,7%
6.	Oak	I / II class	405	855	+111,1%
7.	Beech	3rd class // 25-60	135	247	+83,0%
	Type/Species	Wood Asortment	[m^3 in EUR]	[m^3 in EUR]	[%]
8.	Softwood	Coniferous construction wood	326	360	+10,4%
9.	Pine	Pine frieze	175	495	+182,9%
10.	Oak	Oak frieze	247	1080	+337,3%
11.	Beech	Beech frieze	171	553	+223,4%

Source: Own study based on the prices provided by the NFH State Forests

It was found that the State Forests had completed the procedure of selling wood raw material under systemic auctions for the second half of 2020. The collapse in demand resulted in the freezing of nearly 40 percent of the sale offer. The sales pool included over 3,585 million m^3 of wood, of which only 2,180 million m^3 were sold. Therefore, as many as 39.2% of the round timber obtained was not found. This situation occurred despite a clear change in prices compared to the previous year, on average from 7 to 16%, depending on the type of wood. It was noted that, in contrast to the minimally downward trend in the prices of roundwood, the market prices for general and special purpose sawn saw a completely different behavior. This group saw a clear increase in prices, ranging from a 10-30% increase in the prices of coniferous sawnwood, up to an almost fourfold increase in the prices of special-purpose oak lumber. This specific price asymmetry leads to a collapse in the sale of wood products,

3.2. Hierarchical analysis and selection of the optimal pricing strategy

While implementing PART B of the research scenario, after taking into account the competitive situation resulting from changes in wood prices, a qualitative study was conducted in the form of individual in-depth interviews (IDI). The experts' task was not to directly select the preferred pricing strategy. Thus, five strategies were included in the hierarchical analysis:

S1: LOW PRICES strategy, offensive.

S1 is used in free competition markets, sometimes on the verge of dumping. In its positive scenario, it assumes maintaining the current level of development and cooperation networks with partners, regardless of the conditions of the crisis. In the negative scenario, similarly to the counter-strategy (high prices), it may lead to the complete elimination of competition from the market.

S2: The RELATIVE PRICE LOWERING strategy, prudent with offensive features.

S2 is an intermediate strategy, characterized by gradual or periodic lowering of prices, flexibility of decisions, taking into account the demand reactions of market partners in various risk situations, and at the same time focused on development.

S3: The NEUTRAL strategy, using average prices or keeping current.

S3 is usually a "survival" strategy or the "status quo"; characterized by the lack of a firm reaction to the disclosure of risk factors or symptoms of a crisis.

S4: The PRICE RELATIVE GROWTH strategy, prudent, with defensive features.

S4 is an indirect strategy, characteristic of monopolistic competition or specific industry markets with a mixed profile.

S5: The HIGH PRICE strategy, defensive.

S5 is characterized by the use of prices higher than the average prices in a given market. This is a typical monopoly strategy. It guarantees success under the following conditions: the good / product / product offered is significantly better than the competitive offers, the price is marginal for potential recipients, and also when the price level (ceiling) does not exceed the upper limit of its acceptance by the buyer. Such a strategy is selected by an entity that wants to definitely maintain, strengthen or gain a market leader position. Moreover, a natural monopolist applying such a strategy becomes a direct creator, and sometimes a dictator of the market.

The key was to indicate the relationship between individual strategies. The answers were organized using the Saaty method [7]. A preference ranking for the analyzed pricing strategies was also prepared. Individual strategies were assigned numerical values (weights), depending on the "strength of preference", and then converted to percentage points. The obtained results are summarized in Table 4, identifying the preferences for selecting the optimal pricing strategy for the roundwood market (primary wood market) and wood industry enterprises in the conditions of the economic crisis. The strength of preferences for individual strategies was expressed as percentage points reflecting the acceptance or disapproval of a specific answer.

Table 4. Preferences for the selection of the optimal strategic model (S1-S5) for the development of wood industry companies (WIC) in the conditions of the economic crisis

Place / Pricing Strategy	Low price strategy S1	Relative price reduction strategy S2	Neutral strategy S3 (average prices)	Relative price growth strategy S4	High price strategy S5
Place I	67,3%	32,7%	0,0%	0,0%	0,0%
Place II	32,7%	53,1%	14,2%	0,0%	0,0%
Place III	0,0%	14,2%	35,3%	55,5%	0,0%
Place IV	0,0%	0,0%	55,5%	33,4%	11,1%
Place V	0,0%	0,0%	0,0%	11,1%	88,9%

Source: Own elaboration

The aggregated results were verified and discussed. It was noticed that in view of significant changes in prices on the primary timber market and their asymmetry, the direction of intervention proposed by experts is definitely the strategy of low prices (67.3% of preferences), or a recommendation for a relative reduction of wood prices by 32.7% of preferences. The price of roundwood directly determines the level of sawn timber prices, and therefore the costs of purchasing materials for production by furniture factories and, in fact, their market future.

4. CONCLUSIONS

On the basis of the research, the obtained results, and the descriptive analysis, the following conclusions were formulated. The current prices of roundwood in Poland are lower than the average prices from 2019, but the difference does not exceed 15%. Therefore, one can speak of a certain stabilization, but its result is a collapse in sales. At the same time, a high increase in the selling prices of general and special purpose sawn timber, especially its most popular assortments, was recorded in the next link of the forest and wood value chain. The changes include a 10-30% increase in the price of softwood lumber, up to an almost 4-fold increase in the price of special-purpose oak lumber. This specific price asymmetry leads to a collapse in the sale of wood, and then sawnwood and other wood products.

It therefore seems that the main reasons for changes in the wood market, including a marked decline in demand for roundwood, include: the supply of relatively cheap timber (mainly from the Czech Republic and Germany) and attractive prices of imported sawn timber (from Sweden and Austria); an oversupply of deadwood, and therefore a reduced value raw material, which is particularly important from the perspective of the sawmill industry needs; uncertainty of entrepreneurs related to the partial freezing of the market for the sale of wood and wood-based products, related to the epidemic threat; and also price asymmetry in the wood value chain, between roundwood and wood materials, including general and special purpose sawnwood.

Finally, it is worth noting that the solution preferred by experts, practitioners of the wood market, is a strong recommendation for the strategy of low prices of wood raw material or possibly their relative reduction. On the Polish market, where the state owner of the wood is the monopolist (almost 80% of the ownership), such intervention is possible. The future of the Polish wood industry, both during the crisis and afterwards, to a large extent depends on the potential decision and the method of implementing the selected pricing strategy.

REFERENCES

1. Kusiak, W., Mikołajczak, E., Wanat, L. (2018): *Institutional and Industrial Symbiosis Case Study of Cooperation for Development in Forestry and Wood-Based Sector*. [In:] Increasing the use of wood in the global bio-economy. Glavonjic B. (ed.), September 26th-28th, 2018, University of Belgrade, Belgrade, Serbia, pp. 388-399.
2. Mikołajczak E., Wanat L., Styma-Sarniak K., Czarnecki R., Topczewska A. (2020): *The Prospects to Applying the Best Practices Model as One of the Pillars of Business Management in the Wood Market*, [in:] D. Jelačić (ed.) Management Aspects in Forestry and Forest Based Industries, WoodEMA ia., Zagreb, pp. 125-136.
3. Paluš H., Parobek J., Vlosky R.P., Motik D., Oblak L., Jošt, M., ... & Wanat L. (2018): *The status of chain-of-custody certification in the countries of Central and South Europe*. European Journal of Wood and Wood Products 76(2): pp. 699-710, https://doi.org/10.1007/s00107-017-1261-0.
4. Potkański, T., Wanat, L., Chudobiecki, J. (2011): Leadership in time of crisis or crisis of leadership? Implications for regional development. Intercathedra, 4(27).
5. Von Carlowitz, H. C. (1713): *Sylvicultura Oeconomica*. Leipzig: Braun.
6. Wanat L. (2009): Wood market science a new discipline of economic sciences supporting knowlege-based economy development. Intercathedra, (25): pp. 149-151.
7. Wanat L., Mikołajczak E., Sarniak Ł., Czarnecki R., Topczewska A. (2020): *Application of Analytic Hierarchy Process (AHP) Algorithm to Optimize Business Model for the Kitchen Furniture Marke*t, [in:] D. Jelačić (ed.) Management Aspects in Forestry and Forest Based Industries, WoodEMA ia., Zagreb, pp. 111-124.
8. Wanat L., Potkański T., Chudobiecki J., Mikołajczak E., Mydlarz K. (2018): *Intersectoral and Intermunicipal Cooperation as a Tool for Supporting Local Economic Development: Prospects for the Forest and Wood-Based Sector in Poland.* Forests 9 (9), 531, 1; https://doi.org/10.3390/f9090531.
9. ***Auction service of NFH State Forests, URL: https://www.e-drewno.pl (10.07.2020).
10. ***Przemysł Drzewny, URL: https://forestor.przemysldrzewny.eu (13.07.2020).
11. ***Rynek Drzewny, URL: http://rynek-drzewny.pl/ (15.06.2020).
12. ***Statistical Yearbook of Forestry 2019. Central Statistical Office (GUS 2019). Warsaw.

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NON-FINANCIAL REPORTING - A STEP TOWARDS IMPROVING THE SUSTAINABILITY OF THE WOOD-BASED INDUSTRIES

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Abstract: The aim of this paper is to justify the need of introduction an uniform practices in the disclosure of non-financial information by enterprises in the wood-based industries in order to achieve sustainable growth and development. Based on a critical analysis of existing research in this area and an analysis of the financial statements for 2018 of three of the largest Bulgarian companies in the industry, we found out that despite the importance of environmental and social issues, companies in this industry are not required to prepare a non-financial statement within the meaning of the European and Bulgarian legislation. The information disclosed in management reports and corporate websites is mainly descriptive and does not meet the requirements of the European Directive. As a result, it is argued that the enterprises in the wood-based industries that use non-financial reporting would gain competitive advantage by revealing specific features of the business model change and reporting “structured” and “tied” non-financial information to the entity's financial performance.
Keywords: non-financial reporting; wood-based industry; sustainability; benefits; European Directive

1. INTRODUCTION

Issues related to the sustainable development of the enterprises and the transparency of their financial statements are becoming increasingly important for both their management and external users of information. Conventional (traditional) financial statements prepared on the basis of applicable accounting standards are mainly aimed at external users of information and present mainly the financial aspects of the activities of the enterprises. We share the view that despite the increased demand for non-financial information, the benefits associated with its disclosure to some stakeholders seem long-term and difficult to accurately convert into quantitative units, while short-term costs are visible and easily measurable. We believe that the reporting of non-financial information must be linked to the development of a unified system of indicators in specific areas of disclosure, which should be applied in order to increase the comparability and analytical qualities of the disclosed information. The purpose of this publication is to justify the need to introduce uniform practices for the disclosure of non-financial information by enterprises in the wood-based industry as a factor in increasing the sustainability of these enterprises.

2. MATERIALS AND METHODS

In the study there have been used the publications of leading researchers and international organizations which have to do with non-financial reporting, such as: the International Integrated Reporting Council (IIRC), the Global Reporting Initiative (GRI), etc., as well as legislative acts that have a bearing on these issues. In the study there has also been examined the existing normative framework, set by Directive 2014/95/EU and the Bulgarian Accountancy Act (AA) in respect of the enterprises which are to prepare a non-financial declaration (statement).

As regards the application of non-financial reporting by the surveyed enterprises in the wood-based industry in Bulgaria, there has been researched publicly accessible information disclosed in the financial statements and management reports of the three of the largest Bulgarian companies in the industry, according to the amount of their revenue, as well as information from their corporate sites and other public sources, pertinent to non-financial reporting. Three of the largest companies were selected because they are expected to have more motivation and resources for more detailed and comprehensive reporting of non-financial information.

3. CORPORATE SUSTAINABILITY AND NON-FINANCIAL REPORTING

In order to meet modern expectations for sustainability, the business must adapt to the change in conditions and factors that determine the value of the business. It is necessary to change the way of doing business and shifting the focus to "profit only", to a holistic perspective and balance between economic, social and environmental aspects of creating company value, as well as rethinking the risks facing business.

In general, non-financial reporting is less developed than financial reporting, but more and more organizations and external users are beginning to apply various forms of non-financial reporting. There is a kind of consensus that publicly disclosed financial information is no longer able to present to stakeholders the "overall picture" of the company's development. At the heart of this consensus is the understanding that companies today are increasingly dependent on intangible factors that shape the corporate value and that are not present in the financial statements, unlike in years when tangible assets were decisive for corporate value. In addition, the growing demand from stakeholders to have a better understanding of the company's long-term value factors, prospects and risks, including its impact on the environment and society, continues to fuel NFI's development and necessitates a rethinking of corporate reporting in general. The relationship between the financial and non-financial aspects of business is also becoming increasingly recognized. In this aspect "by investigating how an organisation defines its reporting boundaries, it is possible to understand what is truly 'valued' (or not) in its business model and in its value creation". (Girella, 2018)

The model by which companies create value is the basis of a significant part of investment decisions in search of sustainable growth and development. Therefore, many managers have difficulties determining the scope of notes to traditional financial statements and management (activity) reports because they know that a significant portion of the value of their business is due to intangible factors that could be difficult to cover in the financial statements. Dropulić & Čular state that companies have to develop and expand their economic, social and environmental capital, the three key elements of corporate sustainability. (Dropulić & Čular, 2019)

Investors' interest in the ESG aspects of the business can be explained by their focus more on the long-term aspects of the business. The more investors ask questions on ESG issues, the more they understand the core risks to business these factors can represent. Moreover, as Lozano state the existing financial statements are often lacking the link between business strategy and sustainability issues and practices. (Lozano, 2013)

The focus on non-financial performance indicators has led to a kind of "invasion" of non-financial reporting over the last 10 years. Various studies indicate that there are currently more than 30 international frameworks for sustainable non-financial reporting worldwide. (Brown, 2009) Recognizing the importance of non-financial reporting, the EU has introduced Directive 2014/95 / EU on the mandatory reporting of non-financial information, which is applied only by large public interest companies with more than 500 employees. The requirements of the Directive have been implemented in the Bulgarian legislation through the requirement for preparation of a non-financial statement/declaration (NFS) by the indicated enterprises. The Directive does not specify a single disclosure framework, thus making it difficult for businesses to determine which of the existing frameworks to use to report on the specificities of their activities. The existing frameworks differ both in their purpose and in their content and the indicators used to assess the non-financial aspects of the activity and each company has the freedom to choose one of the applicable reporting frameworks. . In order for non-financial information to be useful to investors it must be comparable across companies. Respondents state that current non-financial reporting is not sufficiently comparable and agree that non-financial information should be better integrated with financial information. (ACCA & Eurosif, June 2013) This gives us reason to believe that the lack of uniform generally accepted standards, respectively framework for reporting non-financial information, often make investors unable to compare the companies they analyze. If companies disclose different types of data and use different metrics (KPIs), this makes it almost impossible to compare them or identify trends in their development and assess non-financial risks and their impact on business, which in turn compromises sustainability. As White quite properly notes in terms of reporting, leading companies tend to use non-financial information to present in a fair and balanced way past achievements, current shortcomings and future opportunities and challenges related to the company.(White, 2005)

4. NON-FINANCIAL REPORTING IN BULGARIAN WOOD-BASED INDUSTRY

At European level, the wood-based sectors are complex and strongly linked to the workforce. They rank fourth in the EU as an industry by number of enterprises (170,000), followed by the furniture industry (120,000). The woodworking sector alone employs more than 1 million people, and the industry contributes € 133 billion to EU GDP in 2017. Adding the furniture industry, employment reaches almost € 2 million and an annual turnover of € 243 billion. (БТПП, 2019) In addition, Chobanova and Popova note that one of the main characteristics of the furniture industry is the intensity of labor resources used. These characteristics of the industry make it very sensitive to the social and environmental aspects of the activity, which focuses our research interest in this industry. As Sierra-Garcia et. al. indicate the business sector in which the company operates is a determining factor for its level of compliance with regulatory norms and the more sensitive sectors are those that provide more information. (Sierra-Garcia et., 2018)

Industry-specific is the presence of PEFC standardization. This standard contributes to achieving the SDGs as we work towards unlocking the full potential of forests for a sustainable world. Another specific certificate for this enterprises is FSC. Using FSC certification can help companies meet legislative requirements while improving market access, increasing revenue and showcasing your sustainability policies. They promote the responsible management of the world's forests, bringing together the environmental, economic and social spheres of the business. Of interest is the fact that the standard was introduced 25 years ago, which is much earlier than the adoption of Directive 2014/95 / EU and shows that companies in this industry are ready to follow the path of voluntary non-financial reporting and even exceed the requirements of national and European legislation in this field. But just one of the entities surveyed owns FSC certification.

The current survey covers three of the largest enterprises according to the amount of their revenues in 2017 (Table 1).

Table 1. Ranking of enterprises by revenue for 2018

Position	Enterprise	Revenue (thousand BGN)	Staff	Large enterprise	Meets the criteria for public interest company
1	Kronospan Bulgaria	178234	441	Yes	No
2	Kastamonu Bulgaria	93999	314	Yes	No
3	Welde Bulgaria	48020	709	No	No

Source: Author's work based on 2018 Annual reports and corporate sites of the entities

This study examined publicly available information that is disclosed in the financial statements and management reports of these companies, as well as information from their corporate websites and other publicly available sources that is relevant to non-financial reporting. The results are summarized and presented in Table 2.

Table. 2. Disclosed non-financial information from the surveyed enterprises for 2018

	Obligation to prepare NFS	Other sources of non - financial information	Disclosed information	Key non-financial indicators used	Disclosure framework used
Entity 1	No obligation	Corporate website of the parent company	Social, environmental, intellectual property	Not specified	Not specified, FSC®, PEFC Certification
Entity 2	No obligation	Management Report, Corporate website	Human resources, environmental, education and culture	Not specified	Not specified
Entity 3	No obligation	Management report	Human resources, environmental	Labor productivity, Labor profitability, Staff costs per person	Not specified

Source: Author's calculation based on 2018 Annual reports and corporate sites of the entities

As a result of the study, the following summaries and conclusions can be made:

✓ There is no obligation for the surveyed enterprises from wood industry to prepare a non-financial statement, as they do not meet the combination of criteria specified in the Accounting Act. The main reason is that they do not fall within the scope of public interest enterprises, which we believe should be clarified by the legislator given the economic and social importance of this sector for the country;

✓ Although they are not obliged to prepare NFS, the three surveyed companies disclose certain non-financial information through various channels, the main ones being: management report and corporate website;

✓ The main information is related to the implementation of activities in the field of human resources, social and environmental activities. It should be noted that none of the companies provided information on their business model, and only one company provided additional information related to intellectual property;

✓ The main conclusion of the study is that the disclosed information is mainly descriptive without specifying certain KPI that characterize the non-financial reporting in the surveyed enterprises. Only one of the surveyed enterprises indicated specific indicators characterizing human resources - labor productivity, labor profitability, staff costs per person. The disclosed information covers only the current reporting period and there is no comparable information even for the previous year. All this makes the disclosed information incomparable between individual companies and useless in decision-making;

✓ Although all three companies disclose a certain set of non-financial information, there is no single disclosure framework that companies use. It was found that all of them have ISO certification, but none of them provides information about the sample measures according to ISO 26000: 2010. Only one of the companies indicated the existence of a specific FSC® and PEFC Certification.

5. CONCLUSION

The results of the study show that companies in the wood-based industry in Bulgaria disclose only limited, mainly on social and environmental issues. The objective analysis of the results gives us reason to assume that the development of uniform standards for NFR together with a single framework for disclosure are of particular importance for obtaining benefits from non-financial reporting. All these will increase the comparability and reliability of disclosed non-financial information and the confidence of corporate reporting by stakeholders. At the same time some sectoral initiatives that build on core non-financial KPI will be key instruments for ensuring that disclosed information is in fact material to different stakeholders.

By connecting the financial and non-financial aspects of the business activity can be "build" the history of the business - from the description of the business model, through external factors and risks influencing business strategy and decisions of the management for overcoming them, to their connection with the current financial indicators of the activity and their influence on the future development of the company. This allows to be analyzed not only the results, but also the prospects and management of the business in a way that focuses on its most important aspects in achieving a sustainable business development.

Today, the European Union and the world economy face one of the greatest challenges of our time in designing the means and instruments to promote the ecological and social recovery of the economy. (Accountancy Europe, 2020). In addition, the current COVID-19 crisis has put not only wood-based industries, but also the whole world at a crossroads with an important choice in finding the best ways out of the crisis and improving sustainability from an economic, social and environmental point of view. The COVID-19 showed that economic, social and environmental aspects are interrelated. That is why we believe that a sustainable recovery is needed and the enterprises in the wood-based industries that use non-financial reporting would gain competitive advantage.

REFERENCES

1. ACCA, & Eurosif. (June 2013). *What do investors expect from non-financial reporting?* London: The Association of Chartered Certified Accountants. Retrieved from https://www.accaglobal.com/uk/en/technical-activities/technical-resources-search/2013/august/investors-and-non-financial-reporting.html
2. Accountancy Europe. (2020, 6 25). *Joint statement on the revision of the non-financial reporting directive in the context of Covid-19*. Retrieved from https://www.accountancyeurope.eu/good-governance-sustainability/joint-statement-on-the-revision-of-the-non-financial-reporting-directive-in-the-context-of-covid-19/
3. Brown, H. d. (2009). Building institutions based on information disclosure: lessons from GRI's sustainability reporting. *Journal of Cleaner Production, 17*(6), 571-580.
4. BCCI. (2019, 7 10). First national project event GOOD WOOD. *INFOBUSINESS*, 130 (1888). Retrieved from https://www.infobusiness.bcci.bg/good-wood-event.html (in Bulgarian)
5. Chobanova, R., & Popova, R. (2015). *Furniture Manufacturing Challenges On The World Market: The Bulgaria's Case,* In: Proceedings of Scientific Papers "Wood Processing And Furniture Manufacturing Challenges On The World Market And Wood-Based Energy Goes Global", Dubrovnik, Croatia: WoodEMA, i.a., pp. 47-57. Retrieved from http://www.woodema.org/proceedings/WoodEma_2015_Proceedings.pdf

6. Dropulić, I., & Čular, M. (2019). The Effect Of Corporate Social Disclosure Practice On Reporting Quality: Evidence From The Insurance Sector In Croatia. *Management, 24*(2), 23-38.
7. Girella, L. (2018). *The Boundaries in Financial and Non-Financial Reporting. A Comparative Analysis of their Constitutive Role.* NY: Routledge.
8. Lozano, R. (2013). Sustainability inter-linkages in reporting vindicated: a study of European companies. *Journal of Cleaner Production, 51*, 57-65.
9. Sierra-Garcia, L., Garcia-Benau, M. A., & Bollas-Araya, H. M. (2018). Empirical Analysis of Non-Financial Reporting by Spanish Companies. *Administrative Sciences*, *8*(3), 29. MDPI AG. Retrieved from http://dx.doi.org/10.3390/admsci8030029
10. White , A. L. (2005, 6 20). *New Wine, New Bottles: The Rise of Non-Financial Reporting /A Business Brief by Business for Social Responsibility/*. Retrieved from https://www.businesswire.com/portal/binary/com.epicentric.contentmanagement.servlet.ContentDeliveryServlet/services/ir_and_pr/ir_resource_center/editorials/2005/BSR.pdf

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ASSESSMENT OF FSC CHAIN OF CUSTODY IN BULGARIAN FOREST BASED INDUSTRIES

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Abstract: Forest certification plays an important role in helping and guaranteeing sustainable forest management. The interest in certification has increased in recent years. FSC-certified forestry holdings are more than 72, some of which are included in group certificates of the respective state-owned enterprises in whose territory they are located. The certified forest area is more than 1 315 594 ha. Issues related to forest certification and sustainable management of woodworking and furniture producing enterprises in the country are becoming increasingly important. For studying this influence, have been analyzed the main attitudes towards certification. Problems appeared to the supply markets are considered in meaning of the supply chain costs in order to follow Chain of Custody requirements. The main benefits of FSC CoC are considered as well as the costs associated. The aim of the study is to reveal owners' understanding of the main benefits of certification and it's role as tool for economic crisis overcoming and estimate relations between number of certified under CoC companies and economic indicators describing the forest based industries in Bulgaria.
Keywords: certification, FSC, Chain of Custody

1. FSC CoC STANDARTIZATION IN FOREST INDUSTRIES

Forest certification adjusts timber procurement and usage in forest based industries to a specific standards (see Enescu et.al., 2019). It seeks to create a set of rules and institutions for forest certification that integrate environmental, social, and economic goals (Meidinger, 2003). There are two certificates under FSC: certificate for forest management (FM) and certifiate for Chain of Custody (CoC) (Klarić et.al., 2016). The second one appeared to establish inter and infra company environment for economically and environmentally efficient algorithm to make a business. Chain of Custody system was aimed to give clarification of timber mobilization system in an industry (Dewa et.al., 2017).

According to Kitchoukov et. al. (2018) in Bulgaria, in 2016 almost the 19% of the all forest areas are certified under FSC. Till now there is only the FSC official database that reveal the number of the certified enterprises. The managers are too conservative about certification in FSC. Gilani et. al. (2017) states that costs for certification are among the the most important barrier for certification. One of the main issues appeared to be the perceptions of stakeholders about the benefits and the coststhat have to be covered. Often, according to the issues described, the business community approaches with suspicion to FSC CoC certification and needs to be better informed. In previous research based on surveys among the forest owners and entrepreneurs in UK (Samuel, 1999) found that the principle reasons of stakeholders are economic. Certification seems to have a good potential as a marketing tool (Rametsteiner, 1999). In the research about certification in Romania (Hălălişan et al. 2013) found that main benefits of FSC custody chain certification are to keep the customer and to improve the image(see also Paluš et.al., 2016). Another research revealed, that some Asian countries rated "reduce business risks" as the top FSC benefit followed by "meet corporate social responsibility goals" and "meet buyer's requirements" of the company (Bowers et. al., .2012). Cao et.al. (2011) stated that the main benefits of certification under FSC FM/CoC are price premium; product differentiation; market access; consumer goodwill; environmental and social benefits. Definitely the market derived benefits, or market driven (Klarić et.al., 2016) are of the most wanted by the companies owners.

2. MATERIALS AND METHODS

In the current study have been implemented the following approaches in order to clarify the possible understandings of the managers:

- Survey. Amongst the certified and noncertified companies has been conducted a questionnaire survey. It includes 12 questions. The purpose is respondents to answer what they expected before the certification and what happened after.

- Estimating the relations between number of certified companies and the market changes. Relations have been estimated throughout regression analyses (see Anderson et.al., 2012). Models place the hypothesis about the market driven reasons for certification.

Information for modelling the regression equations have been taken from the FSC database for certified companies. Companies within the scope of the study are from economic sectors C16 (Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials) and C31 (Manufacture of furniture) (see NACE - 2008 by Bulgarian Statistical Institute). Number of certified enterprises is regressed against the average price of the unit produced in previous year. Through this way the market improvement is presented in price increment and consequently would be a part of motivation factors in context of overall mainstream of certification among the competitors. Market information is derived from Eurostat – Structural Business Statistics and Sold production, exports and imports by PRODCOM list. For C16 have been successfully used data from FAOSTAT (Forestry Production and Trade).

3. RESULTS

Results for the C31 (Production of furniture) are very informative in context of the relationships between number of enterprises certified and the market developments. The Figure 1 presents the regression of certified companies under FSC CoC and exports values for previous year.

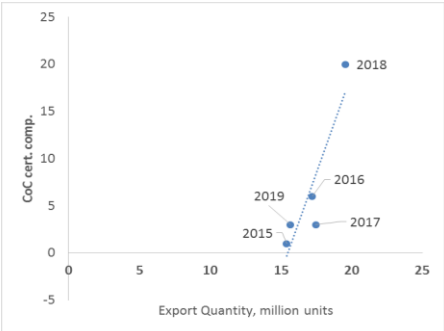

Figure 1. Relationship between previous year Export Quantity and CoC newly certified companies

The graph in Figure 1 presents the huge skepticism of Bulgarian furniture manufacturers. Out of approximately 1500 companies, only 33 and the largest ones have been certified. The biggest boom is in 2018, when we assume that the influence of "fashion" is manifesting itself. Companies invest in certification based on generally accepted understandings of the effect of such a certificate. The regression model is close to linear. This means that the correlation is very strong (R^2=0.81). The coefficient of dependent variable is β=4.18 (y=4.1806x-64.753), which means that in 1 million increment of the units (including all types of furniture production) exported, 4 companies go under FSC CoC certification. For no other factors have been discovered statistically significant results. The requirements of the export market and the expectations of getting better market position on it, motivated entrepreneurs to certificate their companies.

On Figure 2 are presented wood processing companies certified under CoC.

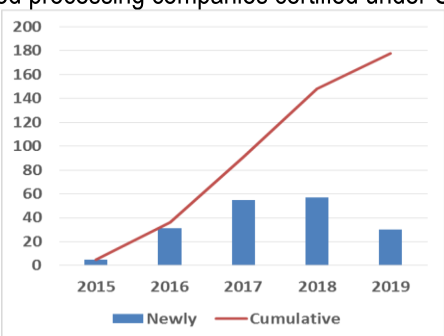

Figure 2. CoC newly certified companies and cumulative number of certified wood processing companies

The figure presents, that the „fashion“ influence involved the manufacurers of wood products into certification. The reasons here have not arised from the market and the empirical results proved it. The number of certified companies is about 178 in the end of the 2019. This comprises 9.1% of all wood processing enterprises in the country. The bigger number in compare to furniture producing enterprises comes to fill the requirements of the markets for environmently friendly wood procurement and wood products production. In difference of the C31 companies, in this case the short run market demand is not a factor. In the current study have not been discovered any significant relationships between CoC certified wood processing companies and changes in export market, import quantities and production in quantity and value. There can be plase hypothesis about the long run market demand. Export in quantity has follen in about 25% since 2014. Such a development could forced managers to take decisions for certification under FSC - CoC in order to improve the companies export sales.

The results from the survey reveal the hidden reasons for the behaviour of companies during the survey period. The surveyed companies are 31, from which 21 come from the furniture industry and 10 from the wood processing. The export orientation of furniture producing enterprises have 50% of them and a 100% of wood processing companies. The interesting detail here is that companies from export – elastic sector (C31) is in fact in 50% export- oriented, as well as only 40% of them answered, that they want to improve the export. 75% of these enterprises perceive standardization as a tool to improve the market position. In compare a 100% of the wood processing companies have accepted the standardization under CoC as a purely marketing tool. Wood processing companies engaged in greater extend in the standardized production – half of them produce production more than 50% under FSC. This greater engagement led to facing greater problems. Half of the companies from C16 reported they had struggles with standardization due to higher costs of implementation (comprehensively described by Breukling et. al. (2015)). This is a result of greater scale of these companies – all of surveyed have more than 250 employees, in compare to 75% of surveyed furniture producing enterprises. To the question whether they derived greater profits for the period after standardization, the answer is 100% no for wood processing companies and 75% no for furniture producing. Have the surveyed companies perceive the FCS CoC as a tool for overcoming the economic crisis, the managers from wood processing companies are 100% sceptical (no), until producers of furniture are more optimistic 50% answered “yes”.

4. CONCLUSIONS

The present study revealed some of the leading reasons for certification according to FSC standards in the enterprises of the Bulgarian forest based industry. Furniture manufacturing companies are more adaptable to market changes. They react quickly due to their greater propensity for change and optimism. They are influenced by other companies in the sector and market development in the short term. They accept FSC CoC as a useful tool not only in terms of the market, but also to improve the overall image. We hypothesize that there are discrepancies between the understandings shared by managers in furniture companies and the actions of the sector as a whole. This sector is very reactive to market conditions due to the specific requirements of the customers. The costs for certification are lower than those in the woodworking industry and imply a rapid response in realizing the need for FGC - CoC. The considerable optimism of the managers also contributes to this. These manager are willing to try the FSC and to wait the good outcome in the future.

Unlike companies in the furniture industry, those in the woodworking industry are more conservative. They accept standardization as a strategic tool. They try to solve structural problems rather than react to annual fluctuations in demand. Expensive certification and its slow effect on profits make woodworking managers sceptical. They do not accept that in conditions of difficulty, the FSC will pull them out of the crisis. We make the assumption that the certification here is dictated by the fears of missing something that could possibly help, since it is widely used in this sector in Europe. Meanwhile the significant use of round wood requires maintaining the image of environmentally oriented companies, which is the key to keep market positions on export markets, despite the requirements of the customers have not required the immediate reaction from the companies.

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REFERENCES

1. Anderson, D., D. Sweeney, T.A. Williams (2012) Essentials of Modern Business Statistics, South – Western, Mason USA, pp.
2. Bowers, T., I. Eastin, I. Ganguly, J. Cao, M. Seol (2012) Forest certification in Asia: The changing marketplace for value-added wood product manufacturers in China and Vietnam, The Forestry Chronicle septembre/octobre 2012, Vol. 88, No 5 , pp. 578-584
3. Breukink,G., J. Levin, K. Mo (2015) Profitability and Sustainability in Responsible Forestry - Economic impacts of FSC certification on forest operators, Jürgen Freund / WWF, p.48
4. Cao, X., M. Seol, I. Eastin (2011) An Overview of Forest Certification in China: Benefits and Constraints, International Scientific Conference on Hardwood Processing (ISCHP2011), p. 171
5. Dewa, P.K., F. S. Rahayu, H. Gunawan, Y. P. Wibisono (2017) Human Aspect on Chain of Custody (CoC) System Performance, Proceedings of the Asia Pacific Industrial Engineering & Management Systems Conference 2017, https://www.researchgate.net/publication/321624674
6. Enescu, C.M., A. Apăfăian, A. F. Hălălișan, D. Răzvan, E. Puicea (2019) Current profile of PEFC Chain of Custody certified companies in Romania, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development Vol. 19, Issue 1, 2019, p. 189
7. Eurostat (2020): Structural Business Statistics: URL: https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=sbs_na_ind_r2&lang=en
8. Eurostat (2020): Sold production, exports and imports by PRODCOM list: URL: https://appsso.eurostat.ec.europa.eu/nui/setupModifyTableLayout.do
9. FAOSTAT (2020): Forestry Production and Trade: URL: http://www.fao.org/faostat/en/#data/FO
10. FSC database (2020): Information from 2020/07/06 - 8:24 UTC: URL: https://info.fsc.org/certificate.php
11. Gilani, H. R., R. A. Kozak, J. L. Innes (2017) Chain of custody certification involvement by the British Columbia value-added wood products sector, Eur. J. Wood Prod., Springer-Verlag GmbH Germany 2017, DOI 10.1007/s00107-017-1253-0
12. Hălălișan A. F. (2015) Forest certification in Romania: the view of the experts, Proceedings of the Biennial International Symposium FOREST AND SUSTAINABLE DEVELOPMENT Braşov, 24-25th of October 2014, pp. 104 – 109
13. Karmann, M. A. Smith (2009) FSC reflected in scientific and professional literature Literature study on the outcomes and impacts of FSC certification, Forest Stewardship Council A.C., p.17
14. Kitchoukov, E., N. Stoyanov, T. Simeonov-Zarkin, Todor Stoyanov (2018) Analysis and Estimation of the Profitability of Forest Certification in Model Forest Areas in Bulgaria, Challenges to Industrial Growth – proceedings, Sofia, p. 36
15. Klarić, K., K. Greger, M. Klarić, T. Andrić, M. Hitka, J. Kropivšek (2016) An Exploratory Assessment of FSC Chain of Custody Certification Benefits in Croatian Wood Industry, Drvna industrija 67 (3), pp.241-248
16. Meidinger, E., C. Elliott, G. Oesten (2003) Social and political dimensions of forest certification. Remagen-Oberwinter, Germany: Dr. Kessel. pp.219-233
17. NSI (2008) Classifier of economic activities in Bulgaria. https://kik-info.com/spravochnik/kid-2008.php.
18. Paluš H.; Parobek J; Vlosky P. R; Motik D.; Oblak L.; Jošt M.; Glavonjić B.; Dudík R.; Wanat L. (2016) Survey of chain of custody certification in the countries of Central and South Europe, The path forward for wood products: a global perspective - Proceedings of Scientific Papers, WoodEMA, pp.85-92
19. Rametsteiner E., S.Nilsson, H.Böttcher, P.Havlik, F.Kraxner, S.Leduc, M.Obersteiner, F.Rydzak,, U.Schneider, D.Schwab, L.Willmore (2006): Study on the Effects of Globalization on the Economic Viability of EU Forestry. EC Contract No. 30-CE-009757/00-89. International Institute for Applied Systems Analysis, p. 198.
20. Samuel, J., R. Cooper (1999) Results of the UK Forestry-Wood Chain Survey, Potential Markets for Certified Forest Products in Europe, EFI Proceedings No. 25, p. 185Gary, D. (2012): *Nanocellulose: From Nature to High Performance Tailored Material*. Holzforschung 67 (3): pp. 353-353.

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SELECTED SUSTAINABILITY INDICATORS OF FOREST CERTIFICATION BEYOND THE REGULATORY INSTRUMENTS OF THE SR

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Abstract: Forest certification is a voluntary tool largely based on the international principles of sustainable forest management. At the same time, national forest certification schemes follow the national legislation, build on the local and regional traditions, consider local natural conditions, existing institutional structure and incorporate the local sustainability principles and criteria. Hence the international requirements may be beyond the scope of national legislation and long-established forest management practices, which often reflect the traditional ways of utilisation of raw wood material and other ecosystem services provided by the forests. National forest certification standards also vary depending on the stringency of national legal systems. Therefore, the main objective of this paper is to assess the selected indicators of the Slovak national forest certification scheme (SFCS), internationally endorsed under the PEFC system, against the requirements of the national regulatory instruments.
Keywords: forest certification, sustainable forest management, sustainable principles, regulatory

1. INTRODUCTION

Today, forestry in every country faces a multitude of challenges for sustainability that are mostly in conflict with interests like adaptation to climate change, provision of timber and ecosystem services or maintaining forest carbon stocks. Therefore, the basic strategy line of world forestry is sustainable forest management (Köhl et al., 2020). At present sustainability of forestry is based on „Forestry Principles "adopted at the United Nations Conference on Environment and Development in Rio de Janeiro 1992. Criteria and indicators for valuation of sustainable forest management were set at the aforementioned conference. These criteria were accepted in 1998 at the third Ministerial Conference on the Protection of Forests in Europe, that took place in Lisbon. Criteria and indicators serve as a tool for definition, valuation and monitoring of forest and forestry development within sustainability. Criteria are defined by quantitative and qualitative indicators (measured and monitored regularly). More important, however, is their development, which reveals unfavorable trends early and at the same time measures threatening the future of the forests are being taken. Every forest in a given country has different characteristics. The country must therefore adapt to its own economic, ecological, social and institutional conditions (Forest Europe, 1998).

Based on the Forest Act 326/2005 Coll. forest in Slovakia must be professionally managed in accordance with principles of sustainable management. The tool that is being used for this purpose is a forest management program. Forest certification is also a way to achieve sustainable management. Currently, forest management certification is being introduced as a widely used private instrument. Such a voluntary instrument represents a free decision of a business or other entity to comply with above-standard social and environmental requirements. It meets requirements that go beyond regulatory and economic instruments of public policy (FAO, 2014).

In forest management, however, it is important to distinguish between two requirements, namely legality and sustainability. The aim of the legality requirements is to eliminate negative activities in forestry. In Slovakia, these were defined in more detail in 1995 in the explanatory memorandum to the Act on Forest Management and the State Administration of Forestry, and it also proposes measures emphasizing the public interest in wood management. Currently, the requirements for legality are set out in the Forest Act, the Nature Protection Act and in related decrees and legislative regulations. On the other hand, sustainability requirements are based on the basic definition of TUOL (MCPFE, 1993). Within the PEFC certification scheme, this definition is developed through six basic TUOL criteria (PEFC ST 1003, 2018) as well as controversial resource requirements (PEFC ST 2002, 2020). The additional requirements for sustainability consider the requirements of public policies for the purchase of timber.

Within the Slovak Republic, the basis of the PEFC recognized national Slovak forest certification system (SFCS) is the certification of the system of quality of forest management as a tool ensuring sustainable forest management. SFCS develops general criteria and principles, which are developed at the level of indicators. Their legislative basis is based primarily on the Forest Act no. 326/2005 Coll. as amended, which refers to the applicable legislative standards containing or regulating the issue. Based on these, it is possible to assess the compliance of management with these international requirements. Criteria and indicators of sustainable forest management in

Slovakia form an integral part of the basic SFCS documents. They are valid throughout the territory of the Slovak Republic. Observance of these criteria and indicators is essential for all participants in the certification process (PEFC, 2014).

The main goal of this paper is to compare selected indicators of sustainable forest management of the Slovak forest certification system with the framework of valid legislation in the field of forestry, nature protection and related regulations in the Slovak Republic through a comparative analysis.

2. MATERIAL AND METHOD

The basic methods to achieve the goal of this paper are analytical method and comparative method of currently valid SFCS documents and legislation in the field of forestry. Criteria for certification are specified in the technical regulations of SFCS TD PEFC 1003:2014. Criteria and indicators of sustainable forest management, which contains 7 international principles, 32 national criteria, 59 indicators at the regional level and 110 indicators of sustainable forest management at the individual level. Since wood is the basic raw material for relations in the forestry and timber complex, specific indicators were selected at the individual level to compare their content with the valid legislation of the Slovak Republic, which define borderline requirements to ensure sustainable forest management for each participant in regional certification within the international principle no. 3 - preservation and support of the productive function of forests (wood and non-wood products). This principle consists of four national criteria. These indicators were selected for analysis 3.1 Sustainability and fluency of logging, 3.2 Raw wood 3.3 Non-timber forest products and services. Criterion 3.4 The forest road network can be considered supportive, as its main objective is to optimize the transport accessibility of forest stands. The legislative and normative basis of the selected criteria is the Forest Act no. 326/2005 Coll. as amended, Nature and Landscape protection Act no. 543/2002, Act of the National Council of the Slovak Republic no. 274/2009 Coll. on hunting as amended, Decree of the Ministry of Justice of the Slovak Republic no. 453/2006 Coll. on the economic management of forests and on the protection of forests, as amended, Decree of the Ministry of Industry and Trade of the Slovak Republic no. 297/2011 Coll. on forest management records and Slovak technical standards STN 48 0050 Raw wood, STN 48 0055 Qualitative classification of coniferous logs and STN 48 0055 Qualitative classification of deciduous logs.

The wording and the content of the analyzed indicators were compared to the aforementioned legislation. Based on the comparison, requirements of the indicators that are beyond the scope of national legislation and at the same time represent a voluntary commitment of managers to the principles of sustainable forest management and provision of the necessary functions without their negative impact on other ecosystems, were identified.

3. RESULTS

Through the valid document SFCS TD PEFC 1003:2014 Criteria and indicators of sustainable forest management and selected the third international principle – Preservation and support of the productive function of forests (wood and non-wood products), which was compared with the relevant legislative and normative basis formed by relevant laws, decrees and STN documents in tab. 1 found the following differences.

Table 1. Comparison of individual indicators and Slovak legislation

3.1.4 Compliance with legislative principles for timber harvesting
The Forest Act, § 23 Principles of felling • The felling can be carried out only after marking for felling and on the basis of a written consent of a professional forest manager. Marking for felling is not required in the case of forest tending in forest stands of age up to 50 years. • The forest user is obliged to carry out the felling so as to minimise adverse impacts on soil, water courses, forest stand, adjacent trees, and timber quality. • The forest user or timber purchaser is obliged, not later than at the hauling place, to mark harvested timber in an approved manner registered by the forestry state administration body.

In the case of protection areas declared by the Nature and Landscape Protection Act, it is prohibited to carry out felling within the areas and during the periods specified by the respective nature protection legal norms.
3.1.5 The total volume of timber harvesting prescribed in FMP shall not be exceeded
The Forest Act, § 23 Principles of felling • Timber volume from felling carried out in a compartment with the age over 50 years can be exceeded not more than by 15%, as compared to the felling volume recommended in the forest management plan. After that, only accidental or extraordinary felling can be carried out. • Total timber volume planned for felling in the forest management plan for a forest unit and forest category cannot be exceeded. If a forest unit is managed by several forest users, none of them can exceed total timber volume planned for felling within his particular ownership unit. • Stocking of forest stand shall not be reduced by intentional felling below 7/10 of full stocking, unless otherwise specified (e.g. in the case of regeneration felling or forest reconstruction).
3.1.6 The annual volume of harvesting during the validity of the FMP under the proper forest management shall be in the range between 70% to 130% of the 1/10 of the FMP prescription (valid for entities over 1000 ha)
• Legal regulation absents (regulated by the legally non-binding forest management guidelines only).
3.1.7 The volume of intentionally harvested timber by species shall equal (+/- 15%) to data on volume obtained from trees marking and recorded in the harvesting permit
• Legal regulation absents at the level of species (legally regulated at the level of forest stands only).
3.2.2. Volume of timber placed on the market, divided into coniferous and non-coniferous, corresponds to the volume of harvested timber (m^3)
• The Act on the Placing of Timber and Timber Products on the Market, § 3 General conditions of the placing of timber and timber products on the market.
3.2.3. Evidence of timber origin and movement
The Forest Act, § 24 Obligations and rights in skidding, transportation, and storage of timber The Decree on the Marking for Felling, Marking of Harvested Timber and Proofs of Timber Origin, § 6 Proofs of Timber Origin and Their Presentation • It is possible to place timber and timber products on the market only if all conditions imposed by the appropriate forest legislation are met. • The forest user or timber purchaser is obliged to issue proofs of the timber origin and to exercise the due diligence system for placing timber on the market • All legal and physical persons who transport, store or process timber as well as all timber purchasers are obliged to prove the origin of transported or stored timber to the prompt of competent authorities (forestry state administration bodies, forest guards, police authorities) by the legally approved evidence and to keep this evidence for the period of at least 10 years. • The proof of the timber origin shall include information on the timber volume, species, and qualitative class.
3.2.4. Exercising of due diligence system for placing timber on the market
The Act on the Placing of Timber and Timber Products on the Market, § 4 Due diligence system • The operator, placing timber and timber products on the market, is obliged to exercise the due diligence system (either in the paper or electronic form) before timber and timber products are placed on the market. • In case such operator is also the forest user within the area of the Slovak Republic, the due diligence system shall include the evidence according to the Forest Act (e.g. information on timber harvesting and transportation).
3.2.5. Trade documentation for timber from certified forests shall include minimally the number of confirmation and the claim on certified timber origin
• Legal regulation absents.
3.2.6. Timber originating from non-forest land or purchased timber shall be separated and sold as uncertified

• Legal regulation absents.
3.3.2 Exploiting the potential supply of non- wood products and services shall be in line with the fulfilment of other functions of the forests in favour of maintaining their rational and long-term use
The Forest Act, § 12 Forest categorisation and The Forest Act, § 15 Commercial Forests • Forests are categorised from the point of view of using their functions to protective forests, special purpose forests, commercial forests. • Commercial forests are forests which are not either protective forests or special purpose forests and which are intended for production of timber and other forest products, while simultaneously ensuring non-production functions of forests.
3.3.3 Game management shall be organized in such a way that it does not undermine the stability of forest stands and fulfilment of other functions of the forests
The Game Management Act, § 30 Game management planning The Game Management Act, § 69 Liability of the hunting area user • The game management plans have to secure sustainable game management, protection and preservation of the game genetic resources and biodiversity. They shall be elaborated in an accordance with the needs and requirements of nature and landscape protection as well as in an accordance with the protection of agriculture and forest production against damages caused by the game. • Users of the hunting areas are obliged to compensate forest users for damages caused by the improper use of the hunting areas within the forest stands.

4. CONSLUSIONS

Forest certification is a voluntary tool based on international principles of sustainable forest management. At the same time, they include national legislative requirements, institutional structure and local sustainability criteria. From the given comparison of at individual indicators and Slovak legislation, differences can be found for specific indicators related to the requirements for annual volume of harvesting during the validity of the FMP, volume of intentionally harvested timber, terms of trade documentation and separation of non-certified timber.

The comparison shows that the SFCS certification scheme also includes criteria that go beyond the legislation and meet additional conditions that ensure sustainable forest management practices that reflect traditional uses of raw timber and other ecosystem services provided by forests.

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REFERENCES

1. FAO. (2014): *State of the World´s Forests 2014.* Enhancing the Economic Benefits forom Forests. 2014. Rome
2. Forest Europe. (1998): *Annex 2 of the resolution L2.* Pan-European Operational Level Guidelines for Sustainable Forest Management.
   URL: https://www.foresteurope.org/docs/MC/MC_lisbon_resolution_annex2.pdf
3. Köhl, M., Ehrhart, H. P., Knauf, M., Neupane, P. R. (2020): *A viable indicator approach for assessing sustainable forest management in terms of carbon emissions and removals.* Ecological Indicators, 111, 106057.
4. MCPFE (1993): Ministerial conference on protection of forests in Europe. Conference Proceedings. Ministry of Agriculture and Forestry, Helsinki, Finland.
5. UN. (2007): United Nations Declaration on the Rights of Indigenous Peoples
   URL:https://www.un.org/development/desa/indigenouspeoples/declaration-on-the-rights-of-indigenous-peoples.htmll
6. PEFC. (2014): *TD SFCS 1003:2014 Kritéria a indikátory trvalo udržateľného obhospodarovania lesov.*
   URL: http://pefc.sk/dokumenty-sfcs/struktura-dokumentov/technicke-dokumenty/item/72-td_sfcs_1003_2014
7. PEFC. (2018): PEFC ST 1003:2018 Sustainable Forest Management – Requirements
   URL: https://cdn.pefc.org/pefc.org/media/2019- 01/b296ddcb- 5f6b- 42d8- bc98- 5db98f62203e/6c7c212a-c37c-59ee-a2ca-b8c91c8beb93.pdf
8. PEFC. (2020): PEFC ST 2002:2020 Chain of Custody of Forest and Tree Based Products – Requirements
   URL: https://cdn.pefc.org/pefc.org/media/2020- 02/66954288- f67f 4297 9912 5a62fcc50ddf/23621b7b-3a5d-55c9-be4d-4e6a5f61c789.pdf
9. Schwarz, M., Kajba M., Maruška. P (2013): *Trvalo udržateľné hospodárenie v regiónoch projektu VYNALES.* Aktuálne otázky ekonomiky a politiky lesného hospodárstva Slovenskej republiky, Zvolen: Národné lesnícke centrum, 75-85.
10. Zákon č. 326/2005 Z. z. o lesoch v znení neskorších predpisov

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APPLICATION OF QUALITY MANAGEMENT TOOLS AND THEIR IMPACT ON BUSINESS DEVELOPMENT IN WOOD PROCESSING INDUSTRY IN SLOVAKIA

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Abstract: The article deals with the application of selected methods and tools of quality management to the performance and development of companies in the wood processing industry in Slovakia. Through these tools and methods, businesses can solve problems more effectively by trying to prevent them. By focusing on quality, companies can be successful, they can better meet customer requirements, which has a positive effect on their economy. Article presents the results of the research, which analyzes the relationship between the application of quality management tools and methods and their impact on the overall performance of these enterprises.
Keywords: quality, performance, quality costs, wood processing industry

1. INTRODUCTION

The adoption of a quality management system is a strategic decision for an organization that can help to improve its overall performance and provide a sound basic for sustainable development initiatives. The reason for the resulting changes in the quality and quality management is the overall development of the economic and political situation in developed countries. This trend is particularly marked change in producers' market to market buyers, quality assurance for the entire lifecycle of the product and the utilization factor of time to influence the market. At present, the companies aim to be able to enforce the domestic and foreign markets, while in the past focused primarily on increasing production volume and cost reduction. The success of any organization in the market depends on the quality of its manufactured products and services that are compared to the competition as well as the performance of the processes that take place within companies. An integral part of quality management in companies, not excluding furniture production are the using of modern techniques for securing and improving quality within process management, change management and performance improvement. The aim of the paper is to present the results of the questionnaire survey, in which was investigated the extent of utilization of modern concepts and methods used for quality improvement in wood processing enterprises (WPI) in Slovakia.

2. MATERIAL AND METHODS

Owen and Maidment (1996) define quality as a sum of features and characteristics of the product (production line), or a service related to its ability to meet the desired need. Customers are changing their expectations and requirements due to the availability of information. The assurance and improvement of the processes can be achieved by various methods and techniques such as e.g. ISO standards Total Quality Management TQM, EFQM excellence model, statistical methods of SPC, PDCA cycle, DMAIC, Quality costs, Six Sigma conception.

Results of many studies (Nguyen *et al*. 2018; Alharbi *et al*. 2017; Rebelo *et al*. 2016; Rentková 2017; Malá *et al*. 2017; Minarová *et al*. 2015, Peráček *et al*.2018, Milošovičová 2019, Kottulová *et al.2016*) indicate that the best management principles, models, and practices contribute positively to achieving sustainable development. Such principles include also quality management practices based on the practical use of the practices and methods such as total quality management (TQM), six-sigma, kaizen and quality controlling. Quality management and its future direction will be influenced by changes and trends in enterprise environment. One of nowadays trend is sustainable development that affects many areas of life. Quality management and sustainable development have much in common. An example is emphasis on stakeholders as customers, employees and their safety and satisfaction, monitoring and self-evaluation for continuous improvement, waste reduction, employee engagement and training, and so on (Garvare and Isaksson 2001; Saad *et al*. 2015; Khodeir and Othman 2016).

Quality is mainly economic category and factor which has a great influence on long-term business results and if profit or loss are reached. From this point of view it is important that activities connected with quality assurance won´t be evaluated only from the view of effectiveness of these activities.

Costs of quality are financial expenditures on activities which are from the point of view of quality assurance necessary needed. It is also necessary to monitor effectiveness of spend expenditures but it isn´t rational to eliminate or to cut these ones (prevention costs - PC, appraisal costs - AC). Costs of quality assurance which could be zero in optimal case (internal failure costs - IFC, external failure costs - EFC). This classification of quality costs is according to ISO 9000 standards and at the same time it is recommended as a base in EOQC vocabulary. It´s dealt about specific costs classification of costs what is the base of the British standard BS 6134.

3. RESULTS AND DISCUSION

The data were obtained through an on - line research questionnaire and a direct - led interview with managers of randomly selected businesses. The first database of enterprises was the data of the Statistical Office of the Slovak Republic, which was subsequently verified by Internet databases in order to select existing enterprises. The questionnaire 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. According to the calculation of the minimum statistical survey through the online application on www.raosoft.com, it is a representative sample at 99% confidence and 4% of the standard deviation.

The Figure 1 shows the answer of question “What new concepts and methods have you used or used to improve processes”. From the answers to the question of the use of concepts and methods in process and quality improvement, the highest percentages received in the evaluation the answer that enterprises do not use any of the methods and concepts for process improvement.

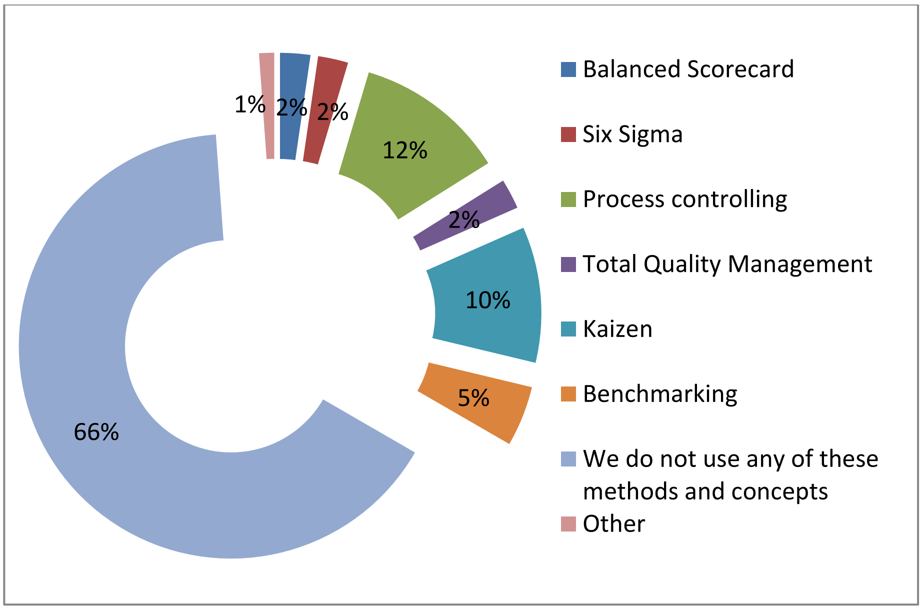

Figure 1. New concepts and methods used to improve processes in wood processing enterprises in the Slovak Republic

Table 1. Contingency question D-14

D. What is the Return of Equity (ROE) of your company? 14. What new concepts and methods have you used or used to improve processes and quality?						
Average number of responses per group	ROE value					
	< 0%	0% - 2%	2% - 4%	4% - 7%	7% - 10%	> 10%
All enterprises	*1,17*	*1,00*	*1,00*	*1,08*	*1,08*	*1,33*

The Table 1 show that the wood processing enterprises in Slovakia mostly do not use process improvement concepts, or use only one concept regardless of ROE, so it can be stated that the use of these concepts does not affect the ROE of enterprises in the wood processing industry.

As can be seen from Figure 2, the most companies in the wood processing industry in Slovakia monitor internal and external failure costs, less appraisal costs and prevention costs. The least monitored costs are according to the process model of quality costs (conformance costs and non-conformance costs) and cost related to envirinmental damage.

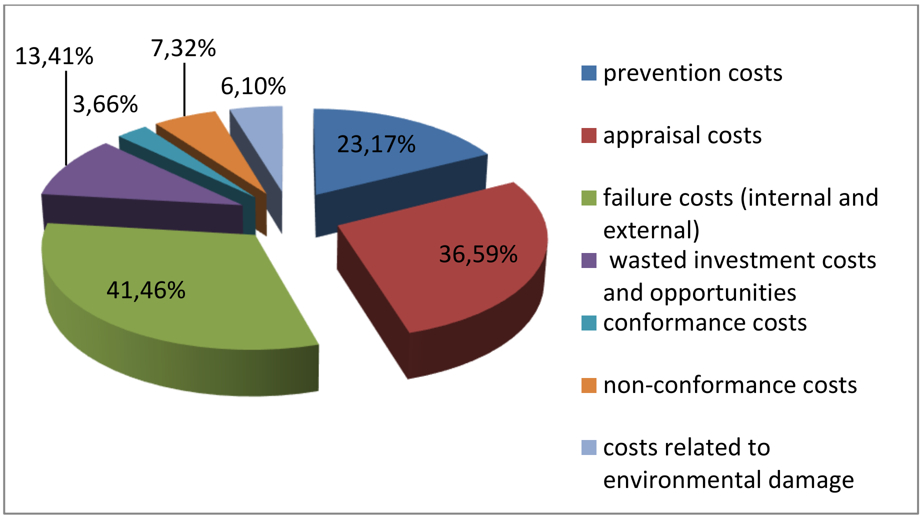

Figure 2. Quality costs which are monitored in wood processing enterprises in the Slovak Republic

Table 2. Contingency question A-18

A. What is the average number of employees in your company? 18. Which quality costs do you monitor in your company?						
Quality costs	**Number of employees**					**SUM**
	0 - 10	**11 - 20**	**21 - 50**	**51 - 250**	**250 +**	
prevention costs	*24,32%*	*23,81%*	*16,66%*	*33,33%*	*16,67%*	
appraisal costs	*29,73%*	*28,57%*	*66,67%*	*33,33%*	*50,00%*	
failure costs (internal and external)	*35,14%*	*42,86%*	*41,67%*	*50,00%*	*66,67%*	
wasted investment costs and opportunities	*13,51%*	*14,29%*	*16,66%*	*0,00%*	*16,67%*	
conformance costs	*2,70%*	*0,00%*	*0,00%*	*16,67%*	*16,67%*	
non-conformance costs	*5,41%*	*0,00%*	*16,66%*	*0,00%*	*33,33%*	
costs related to environmental damage	*8,11%*	*0,00%*	*8,33%*	*0,00%*	*16,67%*	
we do not monitor quality costs	*32,43%*	*28,57%*	*0,00%*	*16,67%*	*33,33%*	
relative abundance	*43,41%*	*22,48%*	*15,50%*	*6,98%*	*11,63%*	*100%*

Table 2 analyzes the relationship between the size of wood processing industry enterprises and the observed quality costs. From the analyzed data, it can be seen that the most monitored quality costs are the failure costs, the costs of appraisal and the costs of prevention. At the failure costs, the highest percentage was achieved by enterprises with more than 250 employees, namely 66.67%, and the lowest percentage of 35.14% was achieved by enterprises with 0 to 10 employees. The costs of appraisal are mostly monitored by enterprises with 21 to 50 employees 66.67% and the costs of prevention are mostly monitored by enterprises with 51 to 250 employees 33.33%. In the case of companies in the wood processing industry, the most costly quality costs are monitored by companies with 250 or more employees. Based on the results, it can be stated that the size of the company does not affect what kind of quality costs companies monitor.

Table 3. Contingency question D-18

D. What is the Return of Equity (ROE) of your company? 18. Which quality costs do you monitor in your company?						
Average number of responses per group	ROE value					
	< 0%	0% - 2%	2% - 4%	4% - 7%	7% - 10%	> 10%
All enterprises	*1,67*	*1,29*	*1,46*	*1,50*	*2,00*	*2,67*

Table 3 analysed the relationship between the ROE indicator and the observed quality costs. From the results for all companies it can be seen that the group of companies with a ROE profitability of over 10% monitors the highest quality costs.

Table 4. Contingency question C-18

C. What is the ownership of your business? 18. Which quality costs do you monitor in your company?					
Quality costs	**Business ownership**				**SUM**
	net domestic capital	**domestic capital predominates**	**foreign capital predominates**	**net foreign capital**	
prevention costs	*24,62%*	*16,67%*	*0,00%*	*25,00%*	
appraisal costs	*32,31%*	*50,00%*	*0,00%*	*75,00%*	
failure costs (internal and external)	*38,46%*	*41,67%*	*0,00%*	*100,%*	
wasted investment costs and opportunities	*10,77%*	*25,00%*	*0,00%*	*25,00%*	
conformance costs	*3,08%*	*8,33%*	*0,00%*	*0,00%*	
non-conformance costs	*7,69%*	*8,33%*	*0,00%*	*0,00%*	
costs related to environmental damage	*4,62%*	*8,33%*	*00,00%*	*25,00%*	
we do not monitor quality costs	*27,69%*	*8,33%*	*100,00%*	*25,00%*	
relative abundance	*75,19%*	*15,50%*	*0,78%*	*8,53%*	*100%*

It can be seen from Table 4 that companies with a capital structure consisting of net domestic capital follow the failure cost the most, at 38.46%. In companies with a predominant domestic capital, up to 50% of companies monitor the appraisal costs. The relationship between business ownership and observed quality costs cannot be confirmed from the available data, but in general it can be argued that despite business ownership, the most monitored costs for wood processing companies are failure costs, as they have the greatest impact on business profitability.

4. CONCLUSION

Based on the results of the research, we can conclude that woodworking enterprises use very little or no quality improvement tools, concepts and methods. Based on statistical results testing, we can say that the positive effects of quality management and its performance improvement principles have not been confirmed in the wood processing industry in Slovakia.

Today's highly competitive market environment increases the enormous demands on the products and services provided and anyone who wants to apply to the market must adapt to these rules. Today, the customer does not accept a poor product, so it is up to manufacturers to improve the quality of their products, accept customer requirements, and minimize the production of poor quality products, as there is no other way to succeed.

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REFERENCES

1. Alharbi, K., Yusoff, R. Y., and Al-Matari, E. M. (2017). "The Moderating effect of organizational climate on the relationship between of total quality management (TQM) on organisational sustainability: The case of the hotel industry in Saudi Arabia," *International Business Management* 11(2), 350-356. DOI: 10.3923/ibm.2017.350.356
2. Garvare, R., and Isaksson, R. (2001). "Sustainable development: Extending the scope of business excellence," *Measuring Business Excellence* 5(3), 11-15. DOI: 10.1108/1368304011043899
3. Khodeir, L. M., and Othman, R. (2016). "Examining the interaction between lean and sustainability principles in the management process of AEC industry," *Ain Shams Engineering Journal* 9(4), 1627-1634. DOI: 10.1016/j.asej.2016.12.005
4. Kottulová, J. and Mitková, Ľ. (2016). "The technology start-up scene in Slovakia: No woman's land?" In: Innovation, management, entrepreneurship and corporate sustainability: Proceedings of the 4th international conference. - Praha : Vysoká škola ekonomická v Praze, 328-337. ISBN 978-80-245-2153-4.
5. Malá, D., Sedliačiková, M., Dušak, M., Kasčáková, A., Musová, Z., and Klementová, J. (2017). "Green logistics in the context of sustainable development in small and medium enterprises,"_*Drvna Industrija* 68(1), 69-79. DOI: 10.5552/drind.2017.1620
6. Milošovičová, P. (2019). "Interkulturelles Management". Wolters Kluwer, Praha. ISBN 978-80-7598-365-7
7. Minarová, M., Malá, D., and Sedliačiková, M. (2015). "Emotional intelligence of manageres," *Procedia Economics and Finance* 26, 1119-1123. DOI: 10.1016/S2212-5671(15)00939-9
8. Nguyen, M. H, Phan, A. Ch., and Matsui, Y. (2018). "Contribution of quality management practices to sustainability performance of Vietnamese firms," *Sustainability 10*(2), 375. DOI: 10.3390/su10020375
9. Owen F., Maidment, D., 1996. Quality Assurance. Institution of Chemical Engineers, Rugby, ISBN 0- 85295-372-0.
10. Vilčeková, L., Mucha, B., Peráček, T. and Strážovská, Ľ. (2018). "Selected Issues of Family Business in Selected Countries with Emphasis on the Slovak Republic," in: Proceedings of the 31st International Business Information Management Association Conference, IBIMA 2018: Innovation Management and Education Excellence through Vision 2020, pp. 2500-2509. ISBN:978-0-9998551-0-2
11. Rebelo, M. F., Santos, G., and Silva, R. (2016). "Integration of management systems: towards a sustained success and development of organizations," *Journal of Cleaner Production* 127, 96-111. DOI: 10.1016/j.clepro.2016.04.011
12. Rentková, K. (2017). "Regional development planning in the Slovak Republic," in: *World Multidisciplinary Civil Engineering-Architecture-Urban Planning Symposium,* Prague, CR. DOI: 10.1088/1757-899X/245/6/062013
13. Saad, A., Su, D., Marsh, P., and Wu, Z. (2015). "Investigating environmental management and quality management issued in the Libyan food industry," *British Journal of Economics, Management & Trade* 9(3), 1-16. DOI: 10.9734/BJEMT/2015/19564

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SUSTAINABILITY OF FOREST-BASED INDUSTRIES IN THE GLOBAL ECONOMY

PROPERTIES OF WOOD FIBRE BOARDS PRODUCED FROM RAPESEED STALKS RESIDUES

Kopanskyy, M., Myklash, L.,

Abstract: The research is focused on investigation of the mechanical properties of wood fibre boards (WFB) produced by wet product forming method from rapeseed stalk residues. In the article, we present the data on effects of the content of rapeseed stalk particles and the amount of adhesive upon the WFB mechanical performance. It is experimentally proved the possibility of manufacturing WFB from rapeseed stalk residues as an adequate substitute for medium-density fibreboard (MDF). Taking into account that timber price tends to rise, the utilization of rapeseed stalks can become a very prospective valuable plant raw source that in the near future may completely replace wood in the WFB production. In addition, rapeseed is also a good insulation material. Utilization of rapeseed will reduce the cost of fibreboards and will have a positive contribution in saving valuable timber resources.
Key words: wood fibre boards, mechanical properties, rapeseed stalks

1. INTRODUCTION

Sustainability is currently considered to be the key requirement for further development of mankind. All spheres of human activities, the manufacturing realm in particular, work towards sustainable solutions. The rapid deforestation, which has caused serious environmental damage worldwide, forces manufacturers of wood products to search for alternative raw materials. As a matter of choice, it can be lignocellulosic biomass, a plant raw material of agricultural production. Among the agricultural residues, straw is widely used due to its relatively low price.

The research is focused on investigation of the mechanical properties of WFB since their applications are mainly determined by these characteristics. The study provides investigation of the properties of WFB produced by wet product forming method from rapeseed stalk residues and is aimed to find out a dependency of the mechanical performance upon the content of rapeseed stalk particles and the amount of adhesive.

2. DISCUSSION AND RESULTS

One of the main factors that hinder the wheat straw from its utilization as a plant raw material for wood-based composite production is the presence of wax along with a rather complex chemical composition. It is a known fact that wax is not scattered throughout the straw mass as it is in a case of wood, but it is almost entirely spread on its surface. The formation of such an anti-adhesive layer on the surface of the straw particle prevents the surface of the particle from getting wet and impairs adhesion. Since the positive attribute of straw raw material makes it possible to search for other ways of its utilization in the wood composite manufacturing.

There have been proposed a number of various methods of chemical treatment of the surface of straw particles. There is a best known method of producing WFB from plant raw material used ammonia. Straw is previously treated with water vapour at a temperature of 140-200°C subsequently molding and hot pressing. The drawback of this method is a complicated technological process and ammonia toxicity.

Equally with straw, oilseed rape stalks can be also one of the most perspective plant raw materials for manufacturing of wood composites. Rapeseed is considered to be an extremely valuable oil plant; furthermore, it can also be used as one of the components for the wood composite production. The chemical composition of rapeseed stalk is similar to wheat straw but it has a number of specific features. The data are summarized in table 1.

Table 1. Component Composition of Different Types of Plant Raw Materials and Wood [4:47].

Material	Cellulose	Lignin	Pentosans	Resin, Fat, Wax	Ash
Wheat Straw	44.3	16.5	26.7	5.22	6.65
Rye Straw	45.2	19.3	26.2	5.86	4.63
Rape Stalk	39.3	18.5	20.2	3.12	10.9
Spruce Wood	46.1	28.5	10.7	2.93	0.18

According to the Table 1, it should be pointed out that the rapeseed stalks differ from the straw of other crops in terms of its increased thickness and rigidity, and because of that, they have not been widely used in the traditional agriculture. However, it is unlike hollow rye straw, the inner axial layer of rapeseed stalks are filled with porous white parenchyma tissue regardless of the rigid outer layer. The shape of the parenchyma tissue cells in cross-section is similar to hexagonal and the transverse dimensions of the cells do not much exceed longitudinal ones. The cellule structure of the parenchyma tissue is different in shape and size from the rigid layer of the stalk wall that makes it easier to determine the boundaries between the outer and inner layers. The capillaries in the wall of the rapeseed stalk are narrower than in the straw; their diameter does not exceed 50 microns with an average size of 20 microns that is less than in the peripheral layer of the rye straw [4:48].

The analysis of recent research data on the utilization of agricultural residue sources for the pulp, paper and wood composite production allow us to conclude that besides wheat and rye straw, the use of rapeseed stalks is also appropriate for this purpose. As to rapeseed, the volume of the axial canal is 38.0-54.0% of the total stalk volume and it depends on the stalk part (pre-rooted, central, and upper); the density of the parenchyma tissue that fills the axial canal is really small. The internal parenchyma structure of rapeseed stalk is characterized by extremely high porosity. The composition of pentosans within the rapeseed parenchyma is 15.3-17.3%. Rapeseed stalks are slightly inferior to straw in terms of overall porosity [4:50].

Therefore, we can conclude that:

1. The rapeseed stalk tissue structure is denser and firmer than the wheat and rye straw tissue.
2. The type of chemical components and quantitative composition of rapeseed stalks are similar to the wheat and rye straw.
3. Unlike the wheat and rye straw, rapeseed stalks contain relatively a small amount of waxy substances.
4. The internal parenchyma tissue of rapeseed stalks is of extremely high porosity. It is a natural foam (insulation) product.
5. Similar chemical composition and properties of rapeseed comparing to the wheat and rye straw or wood give reasons for the use of rapeseed stalks as a good source for the composite material production.
6. It can be anticipated that the low content of waxy substances in the rapeseed stalks will positively influence on the degree of holding grinded particles with a binder, so adhesion will enhance.
7. The high content of mineral substances in the rapeseed stalks will also have a positive effect on adhesion with mineral binders.
8. The highly porous internal parenchyma tissue in the rapeseed stalks can provide a possibility for production of a new insulation wood-composite.

Therefore, paper, cellulose and cardboard can be made from rapeseed stalks. These technologies have been used successfully in the UK, Hungary, Spain, and Portugal. Approximately 10% of all cellulose in the world is produced from non-wood raw materials. One hectare of a rapeseed field can serve for production of 2-6 tons of paper. For example, in Ukraine the rapeseed fields are tending to grow and amounted to 1.3 million hectares; the total rapeseed yield reached 5-6 million tonnes in 2019 [2].

The quality characteristics of wood composite materials during the final testing in the furniture field are the following: ultimate strength (strength limit in static bending), MPa; density, kg/m^3; swelling in thickness,%; moisture,% [3]. The ultimate strength in static bending is considered to be the most important mechanical characteristic value for composite boards as engineered wood composites are mainly undergone bending [1:48].

While carrying out the research the following materials were used: wood fibres applicable for manufacturing of fibre boards; rapeseed stalk particles produced by grinding on a blade mill that is mainly used for grinding organic materials; phenolic resin (Lignofen G/3 produced by the 'LERG' Polish company); precipitate: aluminum sulfate $Al_2(SO_4)_3 \cdot 18H_2O$ (State Standard of Ukraine No. 12966-85); drinking water (State Standard of Ukraine

No. 2874-82); filter paper; distilled water (State Standard of Ukraine No. 6709-72). In the experiment, the conifer fibre particles were used to form a fibrous carpet and a WFB itself. The rapeseed particles were made by grinding the rapeseed stalks on the blade mill and a fine fraction of stalk particles was applied. Since rapeseed stalks are soft, to obtain them grinded is not energy consumed if comparing with wood. Further on, a fibrous suspension was formed in the aqueous solution of wood fibres and rapeseed particles.

The variable factors were the following:

- ✓ the ratio of rapeseed and wood particles in different proportions, % (75:25, 50:50, 25:75, 0:100);
- ✓ the amount of adhesive, % (0, 2, 4, 6).

The process of making specimens consisted of 6 stages such as: preparing of rapeseed particles, wood fibre preparation, adhesive composition and its application to fibrous mass in aqueous solution, carpet formation, water extraction, drying and sample pressing. In order to identify the specifics of correlation between fibre board properties and technological parameters, a classic experiment was carried out.

In the research there were the following *constant factors*:

- ✓ periodic method of pressing; pressing temperature of 170°C;
- ✓ compression pressure, MPa (in the first phase of 1 MPa; in the second phase of 5.5 MPa; in the third phase of 5 MPa);
- ✓ smooth character of pressure reduction;
- ✓ board thickness of 9 mm;
- ✓ board density of 700 kg/m^3;
- ✓ board moisture of 8 %;
- ✓ single layer board design;
- ✓ degree of surface treatment: unpolished fibre board surface.

A wood composite material of flat pressing was made by hot pressing of a mixture of resinous wood and rapeseed particles. The amount of the consumed components for the composite mixture mass was performed by using computer calculation software and was dosed by weight according to the proportion required for the experiments. The adhesive was applied to an advanced prepared mixture of wood and rapeseed particles. The duration of mingling was 10 min. The adhesive polymer serves for increasing board strength. The precipitate makes the adhesive changed into a solid substance with the fibres. The adhesive composition of concentration 10% was applied into the fibre mass (amount of 1% in absolute dry matter content). Then the precipitate of concentration 10% (aqueous solution of aluminum salts ($Al_2(SO_4)_3 \cdot 18H_2O$)) was applied into a fibrous mass of concentration 1% to the amount of adhesive.

The next step was conducted to study the physical and mechanical properties of specimens of relevant sizes which were cut out from the produced fibre boards. The specimens were numbered and tested in 5 days after the pressing. As a preliminary test procedure dimensional and weight characteristics of the specimens were examined.

Graphical representation of the effect of rapeseed particles content on the ultimate strength of WFB in static bending is shown in Fig. 1.

As can be seen from the Figure 1, the obtained graph shows an approximate linear relation. Thus, as the content of rapeseed particles is increased, the strength index is decreased. It could be attributed that the strength of rapeseed particles is less than the strength of wood fibres. It is commonly known that the strength value of the composites depends on the strength of their components. As expected, according to the data, our experiments prove that composites produced by classic wood fibre manufacturing process and in case if the rapeseed particle content is less than 25 %, their mechanical properties comply with the requirements of standard EN 312-2: 2003.

The relationship between the strength value of WFB in static bending and the amount of adhesive is shown through bar graph in Fig. 2.

According to the Figure 2, it is also evident from the bar graph, as the binder content increases, the strength of the fibre board increases. This can be explained that an increase of adhesive reinforces chemical bonding between the fibres and the binder, thus it is resulted in strength enhance. An increase of the binder improves the physical and mechanical properties of wood composites. However, it should be noted that the binder content in the particle and adhesive composition mass largely determines both the quality and the cost of composites.

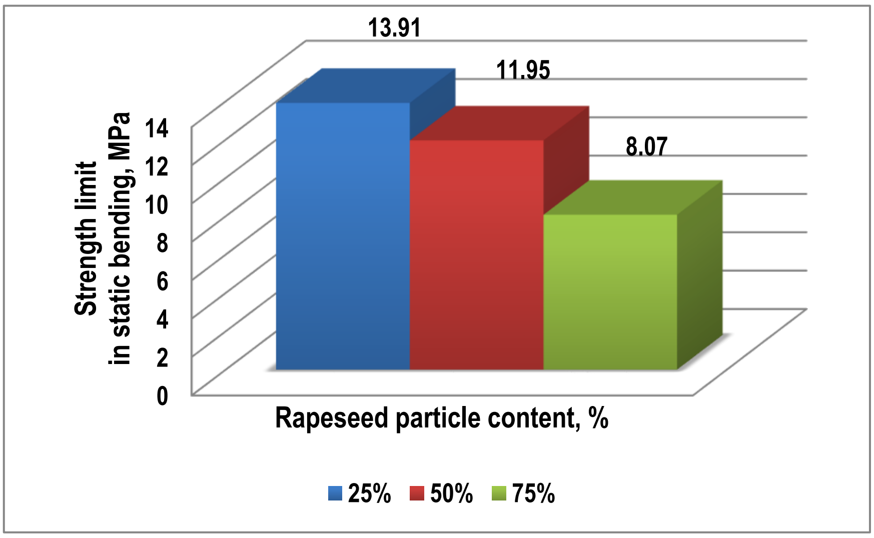

Figure 1. Dependency of the ultimate strength of WFB on the ratio of wood fibre and rapeseed stalk particles.

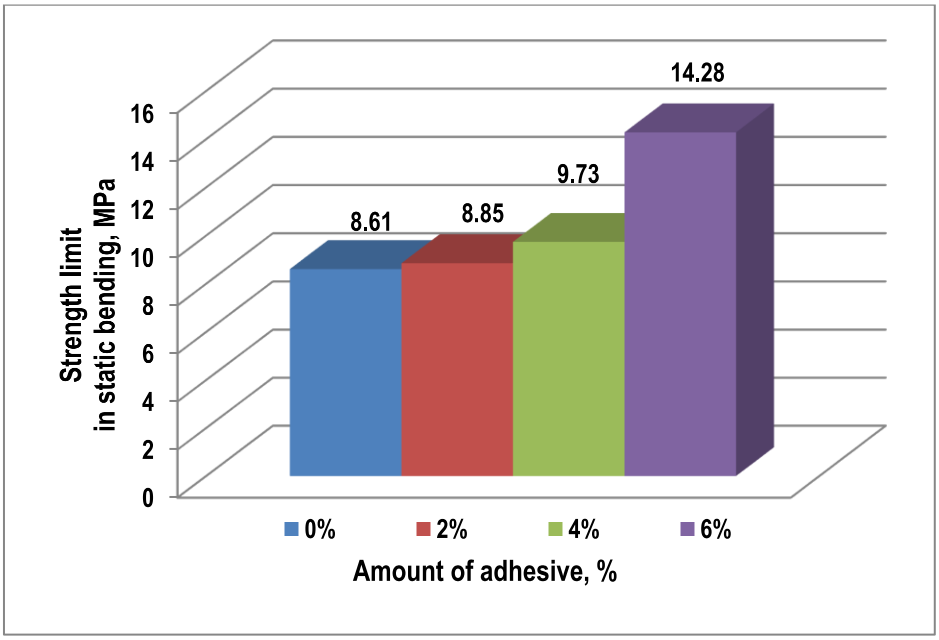

Figure 2. Dependency of the ultimate strength of WFB in static bending on the amount of adhesive.

3. CONCLUSIONS

The analysis of the experimental study done to find out the effect of the main manufacturing process parameters on the mechanical performance of wood composites made from rapeseed stalk residues allows us to conclude the following:

1. The first wood fibre boards have been obtained based on the commonly accepted technology process by wet-product forming method. Moreover, it is demonstrated that the product made from rapeseed stalk particles is also feasible to be manufactured by using the available industry machinery and equipment.
2. The findings of the research prove that wood composites can be made using classic wood fibre manufacturing process. In case, if the rapeseed particle content is less than 25 %, their mechanical properties comply with the requirements of standard EN 312-2: 2003.
3. Based on the data obtained from the research, the manufacturing methods of WFB using rapeseed stalk particles are proposed. This technique will permit to apply the stalks of rapeseed in WFB production.
4. Taking into account that timber price is tending to rise, the utilization of rapeseed stalks can become a very prospective valuable plant raw source that in the near future it may completely replace wood in the WFB production. What is more, to obtain rapeseed particles by grinding is less energy consumed if comparing with having other ingredients grinded. Rapeseed is also a good foam (insulation) material and can reduce the cost of fibreboards. The utilization of rapeseed will have a positive contribution in saving valuable timber resources and can be one of the sustainable solutions within the wood-based industries.

REFERENCES

1. Bekhta, P. (2004): *Tekhnolohiya derevynykh plyt i plastykiv* [Technology of wood-based boards and plastics]. Kyiv: Osnova: pp. 406-413 (*in Ukrainian*).
2. Sowing Plot of Land for Raising Winter Crop Harvest Statistical Bulletin. Issue of State Statistics Service of Ukraine (2019) (*in Ukrainian*).
3. State Standard of Ukraine EN 622-3:2006 (2011). Fibreboards – Specifications. Kyiv (*in Ukrainian*).
4. Torgashov, V. (2009): *Sravnitelnoye issledovanie usloviy vydeleniya, morfologii i svoyistv tselulozy iz stebley zlakovykh i maslichnykh kultur* [Comparative research of extraction conditions, morphology and properties of cellulose from stems of oil and crop plants]. In: Gert E., Zubets O., Kaputskyy F. Khimiya rastitelnogo syriya [Chemistry of plant raw materials]. Minsk, No. 4: pp. 45-54 (*in Russian*).

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AIR PERMEABILITY OF OSB AND ITS INFLUENCE TO HEATING ENERGY COSTS

Sedlák, P., Bednár, J., Búryová, D.

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. In order to significantly reduce demand for building heat energy by using ventilation systems with heat recovery and therefore satisfy sustainable standards, air permeability of building envelope became an important issue during the last years. In timber frame construction the airtight layer is often formed by oriented strand boards (OSB) which are considered healthier and environmentally friendlier than their counterparts using plastic foils as vapour barrier, though they are more expensive in general. This paper analyses the air permeability of OSBs used as airtight layer in timber structures. Some house manufacturers decided to use more expensive OSB4 type with guaranteed air permeability on few sample houses, instead of OSB3 type. The results described the effect of different air permeability is then shown on typical house in terms of heating energy demand and energy costs over selected period, compared to additional input costs of higher quality OSB.
Keywords: air tightness, air permeability, building envelope, oriented strand board, heating energy, energy costs

1. INTRODUCTION

The wood processing industry holds a significant position within the industrial sector in Slovakia [5]. Wood has been traditionally applied in different applications, mainly in construction, furniture production, etc. However, housing quality and costs are key for choosing a type of construction for final consumers.

Building envelope needs to be compact in terms of thermal insulation and also in terms of air-tightness. Highly air permeable materials allow air penetration through external walls and cause additional thermal loss by uncontrollable and undesirable air infiltration, particularly if mechanical ventilation system with heat recovery is installed.

In timber frame house design the airtight layer is usually formed either by oriented strand boards (OSB) or by various foil materials, which both usually work as a vapour retarder. The problem is that OSBs provide highly various airtightness level, depending on thickness, type, manufacturer and surface finishing.

This paper discusses the air permeability of OSB3 used as airtight layer in timber structures. In order to determine and compare the air permeability of different OSBs, a laboratory test was performed in a pressurized chamber. There have been samples 1.2 x 1.5m investigated. As main factor of influence, surface structure and orientation of the strands have been detected. Especially the gaps between strands turn out to permit air flow through the board.

Recently, some timberframe house manufacturers in Slovakia noticed quality deteriorating in premium OSB3 boards used, confirmed by Blower Door Tests on site. To satisfy strict design requirements, they have used OSB4 type with guaranteed air permeability instead of OSB3 on few houses. The later testing confirmed greatly enhanced performance.

The effect of different air permeability was then shown on examples of houses in terms of heating energy demand and energy costs over selected period, compared to additional input costs of higher quality OSB.

2. LABORATORY TESTING

We had conducted laboratory testing on number of OSB samples, according to STN EN 12114 standard, the most suitable method to determine board material air permeability.

Table 1. An overview of OSB3 tested samples

Sign of sample	Title of sample	Thickness				
		8mm	12 mm	15 mm	18 mm	22mm
O/A	OSB/ 3 brand n.1	■	■	■	■	■
O/B	OSB/ 3- brand n.2		■	■	■	
O/C	OSB/ 3- brand n.3		■	■	■	

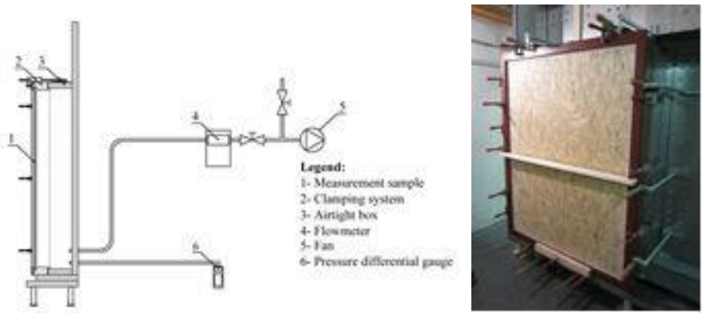

Figure 1. The laboratory apparatus scheme (as per EN 12114) and OSB3 sample installed

2.1. Analysis

The air flow rate is described by power law relationship, where parameter C and n describe airtightness of a sample. The relationship is usually plotted in logarithmic scale to obtain linear relation (Fig. 2).

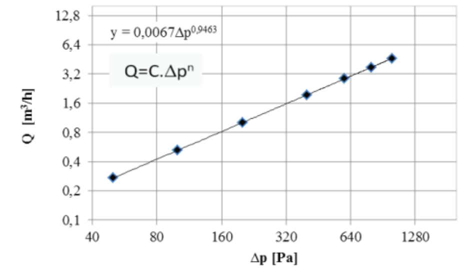

Figure 2. An example of relationship of air flow rate to pressure difference, logarithmic scale

The purpose of this process is to determine parameters for power law relationship, where graphical outcome is depicted on Fig. 2. Values of parameters C and n are obtained by method of least squares, in order to calculate air flow rate Q_{50} at standard pressure difference of 50 Pa. Air permeability q_{50} is then calculated as Q_{50} per effective area (square meters) of a tested sample.

2.2. Results of the testing and considered values

The samples were made of three different OSB brands from different manufacturers (A, B, C) and were marked as O/A, O/B, O/C. Figure 3 shows visible difference between air permeability of the samples. High variety for OSB is caused by several factors observed during the testing. Most significantly, the samples having high surface porosity produced the worst results, as there were visible gaps between strands in the surface structure, allowing an air to flow through the board. We found out that the air permeability is affected mainly by surface structure quality and porosity, rather than thickness of the board.

Only values for OSB3 15mm (B-0.248, C1.019) were considered in order to keep cost analysis clean, as the thickness 15mm is generally used for imberframe walls. As discussed previously and in following chapter, values for premium OSB O/A_3 got probably worse in later years, proved by multiple in-situ Blower Door Tests, and this value is not taken into account for later comparison.

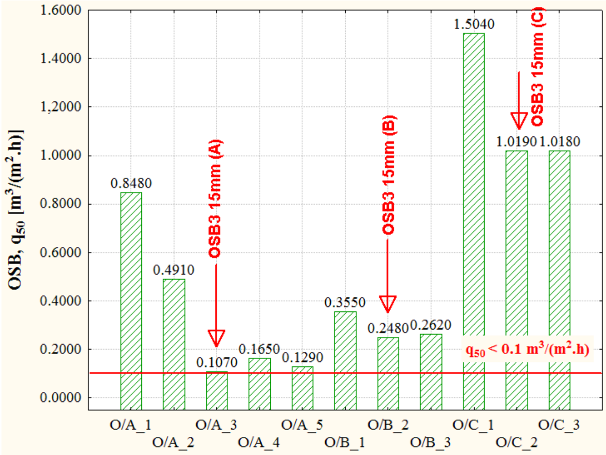

Figure 3. Air permeability of OSB – different manufacturers, different thickness (2013)

3. IN-SITU TESTING

There have been discussion about quality reduction of premium OSB3 properties recently, in relation to OSB manufacturer's competitiveness on market and input costs savings, so we have tested several houses which used enhanced OSB4 15mm within the envelope, by conducting Blower Door Tests due to high flexibility and ability to record values for built-in materials.

The main advantage of the test is quick setup of the portable apparatus, almost immediate results which are determined using the same power law as described earlier for laboratory testing, and ability to use the values as direct input for building heating energy calculation procedure. Air permeability q_{50} of an envelope material is also possible to deduce, but due to nature of the test (it is possible to test all leakages together only) it is important to treat and eliminate all structural junctions, windows and other material's air leakage – therefore only fraction of the houses were suitable for this calculation. In such cases, we would assign entire air leakage to OSB4 board and be able to get so-called "the worst case scenario" q_{50} values for OSB.

For later assessment there was value for "test house 1" used, which roughly correlates with OSB4 manufacturer's air permeability declared value q_{50} max=0.12 $m^3/(m^2.h)$, as "test house 2" would not have accessible entire air barrier for inspection during the test.

Table 2. Values for tested suitable houses to deduce OSB4 air permeability

	Blower Door Test result, n50 [1/h]	internal volume V [m3]	air flow - envelope Q50 [m3/h]	OSB4 in the envelope net area, A [m2]	OSB4 air permeability q50 [m3/(m2.h)]
Test house 1	0,114	275,8	31,4	222,61	**0,141**
Test house 2	0,16	421,5	67,4	281,2	**0,240**

Figure 4. Blower Door Test being conducted in a house with OSB4 as main air barrier

4. CASE STUDY MODELS

Table 3. Case study model houses – basic information

	EcoBase Plus	EcoCube Plus
		
Net area of OSB in external walls	75.3 m^2	158.7 m^2
Internal building volume	270.15 m^3	334.3 m^3
Ratio A_{OSB}/V	0,28 m^2/m^3	0.47 m^2/m^3
Building envelope total	446.5 m^2	400.7 m^2
Net usable floor area	98.6m^2	119.7 m^2

The effect of OSB's air permeability contribution to overall airtightness, heating energy and energy costs is demonstrated on examples of wood-based passive houses - single storey EcoBase Plus and two-storey EcoCube Plus [1]. An analysis of the building envelope was performed, to show area of OSB used in external walls. Each house uses mechanical ventilation system with heat recovery, which is crucial to further heating energy savings and related cost reduction in addition to well insulated envelope and high quality windows [4].

5. ENERGY COSTS

Heating energy demand was assessed in Passive House Planning Package (PHPP) software [6], which allows various scenario modelling, and is designed specially for passive houses. The contribution of different envelope materials is calculated in terms of changed overall building air tightness n_{50} [1/h], based on relation of external air infiltration to an air flow at test pressure difference 50Pa .

The contribution to heating energy cost is calculated by means operational costs of direct electric heating (underfloor, wall, electric boiler). Other heating systems could be considered as well, but the complexity of the possible results (high portion of heating system depreciation can not be omitted) made further analysis too complicated to present.

Table 4. Annual heating energy demand and energy costs for the model houses

Type of air barrier in external wals	EcoBase, single storey		EcoCube, two storey	
	heating energy [kWh/a]	energy costs [Eur/a]	heating energy [kWh/a]	energy costs [Eur/a]
non air-permeable material	*2504*	*501 €*	*2196*	*439 €*
OSB 3, 15mm, manuf. C, 4.95 E/m2	2713	543 €	2633	527 €
OSB 3, 15mm, manuf. B, 5.22 E/m2	2556	511 €	2304	461 €
OSB 4, 15mm, 7.56 E/m2	2533	507 €	2259	452 €

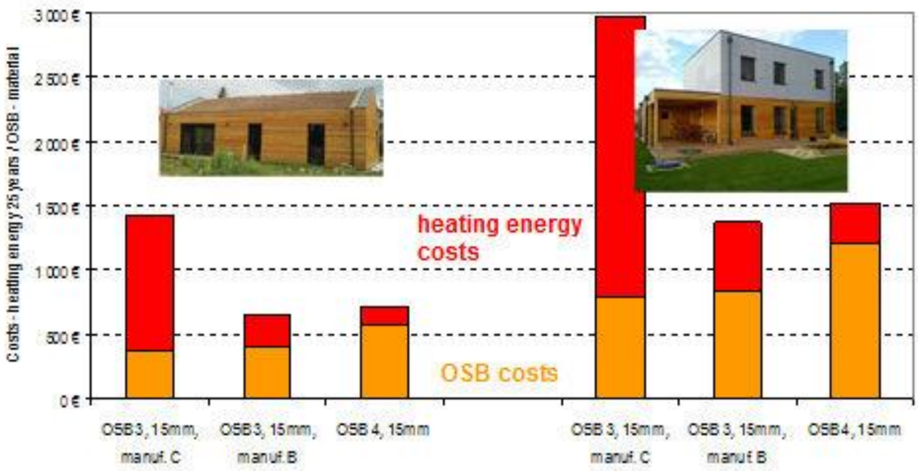

Figure 5. OSB material costs and OSB's contribution to heating energy costs over 25 years for model houses using different OSB

6. CONCLUSION

The cost structure seems to be identical for both houses, and it is obvious the material/energy ratio depends solely on unit price and material properties, and neither on size of the house nor OSB area used in external walls. But, on the other hand, the importance of the material selection depends on scale of application in a house, as presented in other studies as well [2].

As could be seen from Fig. 5, potential cost saving measure as choosing the cheapest OSB can end up in rapidly higher final costs over the time. It seems that selecting appropriate OSB3 for external walls would be the best solution - but the problem is these boards do not have guaranteed air permeability values, and the properties may vary from batch to batch, and even more expensive OSB3 can perform poorly, without any later compensation from OSB manufacturer. Therefore, for certified passive house manufacturers, using OSB4 as air and vapour barrier will probably be the only solution, if no additional foil is to be installed.

At the present time significant changes in the political, social and economic areas are reflected in the use of domestic renewable resources. Wood production has a long tradition in the Slovak Republic [3]. Nowadays wood as a significant renewable resource is closely linked with many other sectors of the national economy, and construction costs represent a key factor in competitive advantage. The cost of analysed structures is widely used and it is important issue for purchase decision making of final customers.

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REFERENCES

1. CREATERRA Architects, https://www.createrra.sk/
2. Debnar, M.; Jochim, S.; Stefko, J.; Potkany, M. (2018): *The impact of the selection of the perimeter wall of a family house on the assessment of the life cycle and its costs*. In: Increasing the use of wood in the global bio-economy. Belgrade, Serbia, p. 192-199. ISBN:978-86-7299-277-9
3. Kalamarova, M.; Parobek, J.; Loucanova, E.; Trebuna, P. (2014): *Competitiveness evaluation of the Slovak forest industry*. In: Position and Role of the Forest Based Sector in the Geen Economy: Proceedings of Scientific Papers. Zvolen. 2014. 58–62.
4. Nota, R. (2016): *Thermal performance of wood aluminium and wooden windows*. In: Acta facultatis xylologiae Zvolen, v. 58 (1). Zvolen, Slovakia. p 83-94. ISSN: 1336-3824
5. Paluš, H.; Parobek, J.; Dzian, M.; Šupín, M. (2018): *Determinants of Sawnwood Consumption in Slovakia*. BioResources 2018, pp. 1-13.
6. Passive House Institute, https://iepd.sk/

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RECENT DEVELOPMENTS IN MODIFICATION TECHNIQUE FOR WOOD AND WOOD-BASED COMPOSITES

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Abstract: Wood modification processes used in wood and wood-based composite industry are non-toxic in service and when disposed at the end of life does not result in the generation of any toxic residues Wood modification improves wood performance and leads to improved water repellency, rebuilding duced shrinkage and swelling, higher decay resistance, reduced extractive contents, lower equilibrium moisture content and increased thermal insulating capacity. More recently the interest in heat treatment processes has been renewed. This renewed interest is due to the declining production of durable timber, to the increasing demand for sustainable building materials, to the deforestation of especially sub-topical forests, and to the increased introduction of governmental restrictive regulations reducing the use of toxic chemicals. Thermal-modification is environmentally frienly moficiation for wood material. There is also other modification techniques are acetylation, furfurylation, resin impregnation, plasma treatment, silanes, maleics, alkali treatment, methacrylate, and other chemical treatments; (i.e. stearic acid in ethyl alcohol solution and permanganate treatment). In this study, the modification techniques, their effects physical and mechanical,properties of wood and wood-based panels were reviewed.
Keywords: wood modification, wood, wood-based panels, technological properties

1. INTRODUCTION

When wood or wood-based panels are exposed to humid or water, ther biological durability and dimensional stability will be adversely affected in the service life. Chemical or thermal modification reduces the number of hygroscopic functional groups and thus prevents absorption of water molecules (Ormondroyd et al., 2015). Some advanced modification technologies and materials considerably protect the wood against abiotic degradation factors. Moreover, recent novel techniques are the application of nano-based surface barriers, plasma treatments and grafting (Papadopoulos et al, 2019). The modified wood and wood-based composites can be used in different usage areas such as cellulosic insulation panels, waterproof panels, and wood-polymer composites, appropriate for high humidity conditions.

In general, modification techniques can be classified according to their applications. These are as follows:
- Chemical Modification
- Thermal Modification
- Surface Modification
- Impregnation Modification

One of the oldest modifications for wood is thermal modification, which leads to chemical modifications of hemicelluloses, cellulose and lignin (Militz, 2002; Hill, 2006; Sandberg and Kutnar, 2016). It is environmentally friendly method because no chemical is used in the process. Thermal modification can adversely affect the bonding process with adhesives and decrease the mechanical properties of wood (Sernek *et al*., 2008). Thermal-treatment cause to inactivation on the wood surface and negatively affect the bond performance with some adhesives. The shear strength of adhesive bond is usually reduced due to lower strength of modified wood and lower adhesion to modified wood surface. Thermal modification makes wood more brittle and decrease its abrasion resistance (Hill, 2006). Beside to the thermal modification, different chemical modification processes are known to negatively affect especially dynamic strength properties, such as furfurylation and acetylation (Mantanis, 2017), DMDHEU (1.3-dimethylol-4.5-dihydroxyethyleneurea (Emmerich et al., 2019), and treatment with melamine resin (Pittman *et al.,* 1994).

Chemical-based wood-modification methods can be divided into 3 categories. Filling lumens with a substance (eg with resin): this application can increase the strength properties of the wood and slow down the water (steam) uptake process. However, this does not change the sorption behavior of wood for a long time. To increase the volume by filling the cell wall: this application swelling and shrinkage of wood. It is aimed at reducing its properties. It even has a beneficial effect on long-term sorption behavior. Modifying wood: this method is the most effective. The chemical structure of the cell wall components (cellulose, lignin, and hemicellulose) is altered and covalent bonds created. The types of wood modification that can occur in wood are shown in Figure 1.

Acetylation technique applied to wood improves the biological durability of wood and water resistance and dimensional stability under high humidity conditions. A new commercial method, named Accoya® wood (www.accoya.com) was introduced to the market in 2007. A detailed review on the acetylation technique and its effecton the physical and mechanical properties of wood was studied by Bongers *et al.* (2010). Recently the architectural use of modified wood has increased in the area of high level design outdoor and indoor furniture due to the modified wood has better dimensional stability biological durability, and different shades of colours. Modification types for wood was given in Table 1.

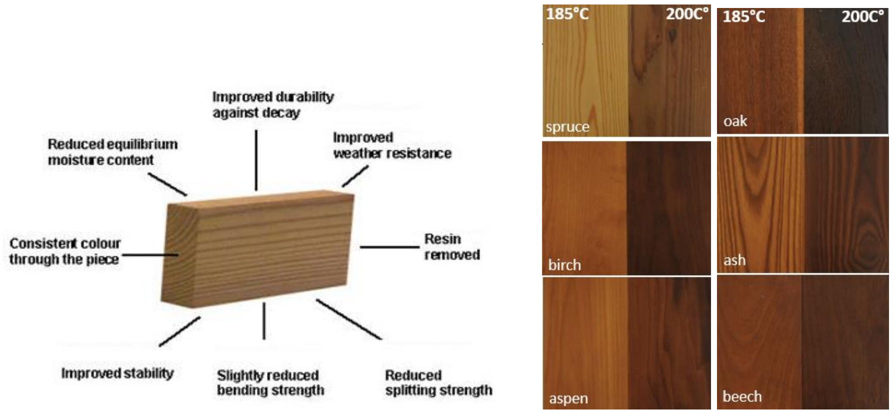

Figure 1. Advantages of thermally treated wood.

Table 1. Modification types for wood (Pickering et al.2016; Ayrilmis et al. 2016).

Modification type	**Effect of modification**
Alkali	Reduce the lignin and hemicullose, pectin, and extractive (waxs and fats) content. Increasing srface roughness and surface providing Improved fibre-matrix adhesion, thermal stability and heat resistivity
Acetylation	Esterification occurs by reaction of acetyl groups ($CH_3CO–$) with hydroxyl groups (–OH) on the fibres resulting in increased hydrophobicity, İmproved tensile and flexural strength, biological durability against to biological attacks.
Benzoylation	Improve hydrophobicity
Enzyme	Reduce the lignin content
Grafting	Maleic anhydride (MA) grafted polymers react with the hydroxyl groups on the natural fibre surface which leads to covalent (ester bonds) or hydrogen bonding. They improve UV-protective properties and fibre-matrix adhesion, hydrophobicity and mechanical properties.
Isocyanate	Surface modification
Mercerization	Reduce the moisture reagain and improve the mechanical properties
Wax impregnation	Wood cell wall modification and improve water resistance and dimensional stability, but decrease inin dynamic strength properties
Wax heat treatment	
Impregnation with linseed oil	
Melamine resin treatment	
Furfurylation	
1,3-dimethylol-4,5-dihydroyethyleneurea (DMDHEU)	
Methacrylate	Improve tensile and flexural strength
Ozone	Affect surface energy and contact angle
Peroxide	Reduce the moisture regain
Plasma	Improve hydrophobicity
Silane	Silanes such as amino, methacryl, glycidoxy and alkyl silanes are used for treatment of fibres have different functional groups at either end such

	that interaction at one end can occur with hydrophilic groups of the fibre whilst the other end can interact with hydrophobic groups in the matrix to form a bridge between them. They improve hydrophobic and mechanical properties
Sodium chlorite	Improve tensile strength, young's 287odulus and elongation at break
Thermal-treatment	Improve fibre-matrix adhesion, hydrophobicity and mechanical properties
Biological-treatment	Improve fibre-matrix adhesion, hydrophobicity and mechanical properties

The main purpose for the thermal-treatment between approximately 150°C and 220°C is to achieve new material properties such as increased biological durability and weather resistance, enhanced dimensional stability, reduced extractive contents, increased heat insulating capacity, lower equilibrium moisture content, which might prolong the service life of wood products (Hill, 2006).

Kwon et al. (2016) investigated that the thickness swelling and water absorption of flakeboards pressed at different temperatures. The flakeboards pressed at 190°C showed better water resistance than the flakeboards pressed at 170°C. The control of hot-press temperature and duration appears an effective method to enhance serviceability of flakeboard. Especially, the degredation of hemicellullose due to cumulative thermal exposure in the hot-press decreased the thickness swelling of the flakeboards. Similarly, the bending strenght was improved with increasing temperature from 170 to 190°C, but the bending strength decreased.

Some novel modification techniques such as nitrogen, steam or oil are commercially used in the production of modified wood so that the amount of oxygen content is decreased in the kiln atmosphere (Militz, 2002). A process without special heating medium, but with an initial vacuuming step was developed at the Biotechnical Faculty, University of Ljubljana and reported by Rep *et al.* (2004). This technology is successfull used by a commercial company, Silvaprodukt, in Llubjana, Slovenia.

One of the recent modification techniques is sandwich stacking which is a simple and smart process improvement. Decrease in the amount of the oxygen during the heat-treatment process is significant parameter. This new process is effective to limit or reduce oxygen content for specific products, especially wood veneers, wood lamella and wood-based panels. It can be easily applied to new and existing thermo process kilns. Sandwich stacking technique improves the quality of the product and decrease the production cost (Scheiding et al., 2012).

Citric acid was used as a modifier to improve dimensional stability and mechanical properties of wood in a previous study by Hussain et al. (2012). They reported that the durability of modified wood was increased by 8.3 times higher than unmodified. Furthermore, the thermal treatment did not give a significant improvement in the durability of the wood as compared to the citric acid treatment. In a previous study, wood materials were treated with chitoson oligomers and tested their antifungal performance. They found considerable improvement in the biological durability of the modified wood.

CONCLUSIONS

Wood is environmentally friendly material used in many industries from furniture to construction industry. It is natural and sustainable material. The use of wood is increasing in many sectors due to its significant advantages. However, the major drawbacks of wood are lower dimensional stability and biological degradation. When the wood is modified by different techniques, its service life can be increased. This is is because the wood will be durable to the biological attacks and its dimensional stability will increase. This can be achived by the decreasing free-hydroxyl groups, infilling of lumens, degrefation of hemicellulose, addition of some reactive oils and chemicals, etc. Some factors for the modification of wood and wood-based panels such as environmentally friendly method, non-toxic chemicals, cheaper and easy application in the process should be considered.

REFERENCES

1. Ayrilmis, N., Ashori, A., and Kwon, J.H. (2016): *Properties and Utilization of Plant Fibers and Nanocellulose for Thermoplastic Composites*, in *Polyethylene-Based Biocomposites and Bionanocomposites*, John Wiley & Sons, Inc., Hoboken, NJ, USA, pp. 405–428.

2. Ayrilmis, N., and Winandy, J.E. (2009): *Effects of Post Heat-Treatment on Surface Characteristics and Adhesive Bonding Performance of Medium Density Fibreboard*. *Mater. Manufac. Proces*. 24(5): pp. 594-599.
3. Emmerich, L., Bollmus, S., and Militz, H. (2019): *Wood modification with DMDHEU (1.3-dimethylol-4.5-dihydroxyethyleneurea) – State of the art, recent research activities and future perspectives*. Wood Mater. Sci. Eng. 14:1: pp. 3-18
4. Hill, C.A.S. (2006): *Wood Modification: Chemical, Thermal and Other Processes*. John Wiley & Sons, Ltd.
5. Hussain, I., Singh, T. and Chittenden, C. (2012): *Preparation of Chitosan Oligomers and Characterization: Their Antifungal Activities and Decay Resistance*. *Holzforschung*, 66(1), 119-125.
6. Kwon, J., Ayrilmis, N., and Han, T.H. (2016): *Effect of Hot-Pressing Parameters on Selected Properties of Flakeboard*. *Wood Res.* 61(6): pp. 1033-1040.
7. Mantanis, G.I. (2017): *Chemical Modification of Wood By Acetylation or Furfurylation: A review of the present scaled-up technologies*. *BioRes.* 12(2): pp. 4478-4489.
8. Militz, H. (2002): *Heat Treatment Technologies in Europe*: *Scientific Background and Technical State-of-Art*. In: Proceedings of the conference on "Enhancing the durability of lumber and engineered woods products. February 11-13, 2002, Orlando, Forest Products Society, Madison, US.
9. Ormondroyd, G., Spear, M.J., and Curling, S. (2015): *Modified Wood: Review of Efficacy and Service Life Testing*. Proceedings of the Institution of Civil Engineers 168(4): pp. 187-203.
10. Papadopoulos, A.N., Bikiaris, D.N., Mitropoulos, A.C., Kyzas, G.Z. (2019): *Nanomaterials and Chemical Modifications for Enhanced Key Wood Properties: A Review*. Nanomaterials (Basel). 9(4): pp. 607.
11. Pickering, K.L., Efendy, M.G.A., and Le, T.M. (2016): *A Review of Recent Developments in Natural Fibre Composites and Their Mechanical Performance*. *Compos. Part A Appl. Sci. Manuf.*, 83, 98–112.
12. Rep, G., Pohleven, F., and Bucar, B. (2004): *Characteristics of Thermally Modified Wood in Vacuum.* The International Research Group on Wood Preservation. Document No. IRG/WP/ 04-40287.
13. Sandberg, D., and Kutnar, A. (2016): *Thermal modified timber: recent developments in Europe and North America*. Wood and Fiber Science 48: pp. 28-39.
14. Scheiding, W., Flade, P., and Plaschkies, K. (2012): *Sandwich Stacking – A Smart Innovation For Thermal Modification in Open Kilns*. Proceedings of the Sixth European Conference on Wood Modification 2012, Ljubljana, Slovenia, pp. 21-28.
15. Sernek, M., Boonstra, M., Pizzi, A., Despres, A. and Gerardin, P. (2008*): Bonding Performance of Heat Treated Wood With Structural Adhesives*. *Holz Roh Werkst.*, 66(3), 173-180.

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REDUCTION OF FORMALDEHYDE EMISSION FROM ENGINEERED WOOD PANELS BY FORMALDEHYDE SCAVENGERS – A REVIEW

Antov, P., Savov, V., Neykov , N.

Abstract: The increased environmental consciousness related to the sustainability of raw materials and final products, as well as the stricter legislative requirements to formaldehyde emission from wood-based panels are the main driving factors for shifting the industrial interest to production of eco-friendly wood composites. The common methods to reduce the formaldehyde emission from engineered wood panels have been to decrease the free formaldehyde in the adhesive by using low-emission or bio-based adhesives, and by applying suitable additives, called formaldehyde scavengers. This article presents a review and analysis of the current state of research in the field of formaldehyde scavengers for achieving lower formaldehyde emission from wood-based panels, such as urea, ammonia, ammonium salts, and some natural compounds, such as tannin and wood bark. Factors, affecting the amount of formaldehyde emissions from wood-based panels, have also been presented and discussed.
Keywords: formaldehyde emission; formaldehyde scavengers, wood-based composites

1. INTRODUCTION

Formaldehyde emission from conventional thermosetting resins, such as urea-formaldehyde (UF), phenol-formaldehyde (PF), melamine-urea-formaldehyde and melamine-formaldehyde (MF) resins, especially in indoor environments, is one the most negative aspects of engineered wood panels. At present, about 95% of the total wood adhesives, used in the production of wood-based panels, are formaldehyde-based resins (Kumar and Pizzi, 2019). UF resins are the most predominant ones, accounting for nearly 85% of the total worldwide, followed by melamine, 10% and phenolics, 5% (Byung-Dae and Jae-Woo, 2008; Costa *et al.*, 2013b; Kumar and Pizzi, 2019). Due to their high reactivity, chemical versatility, cost effectiveness, and technological performance regarding their adhesion strength and moisture resistance, these formaldehyde-based polycondensation adhesives have been widely used in wood-based panel industry (Dunky, 2003; Jin *et al.*, 2010; Frihart, 2012; Zhang *et al.*, 2013, Jivkov *et al.*, 2013; Mantanis *et al.*, 2018). However, they have one major disadvantage, i.e. the hazardous emission of volatile organic compounds, such as formaldehyde, from finished panel products, especially in indoor applications (Kelly, 1997; U.S. Consumer Product Safety Commission, 2013). Formaldehyde emission is caused mainly from the residual formaldehyde present in the resin and the hydrolytic degradation under moisture conditions of cured resins (Myers, 1983; Park and Jeong, 2011). It should be noted, that formaldehyde is a naturally occurring compound in wood, formed by its main polymeric components (i.e., cellulose, hemicellulose, and lignin) or extractives (Schäfer and Roffael, 2000; Birkeland *et al.*, 2010; Salem and Böhm, 2013).

Formaldehyde (CH_2O; CAS no. 50-00-0) is a highly-reactive, colourless, strong-smelling gas responsible for significant environmental problems and human health hazards at certain concentrations, such as skin and respiratory tract irritaiton, skin sensitisation, nausea, genotoxicity and cancer. There is sufficient evidence that long-term formaldehyde exposure can cause cancer of the nasopharynx and leukaemia. Also, a positive association has been observed between exposure to formaldehyde and sinonasal cancer (IARC, 2006; SCOEL, 2016). Based on these serious human health hazards, in 2004 formaldehyde was re-classified from "probable human carcinogen" to "known human carcinogen" (Group 1) by the International Agency for Research on Cancer (IARC, 2004). Since then, the formaldehyde limit values have steadily been lowered, e.g. in Germany the European E1 emission level of 0.10 ppm was decreased to 0.05 ppm (BMU, 2018). Thus, the growing social concern about free formaldehyde emissions from wood-based composites, along with the increased environmental consciousness related to the sustainability of raw materials and final products, have been the main driving factors for shifting the industrial and scientific interest from the traditional formaldehyde-based synthetic resins to the development of less toxic, renewable and bio-based adhesives for production of eco-friendly wood composites with acceptable physical and mechanical properties (Widyorini *et al.*, 2005; Pizzi, 2006; Kües, 2007; Papadopoulou, 2009; Navarrete *et al.*, 2010; Frihart, 2012; Ferdosian *et al.*, 2017; Nordström *et al.*, 2017; Hemmilä *et al.*, 2017; Mantanis *et al.*, 2018; Hosseinpourpia et al., 2019; Antov *et al.*, 2020a; Antov *et al.*, 2020b; Taghiyari *et al.*, 2020). However, reaching a 100% bio-based formulations for wood adhesives is challenging, mostly because of the deteriorated dimensional stability and mechanical properties of the composites. The other common method for reducing the formaldehyde emission is by applying chemical additives, called formaldehyde scavengers. The aim of the present review is to summarize the current state of research in the field of formaldehyde scavengers for achieving lower formaldehyde emission from wood-based panels, such as urea, ammonia, ammonium salts, and some natural compounds, such as tannin and wood bark.

2. FACTORS AFFECTING FORMALDEHYDE EMISSION FROM WOOD-BASED PANELS

Formaldehyde emission from engineered wood panels depends on a number of factors, which can be classified into two groups, namely endogenic and exogenic factors. Endogenic factors are related to wood species, type of adhesive used, resin addition level, production conditions employed and type of hot press (Roffael, 2006; Mantanis *et al.*, 2018; Kumar and Pizzi, 2019). Exogenic factors are related to the ambient conditions, i.e., temperature and relative humidity, under which the panels are tested (Peterson *et al.*, 1974; Sundin *et al.*, 1992; Roffael, 2006). In addition, ageing of the wood-based panels was reported to significantly decrease their formaldehyde release (Sundin and Roffael 1989; Roffael *et al.*, 2010). Other exogenic conditions to which formaldehyde-based wood composites may be subjected to include heating or vibration during grinding, sanding, cutting, sawing, etc. (Kovatchev, 2018). The factors described can lead to increased formaldehyde emission in the air. The presence of formaldehyde-based materials in a closed environment (indoors) may increase the air pollution, depending on the following factors: room temperature and relative humidity, wood-based panel properties, air exchange rate, air velocity at the emitting surface and the presence of reactive materials (sinks), removing formaldehyde over time (Liu *et al.*, 2009; Kumar and Pizzi, 2019).

Regarding the occupational exposure limits, the values, recommended by the EU Scientific Committee on Occupational Exposure Limits (SCOEL) and agreed by the members of the European Panel Federation (EPF) and the European Federation of Building and Woodworkers (EFBWW), are as follows: 8-hour time weighted average: 0.3 ppm (0.369 $mg.m^{-3}$) and short-term exposure limit of 0.6 ppm (0.738 $mg.m^{-3}$) (SCOEL, 2016; EPF, 2018).

3. FORMALDEHYDE SCAVENGERS FOR ENGINEERED WOOD PANELS

The low formaldehyde limits, required by the new stricter environmental legislation, can be achieved by modifying the existing adhesives systems for wood-based panels by adding formaldehyde scavengers, often referred to as formaldehyde catchers (Mantanis *et al.*, 2018; Hemmilä *et al.*, 2019). These are chemical compounds, added to the adhesive mix or to the wood particles in order to decrease the formaldehyde emission from the finished wood-based panels (Dunky, 2003). One of the most widely applied formaldehyde scavenger is urea, mainly as aqueous solution, due to its low price and good performance (Park *et al.*, 2008; Costa *et al.*, 2011). The addition of urea, often in combination with ammonium chloride, improves the stability and controls the pH of the UF resin. Funk *et al.*, 2017 investigated the scavenging properties of an inorganic additive (nano-mesoporous diatomaceous earth) with and without urea for reducing the formaldehyde emission in particleboards.

In addition, the use of sodium metabisulfite ($Na_2S_2O_5$) and ammonium bisulfite ($(NH_4)HSO_3$) as formaldehyde scavengers in particleboards, produced with UF and MF resin was studied (Costa *et al.*, 2012; Costa *et al.*, 2013a) with promising results. The use of propylamine (Boran *et al.*, 2011; Ghani *et al.*, 2017), ammonium pentaborate (Gao *et al.*, 2015) and ammonium bicarbonate (Valyova *et al.*, 2017) were also reported to reduce formaldehyde emission. The incorporation of Al_2O_3 nanoparticles into UF resin was reported to reduce the formaldehyde emission in MDF panels at environmental temperatures (de Cademartori *et al.*, 2019).

The use of natural or bio-based formaldehyde scanvengers, such as tannin powder, wheat flour, rice husk flour, and charcoal, to reduce formaldehyde emission from wood-based panels and improve the adhesion properties, has also been studied (Eom *et al.*, 2006; Kim *et al.*, 2006; Kim *et al.*, 2007; Kim, 2009). The effect of tannin, extacted from the bark of white oak (*Quercus alba*) as formaldehyde scavenger in MDF panels was demonstrated by Boran *et al.*, 2012. Hoong *et al.*, 2010 indicated that condensed tannins have complex polyphenolic structure, giving higher reactivity towards formaldehyde, which makes them suitable for utilization in wood adhesives, resulting in finished products with low or nearly zero formaldehyde release after curing.

Bark flours, obtained from different tree species having high polyphenol content (walnut, chestnut, fir and spruce) also exhibited formaldehyde scavenging properties when added in the adhesive mixtures for bonding plywood (Aydin *et al.*, 2017; Ružiak *et al.*, 2017). The utilization of powdered beech bark was reported to reduce the formaldehyde emission from plywood by up to 74% while maintaining the good mechanical properties of the panels (Réh *et al.*, 2019). Other studies were implemented to analyze bark formaldehyde absorption in particleboards (Colakoglu *et al.*, 1993; Nemli *et al.*, 2002; Sari *et al.*, 2012; Salca and Hiziroglu, 2019), thermal insulation panels (Pásztory *et al.*, 2017) and decorative boards, based on European larch (*Larix decidua*) bark (Tudor *et al.*, 2020). The decrease in formaldehyde emission was attributed to the greater amount of polyphenolic extractives in bark than in wood. The effect of adding pine-cone flour into particleboards (Buyuksari *et al.*, 2009) and MDF (Ayrilmis *et al.*, 2009) on their formaldehyde release was investigated and significant decrease of formaldehyde emission was reported.

4. CONCLUSIONS

This article presents a review and analysis of the current state of research in the field of formaldehyde scavengers for achieving lower formaldehyde emission from finished wood-based panels. It was demonstrated that the addition of formaldehyde-scavenging compounds to the existing adhesive systems for wood-based panels is an efficient way to decrease formaldehyde emission levels from the finished products. It should be noted that performance of each scavenger is strongly dependent upon the formaldehyde test method and ambient conditions, namely temperature, relative humidity and air exchange rate, under which the panels are tested.

Other technological methods for decreasing the free formaldehyde emission include adding formaldehyde scavengers to wood finishes, application of suitable coatings, replacement of formaldehyde with a less volatile compound, and development of sustainable, formaldehyde-free bio-based wood adhesives.

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REFERENCES

1. Antov, P.; Mantanis, G.I.; Savov, V. (2020a): *Development of Wood Composites from Recycled Fibres Bonded with Magnesium Lignosulfonate*. Forests, 11, 613.
2. Antov, P.; Savov, V.; Mantanis, G.I.; Neykov, N. (2020b): *Medium-density fibreboards bonded with phenolformaldehyde resin and calcium lignosulfonate as an eco-friendly additive*. Wood Material Science and Engineering, https://doi.org/10.1080/17480272.2020.1751279.
3. Aydin, I.; Demirkir, C.; Colak, S.; Colakoglu, G. (2017): *Utilization of bark flours as additive in plywood manufacturing*. European Journal of Wood and Wood Products 75, 63–69.
4. Ayrilmis, N.; Buyuksari, U.; Avci, E.; Koc, E. (2009): *Utilization of pine (Pinus pinacea L.) cone in manufacture of wood based composite*. Forest Ecology and Management 259, 65–70.
5. Birkeland, M.J.; Lorenz, L.; Wescott, J.M.; Frihart, C.R. (2010): *Determination of native (wood derived) formaldehyde by the desiccator method in particleboards generated during panel production*. Holzforschung, 64, 429–433.
6. Boran, S.; Usta, M.; Gümüskaya, E. (2011): *Decreasing formaldehyde emission from medium density fiberboard panels produced by adding different amine compounds to urea formaldehyde resin*. International Journal of Adhesion and Adhesives 31(7):674–678.
7. Boran, S.; Usta, M.; Ondaral, S.; Gümüskaya, E. (2012): *The efficiency of tannin as a formaldehyde scavenger chemical in medium density fiberboard*. Composites Part B, 43, 2487–2491.
8. Bundesministerium für Umwelt Naturschutz und nukleare Sicherheit, Bekanntmachung analytischer Verfahren für Probenahmen und Untersuching für die in Anlage 1 der Chemikalien-Verbotsverordnung genannten Stoffe und Stoffgruppen. 2018, Bundesanzeiger, BAnz AT 26.11.2018 B2. Available online at: https://www.umwelt-online.de/recht/gefsto_/chemverb.vo/chvvanalyt18.htm (accessed on 9 June 2020).

9. Buyuksari, U.; Ayrilmis, N.; Avci, E.; Koc, E. (2009): *Evaluation of the physical, mechanical properties and formaldehyde emission of particleboard manufactured from waste stone pine (Pinus pinea L.) cones*. Bioresource Technology 101, 255–259.
10. Byung-Dae P.; Jae-Woo K. (2008): *Dynamic mechanical analysis of urea-formaldehyde resin adhesives with different formaldehyde-to-urea molar ratios*. Journal of Applied Polymer Science 108(3):2045–51.
11. Colakoglu, G.; Kalaycioglu, H.; Ors, Y. (1993): *Utilization of the bark of Turkish red pine on particleboard and plywood manufacturing*. International Red Pine Symposium, Proceedings, October 18-23, Marmaris, Turkey, pp.701-710.
12. Costa, N.: Pereira, J.: Martins, D.; Martins, J.; Ferra, J.; Cruz, P.; Magalhães, F.; Mendes, A.; Carvalho, L. (2011): *Innovative catalysts for urea-formaldehyde resins.* In: Caldeira F (ed) Minimizing the environmental impact of the forest products industries. University Fernando Pessoa, Porto.
13. Costa, N.; Pereira, J.; Ferra, J.; Cruz, P.; Martins, J.; Magalhães, F.; Mendes, A.; Carvalho, L. (2013a): *Sodium metabisulphite as a scavenger of air pollutants for wood-based building materials*. International Wood Products Journal. 4. 242-247.
14. Costa, N.; Pereira, J.; Ferra, J.; Cruz, P.; Martins, J.; Magalhães, F.; Mendes, A.; Carvalho, L. H. (2013b): *Scavengers for achieving zero formaldehyde emission of wood-based panels.* Wood Science and Technology, 47, 1261–1272.
15. Costa, N.; Pereira, J.; Martins, J.; Ferra, J.; Cruz, P.; Magalhães, F.; Mendes, A.; Carvalho, L. (2012): *Alternative to latent catalysts for curing UF resins used in the production of low formaldehyde emission woodbased panels*. International Journal of Adhesion and Adhesives 33:56–60.
16. de Cademartori, P.H.G.; Artner, M.A.; de Freitas, R.A.; Magalhaes, W.L.E. (2019): *Alumina nanoparticles as formaldehyde scavenger for urea-formaldehyde resin: Rheological and in-situ cure performance*. Composites Part B 176, 107281.
17. Dunky, M. (2003): *Adhesives in the wood industry*. Chapter 47 In A. Pizzi, K. L. Mittal (eds.) Handbook of Adhesive Technology (New York: Marcel Dekker), pp. 872–941.
18. Eom, Y-G.; Kim, J-S.; Kim, S.; Kim, J-A.; Kim, H-J. (2006): *Reduction of formaldehyde emission from particleboards by bio-scavengers*. Mokchae Konghak 34:29–41.
19. European Panel Federation (2018): *Autonomous agreement on a European Action Guide regarding the prevention of formaldehyde exposure in the European panel industry and compliance with the occupational exposure limits*, available online at: https://europanels.org/wp-content/uploads/2018/12/Action-Guide-on-Formaldehyde-signed-on-28-Nov-2018-in-Lisbon.pdf (accessed on 9 June 2020).
20. Ferdosian, F.; Pan, Z.; Gao, G.; Zhao, B. (2017): *Bio-based adhesives and evaluation for wood composites application*. Polymers 9, 70.
21. Frihart, C. (2012): *9 Wood Adhesion and Adhesives*. In: Rowell, R.M. (Ed.) Handbook of Wood Chemistry and Wood Composites. 10.1201/b124 87-13.
22. Funk, M.; Wimmer, R.; Adamopoulos, S. (2017): *Diatomaceous earth as an inorganic additive to reduce formaldehyde emissions from particleboards*. Wood Material Science and Engineering, 12(2), 92–97.
23. Gao, W.; Du, G.; Kamdem, D.P. (2015): *Influence of ammonium pentaborate (APB) on the performance of urea-formaldehyde (UF) adhesives for plywood*. The Journal of Adhesion, 91 (3), 186–196.
24. Ghani, A.; Bawon, P.; Ashaari, Z.; Wahab, M.W.; Hua, L.S. (2017): *Addition of propylamine as formaldehyde scavenger for urea formaldehyde-bonded particleboard*. Wood Research, 62 (2), 329-334.
25. Hemmilä, V.; Adamopoulos, S.; Hosseinpourpia, R.; Ahmed, S.A. (2019): *Ammonium Lignosulfonate Adhesives for Particleboards with pMDI and Furfuryl Alcohol as Crosslinkers*. Polymers 11, 1633.
26. Hemmilä, V.; Adamopoulos, S.; Karlsson, O.; Kumar, A. (2017): *Development of sustainable bio-adhesives for engineered wood panels-A review*. RSC Advances 7, 38604–38630.
27. Hoong, YB.; Paridah, MT.; Loh, YF.; Koh, MP.; Luqman, CA.; Zaidon, A. (2010): *Acacia mangium tannin as formaldehyde scavenger for low molecular weight phenol-formaldehyde resin in bonding tropical plywood*. Journal of Adhesion Science and Technology 24:1653–1664.
28. Hosseinpourpia, R.; Adamopoulos, S.; Mai, C.; Taghiyari, H. R. (2019): *Properties of medium-density fiberboards bonded with dextrin-based wood adhesives*. Wood Research, 64(2), 185-194.
29. IARC (2006): *Formaldehyde, 2-butoxyethanol and 1-tertbutoxypropan-2-ol*. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans 88: 1-478.
30. International Agency for Research on Cancer (2004): *IARC Classifies Formaldehyde as Carcinogenic to Humans*; IARC: Lyon, France.
31. Jin, Y.; Cheng, X.; Zheng, Z. (2010): *Preparation and characterization of phenol-formaldehyde adhesives modified with enzymatic hydrolysis lignin*. Bioresource Technology 101, 2046–2048.
32. Jivkov, V.; Simeonova, R.; Marinova, A.; Gradeva, G. (2013): *Study on the gluing abilities of solid surface composites with different wood based materials and foamed PVC*. In Proceedings of the 24th International Scientific Conference Wood is Good–User Oriented Material, Technology and Design, Zagreb, Croatia, 18 October 2013; pp. 49–55, ISBN 978-953-292-031-4.
33. Kelly, T.J. (1997): *Determination of Formaldehyde and Toluene Diisocyanate Emissions from Indoor Residential Sources (No. 97-9)*; California Environmental Protection Agency: Sacramento, CA, USA.

34. Kim, JS.; Eom, YG.; Kim, S.; Kim, HJ. (2007): *Effects of natural-resource based scavengers on the adhesion properties and formaldehyde emission of engineered flooring.* Journal of Adhesion Science and Technology 21(3–4):211–225.
35. Kim, S. (2009): *The reduction of indoor air pollutant from wood-based composite by adding pozzolan for building materials*. Construction and Building Materials 23(6):2319–2323.
36. Kim, S., Kim, HJ.; Kim, HS.; Lee HH. (2006): *Effect of bio-scavengers on the curing behavior and bonding properties of melamine-formaldehyde resins*. Macromolecular Materials and Engineering 291(9):1027–1034.
37. Kovatchev, G. (2018): *Influence of the belt type over vibration of the cutting mechanism in woodworking shaper*, In Proceedings of the 11th International Science Conference "Chip and Chipless Woodworking Processes", Zvolen, ISSN 2453-904X (print) ISSN 1339-8350 (online), pp. 105 – 110.
38. Kües, U. (2007): *Wood Production, Wood technology, and Biotechnological Impacts*; UniversitätsverlagGöttingen: Göttingen, Germany. Available online: https://univerlag.uni-goettingen.de/handle/3/isbn-978-3-940344-11-3 (accessed on 05 June 2020).
39. Kumar, R.N.; Pizzi, A. (2019): *Environmental Aspects of Adhesives – Emission of Formaldehyde*. In Adhesives for Wood and Lignocellulosic Materials; Wiley-Scrivener Publishing: Hoboken, NJ, USA, 2019; pp. 293–312.
40. Liu, X.; Mason, M.; Guo, Z.; Krebs, K.; Roache, N. (2009): *Gypsum Wallboard as a sink for formaldehyde*. In Proceedings, 2009 Healthy Buildings International Conference, Syracuse, NY, September 13 - 17, 2009. International Society of Indoor Air Quality and Climate (ISIAQ), Santa Cruz, CA.
41. Mantanis, G.I.; Athanassiadou, E.T.; Barbu, M.C.; Wijnendaele, K. (2018): *Adhesive systems used in the European particleboard, MDF and OSB industries*. Wood Material Science and Engineering 13, 104–116.
42. Myers, G.E. (1983): *Formaldehyde emission from particleboard and plywood paneling: measurement, mechanism, and product standards*. Forest Products Journal 33(5):27–37.
43. Navarrete, P.; Mansouri, H.R.; Pizzi, A.; Tapin-Lingua, S.; Benjelloun-Mlayah, B.; Pasch, H. (2010): *Wood panel adhesives from low molecular mass lignin and tannin without synthetic resins*. Journal of Adhesion Science and Technology 24, 1597–1610.
44. Nemli, G.; Kırcı, H.; Temiz, A. (2004): *Influence of impregnating wood particle with mimosa bark extract on some properties of particleboard*. Industrial Crops and Products 20:339–344.
45. Nordström, E.; Demircan, D.; Fogelström, L.; Khabbaz, F.; Malmström, E. (2017): *Green binders for wood adhesives*. In Applied Adhesive Bonding in Science and Technology; Interhopen Books: London, UK, pp. 47–71.
46. Papadopoulou, E. (2009): *Adhesives from renewable resources for binding wood-based panels*. Journal of Environmental Protection and Ecology 10, 1128–1136.
47. Park B.D.; Jeong H.W. (2011): *Hydrolytic stability and crystallinity of cured urea-formaldehyde resin adhesives with different formaldehyde/urea mole ratios*. International Journal of Adhesion and Adhesives 31(6):524-529.
48. Park, BD; Kang, EC; Park, JY (2008): *Thermal curing behavior of modified urea-formaldehyde resin adhesives with two formaldehyde scavengers and their influence on adhesion performance*. Journal of Applied Polymer Science 110(3):1573–1580.
49. Pásztory, Z.; Ronyecz Mohácsiné, I.; Börcsök, Z. (2017): *Investigation of thermal insulation panels made of black locust tree bark*. Construction and Building Materials 147, 733–735.
50. Peterson H.; Reuther W.; Eisele W.; Wittmann, O. (1974): *Zur Formaldehydabspaltung bei der Spanplattenerzeugung mit Harnstoff-Formaldehyd-Bindemitteln*; 3. Mitteilung: der Einfluss von Härterart, Härtermenge und formaldehydbindenen Mitteln. Holz als Roh- und Werkstoff 32:402-410.
51. Pizzi, A. (2006): *Recent developments in eco-efficient bio-based adhesives for wood bonding: opportunities and issues*. Journal of Adhesion Science and Technology 20: 829-846.
52. Réh, R.; Igaz, R.; Krišťák, L'.; Ružiak, I.; Gajtanska, M.; Božíková, M.; Kučerka, M. (2019): *Functionality of beech bark in adhesive mixtures used in plywood and its effect on the stability associated with material systems*. Materials 12, 1298.
53. Roffael, E. (2006): *Volatile organic compounds and formaldehyde in nature, wood and wood-based panels*. Holz als Roh- und Werkstoff, 64(2), 144–149.
54. Roffael, E.; Johnsson, B.; Engström, B. (2010): *On the measurement of formaldehyde release from low-emission wood-based panels using the perforator method*. Wood Science and Technology 44, 369–377 Sundin, B.; Roffael, E. (1989): Einfluß der Alterung auf die Formaldehydemissionen von UF-Spanplatten niedrigen Formaldehydabgabepotentials. Holz-Zent., Bl, 115, 704.
55. Ružiak, I.; Igaz, R.; Krišťák, L.; Réh, R.; Mitterpach, J.; Očkajová, A.; Kučerka, M. (2017): *Influence of Urea-Formaldehyde Adhesive Modification with Beech Bark on Chosen Properties of Plywood*. Bioresources 12, 3250–3264.
56. Salca, E.-A.; Hiziroglu, S. (2019): *Hardness and Roughness of Overlaid Wood Composites Exposed to a High-Humidity Environment*. Coatings 9, 711.
57. Salem, M.Z.M.; Böhm, M. (2013): *Understanding of formaldehyde emissions from solid wood: An overview*. BioResources 2013, 8, 4775–4790.
58. Sari, B.; Ayrilmis, N.; Nemli, G.; Baharoğlu, M.; Gümüskaya, E.; Bardak, S. (2012): *Effects of chemical composition of wood and resin type on properties of particleboard*. Lignocellulose 1, 174–184.
59. Schäfer, M.; Roffael, E. (2000): *On the formaldehyde release of wood*. Holz als Roh- und Werkstoff 58, 259–264.

60. SCOEL (2016): SCOEL/REC/125 *Formaldehyde. Recommendation from the Scientific Committee on Occupational Exposure Limits*. European Commission Directorate-General for Employment, Social Affairs and Inclusion Directorate B - Employment Unit B.3 - Health and safety.
61. Sundin, B.; Risholm-Sundman, M.; Edenholh, K. (1992): *Emission of formaldehyde and other volatile organic compounds (VOC) from sawdust and lumber, different wood-based panels and other building materials: a comparative study*, in: Proceedings, 26th International Particleboard/Composite Materials Symposium, Washington State University, Pullman, USA.
62. Taghiyari, H.R.; Tajvidi, M.; Taghiyari, R.; Mantanis, G.I.; Esmailpour, A.; Hosseinpourpia, R. (2020): *Nanotechnology for wood quality improvement and protection*. In Nanomaterials for Agriculture and Forestry Applications; Husen, A., Jawaid, M., Eds.; Elsevier: Amsterdam, The Netherlands, pp. 469–489.
63. Tudor, E.M.; Barbu, M.C.; Petutschnigg, A.; Réh, R.; Krišťák, Ľ. (2020): *Analysis of Larch-Bark Capacity for Formaldehyde Removal in Wood Adhesives*. International Journal of Environmental Research and Public Health 17, 764.
64. U.S. Consumer Product Safety Commission (2013): *An Update on Formaldehyde (Publication 725)*; U.S. Consumer Product Safety Commission: Bethesda, MD, USA.
65. Valyova, M.; Ivanova, Y.; Koynov, D. (2017): *Investigation of free formaldehyde quantity in the production of plywood with modified ureaformaldehyde resin*. Wood, Design & Technology, 6 (1), 72-77.
66. Widyorini, R.; Xu, J.; Umemura, K.; Kawai, S. (2005): *Manufacture and properties of binderless particleboard from bagasse I: Effects of raw material type, storage methods, and manufacturing process*. Journal of Wood Science 51, 648–654.
67. Zhang, W., Ma, Y., Wang, C., Li, S., Zhang, M., Chu, F., (2013): *Preparation and properties of lignin-phenol-formaldehyde resins based on different biorefinery residues of agricultural biomass*. Industrial Crops and Products 43: 326-333.

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NEW APPROACH TO WOOD DEFECTS DETECTION

Jambreković, B.; Veselčić, F.; Sinković, T.; Sedlar, T.

ABSTRACT

Modern wood processing requests access to wood with the aim of maximizing utilization of wood in qualitative and quantitative terms. One of main obstacle to this objective are wood defects which are unavoidable flaws in tree growth and development of wood matter (knots, cracks, discoloration, etc.). The demand for cost-effective and rapid production with as high economic utilization of raw materials led us to the development of high-tech scanners which identify the surface of wood elements more effectively than human eye. Information about identified errors from scanned surface of wood elements is instantly received. This information proposed us a model of cutting elements and associated classes with the aim of maximizing the qualitative or quantitative utilization. Considering that all wood defects from discoloration to cracks are computer programmed with objective view, we are left to assume that the observers will not just look at certain wood element as well as scanner. Their observation is subjective and a matter of the experience and perception of certain changes or anomalies on wood element. The aim of this study was to determine wood defects with industrial scanner as an objective observation and detecting wood defects with human eye as an subjective perception of certain wood defects having regard that human eyes also have its own limits. Wood defects were investigated on wood elements from Slavonian oak (Quercus robur L.).

Key words: human eye scanning of wood, industrial scanning of wood, Slavonian oak (Quercus robur L.), wood defects

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COST EFFECTIVENESS OF REINFORCING OAK WOOD SCANTLINGS BY COMPOSITE

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ABSTRACT

This paper presents a comparative study of two types of metal reinforcements (aluminium and steel), two types of fibers and their combinations (carbon, glass) and two types of adhesives (epoxy and polyester) to improvement of flexural stiffness of oak wood laminated beams.

Four point bending tests were executed on both, unreinforced and reinforced oak wood beams. Testing programme has consisted of two phases: 1. stepwise increase of load was interrupted with a 10 seconds break at 4, 9, and 14 kN and gradual unload to nearly 0 kN, followed by 2. gradual increase of load until failure. The aim of such an approach was to enable a precise monitoring of the deflection at specific load and comparison of different reinforcing schemes at lower levels of load (within the elastic area). Monitoring the residual deflection after releasing of the load gave us insight of the efficiency of reinforcing system to short term load, and to serve as a pre-test for the phase 2: load to failure.

Effectiveness of different materials presented in this paper is not only evaluated in terms of the improvement of mechanical properties of the beams (e.g. load – deflection, deflection after release of the load or at failure), but in terms of cost effectiveness of these materials as well. A term "cost effectiveness" here presents the relation between material cost and enhancement of mechanical properties of reinforced timber scantlings which should help at deciding on the selection of materials with adequate performance/cost ratio.

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FACTORS AFFECTING THE SURFACE FINISHING OF OSB AND PARTICLE BOARDS

Copak, A., Jirouš-Rajković, V., Španić, N., Miklečič, J.

ABSTRACT

The oriented strand boards (OSB) and particle boards (PB) have a wide range of applications because they are cheaper material than solid wood and most other engineered wood products. OSB is used in interior and exterior, while particle boards are mostly used in the interior. Furthermore, particleboards are commonly used in furniture production, while OSB is mostly used as sheathing for roofs and walls, subfloors, and single-layer flooring. Surface finish of OSB and PB with coating materials are very rare, and there is limited information about the interaction between coating and surface of OSB and PB. Moreover, OSB is most used as a non-finish board, while particle boards are mostly covered with overlay paper or foil. The objective of this paper was to study the interaction of different coating systems with OSB and PB surfaces. Three types of the board surface preparation were tested: raw, sanded and reheated in press. After surface preparation, board samples were finished with water-based and solvent-based coating systems. Methods for characterization of boards surfaces were hardness of a material, wetting angle and surface roughness. On finished samples, dry film thickness, adhesion, water absorption, and their aesthetic properties were measured. The results of this research showed significant differences between coated and uncoated samples and between different coating systems.
Keywords: OSB, particle boards, roughness, adhesion, water absorption

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SMART HOME AS CLEVER AND HEALTHY CO-LIVING CONCEPT FOR ELDERLY

Kitek Kuzman, M., Ayrilmis, N.

Abstract: Smart home as a clever co-living concept for elderly could be the future solution for the ageing population, while promoting healthy and safe ageing. It includes the wooden smart furniture, latest equipment, technical aids and rehabilitation technology, which improves the elderly with enriched quality of life and assure their optimal occupational, educational and social integration in society. Improving comfort, accessibility, functionality, and safety at home, at work and in society in general requires combining many disciplines together to develop solutions that integrate ICT, ergonomics, healthcare (psychological and physical), building, and community design. Since the built environment directly affects user health in many ways, wood is an ideal material for restorative environment and ergonomic design. A case study project, Smart Home 'Independent Residing enabled by Intelligent Solutions', will be presented as a clever co-living concept.
Keywords: smart home, elderly, furniture

1. INTRODUCTION

The number of senior citizens is rapidly increasing in many parts of the world, which consequently signifies an increase in the number of people having hampered mobility, sight, hearing, or memory difficulties, and the number of people who find increased difficulties processing information. These challenges and additional requirements have to be addressed by designers of living quarters for the elderly and disabled. In particular, how to facilitate movement for people with disabilities and how to improve their quality of life in general. The majority of flats are designed for young, fit, and active people. Many senior inhabitants do not possess the same attributes, meaning that even performing the simplest home tasks is more challenging for them. Furthermore, inappropriately designed housing space can lead to health issues, such as backache, injuries or accidents (West and Emmitt, 2004).

Products today are designed for healthy and young, active people with normal physical abilities. Many elderly and disabled people do not have the skills to use such products to their full extent, therefore, house chores present greater strain and discomfort for them. Due to inappropriately designed living space, this causes additional health problems like back pain and injuries that emerge at accidents (Hrovatin et al., 2012).

1.1. Aging population in a context of Megatrends

The innovation pipeline is long and must be fed continually with new ideas to sustain multi-year new product development. Global megatrends represent changes in our world that have a sustained impact on everyone. There are many online references and reports that discuss their importance. Understanding how these megatrends impact business can provide insight and inspiration into future product portfolio. While one can argue which megatrend(s) will be
the most influential, there is no doubt they paint an interconnected narrative that will have implications for product development. Drilling down into each megatrend can reveal opportunities for innovation (Androsch and Redl, 2019).

- Digitalization has brought us the internet-of-things, artificial intelligence, augmented reality, 3D printing, and sophisticated robots. These tools can strengthen brands by creating product visualization applications, enterprise manufacturing and quality systems, robotic painters, and new types of polymers to literally print a structure in-situ
- The aging population has resulted in an increased focus on everyone staying healthy longer. Consumers are more concerned about the toxicity of things in their home, and this may influence their buying decisions.
- The shift in global economic power has created wealth in previously poorer regions and changed supply chain logistics.

- Connected customers means on-demand access to information and products at the touch of a button. It has created the ability to instantly comparison shop and make decisions on what to purchase and how to pay for it.
- The lower demand for oil and the increasing demand for alternative sources of energy from wind, solar, battery technology, and geothermal will continue. We already see a shift to more efficient means of transportation in battery-powered vehicles, self-driving cars, trucks and trolleys, and phone apps like Uber and Lyft, that provide us with convenient transport.
- As climate change continues, natural disasters and abnormal weather patterns have resulted in water scarcity, flooding, forest fires, resource and food scarcity, and infrastructure damage.

Understanding how these megatrends impact business and product development can provide a window into the future (Figure 1).

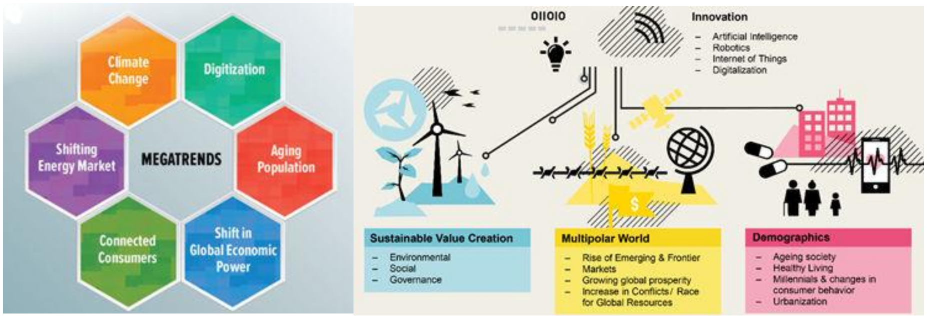


Figure1. Global megatrends represent changes, drive innovations in our world that have a sustained impact on everyone.

1.2. Smart wood furniture

It is important to identify the available technologies, the needs of the elderly, their behaviour, psychological and ergonomic needs in order to define key design aspects that need to be implemented in the design of smart furniture and its integration into a smart habitat. Smart furniture will help to create the most comfortable and cosy living space through innovative, trendy and well-designed solutions.

There are many researches looking toward establishing a model for a participatory and integrative design when designing smart furniture which will be based on defined design criteria. This would enable the development of novel research ideas that generate fixed and moveable furniture. This would help the elderly to define their expectations and needs clearly, which will greatly help to identify design and performance issues at the earliest stage of design projects. Before we start to design the ambients with smart furniture for the elderly people we should take into consideration the following rules:

– Appropriate materials considering the configuration, security, cleaning and manipulation of the funiture,
– Incoporate the inteligent technology a much as possible,
– The organisation of furniture elements in space has to be adapted with the requirements of the senior users in mind.
– Future rooms/ambient design has to include robots, computer regulation, advanced mechanisms and modern nano films on surfaces to simplify everyday chores and ensure better hygiene standards.
- Use wood as an element of restorative environment and ergonomic design (REED). Wood is an ideal material for REED because it satisfies both general tenets of the design paradigm: sustainability and a connection to the nature. Wood from healthy, well-managed forests is a sustainble material, and provides carbon storage in form of dutable products. When used in appearance applications, wood also provides a connection to nature.

2. A CASE STUDY PROJECT: SMART HOME IRIS, SOČA UNIVERSITY REHABILITATION INSTITUTE

A case study project, Smart Home IRIS (Independent Residing enabled by Intelligent Solutions), will be presented as a clever co-living concept. Smart Home IRIS is equipped with state-of-the-art communication technology adapted to different types and levels of disability. The purpose of Smart Home IRIS at Soča University Rehabilitation Institute is to demonstrate adaptations of an elderly apartment and the use of contemporary technology and equipment in the elderly's home environment, as well as to demonstrate and enable testing of various assistive technologies and solutions that would enable the elderly to have maximum functional independence and safety in their home environment (Figure 2).

Figure 2. Presentation of the latest equipment, technical aids and rehabilitation technology improving quality of life of elderly: living made easy adaptable wooden kitchen, working place, safety products in elderly bathroom.

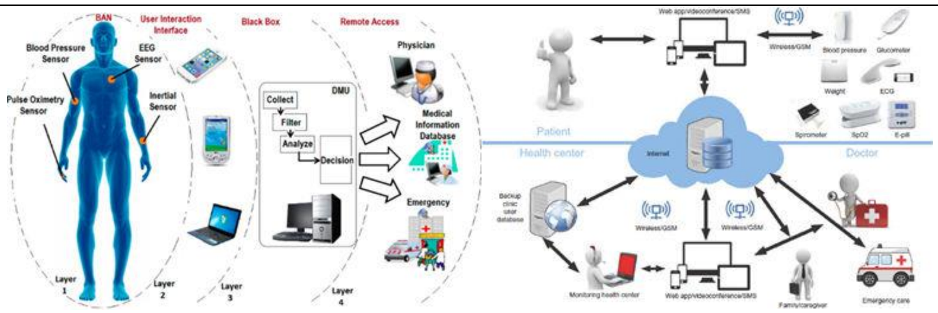
The CoLIVING ICT-based services address the three main areas of the elderly social interaction context: 1) care and wellness, 2) guidance as a daily tasks assistance and 3) mobility monitoring.

As the development of assistive technologies and smart home technologies is spreading, and rehabilitation professionals all over the world are becoming aware of the benefits of assistive technologies, continued research in this area is essential (Encarnação et al., 2013).

1.2. Future clever co-living concept- smart home

– To provide an opportunity for people with disabilities and the elderly to try out and select technical solutions in the demonstration apartment for their respective disabilities in order to maximize functional independence in their home environment;
– To advise elderly, along with their care givers, on the most rational and economic adaptation of their current living quarters with regard to their particular needs;
– To provide equipment manufacturers and service providers, in the field of rehabilitation technology, the opportunity to promote and test their solutions in the integrated environment of the demonstration department;
– To create new opportunities for researchers and developers in the fields of e-accessibility and e-inclusion in Slovenia and elsewhere
– To facilitate activities for the promotion of a e-accessibility policy in Slovenia and elsewhere.
– To facilitate public access in Slovenia the demonstration of contemporary technology that assist people with diverse disabilities and the elderly (Figure 3).

The users of Smart home IRIS are people with different disabilities and elderly, professional organizations use the demonstration facility for training and planning of diverse activities for the users, the general public interested in familiarizing themselves with the requirements of patients and elderly and the technical solutions for their needs as well as designers of similar facilities, especially architects, interior designers and suppliers of equipment, responsible for the technical documentation of new housing or adaptation of existing housing, to meet needs and demands of IRIS users; students of medicine, social services and supportive technology.



a b

Figure 3: a) Health monitoring system b) Scheme of a home telecare system (Bujnowska-Fedak and Borkowska, 2015)

CONCLUSION

Most elderly who would like to renovate their home in order for it being used for the rest of their lives, do not have enough information and experience to consider ergonomic adaptations for specific needs of old age. Manufacturers should design furniture systems that will allow for implementation adapted for special needs and should inform buyers more about the significance of an adequately furnished ambients, heeding the needs of advanced age. In spite of the initial high costs for technology, in the long run investment will reduce public expenditures for the social and medical care of elderly. Smart home as a clever, healthy co-living concept for elderly home is one possible example of future co-living concept for elderly.
Immediate goals of presented Smart Home as a clever co-living concept are to facilitate greater independence among all user groups, to reduce the cost of home-care, to improve the user safety, to reduce the need for re-location to retirement homes and other suitable institutions and to create modular solutions that can be applied in diverse user environments (private living quarters, social institutions, retirement homes, etc.).

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REFERENCES

1. Androsch, F.M.; Redl, U. (2019): How Megatrends Drive Innovation. BHM Berg-und Hüttenmännische Monatshefte. 165, pp. 479-483.
2. Bujnowska-Fedak, MM.; Grata-Borkowska, U. (2015). *Use of telemedicine-based care for the aging and elderly: promises and pitfalls. Smart Homecare Technology and TeleHealth.* vol 2015:3, pp. 91-105.
3. Encarnação, P., Azevedo L, Gelderblom GJ, Newell A. (2013): *Assistive Technology*: *From Research to Practice*. IOS Press BV, Netherlands.
4. Hrovatin, J.et al. (2012): *Furniture for Elderly People in Terms of Safty*. Drvna industrija 63(2): pp. 113-120.
5. West BN, Emmitt S. (2004): *Functional design? An analysis of new speculative house plans in the UK*. Design Studies. 25: pp. 275-299.

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CROATIAN TRADITIONAL CONSTRUCTION AND HERITAGE AS INSPIRATION FOR THE DESIGN OF CONTEMPORARY MODULAR DISPLAYS FOR PUBLIC EVENTS

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Abstract: Globalization and the modern way of life has led to new type of pure architectural and aesthetics standards and along the way they removed the distinctive elements of tradition in the interiors and exteriors of rural and urban buildings. The value and appreciation of traditional building and interior design based on rich and specific heritage in Croatia is often neglected today as well. At the same time, local public events such as Advent events, Christmas fairs, summer festivals or other themed events usually need small movable cottages/displays used as a booth for all kind of shops for goods and services. Those booths are often impersonal so the tourists can't feel the impression of culture or heritage of the city. The aim of the paper is to collect and present visual, aesthetic and particularly wooden constructional details used in traditional constructions in different Croatia regions as the main inspirations for the next step in design concepts of local stands. To reach the goal, different literature and data will be reviewed, photos will be collected and a few experts in the field of heritage, traditional construction and interior design will be interviewed. The data presented will be used as the main inspirations for the design of a small and movable contemporary stand for public spaces based on stylistic, aesthetic and structural components specific to each studied region of Croatia.
.**Keywords:** traditional wooden construction, heritage, design, small houses, contemporary displays

1. INTRODUCTION

In a relatively small geographical area such as Croatia, there is a great amount of different types of buildings that represent the vast variety of traditional heritage (Živković, 2013). The main reason for this variety is the specific geographical location and availability of materials for the construction of residential and commercial buildings. The traditional architectural heritage of the Republic of Croatia is rich, yet often a neglected topic in many places. The current literature discovers and describes numerous examples of Croatian traditional architecture (Freudenreich, 1972; Salopek et al., 2006; Živković, 2013), but there are no examples in which traditional knowledge is applied in modern design solutions for the construction of public buildings.

Over the centuries, a specific way of building houses and farm buildings has developed in Posavina, which in terms of form has resulted in a certain autochthonous architectural expression (Somek, 2013). Without major foreign influences, the construction of residential and commercial buildings in Posavina is primarily the result of function, available material and the craftsmanship of assembling wooden elements (Salopek et al., 2006).

Builders and creators of traditional houses are anonymous today, but we know that they were carpenters, masons, trained peasants, taught by tradition and guided by the functional requirements of living and aesthetic understandings of the rural environment. However, a touch of individuality is often apparent, that is, it is present in many specific details and solutions on the structures and which emphasize the creative power of the individual (Somek, 2013). In the 19th century, there were entire branches of local independent craftsmen in Croatia. These were more skilled craftsmen from villages who were taught craftsmanship and knowledge by older generations. They mastered old techniques due to tradition and sometimes even learned some methods originating from urban environments or other neighboring cultures (Marković, 1989).

1.1. The aim of the research

The aim of the paper is to collect and present visual, aesthetic and particularly wooden constructional details used in traditional constructions in Croatian Sisak-Moslavina County and Lonjsko polje regions as the main inspirations for the next step in design concepts of local stands.

2. MATERIALS AND METODS

The research was conducted in June 2020 at the sites of the Sisak-Moslavina County of the Republic of Croatia, in the area of Lonjsko polje park and the Čigoč and Krapje villages.

The two main methods of collecting data in this research were the collection of photo documentation for its later analysis and an interview with a specialized guide at the Lonjsko polje site. The interview helped to explain the details and history of traditional architecture found in the observed locations.

All pictures presented in the paper are made by co-author Robert Roginić.

3. RESULTS AND DISCUSSION

The collected results of the site survey are shown in Figures 1 - 5 and analyzed below. It can be seen that the plots of family farms in Krapje and Čigoč are rectangular in plan, where the narrower side is located along the street, and the longer side is perpendicular to the street. That kind of plot shape had conditioned the shape of the family houses, which are narrow and long (Figure 1).

According the founded literature and interviewing the guide, residential houses (cro: *hiža, iža, kuća na trem, čardak*) in Posavina are mostly two-story, but can also be single-story houses with different floor plan dimensions and room layouts. The vertical development of houses in the area occurred due to floods that occurred several times a year until the regulation of river flows that began in the second half of the 19th century (Živković, 2013). Vertically, the house is divided into the following areas: ground floor as an area used for all kinds of work purposes or as a craft room, first floor as a residential area and an attic.

The rooms on the ground floor were never used for housing, nor for storing produce or more important household items. The ground floor was used to store items that would not be damaged by the flood such as: tools, plows and other equipment used for farming, which could be easily evacuated if necessary in the event of a flood. Only recently have some owners, who have decided to live in their old wooden houses, adapted the ground floor rooms for the kitchen and living room for easier access to the yard.

Figure 1. Traditional house in Krapje

Upstairs, the room nearest to the street is the largest. It was also known as the family room (Živković, 2013). The other part of the room was the kitchen and on the opposite side, there was a smaller pantry room which was used for storing food. The toilet is usually upstairs, at the end of the hallway, and protrudes from the volume of the house. It is designed in this way so that faeces can fall through a hollow trunk or through space surrounded by vertical planks into the toilet pit next to the house. The attic was never used for housing.

There are two ways of vertical connection of the living space on the first floor with the ground floor, i.e. with the yard. It is always connected with straight wooden stairs, more often with exterior (always covered), less often with interior stairs. In the latter case, the staircase, in addition to its roof, connects the access space on the first floor, and sometimes a special small roof at the beginning as well, which gives the house a special air of playfulness or spaciousness. In the design of houses, the main feature is a covered hallway or a porch (cro: *ganjek, gank*), which extends along the courtyard façade of most houses, and serves for communication between the interior and exterior. The porch, usually with wooden columns, can be completely open to the outside, enclosed by a wooden fence (semi-enclosed) or completely enclosed by wooden paneling.

The roofs of Posavina houses are two-sided, and are covered with so called *biber* roof tiles if they have been renovated in recent times. They have a steep slope (from 45 to 60 degrees) and are built with common rafters with a distance of about 1 m. In such a structure, the roof load is transferred to the outer longitudinal walls, and a wooden ceiling beam transversely connects them and stabilizes the roof structure. The longitudinal beam that extends longitudinally in the middle of the house (cro: *tram, sleme*) supported the ceiling beams and was indispensable to the Posavina houses. The beam protrudes slightly on the external side of the façade at the front, main gable facing the street and it is characteristically decorated. A sacral sign and/or year of construction, initials of the owner or carpenter etc. were often engraved onto the beam in the middle of a large house.

In the case of two-story buildings, eaves (cro: *krovci*) were built around the perimeter on the level of the ground floor ceiling to protect the ground floor walls from rainfall (Figure 2). Roof rafters usually lean on the purlins which are typically decorated with moulding on the drip side. The purlins rest on the cantilevered ground floor ceiling beams. The same applies for the protective eaves in the floor ceiling area. In more modest buildings, the roof rafters rest on the wall of the house over the short diagonal struts.

The inside walls of the house are lined with a mixture of clay and chaff which was put on the prior placement of willow or hazel branches. The clay plaster was painted with lime. The floors are boarded with a compacted earth layer for thermal protection.

Posavina houses are also characterized by excellent artistic design, which is especially evident in the decorations made by a jour carving or cutouts painted with regular or stylized geometric motifs. Decorations most often embellish porches, gables, window frames and the main longitudinal beam (cro: *sleme*).

Figure 1. Traditional house in Čigoč

In the Posavina area, the buildings were made out of pedunculate oak, which could be cut in forests that spread in flood-prone areas along the Sava, Lonja, Odra and other streams of these rivers. In the past, the peasants had certain rights to use these forests, which is why they could cut as much construction wood as they needed to build a house (Freudenreich, 1972).

The basic building elements were oak planks that were stacked horizontally and joined with wooden wedges. The planks were previously sawn and then processed with a hand planer. Angular joints were made in two ways, the so-called Croatian or German type of joint, shown in Figures 3 and 4.

Figure 3. "German" joint, Čigoč

Figure 4. "Croatian" joint, Čigoč

If the planks were not long enough, which was often the case, then the elements were joined lengthwise to the oblique fold shown in Figure 5.

Figure 5. Longitudinal joining of planks

Originally, the houses were built above the ground on wooden, or sometimes stone columns called *bapke* to protect against floods. They were later replaced by brick pillars, and eventually, the foundations were built entirely out of brick (Živković, 2013).

4. CONCLUSION

Croatian traditional heritage is rich in wooden elements and construction details that give the buildings a recognizable visual aesthetics and design, depending on the locality in which it was built. This paper represents the first analyzed location in a series of a few other locations in the Republic of Croatia, and includes Sisak-Moslavina County and the area of Lonjsko polje and surrounding villages. In these villages, Čigoč and Krapje, Croatian traditional houses are still preserved, worth mentioning, observing and further analysing in order to apply in the designing contemporary solutions for buildings of modern purpose. Traditional construction is an underrated topic in the contemporary context. Through adequate analysis of existing solutions and consideration of modern requirements, an appropriate solution could be reached that will simultaneously meet the needs of people and preserve cultural identity.

The collected photo documentation and knowledge presented in this paper will be used in the future design of contemporary modular displays for public events.

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REFERENCES (alphabetical order)

1. Freudenreich, A. (1972): *Kako narod gradi* [How the People Build]. Zagreb. Institute for the Protection of Cultural Monuments
2. Marković, K. (1989): *The Master Carpenters of the Traditional Architecture in the Commune of Velika Gorica,* Radovi ipu 12(13), pp. 287-293
3. Salopek, D.; Petrić, K.; Mlinar, A.; Horvat, M.; Mavar, Z.; Rajković, V.; Gugić, G. (2006): *Traditional wooden house of Posavina: handbook for restoration*. Zagreb: Croatian Ministry of the Sea, Tourism, Transport and Development, Croatian Ministry of Culture
4. Somek, P. (2013): *Traditional Building of Rural Structures in Podravina*, Podravina 12(23), pp. 52-69
5. Živković, Z. (2013): *Croatian traditional architecture*. Zagreb: Croatian Ministry of Culture, Directorate for the Protection of the Cultural Heritage

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EDUCATIONAL FURNITURE FOR UNDERDEVELOPED COUNTRIES

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Abstract: School furniture is one of the most needed item that is still missing in underdeveloped countries. Education of our children makes the society more competitive and adjustable to new situations. Those who are in need of educational furniture are mostly located in Africa, south-east Asia, south and central Americas but also in some European countries or countries in desperate need of resources caused by war or natural disasters. Current World wide pandemic situation makes the situation even worst therefore some communities may need this kind of furniture as well. Goal of this article is to present possible way of "self-made" furniture based of very fundamental technologies and local resources. In the past when our Earth was not so dependent of global economy and transportation of goods we were able to help ourselves. Therefore the solution can be found either in the history or in the skilled people homes that did not forgot their knowledge and traditions. Example of construction and techniques presented in this article was designed for Africa (Zambia). It demonstrates what different material and skills out of industrial world can be useful and to help those who desire to be educated.
Keywords: furniture, education, chair, Africa

"Man is a tool-using animal. Without tools he is nothing, with tools he is all."
Thomas Carlyle (1833)

1. INTRODUCTION

To introduce the problem, Jeníček and Srnec (2012) stated: more than 75% of the total world population live in developing countries, the higher proportion of which live in South Asia, and the least in Arabic countries. There is no specific definition of developing or an underdeveloped country to tell us which one is developing, being underdeveloped and which ones is already developed. In the past, there was a big emphasis on the economic and industrial growth. The most wide-spread tool is the Human Development Index (HDI). HDI reflects both economic and social aspects of development. It includes education levels, the average life expectancy and *„the standard of living which is measured by the income per 1 inhabitant, represented by the GDP (Gross Domestic Product) per capita and year in the purchasing power parity."* Therefore, we may state that a developing country is a country with low living standards of the population, undeveloped industry and a low HDI.

There is a persistent shortage of school furniture because it is one of the most expensive components of child education. It has the lowest priority as far as budgets are concerned. As well as its quality is usually very bad and it needs a frequent replacements. The service life of the furniture is usually from one to three years (Haviarova, 2000).

Further, we will focus on Africa, specifically Zambia. Here are some of the findings about Africa that may change our perception. Africa is not all about poverty, as many people things. It is extremely rich in resources both human and natural. People often give money in an attempt to make them feel good. The governments are often incompetent and corrupt. The intended recipients of aid are not at fault. One of the best ways to help is empowering a local individual. Invest time in teaching and learning with that person so he can pass the knowledge on to others in the community.

More than 2 trillion US$ of foreign aid has been transferred from rich countries to poor over the past fifty years – Africa the biggest recipient, by far. Yet regardless – aid has failed to deliver the promise of sustainable economic growth and poverty reduction. (Moyo, 2009)

Zambia is known for the largest waterfalls, the wild Zambezi River, beautiful lakes and wetlands, many birds and wildlife and unspoiled wilderness. Approximately 57% of Zambia's land area is forested, although there is no primary forest remaining. It was one of the top 10 countries for deforestation between 2000 and 2006, (Njovu, 2004).

Primary education is available for most young people. More than 75% of adults are literate. Lower education in Zambia is divided into three levels; primary (1st - 7th grade), junior secondary (8th -9th grade) and upper secondary (10th – 12th grade). However, schooling is only free up to year seven and most children drop out then. Both government community and private schools exist in Zambia. Private schools operate under either the British or American way of schooling. Most Zambians can't afford higher education. Cecily's Fund is one of the supporters of education in Zambia, funding the school courses of over 11,000 children (Nkamba and Manyika, 1998).

2. THE GOAL

There is a need to design furniture that would be specifically suitable to school needs and that can be constructed from locally available resouces by local industry using only low-technology processes. The construction techniques presented in this work are not limited to the designs. They can be applied to a wide variety of designs as long as the basic principles presented are followed.

2.1. Construction and technology

Mortise and tenon joinery has been used for furniture construction through the ages. It is one of the oldest methods of joining wood developed many centuries before metal was used as a fastener. Most people think of a mortise and tenon joint as a square peg in a square hole, but there are also round pegs in round holes. The mortise and tenon joinery method produces one of the strongest joints in woodworking for angled joints. A simple mortise and tenon joint consists of a protrusion (the tenon) that is inserted into a hole of corresponding size (the mortise), which has been cut or drilled in the mating piece of wood. The secret to a well formed joint is the snugness of the fit. The tenon must be a neat fit into the mortise for the joint to be strong. A rule of thumb says that the tenon width should be one third the width of the timber into which it is to be fitted. There are different types of mortise and tenon cuts, but they serve the same purpose Some designs are stronger than others, and different cuts are used to conceal joint construction.

Rounded joint version has been used for years in the construction of Shakers Furniture. For our construction it would be the most suitable to use the round tenon and mortise joints as well as they are simple to cut with deep hole saws and mortises are simple to machine with conventional wood bits. Moreover those are relatively easy to fit together. Additionally, shrink and swell fit construction might be used to get strong and durable furniture. This method of construction is effective both in constructing very strong side frames and in joining side frames together to form complete chair or table frames. Performance tests showed that properly designed chairs constructed with round mortise and tenon joints were both strong and durable. What is even more important that they were highly resistant to cyclic loading that would be associated with high level of usage (Haviarova and Eckelman, 2006).

On the low industry production level, a simple table saw and a device for cutting round tenons are needed. Although a drill press or wood lathe may be substituted for the latter device. A small jointer is extremely useful as it can also cut rabbets, tapers, bevels, and chamfers. A small thickness planer is also useful, but not essential. The chairs can be constructed in batches by semi-skilled student labor under conditions similar to those that might be expected in "cottage" industries. Although the process is low technology, it is most labor intensive. The small parts could be machined from sawmill waste. Parts such as table legs and back posts of chair might be sawn from small stems.

2.2. Furniture design

The furniture should be modular in design, with many interchangeable parts so that any desired functional design can be assembled from a common pool of parts. The design should also by appropriate to the production technology of the region. Many parts as well as some complete pieces can be produced by local cottage industry, whereas other parts and completed pieces could be designed to utilize factory production.

The chair would have either a straight or angled back. However practical considerations prefer to use straight rather than angled back post. The seat should have a slight front to back slope. The seat should cover the tops of the front posts. The design is based on round and mortise construction as it is strong, durable, easy to assemble and manufacture. The furniture would be designed for children in the 9 – 10 year-old (height of the seat about 355 mm), but essentially it can be scaled to size of all grades. The chair would have three side stretchers and a front stretcher and front rail to ensure requiring strength. The last but not least the chair would have a back stretcher and top and bottom back seat rails, a top rail and a back seat. Construction must be kept simple, as there is limited equipment.

Presumably, most of the furniture constructed of squares would be of stretcher and post construction in which stretchers with turned pin ends are used to join the posts together to form three-dimensional frames. This construction has many advantages. Individual parts are easy to machine from stems. Construction of joints is relatively simple. Holes must be drilled in the posts at the appropriate locations and pins must be turned or cut on the ends of the stretchers. The walls of the holes are coated with adhesive, and finally, the frame is assembled with a „swell“ fit between the tenons and the posts. A tight fit between these parts is useful in that it eliminates the need to clamp the assembly while the adhesive dries (Haviarova, 2000).

2.3. Material

The furniture can be manufactured from local woody materials, wood residues, pallet deckboards or plantation thinning. Parts needed for the construction of the chair, desk and table may be cut from conventional sources of material such as lumber obtained from sawmills. Most of the parts may be cut from wood waste discarded by sawmills, while other parts may be fabricated from low-cost semi-processed wood materials such as pallet deck boards. When portable thin-kerf sawmills are available, woody plantation thinnings may be processed into slats, boards, and squares that are suitable for converting into furniture parts.

When none of these sources are available, school furniture can be constructed from small round woody stems, obtained either from natural growth or from small tree plantations planted specifically to provide such material. The most common material, particularly in remote regions would be small woody stems obtained from plantations (Eckelman et al, 2001). The problem might be that the smaller the stem, the greater the waste is. This type requires that stems are largely free of growth stresses, have low shrinkage coefficients, and exhibit minimum juvenile wood characteristics. Ideally the wood should also have good steam bending characteristics. The moisture content of the parts at time of machining and assembly is recommended to be at 7 - 8 percent.

3. DESIGN FOR ZAMBIA

In Zambia there are over 55 000ha of industrial forest plantations. The species used have mainly been Pine (79%) and Eucalyptus (20%). Currently the commercial plantations are being reduced, as there has not been enough replanting and expansion.

The major consumers are the industrial sector and households, although the utilization rate has been very slow due to a number of factors such as weak domestic demand and undeveloped export markets (Sekeli, P.M. and Phiri, M. 2002). Dry forest resources are important engines for growth and poverty reduction in Zambia. These could possibly provide the basis for sustainable development and improve rural livelihood (Jumbe, 2004).

Final design of the furniture for educational needs was therefore constructed out of Pine. Pinus Oocarpa and Pinus Kesyia is spreaded in south Zambia, region Choma, where our project started. Dimensions (in mm) and design is shown on Figure 1.

4. CONCLUSION

Concerned by increasing poverty and social exclusion around the World, and by the inadequate emphasis so far placed on skills and training as a critical component of any strategy for tackling the problem it was decided to offer training facility to teach carpentry and craftwork in Africa.

In the context of mass poverty in most developing countries, the critical role of training in furnishing badly needed skills to improve productivity, incomes and equitable access to employment opportunities seems particularly obvious and straightforward.

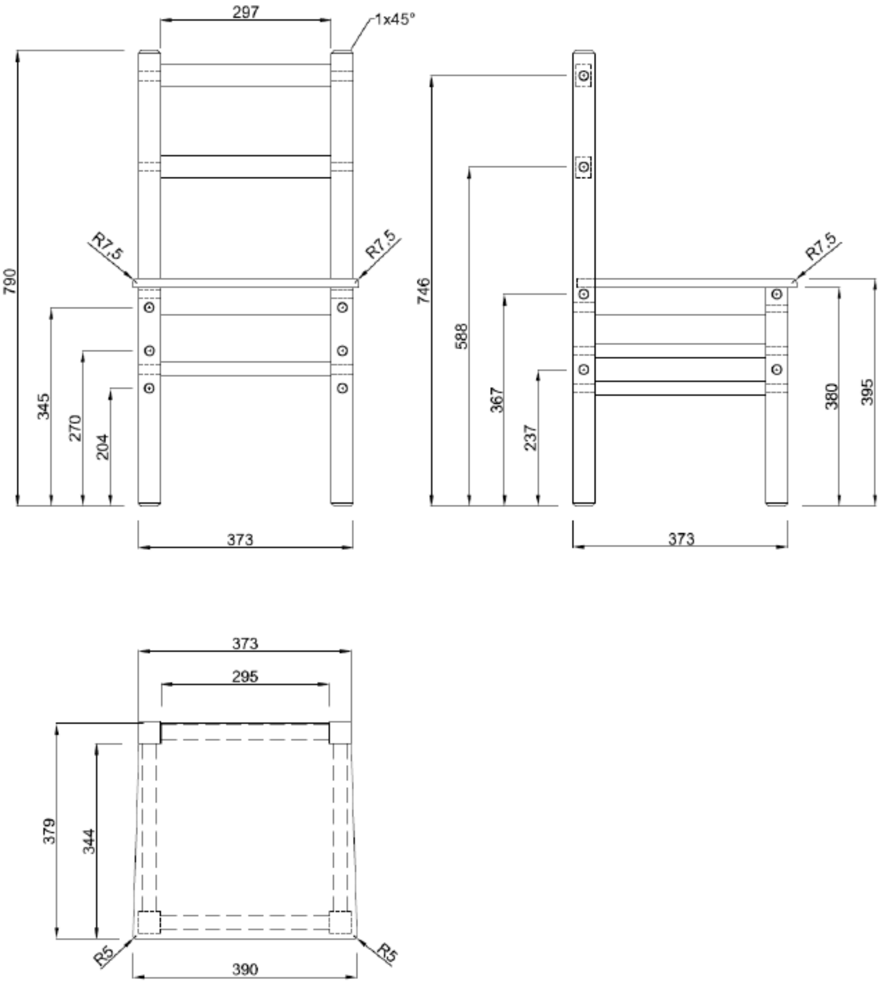

Figure 1. Chair design for educational purposes

As we found out Zambian government would probably not welcome our attempt to help as it is very protective of their own training programs. If possible, it is effective to start by encouraging the authorities to participate in that development process. There is also enormous risk of health problems and bureaucratic scrambles that needs to be taken into account.

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REFERENCES

1. Eckelman, C.; Haviarova, E.; Zui, H.; Gibson, H. (2001): *Considerations in the design and development of school furniture for developing regions based on local resources.* Forest Products Journal 51(6), p.56-63.
2. Haviarova, E.; Eckelman, C. (2006): *Performance tests of school chairs constructed with round mortise and tenon joints.* Forest Products Journal 51(5), p.79-88.
3. Haviarova, E. (2000); *Design and Construction of Wooden School Furniture for Children in Developing Countries*. PhD thesis, Purdue University, West Lafayette, 200p.
4. Jeníček, V.; Srnec, K.(2012): *Fundamental problems of developing countries*. Čeněk Aleš Publishing, Plzeň, 265p.
5. Jumbe, C.(2004): *Contribution of dry forests to rural livelihoods and the national economy in Zambia*. Centre for International Forestry Research, University of Zambia, 25p.

6. Moyo, D. (2009): *Dead Aid*: *why aid is not working and how there is a better way for Africa*. (1st edit.) New York: Farrar, Straus, Giroux, 188p.
7. Njovu, F. (2004): *Forest Certification in Zambia*. Forest Economist. Copperbelt University, June 2004. Symposium. Forest Certification in Developing and Transitioning Societies: Social, Economic, and Ecological Effects Yale School of Forestry and Environmental Studies, p. 535-559.
8. Nkamba, M.; Kanyika, J. (1998): *The quality of primary education some policy suggestions based on a survey of schools*. Ministry of Education, Zambia, International Institute for Educational Planning, UNESCO.
9. Sekeli, P.M.; Phiri, M. (2002). *State of Forest and Tree Genetic Resources in Zambia.* Prepared for the Second Regional Training Workshop on Forest Genetic Resources for Eastern and Southern African Countries 6-10 December 1999, Nairobi, Kenya; and updated for the SADC Regional Workshop on forest and tree genetic resources, June 2000, Tanzania.

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SENSORS IN OFFICE WORK CHAIRS - DETECTING SITTING POSITIONS AND SITTING HABITS

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Abstract: Sitting excessively on a chair that is not user-friendly or sitting in a position that is not favourable to our body is detrimental to human health in the long-term. The paper shows that active sitting, which has been imposed as a lifeline in recent years, does not justify this role. The paper is based on literature searched through available databases. Articles related to work chairs that have built-in sensors for detecting seating patterns and habits are included. Some papers are based on measuring the contact pressure between the body and the chair and reading the seating position. A number of papers are based on the fact that in addition to detecting body pressure and defining positions, they also detect other parameters, such as heart rate, activities of certain muscle groups, etc., and showing how certain postures during sitting affect, for example, the heart rate. Based on that information and using algorithms, the user can be instructed in a less harmful way of sitting, without compromising the comfort of sitting.
Keywords: Smart chair; sensor chair; smart seating; sensors

1. INTRODUCTION

Prolonged sitting on a chair that is not suitable for the user or sitting in a position that is not favourable for our body, is harmful to human health in the long run. A 2002 study by the Journal of the American Medical Association estimates that U.S. residents spend nearly $ 86 billion a year on surgeries to reduce neck and low back pain, MRI scans, doctor visits, and X-rays and medications. Also, it is estimated that more than 93 million working days that workers spend at home on sick leave are lost due to low back pain (Spear, 2012). After reviewing recent literature, the paper shows that active sitting, which has been imposed in recent years as a kind of salvation, does not actually justify this role.

2. MATERIALS AND METHODS

The paper is based on literature searched through available databases, such as Scopus, Web of Science or Google Scholar. The paper clearly explains the process of searching by databases, which keywords, language and other parameters were used to make the search repeatable. All databases were searched by keywords, then the obtained result was checked to determine the compliance of the obtained works with the topic of the paper, and all papers that did not meet the criteria were rejected. The criteria were that the paper must not be older than 2010, that the language is English, that it contains some of the key words ("sensor chair" and / or "smart chair") and that the papers are available free of charge. After these first criteria, it was important that the paper study the human body while sitting, measure and record the behaviour of the human body with sensors, and that this data can be processed. It was primarily office chairs, but if the work satisfied, studied sitting and implemented some other sensor that is not related necessary for office work, but is potential for something else such as the example of voice chair control (Puviarasi and Greeshma, 2019), it was accepted and processed. Also, all duplicates of previously obtained articles were rejected. Articles related to work chairs that have built-in sensors for the purpose of observing the manner and habits of sitting are included.

3. RESULTS AND DISCUSSION

This paper, which include selected citations of relevant literature dealing with the use of sensors, presents a part of the wider research conducted for the purposes of the diploma thesis.

Most of the processed papers (Lee, Saidy and Fitri, 2019; Zhang *et al.*, 2019; Sifuentes *et al.*, 2019) are based on measuring the contact pressures between the user’s body and chairs and reading and recognizing the sitting position, there are several types of sensors that record this. There are several pressure reading sensors that are commercially available, while in several papers (Zazula *et al.*, 2015; Zhang *et al.*, 2019; Hu, Tang and Tang, 2020) a sensor was designed and compared with an existing one. Almost all works are based on the fact that sensors in addition to reading body pressure and determining the current position, they also read other parameters, such as heart rate, activity of individual muscle groups, breathing, assessment of blood oxygen levels, and showing how certain sitting positions affect e.g. heart rate per minute, respiration and the like. Given that while sitting, few of us know how to sit properly and how the current sitting position will affect our health, there is a need for the chair to be equipped with various types of sensors that will assess the current situation in real time, analyze it and in relation to our habits to display all relevant data. Based on this data and with the help of algorithms, the user can be instructed in a less harmful way of sitting, without compromising the comfort of sitting. Comfort can refer to both a feeling of comfort and a feeling of discomfort.

This preliminary paper mostly points to this, there are several processed articles (Sifuentes *et al.*, 2019; Prueksanusak, Rujivipatand and Wongpatikaseree, 2019; Flutur *et al.* , 2019) who have a holistic approach to existing issues. There is prototype of the chair that measure heart rate, blood pressure, respiration, assess blood oxygen levels, define the position we sit in and how long we sit in which position. All this happens without the user being aware, and he just takes some sort of smart device (e.g. smartphone) and sees the current data, daily and weekly average, etc. through the application. Also, one study (Woo, Lim Kim and Lim, 2019) shows an experiment where a sensor has been developed that mounts to the user's neck but has been discarded due to impracticality. It is interesting how many researchers have developed a number of systems for observing and defining sitting position, pulse, respiration, and processing and interpretation of the obtained data. In papers dealing with comparing and defining sitting positions (Prueksanusak, Rujivipatand and Wongpatikaseree, 2019; Lee and Lee, 2018), sensors with accompanying algorithms have an accuracy of more than 90 %, with some papers that accuracy exceeds 97 %. Which means that if we sit on a chair 100 times in different positions, it will recognize at least 97 times on which part of the chair we are sitting on, in which position and what action we are doing (working on the computer, watching movies, eating, coughing, reading a book, etc.).

Several processed papers (Flutur *et al.*, 2019; Prueksanusak, Rujivipatand and Wongpatikaseree, 2019; Hesse *et al.*, 2017; Lee, Saidy and Fitri, 2019) explain the importance of algorithms, their types and what are the advantages and disadvantages of each type of algorithm. In a significant part of the work, the force sensitive resistor (FSR) is used, which is a sensor that measures the resistance to a force and is thus used as a sensor for monitoring and defining a sitting position. A potential disadvantage of such sensors is that even if they were used to measure working hours, or how many hours an employee spends in the workplace, an object could be placed on a chair instead of a person. This problem is addressed by adjusting the sensor to sense and recognize the breathing pattern (measures the resistance created by the chest in the backrest when breathing) or even the heartbeat. A special sensor is often placed to accurately measure heart rate.

4. CONCLUSION

With the problem of improper sitting and its impact on human health we will struggle for many years to come, but it turns out that using modern technology and a better understanding of sitting using various sensors and applications can act preventively in most situations. This paper serves as an introduction to the main research in which a review of recent literature was conducted, from which 11 articles were selected, and their topics were briefly explained in the previous chapter.

During the research, various sensors were processed, and some of them are: force sensitive resistor (FSR), heart rate sensor, respiratory monitoring sensor, voice control sensor and acceleration sensor. The system for observing the way of sitting, collecting data and their processing, and displaying it in real time brings the most results, because in that way it directly influences the user to change the position or keep it.

For the future sequel of this preliminary paper, there is a need to compare the sensors, the used methods and the obtained results in order to observe in which direction the devolpement of those kinds of seating furniture will go on.

REFERENCES

1. Flutur, G., Movileanu, B., Karoly, L., Danci, I., Cosovanu, D., Stan, O. (2019) *Smart Chair System for Posture Correction*, Proceedings – Euromicro Conference on Digital System Design, DSD 2019, pp. 436-441.
2. Hu, Q., Tang, X. and Tang, W. (2020) *A Smart Chair Sitting Posture Recognition System Using Flex Sensors and FPGA Implemented Artificial Neural Network*, IEEE Sensors Journal. IEEE, pp. 1.
3. Kim, Woo Lim and Lim, S. B. (2019) *Smart chair cover for posture correction*, International Journal of Emerging Trends in Engineering Research, 7(8), pp. 191-196.
4. Lee, C.-C., Saidy, L. and Fitri (2019) *Human Activity Recognition Based on Smart Chair*, Sensors and Materials, 31(5, SI), pp. 1589-1598.
5. Lee, F. and Lee, C. C. (2018) *User Activity Recognition Based on Smart Chair with Pressure Sensors*, 2018 IEEE International Conference on Consumer Electronics-Taiwan, ICCE-TW 2018. IEEE, pp. 3-4.
6. Prueksanusak, B., Rujivipatand, P. and Wongpatikaseree, K. (2019) *An Ergonomic Chair with Internet of Thing Technology using SVM*, TIMES-iCON 2019 - 2019 4th Technology Innovation Management and Engineering Science International Conference. IEEE, pp. 1-5.
7. Puviarasi, R. and Greeshma, A. (2019) *Design and implementation of modernised dental chair using voice recognition control circuit*, International Journal of Innovative Technology and Exploring Engineering. Blue Eyes Intelligence Engineering and Sciences Publication, 8(9 Special Issue 2), pp. 355-357.
8. Sifuentes, E., Gonzalez-Landaeta, R., Cota-Ruiz, J., Reverter, F. (2019) *Seat Occupancy Detection Based on a Low-Power Microcontroller and a Single FSR*, Sensors, 19(3).
9. Spear, E. J.; Sepulveda J., 2012: *Stand-Sit workstations, an alternative to sedentary work*, URL: http://jespear.com/articles/12-01-sit-stand-workstations.pdf
10. Zazula, D., Kranjec, P., Kranjec, J., Cigale, B. (2015) *Assessing blood pressure unobtrusively by smart chair*, 38th International Convention on Information and Communication Technology, Electronics and Microelectronics, MIPRO 2015 - Proceedings. MIPRO, (May), pp. 385-389.
11. Zhang, Y., Chen, Z., Chen, W. and Li, H. (2019) *Unobtrusive and Continuous BCG-Based Human Identification Using a Microbend Fiber Sensor*, IEEE Access, 7, pp. 72518-72527.

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ANALYSIS OF PRECONDITIONS FOR DESIGN OF SENSORY ENVIRONMENT IN CZECH, BULGARIAN, MACEDONIAN AND CROATIAN KINDERGARTEN

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Abstract: In order to increase children's creativity and well-being, it is necessary to provide quality didactically designed products that will develop and maintain children's sensory integration. Such objects are needed for healthy children, and especially those suffering from sensory integration disorders. The aim of the paper is to analyze interiors of kindergartens in the Czech Republic, Bulgaria, Macedonia and Republic of Croatia in order to determine the quality and conditions of the environment for the application of sensory integration of children. The results in the paper are to stimulate further research on this topic and to define requirements of new design solutions in furniture and didactic products design as an integrated part of the most important educational interiors - kindergarten playrooms.
Keywords: children, didactic products, furniture design, educational environment, sensory integration

1. INTRODUCTION

In the pre-school education program, kindergarten is a place of joyful living: socializing, playing, learning, educating children and adults in achieving quality of life together, and the educator is a leader and facilitator in the play, learning and development of the child (Stokesi Szanton, 2000; cited in: Mlinarević, 2004). Unfortunately, not all children have the same conditions of growth and development in organized educational facilities (Domljan et al, 2015). Modern research has shown that the number of children suffering from sensory integration disorders is steadily increasing, mostly because of the lack of appropriate interior design and designed products (e.g. toys) in kindergartens. All children, healthy and those with health problems or disorders, need to be provided with quality didactically designed objects that will develop sensory integration (Popović Miočinović and Šimunović, 2004).

One of the methods that aims to encourage and develop the functional abilities that a child needs in daily life is occupational therapy for children (OT).Occupational therapy of sensory integration strengthens and supports the educational goals of children and develops the skills needed to cope with the demands of the environment (Hemphill-Pearson,1988). Occupational therapy uses the basic children's activity - play and various products such as toys (Popović Miočinović and Šimunović, 2004).

Figure 1 illustrates sensory toys and wood products made for the combination of access: sensory-integration approach, developmental and / or cognitive, that is, types of wooden aids for the development of sensory perception and fine motor skills. All children benefit from toys and aids in the development of sensory integration.

Many producers offer interesting and good designed products aimed to develop sensory integration in children. Unfortunately, not many kindergartens can afford such products, mostly due to the higher prices.

Figure 2. Sensory wall. Source: Web 1

1.1. The aim of the research

This research was done with the intention of identifying appropriate products, furniture, equipment and toys in kindergartens in the three countries. The aim was to analyze interiors of kindergartens in the Czech Republic, Bulgaria, Macedonia and Republic of Croatia in order to determine the quality and conditions of the environment and related products which apply sensory integration of children.

The paper presents a part of wither research conducted in kindergartens in four countries and their main towns.

2. MATERIALS AND METHODS

In order to compare the levels of furnishing, safety, creativity and functionality of furniture and to gain an insight into the real situation regarding the design of furniture and other products related to development of children's sensory integration in kindergartens, the research covered several methods, types of respondents and polygons.

2.1. Materials

2.1.1. Polygons

The survey was conducted from 2017-2019 in four countries: Republic of Croatia (RH), Republic of North Macedonia (MK), Bulgaria (BG) and the Czech Republic (CZ), in four cities: Zagreb (HR), Skopje (MK), Sofia (BG) and Brno (CZ). In total, fifteen (15) kindergartens (polygons) were included in the research: three (3) in RH, eight (8) in MK, three (3) in BG and one (1) in CZ.

2.2. Methods

2.2.1. Observing and photographing

When observing the equipment of kindergartens and schools, the furniture and functionality of the furniture were photographed, that is, its adaptation to the needs of the educational process. An overview of the current state of the observed objects was made. The aim of this method was to investigate whether the furniture is functional, encourages creativity in children and sensory integration.

3. RESULTS AND DISCUSSION

Due to shortage of the paper, the results of the research include a few photographs of the observed polygons. Photographs of the recorded polygons are taken as „exemplar“ and show the actual situation of playing and working conditions, as well as the quality and design of the kindergartens' interiors in Zagreb (HR) (Figures 2 and 3), Skopje (MK) (Figures 4 and 5), Sofia (BG) (Figures 6 and 7)and Brno (CZ) (Figures 8 and 9).

Figure 2. Kindergarten Medo Brundo, Zagreb, HR.

Figure 3. Kindergarten Medveščak, Zagreb, HR

Figure 4. Kindergarten 11, Skopje, MK.

Figure 5. Kindergarten Park, Skopje, MK.

Figure 6. Kindergarten Bratya Mormarevi 1, Sofia, BG.

Figure 7. Kindergarten Bratya Mormarevi 2 Sofia, BG.

Figure 8. Kindergarten Ponny 1, Brno, CZ

Figure 9. Kindergarten Ponny 2, Brno, CZ

Examples of interiors (Figures 2 - 9) show a creative approach to equipping kindergartens and different functional elements of furniture and equipment. All interiors are equipped with colored products (furniture, toys, accessories, equipment etc.) made of different types of materials. Only in Brno there are painted walls with cartoon or story characters. However in the most observed kindergartens in all four cities/countries the furniture and equipment are old and traditionally designed (e.g. “four legged” chairs and tables), it is evident that the interiors are equipped with colorful sensory elements and toys, made of different materials such as textiles, foams, wood and plastic.

Based on former results (Iliev and Domljan, 2016; Dijanošić et al, 2019; Iliev et al, 2019), furniture doesn't follow contemporary educational methods and anthropometric dimensions of furniture and children is in mismatch which reflects to children's body positions, their growth and health. Thanks to great teachers' enthusiasm and efforts, interiors in observed kindergartens give the impression of potentially greater possibilities for the free, healthy and creative development of children.

The photographs shown in the paper just grabbed the topics of problems of sensory integration and equipment in kindergartens. These short results are to stimulate further research on this topic and to define requirements of new design solutions in furniture and didactic products design as an integrated part of the most important educational interiors - kindergarten playrooms.

4. CONCLUSION

The lack of sensory integration of children and the consequences that occur are a major problem for today's children. These difficulties are attempted to be reduced by occupational therapy (OT). For the full quality growth and development of the child, as well as for the quality of the implementation of occupational therapy in the institutions and places where such development or therapy takes place, it is necessary to provide quality aids and facilities.

This paper points to the need for sensory furniture, toys and didactic devices that will stimulate creativity in children's work and play areas. The authors hope that photos of real-life environments as well as the opinions of teachers and educators will encourage further exploration of this topic and the design of new solutions, where furniture starts to be integrated sensory-didactic product, not only a "traditionally designed piece of furniture". Authors hope as well that in the future, these solutions will be an integral part of the rooms most children stay in - kindergarten living rooms in many other countries worldwide.

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REFERENCES

1. Dijanošić, I; Iliev, B; Dijanošić, O; Domljan, D. (2019): *Impact of the environment and objects in preschool institutions on the healthy growth and development of children*. In: Book of Abstracts on 3rd International Scientific and Professional Conference Health of Children and Adolescents. Portorož, Slovenia. September2019. 144-145.
2. Domljan, D.; Grbac, I.; Jirouš Rajković, V.; Vlaović, Z.; Živković, V.; Župčić, I. (2015): *Quality and technical descriptions of wooden products - Volume 1 - equipping educational facilities.* University of Zagreb Faculty of Forestry, Croatian Chamber of Economy, Zagreb.
3. Iliev, B.; Domljan, D. (2017): *Comparison between preschool tables used in kindergartens in Croatia, Macedonia and Bulgaria*. In: Proceedings of 28th International Conference on Wood Science and technology (ICWST): Implementation of wood science in woodworking sector. Zagreb, Croatia. December 2017. 207-214.
4. Iliev, B.; Domljan, D.; Vlaović, Z. (2019): *Compliance of Preschool Chair Dimensions.* Drvna Industrija 70 (2): pp. 175-182.
5. Hemphill-Pearson, B. J. (1988): *Mental Health Assessment in Occupational Therapy: An Integrative Approach.* Thorofare: Slack, USA
6. Popović Miočinović, Lj; Šimunović, D. (2004): Radna terapija u rehabilitaciji djece. Paediatria Croatica, Hrvatski pedijatrijski časopis 48 (3): pp. 268.
7. Stokesi Szanton, E., 2000: *Kurikulum za jaslice*. cit. u: Mlinarević, *Kurikulum za jaslice: razvojno-primjereni program za djecu određenja do 3 godine*, 2004., Pučko otvoreno učilište Korak po korak; Zagreb. p. 113
8. Web 1: http://www.littlepeoplescove.com/haba-sensory-wall-colorful-squares-wall-game/

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ANALYSIS OF THE IMPACT OF TECHNOLOGICAL INNOVATION ON IMPROVING THE QUALITY OF DOOR JOINERY

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Abstract: The article presents the results regarding the impact of the technological innovation - change in door wrapping technology on the "soft" technology on improving the quality level of manufactured products. The old, standard technology was compared with the new one. The surveyed company - the manufacturer of interior doors and its passion for innovation were presented. The research results concerned the comparison of production at the stage of wrapping with PVC foil of raw wooden doors made of HDF boards of various sizes in terms of obtained production incompatibilities that arose in both old and new "soft" technology. Ten-day production of five types of doors of various sizes from "60"-"100" was analyzed. The scale of decrease in the share of production non-conformity was shown considering individual types of non-conformity and due to the door sizes produced. The analysis showed that the largest share of nonconformity created during the production process by old technology concerned the bulges formed during door wrapping, resulting from getting various types of particles, impurities under the veneer, which in the case of new production technology has been decreased to a minimum level. The biggest decrease in non-conformity level after switching to the new technology concerned the "100" and "60" size doors. Additional benefits associated with the implementation of the technological innovation have also been underlined. The article shows that by implementing technological innovation in the manufacturing process with appropriate organizational and procedural changes, the quality of manufactured products and overall company productivity can be significantly improved.
Keywords: technological innovation, wrapping technology, nonconformity level, quality improvement

1. INTRODUCTION

Innovation is a series of activities leading to the production of new or improved products, technological processes or organizational systems [1]. Designing and implementing innovations is an obligatory activity of enterprises that want to conduct business and compete effectively in a turbulent environment [9]. Innovation can relate to different areas, including new technology application, production methods [7]. One of the types of innovations, due to the area of application, are technological (process) innovations consisting in modification of factors and properties of manufacturing processes [3, 6]. These methods can rely on making changes to devices or in the organization of production, they can also be a combination of these two types of changes or be the result of using new knowledge. They may be aimed at producing or supplying new or improved products that could not be manufactured or delivered by conventional methods [13]. The installation of new or improved production technology, or new equipment associated with the production of new or improved products is an example of this type of innovation [4, 15]. Innovations within processes can be aimed at reducing unit costs of production or delivery, increasing quality, production or supplying new or significantly improved products [10]. As research proves [8], along with the increase in the size of the company, its innovation grows, measured by the number of innovations implemented in the last 3 years. Polish enterprises in terms of innovations is based mainly on accumulating new products and new technologies [5].

Innovations for the degree of their novelty are divided into radical and incremental. Radical innovations are connected with the introduction of new, previously unused solutions [11, 12]. Sources of innovation can be external (from the market) or internal (use of enterprise resources) [17]. The increase in the company's competitiveness through the purchase of innovative machines from the market is the result of using external sources of innovation [14]. The scope of the introduced innovation in the enterprise can be considered for the number of workstations in which the introduced innovation could be used - the smaller the number, the smaller the range [16].

The purpose of the article is to analyze the impact of low-range radical and external technological innovation - the implementation of a new soft door wrapping technology on the quality level of manufactured products compared to the quality level obtained with the old, standard technology and to determine the benefits of introducing the technological innovation.

2. RESEARCH METHODOLOGY

The examined company is a medium-sized door woodwork manufacturer from Poland with over 25 years of experience in the market. The company's activity consists in the production, sale, wholesale, retail and internet trade of doors and their components. Interior doors and their components in the form of door frames, door frames, banding strips, skirting boards and door handles are delivered to individual and wholesale customers in Poland and abroad. Most of the production (about 60%) is sold in Poland, the remaining part goes to the German, Czech and Slovak markets. The company is a precursor to the introduction of new technologies and ecological production solutions. As the first company in Poland, it produced moldings, MDF profiles covered with foils and briquettes from MDF dust.

The subject of research are internal wooden doors made of HDF board. It is a board made of wood chips, fiber bonding resin and wax, which is added to increase moisture resistance. The internal strengthening of vertical stiles are stiffening beams. Between the stile frames and plywood beams, there is a "honeycomb", which is made of cardboard and mounted vertically, thanks to which the door has additional protection - resistances to bending and compression. The leaf is filled with perforated chipboard (reinforced door) or cold-glued plywood. This design increases the sound insulation of the sash as well as its strength, rigidity and durability. The frame (along with the filling) is veneered on both sides with HDF board.

The process subjected to qualitative analysis is the process of wrapping doors. The analysed company was realising this process according to the old technology with the use of edge banding machines on narrow and wide surfaces, after which it decided to implement technological innovation - soft type wrapping technology by purchasing the Barberan PUR-81 wide surface edge banding machine. The factor determining the implementation of technological innovation was the desire to increase the company's competitiveness by shortening the product production cycle, increasing the scale of production, as well as the company's profitability. It was also expected in increasing the quality level by reducing nonconformities in the areas of "machinery and equipment" and "working method".

The previous method of wrapping the door with PVC foil (standard method) consisted in covering the door with PVC foil using two machines - edge wrapping machines for narrow and wide surfaces in four places, which resulted in the need to change over the machines, whereby orders were extended. The "soft" method involves covering doors with PVC foil in one piece (and the joining is only done in two places that are not exposed to dirt as a result of using the product) using one machine - the wide surface edge wrapping machine. The vertical edges of the soft doors are rounded and do not have sharp edges, which is an aesthetic and very modern look. Comparison of both technologies is shown in Fig. 1.

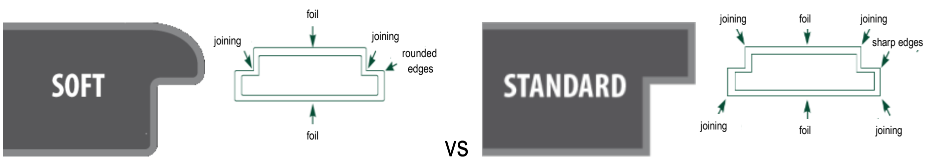

Figure 1. „Soft" wrapping technology vs standard technology

The expected benefit of implementing the new wrapping technology was to be an increase in the quality level of manufactured products. To assess whether this happened, a comparison was made of the level of production defects in old and new technology. Tests were carried out at various intervals. Archived data on the quality of production in the old technology allowed for a comparison of both technologies. The new door wrapping technology was used using the same materials as the old technology. The study concerned the door production process, which covered two weeks of enterprise work (10 days of plant operation). For the comparative analysis of results, data on quality from individual working days were used, distinguishing on the door sizes produced (5 dimensions of the door leaf: "60", "70", "80", "90", "100").

An assessment was made of the improvement in the quality of manufactured products - doors as a result of the introduction of a new wrapping technology. The research consisted of checking production at the stage of wrapping with PVC foil of raw wooden doors made of HDF boards of various sizes in terms of production nonconformities that arose in standard (old) and new technology. The comparative analysis was made in distinguishing between the door dimensions produced, as well as due to the types of non-conformities found.

3. RESULTS

A comparative analysis of the results in the field of door production defects for 2 weeks was performed while the plant was operating with the old and new wrapping technology (Fig.2).

The analysis allowed to state that the most non-conformities in the production process realised with the old technology concerned bulges formed during door wrapping as a result of various types of particles and impurities getting under the veneer (5.63%). In the new production technology, it was possible to reduce this quality problem to the level of 0.76%. The second non-conformity in the old production technology was the cracking of the PVC film due to loosening on the rollers, as well as a decrease in the adhesive temperature on the film (3.74%). Thanks to the new technology, non-conformities have been reduced to 0.85%. The third non-conformity due to share in the old technology was overgrowths and discoloration on the veneer, which was the result of the wrong selection of temperature parameters, the wrong type of PVC film, as well as the storage of wood in the hall with high humidity. The share of this non-conformity in the old technology was 3.18%. The new, "soft" technology reduced the occurrence of this non-conformity to 0.85%. The last in the list quality problem was production damages caused by incorrect transport of pallets with ready-made veneered doors, as well as poor product segregation, with a share of 1.73% in old technology. In the new production technology, this non-conformity was limited to 0.55%. Comparing the old and the new production technology in terms of the frequency of non-conformity in the door wrapping process, it should be stated that every quality aspect of the finished product has been improved as a result of the implementation of the new wrapping technology. Particularly, it was possible to reduce the bulges and PVC foil cracks mismatches by 4.87% and 2.89%, respectively. A comparison was made of results in the field of production defects, distinguishing different types of doors (doors leaf dimensions) and applied wrapping technologies (Fig.3).

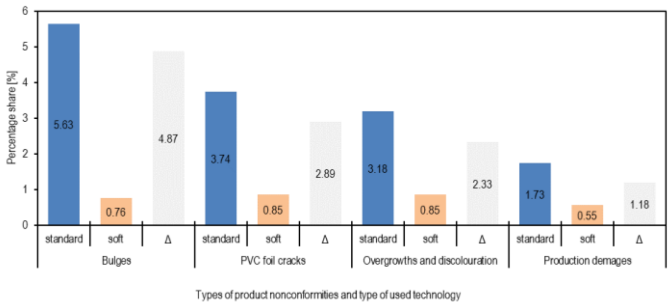

Figure 2. The share of non-conformity in the distinction between its individual types and applied wrapping technologies

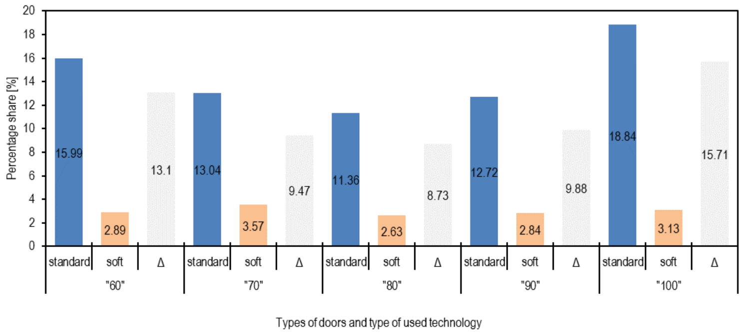

Figure 3. The average share of non-conformities in the distinction between different types of doors and applied wrapping technologies

Analyzing Fig. 3, it should be stated that for all types of doors produced in the new "soft" technology, during 2-week studies, the production defect level decreased. The largest decreases were recorded in order for the door size: " 100 " - a decrease of 15.71%, with defect level in "soft" technology amounting 3.13%; " 60 " - decrease by 13.1%, with the new level of defectiveness amounting 2.89%; " 90 " - decrease by 9.88%, defect level in "soft" technology amounting 2.84%; " 70 " - a decrease of 9.47%, new defectiveness amounting 3.57%; " 80 " - decrease by 8.83%, defect level in "new" technology amounting 2.63%.

The effect of a reduced share of nonconformities should not be associated only with the new machine, but also with the introduced organizational and procedural changes as a result of the implementation of the new technology. This happened. The employees have been trained in the operation of the machine as well as in basic maintenance. Service deadlines have been created, which currently indicates what machine elements should be maintained, with what frequency and who should do it (division into tasks for operators and employees of the UR department), thanks to which the machine failure rate is now low.

The implementation of technological innovation in the form of soft door wrapping in addition to a clear decrease in non-conformities also allowed the company to achieve other benefits. The production cycle has been significantly shortened by reducing changeover times, unplanned stoppages, reduced speed drops and the machine micro-stoppages. The level of productivity was also increased - the number of doors manufactured based on the new technology doubled compared to the old technology.

4. CONCLUSIONS

This article concerned the analysis of the impact of implementing the technological innovation - a new technology of "soft" door wrapping on the quality level of manufactured door joinery. The results of manufacturing defects were compared before and after the introduction of the new technology. As was shown in the research results, due to the introduction of innovative soft wrapping technology, the door joinery manufacturer significantly reduced the share of non-conformities in the production process. The achieved effect should be directly linked to the implementation of a new Barberan PUR-81 wrapping machine (activity in the "machine" area) made of the highest quality components. Modern technology alone (machine) without proper service and its proper maintenance will not ensure high-quality products. The management of the company realized this, hence the company conducted training in operating the new machine, its proper maintenance for machine operators and maintenance department employees, and made procedural changes (new standards). To further reduce non-compliance, actions were taken to limit the impact of other factors of the production process variability (beyond machine and method), i.e. material, human, management, measurement, environment. Greater attention was paid to the factor that largely influences the quality of the final product, namely the quality of the material. Adequate conditions for transporting the material to the plant and inside the plant were provided, its loading and unloading processes, material storage processes (proper drying parameters) were standardized and the material was protected against fungi, insects, pests. As a result of the detection of non-conformities, causative analyzes are performed as part of teamwork, paying attention to all problem categories (5M + E), corrective actions are indicated and their effectiveness is determined. This contributes to a continuous decrease in the level of production defects in the company.

Striving to achieve error-free production, the company continues to improve its product and process by conducting research and development, thoroughly analyzing cause and effect relationships of appearing quality problems (Ishikawa diagram, 5WHY method), taking care of its machine park, motivating employees to give comments and suggestions for improvement and implementing Lean Manufacturing concept to reduction of time and costs of door production process [2]. The changes made after the implementation of the analyzed technological innovation have contributed to increasing the quality of manufactured products and to increase the company's competitiveness on the market.

REFERENCES

1. Begg, D., Fisher, S., Dornbush, R. (2008): *Economics*, McGraw-Hill Education, Maidenhead.
2. Czerwińska K., Pacana A. (2020): *Analysis of the internal door technological process*. Production Engineering Archives 26 (1), pp. 44-47. DOI: 10.30657/pea.2020.26.06.
3. Diaconu, M. (2011): *Technological Innovation: Concept, Process, Typology and Implications in the Economy*. Theoretical and Applied Economics XVIII, No. 10(563), pp. 127-144.
4. Dodgson, M. (2000): *The Management of Technological Innovation: An International and Strategic Approach*. Oxford University Press, New York.
5. Glin, W. (2018): *Problems of Polish Enterprises in the Field of Innovation*. Production Engineering Archives 21, pp. 44-47. DOI: 10.30657/pea.2018.21.10.
6. Knop, K., Ulewicz, R. (2019). Assessment of technology, technological resources and quality in the manufacturing of timber products, in Digitalisation and Circular Economy: Forestry and Forestry Based Industry Implications - Proceedings of Scientific Papers, 2019, pp. 251-256.
7. Kogabayevm, T., Maziliauskas, A. (2017): *The definition and classification of innovation*. Holistica 8 (1), pp. 59-72. DOI: 10.1515/hjbpa-2017-0005.
8. Kraśnicka, T. (2013): *Innowacyjność przedsiębiorstw – uwarunkowania organizacyjne. Studia Ekonomiczne /* Uniwersytet Ekonomiczny w Katowicach 136, Transformacja współczesnej gospodarki jako przedmiot badań: pp. 165-179.
9. Lendel, V., Varmus, M. (2011): *Creation and implementation of the innovation strategy in the enterprise*. Economics and Management 16: pp. 819-825.
10. Lugovoi, I., Andritsos, D. A. (2018): *Process Innovation in the Pharmaceutical Industry*. SSRN Electronic Journal, pp. 1-31. DOI: 10.2139/ssrn.3272776
11. Meeus, M., Edquist, Ch. (2006): *Introduction to Part I: Product and process innovation*, [in:] Hage J. and Meeus M. (ed): Innovation, Science, and Institutional Change: A Research Handbook. Oxford University Press, pp. 23–37.
12. O`Sullivan, D., Dooley, L. (2009): *Applying Innovation*. SAGE, California.
13. Pypłacz, P., Liczmańska-Kopcewicz, K. (2018): *Process Innovation as a Factor for the Development of Small Enterprises in Poland*. International Business Information Management (IBIMA), Mediolan, Italy, pp. 3156-3165.
14. Smith, D. (2006): *Exploring Innovation*. McGraw-Hill Education, UK.
15. Stasiak-Betlejewska, R., Ulewicz, R. (2016): *The effectiveness of selected machinery and equipment in the woodworking joinery*, Path Forward For Wood Products: A Global Perspective, Proceedings Of Scientific Papers, 2016, pp. 149-156.
16. Tomczak-Horyń, K., Knosala, R. (2018): *Ocena poziomu wprowadzonych innowacji w wybranych przedsiębiorstwach*, [w:] Knosala R. (red.): Innowacje w Zarządzaniu i Inżynierii Produkcji. Oficyna Wydawnicza Polskiego Towarzystwa Zarządzania Produkcją, Opole, pp. 130-138.
17. Wu, AH, Su, JQ, Wang, H. (2013): *Internal innovation or external innovation*? An organizational context-based analysis in China. The Journal of High Technology Management Research 24 (2), pp. 118-129. DOI: 10.1016/j.hitech.2013.09.006.

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BARREL MAKING TECHNOLOGY

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Abstract: Barrel making, as one of the oldest human woodworking activities with a millennial tradition, dates back to 2600 BC, and the first barrels discovered in Europe date from the Iron Age. Although closely related to the production of wine and spirits, wooden barrels were used in many ways – from the production, transportation and storage of food to the maturation and storage of different types of alcoholic beverages. Nowadays, wooden barrels have remained an indispensable part of the alcoholic beverage ware due to their unique characteristics that affect the quality of the product. Today, barrels are still an expensive end-product because of their specific and relatively complicated method of production, and therefore alternatives are being found in other materials that seek to achieve the same quality and aroma of alcoholic beverages. Although the use of alternative solutions has been successful in some segments, there is currently no way that completely replaces all the characteristics that a good wooden barrel gives to its product as it matures. In addition, due to the specific method of production of the wooden barrel, precisely determined by the raw material and technique, the method of their production has remained unchanged for centuries. In history, everything was made entirely by hand, using a specific tool to facilitate part of the design process. Nowadays, we see an increasing use of automated technology and CNC machines, with a small proportion of manual work. This paper presents an overview of the production process and the advancement of wood barrel production technology throughout history, as well as its contemporary appearance and capabilities in today's modern facilities.
Keywords: barrel, barrel making, barrique, coopering, technology

1. HISTORY OF BARREL MAKING

Wine conservation and aging is practice that has been used since antiquity. Coopering is traditional process of making watertight containers out of separate pieces of wood called staves. This is a highly skilled craft and was much in demand in past times. Traditionally, coopers were apprenticed, studying under a master cooper for a considerable time, until they had learnt the craft sufficiently and were able to work independently. However, it is tightly related with wine and alcoholic beverages, wooden vessels made by coopers were used widely – for manufacturing, transportation and storage of food to all kinds of alcoholic beverages. They influence the product that they contain and give the final product (alcohol) distinct characteristics like flavours, aroma and colours. The most common barrel size in winemaking is the French style 225 litres called *barrique*, and the American style 190 litres. *Barrique* is distinct for its use of oak as a primary material and special charring process, which gives wine it's unique characteristics. In the past, people did not think of charring as a part of the process that gives positive qualities to barrels and wine. Although we can notice greater use of stainless steel than wooden casks in today's times (mostly because of its lower price), oak barrels have remained irreplaceable vessels for aging quality wines (Lucić, 2017; Kilby, 2004; Vivas, 2005).

1.1. About the barrel

The factors that people considered many years ago when they had to choose the tree species to use for wine storage were its wood strength, large trunk diameter for economical production, straight and clean wood with no defects or knots to enable clean-cut staves with low chance of leaking, good flexibility and absence of negative undesirable extraction components which might be transmitted from the wood into the wine. The ultimate wood, which meets all the mechanical factors as well as the desired aroma, is oak (Margalit, 2012; Feuillat and Keller, 1997). While building a barrel, cooper can use American or European oak. Species of European oak that is most commonly used for building a *barrique* barrel is pedunculate oak (*Quercus robur* L.), because of its unique microscopic and chemical characteristics. It has tight grain, high concentration of water-soluble extractable compounds and a great content of extractable tannin, which gives a spicier character to wines. Only two 225 l *barriques* can be manufactured from the heartwood of a tree of 80 – 120 years of age.

Larger barrels have thicker staves, giving better insulation and less permeability (***, 1995; Miller *et al*., 1992; Clarke and Bakker 2004; Snowdon *et al*., 2006; Spillman *et al*. 1997; Towey and Waterhouse, 1999).

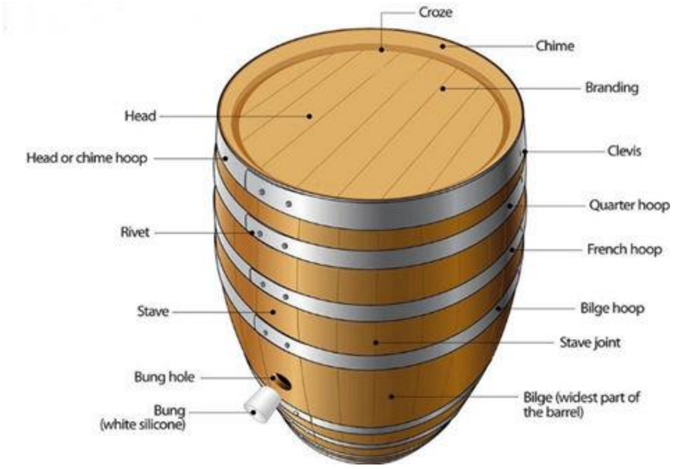

Figure 1. Wooden barrel and part names (source: Web 1)

The starting point in barrel construction are long pieces of oak called staves. Not all staves in a barrel have the same width. The widest stave in a barrel (or one of the widest) is the one where bunghole is drilled later in the process. This is where liquid enters and exits the barrel. Bilge, quarter and head hoops fastened around the staves by rivets are what keep casks intact (Kilby, 2004; Vivas, 2005).

2. COOPERS TECHNOLOGY

In the past, the whole production process was done manually, by hand. Figure 2 shows some of the tools used by coopers. Nowadays, almost everything can be done by machines, i.e. automatically.

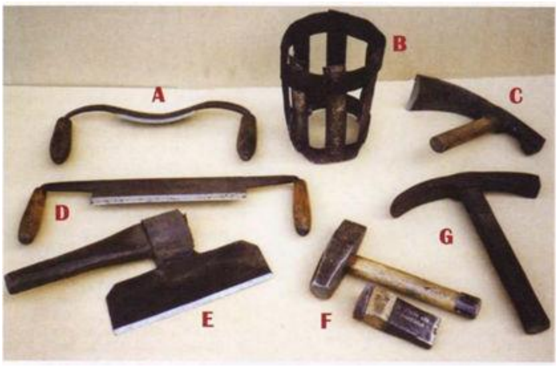

Figure 2. Tools used by a cooper in the past - A. hollow knife; B. cresset; C. adze; D. backing knife; E. axe; F. hammer and driver; G. trussing adze (source: Kilby, 2004)

The whole process can be done by programmable robots (even transportation and manipulation of barrels) (figure 3). The only part of the process that stayed more or less manual is checking the barrels water tightness.

Figure 3. Robots used for barrel manipulation (source: Web 2)

2.1. Splitting, drying and shaping the staves

First, the trunk is sawn into logs of the desired stave length of about 90-95 cm for the 225 l barrels. European oak must be split rather than sawn to preserve water tightness (which is not the case with American oak because of their anatomical differences). Each log is then split radially with hydraulic wedge or an axe at the cross section of the log, so that sections are split along the natural rays of the wood. Splitting the wood prevents leaking from medullary rays, but it is much more expensive than sawing because it is a manual operation and also produces more waste materials than exact cutting with a saw. The lumber is required to be quarter cut or as shown in the figure 4. This cut ensures that the orientation of the growth tings is in the right direction and the barrel has enough stability and leakproofness. It also divides the boards into wide and narrow pieces. The short pieces will become ends and the long will become staves from which the curvature of the cask is made. Only the heartwood is used for making the staves. The quarts are then being split to staves, so that from each quart several staves can be produced (Kilby, 2004; Lucić, 2017; Margalit, 2012; Maršić, 2009; Tao *et al.*, 2013).

The staves are seasoned outdoors (open air drying with exposure to rain and sun) for two to three years before being carefully shaped. It is because of the tannins, which are polyphenolic biomolecules that bind to and precipitate proteins and various other organic compounds including amino acids and alkaloids, that are responsible for bitterness (Miller *et al*, 1992; Clarke and Bakker, 2004). They are seasoned outdoors so rain, wind and sunlight can naturally influence the wood and wash excess tannins away. The staves are dried to a residual moisture content of 16-18 % (Margalit, 2012). If the wood is not dried enough when the barrels are made, they will shrink later and will not hold wine without leakage. This process is not suitable for drying kilns.

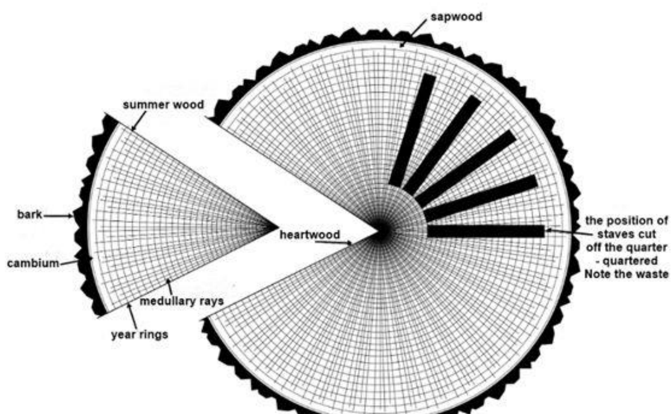

Figure 4. Macroscopic characteristics of trunks cross section (source: Kilby, 2004)

In smaller production workers examine each piece of wood for significant knots or thin spots that might compromise barrel integrity. Today, that can be done with a machine that automatically classifies undesirable wood defects (using cameras and lasers). The exact shape of the staves is vital, because when they are brought together and curved into shape, the barrel must be watertight, without any gluing or mechanical fixing of the staves.

First, the surfaces of the wood are planed. This brings back the lighter colour of the wood and removes all the dirt from the outer layer of the staves. The cross section of the final stave is a trapezoid, because the circumference of the barrel inside is smaller than the outside. The top and the bottom of the stave is narrower than the middle, because the barrel is wider in the middle than on the ends. This can be done using two different machines, automatic stave planer and CNC stave jointing machine, or by an automatic stave planer and jointing machine. In the past, all of this was done by hand using specialised tools (figure 2), and it required a lot of skill and practice (Kilby, 2004; Lucić, 2017; Maršić, 2009; Vivas, 2005).

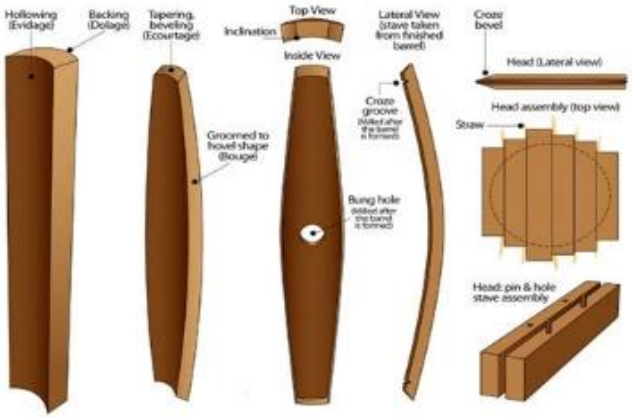

Figure 5. Macroscopic characteristics of trunks cross section *(source: Web 3)*

2.2. Shaping the cask

Cooper assembles wide and narrow staves into a temporary steel ring that holds the staves into place. He has to make sure that the wide and narrow staves are distributed evenly around the circle otherwise, the forces that hold the barrel together will also be uneven. In that case, the areas with less pressure are likely to leak (Kilby, 2004; Lucić, 2017; Maršić, 2009).

Heat or steaming is used to help bend the staves, in conjunction with pressure from metal hoops. If one would just bend the barrel into shape, the staves would break, and the barrel would be lost. The raised barrels are put upside down with the wide end to the bottom, and then treated with hot steam which is blown trough the staves to make them closer to plastic state. A worker can then put on the second temporary steel ring. Another two thick steel rings are added, and the barrel is heading for the heat treatment (charring). This part of the process is still done manually. Once the barrel is constructed, it is charred over a flame. Headless barrels are placed over small fires to be “toasted” on the inside. Customers determine their desired level of toast. The level of toast matters in terms of the flavour impact on the wine that will be stored in it. The lighter the toast, the higher the tannin impact with lighter-tone flavours: amaretto, vanilla, pastry. As the toast is longer or at a higher temperature, the tannin impact is reduced and there are even lower-tone flavours: brown sugar, caramel, toffee, and as you get into a heavy toast, dark chocolate and coffee (Herjavec *et al.*, 2005; Clarke and Bakker, 2004; Snowdon *et al.*, 2006; Spillman *et al.*, 1997; Towey, 1997). This was done with a cresset which was put in the middle of the cask in which fire was lit using wood waste made in the production process (figure 6 – left) (Kilby, 2004). Today, it can be done with a charring machine, which uses natural gasses to produce fire, while the barrel is automatically rotated in place (figure 6 - right).

Figure 6. Charring with a cresset and a charring machine (source: Web 3/left; Web 5/right)

2.3. Barrel head and hoops

A worker crafts the heads, which are fitted onto the barrel and sealed in the groove, or the "croze", with a natural or food – grade synthetic paste. First, the surfaces of the wood are planed. This was done by hand with a tool called bench plane. Today we use automatic surface planer machine. Afterwards a machine drills holes into the sides of the planks and wooden dowels are inserted on one side. This can be done manually, or by a programmable robot. In the past, coopers used a hand drill or a dowelling stock to drill out the holes for the dowels (Kilby, 2004). Pieces of wood can now be fitted together. This is done with the help of sliding clamps or, in today's times, a hydraulic press machine. These pieces are dowelled to a square shape of flat oak wood. This square is then cut into a perfect circle with a rounded edge. This was done by hand with a handsaw or a bow saw, but today, we can use a vertical band saw machine or a CNC machine (Lucić, 2017; Maršić, 2009). The heads can be charred (but not necessarily) in the open flame oven for about 90 seconds.

Galvanized iron is used to form the hoops comes in coils that are run through a machine that cuts them to the proper length, punches holes for the rivets, and slightly flares the iron (figure 7, right). In smaller productions this is done by hand (figure 7, left) (Kilby, 2004).

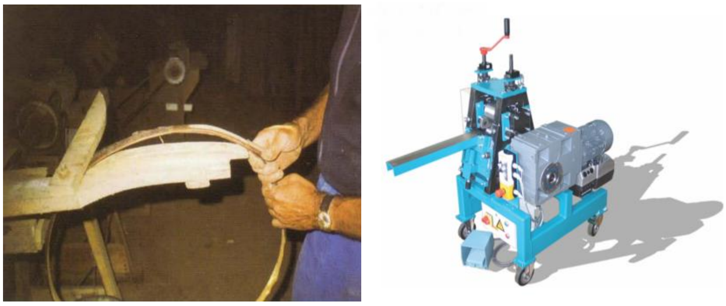

Figure 7. Bending barrel hoops by hand (left) and mobile hoop splayer (right)
(source: Kilby, 2004/left, Web 6/right)

3. FINAL ASSEMBLY OF A BARREL

After charring, barrel has to be cool down before production process can be continued. During the cooling, the barrel shrinks. If the hoops would be put on before it cools down, the barrel would shrink and the hoops would fall off, resulting in the collapse of the barrel (Margalit, 2012). The hoops are removed from the middle of the barrel and the outside is sanded. This was or can be done by hand, using sandpaper, but in these days producers use hand grinders (belt grinders) or machines specialised for sanding a barrel (figure 8/left). Temporary hoops are being replaced with 6-8 galvanized iron hoops and knocked into position. This was done manually with a hammer and a chive. Today, we have machines that can press hoops back into place. That kind of machine is called the hooper (figure 8/middle). When the barrel is assembled, it must be crozed for the heads to be put in the place. This is done by the heavy-duty barrel crozer (automatic or manual) (figure 8/right). In the past this was done with a chiv and a hose (Kilby, 2004).

Once a barrel is assembled, heads are placed at both sides and a bunghole is drilled into one of the wider staves, right in the middle between the heads. This was done manually with a hand drill. Today, a laser can be used to mark the point where the bunghole will be drilled. After the bunghole is in place, the barrel undergoes pressurized water testing to detect leaks (Kilby, 2004). Water is filled into the barrel, and it is then rotated so that the water touches all the staves and the barrel become wet on the inside. Air pressure is added (1-2 bar) and the barrel is checked to see if there are any leakages (Lucić, 2017). If there is a leak, water bubbles will be formed on the surface. It is important to keep the barrel wet, because if the barrel dries out, the wood shrinks, and the stability and airtightness of the barrel is in danger. From there it is off to a final inspection station. If it passes, it is loaded onto a truck and shipped to the distillery, where it is filled with raw wine almost immediately. If a barrel does not pass the airtightness test, it goes of the cooper station. Here the most experienced workers of the plant repair the broken barrels. Cracks can appear if the barrel is not properly manipulated during the production process. Heads are being replaced as a whole or the trenches are cut a bit deeper. If a stave is cracked, they replace the individual stave. Small leaks are repaired, and the cask is returned to the testing station.

Figure 8. Barrel sanding machine (left), the hoope*r and heavy-duty barrel crozer (right)*
(source: Web 7/left; Web 5/middle; Web 6/right)

After the barrel has been tested, the production process is over. The rest depends on the winemakers and their maintenance.

4. DISCUSSION AND CONCLUSION

Although the whole process can be automatized (except fixing the cracks and leaks which has to be done by a master cooper), every barrel is unique and should be treated that way. High automatization of the production process is beneficial for the producer, from the financial point of view and produced quantity, but this influences the final product which requires individual approach. Some of the actions like shaping the stave, planning, crozing and sanding are time saving if done by a machine, but selecting better side of a stave, charring and fixing the leaks cannot be done without appropriate human intervention. A wine barrel is a very expensive final product, and it should be treated that way during the manufacturing process. There's no better tool than human experience when producing a wooden wine barrel. The moment of truth comes a few years later, when the sum of all the time, hard work, and attention detail that went into making the barrel reveals itself inside the glass. You cannot just computerize it, you can use some automation, but in the end, every barrel is going to be a little different.

REFERENCES (alphabetical order)

1. Feuillat, F., Keller, R. (1997) *Variability of oak wood (Quercus robur* L.*, Quercus petrea* Liebl.*) anatomy relating to cask properties,* Am. J. Enology Viticulture 48:502-508
2. Herjavec S., Jeromel A., Da Silva A., Orlić S., Redžepović S. (2005) *The quality of white wines fermented in Croatian oak barrels,* Faculty of Agriculture, University of Zagreb, Zagreb
3. Kilby, K. (2004) *Coopers and coopering*, Buckinghamshire (UK): Shire Publifications Ltd.

4. Lucić, F. (2017) *Tehnologija proizvodnje barrique bačava*, Završni rad, Veleučilište u Požegi, Poljoprivredni odjel
5. Margalit, Y. (2012) Concepts in Wine Technology, Small Winery Operations, Third Edition, USA: Board and Bench Publishing
6. Maršić, M. (2009) *Upravljanje proizvodnjom u poduzeću za proizvodnju bačvi*, Diplomski rad, Sveučilište u Zagrebu, Šumarski fakultet
7. Miller, D. P., Howell, G. S., Michaelis, C. S., Dickmann, D. I. (1992) *The content of phenolic acid and aldehyde flavor components of white oak as affected by site and species*. American Journal of Enology and Viticulture, 43, 333-337
8. Clarke, R. J., Bakker, J. (2004) *Wine Flavour Chemistry*, Blackwell Publishing Ltd.
9. Snowdon, E.M., Bowyer, M.C., Grbin, P.R., Bowyer, P.K. (2006) *Mousy off-flavor: A review,* Journal of Agriculture and Food Chemistry, 54, 6465-6474
10. Spillman, P. J., Pollnitz, A. P., Liacopoulos, D., Skouromounis, G., & Sefton, M. A. (1997) *Accumulation of vanillin during barrel-aging of white, red and model wines*. Journal of Agricultural and Food Chemistry, 45, 2584-2589
11. Tao, Y., Garcia, J.F., Sun, D.-W. (2013) *Advances in wine ageing technologies for enhancing wine quality and accelerating wine ageing process,* Crit. Rev. Food Sci. Nutr. 54:817-835
12. Towey, J. P., & Waterhouse, A. L. (1999). *Barrel to barrel variaton of volatile oak extrqactives in barrel – fermented Chardonnay*. American Journal of Enology and Viticulture, 47, 17-20.
13. Vivas, N. (2005) *Manual de Toneleria: Destinado A Usuarios De Toneles,* Ediciones Mundi – Prensa, Madrid
14. *** (1995) *Barrel Maintenance and Repair Manual.* Barrel Builders Inc., St. Helena, CA (USA)
15. Web 1: Barrique barrel - https://en.wikipedia.org/wiki/Barrel (accessed 12.7.2020.)
16. Web 2: Robots handling barrels at Speyside Cooperage - https://www.youtube.com/watch?v=oDtx9X1acOY (accessed 12.7.2020.)
17. Web 3: Getting Blazed with a Napa Valley Master Cooper http://www.hillaryeaton.com/getting-blazed-with-a-napa-valley-master-cooper/ (accessed 12.7.2020.)
18. Web 4: Wooden barrel and part names https://www.pinterest.com/pin/322922235764912411/ (accessed 12.7.2020.)
19. Web 5: Cooper Machine Company Inc. - https://www.coopermachine.com/ (accessed 12.7.2020.)
20. Web 6: Ledinek - www.ledinek.com (accessed 12.7.2020.)
21. Web 7: How oak barrels are made - https://wineanorak.com/howoakbarrelsaremade.htm (accessed 12.7.2020.)

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DESIGN AND CONSTRUCTION OF A MULTIFUNCTIONAL EXHIBITION ELEMENT USING 3D PRINTING

Tauber, J., Svoboda, J., Holouš, Z.

Abstract: The aim of this work is the design and construction of a multifunctional exhibition element used for presentation purposes of a particular organization JMK (South Moravian Region, CZ). It is an exhibition of a multifunctional product (cube), which can be used for various purposes. The construction of the cube is made of plywood. The structural joint uses corner binding in combination with 3D printing. Neodymium magnets are inserted into the side surfaces of the individual walls. The magnets enable to add additional features to the product. To use magnets to connect "cubes" vertically or horizontally into individual variable units. The graphic solution (relief CNC milling, 3D printing and colour drawing) of the exhibition element is based on the logo – the manual of the particular company. Basic strength tests according to EN 16139 and stability EN 1022 were performed on the product prototype in an accredited Furniture Testing Laboratory with the aim of verifying the dimensioning of structural joints and safety in use.
Keywords: furniture design, 3D printing, prototype

1. INTRODUCTION

The project assignment stemmed from the request of JMK to make a new multifunctional exhibition product which would serve various purposes, mainly promotion. It is a multifunctional product – a cube of miscellaneous variations – see the picture attachment. The basic, and main, use of the product is using it either as a seating item with or without upholstery, a coffee table or a display wall.


Figure 1. Photo of a designe of the exhibition element (elevated seating + a coffee table)

2. THE DESIGN – INITIAL REQUIREMENTS

Among other given initial requirements, it was demanded to use 3D print and such print filament, which is ecological and made of cornflour. This way, the ecological standard is guaranteed where, apart from wooden materials which have low energetic demands, also the components of 3D print will have low energetic demands as it is expected that they will decompose spontaneously in the wild. This is caused exactly due to the composition of the filament whose base is made of cornflour.

The size of the cube:	380 mm x 380 mm x 380 mm
The size of the cube with gliders:	380 mm x 380 mm x 390 mm
The size of the cushion:	400 mm x 400 mm x 60 mm
The size of the coffee table boards:	600 mm x 600 mm, 1500 mm x 600 mm

Figure 2. 3D The Printing Centre at Mendel University in Brno - Department of Furniture, Design and Habitation

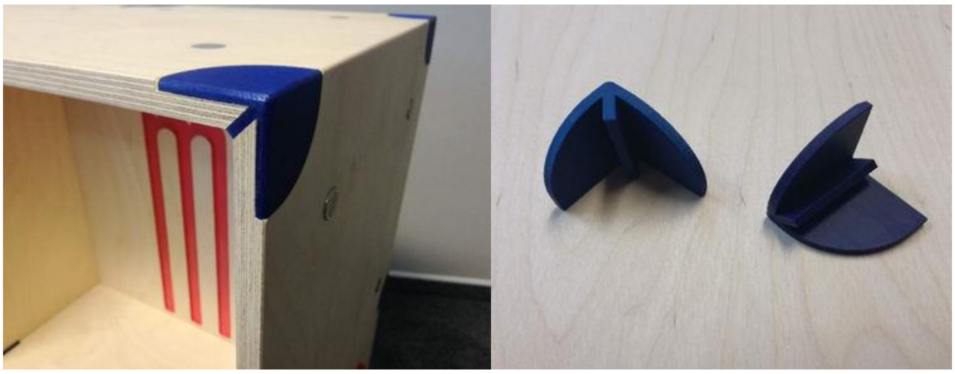

Figure 3. A corner construction item and its mounting

Further added value of this product is placing neodymium magnets to all surface parts of the cube. All sides of the cube are mounted by magnets or metal counterparts. Due to using neodymium magnets, which are small but of great pressure power, it will be possible to compose the cubes into bigger items. For example, using magnets will enable to attach an upholstered seating cushion to the cube and make upholstered seating. Also, the magnets will enable to attach a table board to the cube and make a small table. By embedding magnets into the surface around the perimeter, it will be possible to compose and attach the cubes by power next to each other and even one on another.


Figure 4. and 5. The photo of multi-purpose exhibition item (in the shape of M and square perforation)

Figure 6. The photo of multi-purpose exhibion item (seating a table)

3. DRAWING DOCUMENTATION

Drawing documentation was set up to make the product the way which enabled to make prototypes on a CNC wood-working machine and laser. The drawing shows the basic size and neshape of the product, including processing single details.

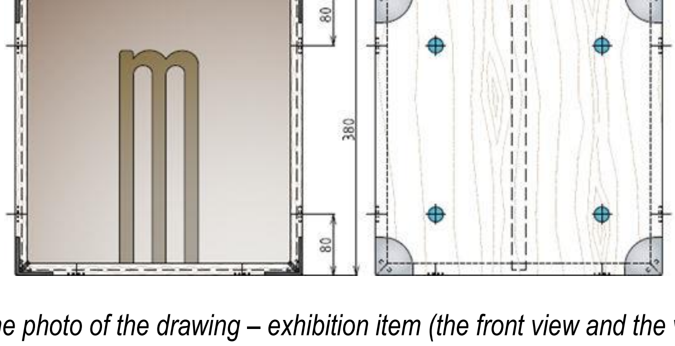

Figure 7. The photo of the drawing – exhibition item (the front view and the view from the top)

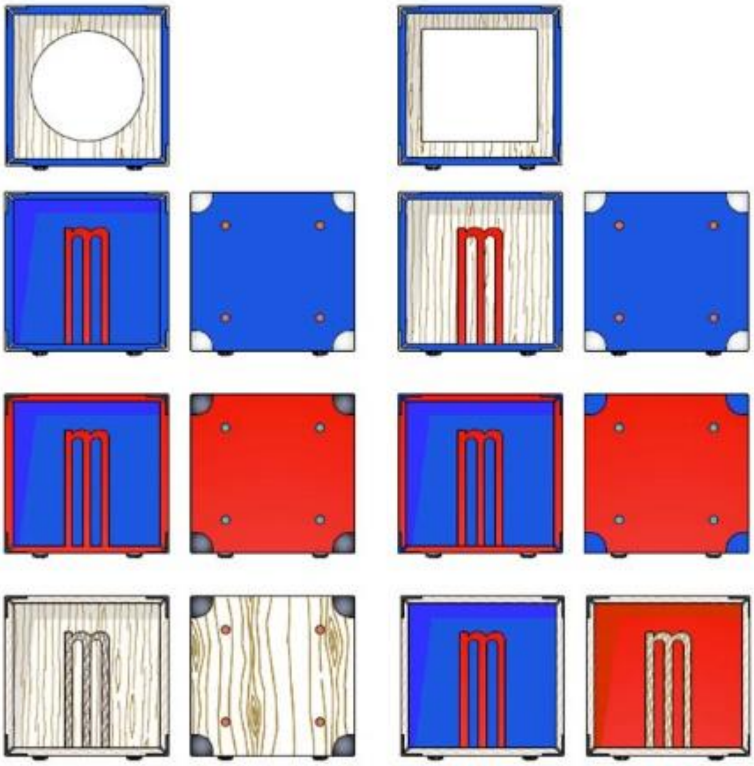

Figure 8. Graphical and material variants of the exhibition item

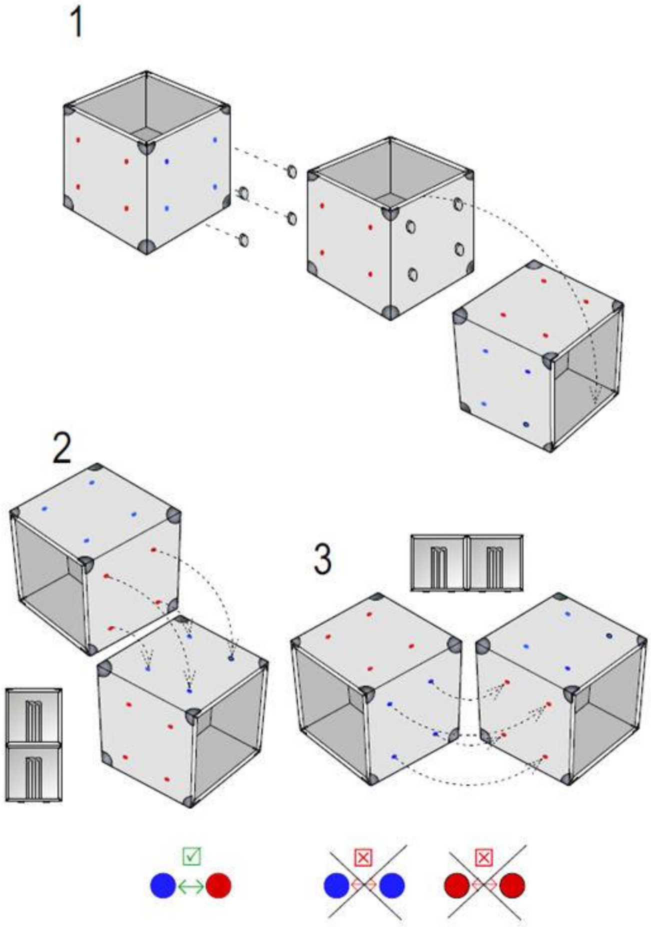

Figure 9. Miscellaneous variants of attaching cubes together by magnets (1 next to each other, 2 on one another)

4. THE DESIGN OF THE PRODUCT

The construction of the cube – corner joining was accomplished by mitre joint with wooden plates of 30 mm, the middle part was embedded into the rabbet in the middle of the inner space of the cube, all joints were being glued (it is recommended to use polyurethane wood glue), the corner plastic design item, which partly strengthen corner joining, is milled into the surface and glued by polyurethane adhesive material. The construction of the cushion – the base is made of foam polyurethane, glued around by natural fleece and put into a sewed fabric cover with a sewed-in zip and magnets to attach it to the upper surface of the board. All the outer edges of all parts were rounded Rmin. 2,5 mm, solid construction parts glued. Surface alteration – water dilutable polyurethane paint – semi matte rendition. The tearing force of the magnets is 8 kg and together with the counter plate they are finished out by polishing to the high gloss. Originally, a magnet of 2,5 kg was considered, but its tearing force was insufficient.

5. VERIFYING FUNCTIONALITY – TESTING THE PRODUCT IN THE ACCREDITED TESTING LABORATORY FOR FURNITURE

Verifying the basic item, the cube, was conducted in the accredited Testing Laboratory for Furniture, which belongs to Testing Laboratory for Joinery Products and Furniture n. 1030.1, accredited entity according to ČSN EN ISO/IEC 17025:2005, accredited entity n. 1030.1, which is part of Faculty of Forestry and Wood Technology at Mendel University in Brno.

The cubes serve primarily as pieces of furniture at exhibition events in South Moravian region and might even serve as subjects of occasional seating. For this purpose, it is possible to attach an upholstered cushion to the upper surface by magnets.

According to the aim of use, three basic tests were chosen on condition that the cubes do not serve for permanent seating. The tests were carried out with a cushion and a metal glider ø20 x 7 mm, attached by magnets to the bottom surface. The tests were carried out on a cube of middle stiffeners, which is the less suitable variant in contrast to the cubes with the front sides and stiffeners.

First, a stability test was conducted according to ČSN EN 1022:2020 Furniture - Seating - Determination of stability, Article 7.3.1 Forwards overturning. This norm contains some changes in comparison to the previous edition in 2005 so that it refers to seating of all use.

The test was conducted according to the technical procedure of Testing Laboratory for Furniture PP 12. The load in the seat at the spot of 60 mm from the edge of the load-bearing structure is 600N, overturning power is 20N.

During testing it was found out that with using gliders the testing item tends to tilt towards the direction of the power effect and leans against the bottom part of the construction (Figure 10), but does not turn over, which is described in the above mentioned norm as unsatisfactory condition. However, it is not possible to state clearly if the item meets the requirements of the norm or not. On the other hand, testing without gliders showed that the item is completely stable and meets all the requirements of the norm (Figure 11).

Based on the above mentioned stability tests, it was decided not to attach the gliders by magnets but to embed them into the bottom surface.

The mechanical tests to verify strength were conducted according to ČSN EN 16139:2013 Furniture - Strength, durability and safety - Requirements for non-domestic seating. Due to the assumed way of use, two tests were chosen: according to Table 1, the level of loading 1 (common use) according to the stated norm, more precisely testing the seat by static loading and testing the seat by shock. The tests were conducted in configuration set by the norm ČSN EN 1728:2020 (Furniture - Seating - Test methods for the determination of strength and durability). Given the results of the stability test and the recommendation that gliders should not be used, the tests were conducted without them.

During static load testing the seat was loaded by 100 mm from the edge of the construction in the axis of the item 10 times by the force of 1300 N over the smaller seat loading pad . The load always had impact for 10 seconds (Figure 12).

The impact test of the upper surface of the seat was conducted by an impact body of the weight of 25 kg with the height of the fall of 240 mm (Figure 13).

The tested item showed no sign of damage and meet the requirements of the stated norms at both tests.


Figure 10. The stability test with gliders *Figure 11. The stability test without gliders*


Figure 12. The static load test *Figure 13. The impact test*

The results of the tests verified that the construction is convenient from the point view of strength. Furthermore, due to some insecurities in the overturn test with gliders, the gliders were decided to be attached differently, more precisely it was decided to embed them into the bottom surface with minimum overlap of 2 mm.

6. CONCLUSION

This paper shows some possible use of current modern technologies on constructing a multiple-purpose product, which is remarkable for its added utility and aesthetic value given by the technology of the neodymium magnets and corner items of the 3D print. The biggest portion of plastic is on the design corner items, which are made by 3D print from PLA (polylactic acid made from starch by enzymatic hydrolysis). This material is fully biodegradable (e.g. composting plants). During manufacturing prototypes it was found out that the magnets, which connect the cubes into sets and attach cushions must have 2,5 – 3 times bigger towing force than it had been stated in the documentation. Three types of prototypes of the cubes were made in total varying in the middle piece. The final product is multi-purpose, interesting in construction and playful.

REFERENCES

1. ČSN EN ISO/IEC 17025 (2005): Conformity assessment - General reguirements for the competence of testing and calibration laboratories
2. ČSN EN 1022 (2020): Furniture - Seating - Determination of stability
3. ČSN EN 16139 (2013): Furniture - Strength, durability and safety - Requirements for non-domestic seatingČSN EN 1022:2020 Furniture - Seating - Determination of stability

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THE POSSIBILITY OF PROCESSING WASTE WOOD BIOMASS FOR FERMENTATION PURPOSES

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Abstract: Wood biomass is a renewable source of energy. It is produced forestry and wood-processing industry. It is referred to as lignocellulosic biomass because it is composed mainly of cellulose, hemicellulose and lignin. Processing consists in splitting the mutual bonds and hydrolysis of cellulose and hemicelluloses to fermentable saccharides, which can be further fermented to bioethanol or biogas. Waste wood biomass includes mainly pieces of soft or hard wood, waste from stands, stumps and roots, sawdust, wood shavings, but also special fast-growing undemanding wood species. Due to the appropriate chemical composition as well as the timber production rate and yield, poplar wood appears to be a suitable biomass for further biotechnological processing, but also pine, spruce, fir, mulberry, oak, eucalyptus or aspen are also promising. The complex structure of woody biomass requires the use of various physical, chemical or biological methods, often in combination. After breaking the bonds between cellulose, hemicellulose and lignin, the biomass is ready for the subsequent enzymatic cleavage of cellulose and hemicellulose into fermentable carbohydrates. The fermentation step is also more complicated because it is necessary to use microorganisms capable of fermenting hexoses (C6) and pentoses (C5 carbohydrates) as well. It is precisely for this that the fermentation use of lignocellulosic biomass for ethanol or biogas is the subject of intensive research worldwide.
Keywords enzymatic hydrolysis, fermentable saccharides, pre-treatment, renewable energy, waste wood biomass

1. INTRODUCTION

The production of energy from renewable resources is increasing worldwide, in the framework of low-carbon economy implementation. Biomass is also a renewable energy source, because the energy of solar radiation is stored in its chemical bonds. From here it can be released back chemically, biologically, resp. biochemically. Wood biomass belongs to lignocellulosic biomass. We consider forest wood waste, wood processing waste and fast-growing wood species to be waste wood biomass. Wood from poplar (Yin et al., 2019, Cornejo et al., 2019, Mirmohamadsadeghi et al., 2016), pine (Linganiso et al., 2019, Cornejo et al., 2019, Mirmohamadsadeghi et al., 2016), spruce, fir (Linganiso et al., 2019), mulberry (Mirmohamadsadeghi et al., 2016) or wood of oak, eucalyptus, aspen (Tian et al., 2019) are suitable for further biotechnological processing.

The conversion of biomass into various value-added bio-chemicals (including biofuels) is demanding process, which requires state-of-the-art technology on an industrial scale. Before fermentation, it is necessary to divide the wood biomass into its basic components (cellulose, hemicellulose and lignin) and to obtain fermentable saccharides from cellulose and hemicellulose by enzyme hydrolysis.

2. COMPOSITION OF WOOD BIOMASS

Wood biomass is an alternative source for several industrial applications (Siracusa et al., 2008, Yin et al., 2019). From the point of view of its fermentation use, an important part is the cell wall, the main function of which is the natural protection of the cell and the maintenance of the cell turgor. Cellulose, hemicellulose and lignin are the main components of the plant cell wall (Tab.1, Hernández-Beltrán et al., 2019).

Table 1. Composition of the cell wall in plants

Composition	Primary wall (%)	Secondary wall (%)
Cellulose	9 – 25	40 – 80
Hemicellulose	25 – 50	10 – 40
Lignin	--	5 – 25
Pectins	10 – 35	--
Proteins	10	--

Cellulose and hemicellulose are potential sources of fermentable saccharides, but hight content of lignin is one of the major impediments to their produce (Lee and Yu, 2020). Lignin coats cellulose and hemicellulose, giving them greater chemical, mechanical and biological resistance. This resistance also conditional by the presence of crystalline sites of cellulose and the hydrophobicity of lignin (Isikgor and Becer, 2015). The lignin content in softwood is usually higher than in hardwood (Sjöström and Westermark, 1999). Soft and hard woods have their specifics not only in the anatomical structure but also in the chemical composition. Some chemical differences are summarized in the following table (Tab.2, Sjöström and Westermark, 1999).

Table 2. Content of cellulose, hemicellulose and lignin in soft and hard wood

Chemical component (% of dry matter)		Soft wood	Hard wood
Cellulose		37-43	39-45
Hemicellulose	Glucomannan	*	2-5
	Galactomannan	15-20	*
	Glucuronoxylan	*	15-30
	Arabinoglucuronoxylan	5-10	*
Lignin		25-33	20-25
Extractive components		2-5	2-4

* The value was not determined

In addition to these major components of plant cells, each plant contains a number of other components synthesized by complex metabolic pathways from primary metabolites. Most of them are tannins, monomeric flavonoids, lignans, alkaloids, terpenes, terpenoids and fatty compounds. Various acids, salts and inorganic substances are also present in small amounts (Hamelinck et al., 2005).

Pine sawdust are one of the main wood residues. This is an attractive low-cost lignocellulosic biomass, it has high hexoses content and broad availability, but it didn´t exhaustively study, mainly because of the high crystallinity of cellulose and the high lignin and extractives content. A typical chemical composition of *Pinus elliottii* is about 41–44 % of cellulose, 28–31 % of lignin, 27–33 % of hemicelluloses, and 2–4 % of extractives (Stoffel et al., 2017, Kruyeniski et al., 2019).

3. PROCESSING BEFORE FERMENTATION

The value of any feedstock for fermentation process depends on the ease, which you can obtain saccharides from it. Cellulose and hemicellulose in wood are in such mutual interaction (and with lignin), which to prevent direct hydrolysis using enzymes (Zhang et al., 2007). For that is necessary to perform pre-treatment of wood biomass before enzyme hydrolysis (Njoku et al., 2012; Cardona et al., 2014; Zabed et al., 2016; Cavalett et al., 2017). The pre-treatment methods are focused to separate the cellulose, hemicelluloses and lignin and to increase the accessibility of them for the subsequent processing steps. Pre-treatment methods should avoid the formation of inhibitors for enzyme hydrolysis and fermentation, too.

3.1. Pre-treatment and enzyme hydrolysis

Current research of pre-treatment is targeted towards developing processes which are mild, economical and environment friendly facilitating subsequent saccharification of cellulose/hemicellulose and their fermentation. The basic methods of lignocellulosic biomass pre-treatment can be divided into mechanical (grinding, milling, chopping), chemical (using acids, alkalies, H_2O_2), thermal (hydrothermal, steam explosion) and biological (using actinomycetes, bacteria, fungi). In order to achieve the desired result and to keep the environmental burden of the technology used to a minimum, pre-treatment methods are often combined (Kumari and Singh, 2018). Very effective and well-known pre-treatment process is hydrolysis in diluted sulfuric acid combined with high temperature and pressure. Cornejo et al. (2019) described the processing of pine and poplar chips for glucose production and they combined three parameters at different levels - temperature, residence time and acid/feedstock ratio. Yin et al. (2019) described pre-treatment of poplar chips with hot water (180 – 210°C) followed by enzymatic hydrolysis. Hydrothermal pre-treatment described by Alvira et al. (2010) as a promising method because it is easy to carry out and, in addition, it never produces enzyme hydrolysis and fermentation inhibitors (furfural, 5-hydroxymethylfurfural, phenolic compounds). On the other hand, hydrothermal pre-treatment alone is not efficient enough and in the next step requires increased dosing of enzymes (Nitsos et al., 2016). Lee and Yu (2020) dealt with acacia wood processing. The pre-treatment was conducted with 0.05% sulfuric acid/deionized water at 200 °C for 5 min and 30 min. Dilute sulfuric acid pre-treatment increased the surface area and pore volume of acacia wood and improved the enzymatic hydrolysis of cellulose. Kruyeniski et al. (2019) evaluated the effect of different pre-treatments on enzymatic hydrolysis of pine sawdust (*Pinus elliottii*). Diluted acid, steam explosion and slight alkali treatments revealed to be not effective to enhance enzymatic hydrolysis. On the contrary, strong alkali treatments promoted the lignin removal, thus increasing the accessibility of the material for enzymatic hydrolysis. Borrega et al. (2013) used water or limited amount of acid/alkaline for pre-treatment of hardwood chips. Technological procedures for cooking with sodium carbonate/sulphite/magnesium hydroxide/hot water were also verified (Tian et al., 2019). Li et al. (2019) discuss the use of extraction methods in pre-treatment processes. The application of extraction methods alone are insufficient for wood biomass. Saritha et al. (2012) reported biological pre-treatment methods using by lignolytic microorganisms. Such organisms are abundantly found in forest leaf litter/composts and especially include the wood rotting fungi, actinomycetes and bacteria. Authors also reported pre-treatment of hardwood and softwood residues with *Streptomyces griseus* isolated from leaf litter. Lignin loss observed was 10.5% and 23.5% in case of soft wood and hard wood, respectively. Delignification of wood biomass by physicochemical pre-treatments is also advantageous because it improves the following enzyme hydrolysis and lignin can be recovered as a co-product with potential higher-added value (Wang et al., 2019). However, pre-treatment of lignocellulosic biomass can lead to degradation products with an inhibitory effect on the enzymatic hydrolysis and fermentation process. Inhibitors (furfural and 5-hydroxymethylfurfural, various phenolic compounds, acetic acid, acid resins, tannins and terpenes and heavy metal ions) arise as result of high temperature in combination with the long retention time and aggressiveness of the chemicals (Harmsen et al., 2010). Therefore, it is important to find optimal methods and conditions for pre-treatment.

Enzyme hydrolysis is an effective and green process to production of monosaccharides from polymeric sugars for further bioprocesses. The effective enzyme hydrolysis is dependent upon a few factors, important is using enzymes with high catalytic activity and stability (Maleki et al., 2020). The enzyme hydrolysis of cellulose and hemicellulose are need highly specific enzymes. It requires the synergistic effect of at least three major classes of enzymes: endoglucanases (EC 3.2.1.4), exoglucanases (EC 3.2.1.91) and β-glucosidases (EC 3.2.1.21). However, the complete enzymatic hydrolysis of these polysaccharides requires the combined action of different enzyme activities (Berger et al., 2014). Conditions for enzyme hydrolysis are usually mild, temperature about 30-60°C and the hydrolysis time 1 - 4 days. Cornejo et al. (2019) report that in the processing of poplar and pine chips, more drastic pre-treatment conditions lead to more efficient enzyme hydrolysis and higher saccharides yields. Similar results describe Yin et al. (2019) in the processing of poplar chips. Lee and Yu (2020) monitored the effect of the amount of enzymes added on glucose yield. They found that the optimal dose was 10FPU/g of glucan, higher doses of enzymes did not adequately increase glucose yield.

4. CONCLUSION

Waste wood biomass is a renewable energy source. Its modifying is possible to obtain fermentable saccharides, from which can be prepared several substances with higher-added value (including biofuels). However, the conversion of wood biomass into fermentable saccharides is a demanding technological process and is therefore the subject of intensive research. The research focuses on finding the optimal technology that will be highly efficient and environmentally friendly as well.

REFERENCES

1. Alvira, P.; Tomás-Pejó, E.; Ballesteros, M.J.; Negro, M.J. (2010): *Pretreatment technologies for an efficient bioethanol production process based on enzymatic hydrolysis: a review.* Bioresource Technology 101(13): pp.4851–4861.
2. Berger, E.; Ferreras, E.; Taylor, M.P.; Cowan, D.A. (2014): *Extremophiles and their use in biofuel synthesis*. In: Industrial Biocatalysis. Pan Stanford Publishing, Hamburg, 239-282.
3. Borrega, M.; Tolonen, L.K.; Bardot, F.; Testova, L.; Sixta, H. (2013): *Potential of hot water extraction of birch wood to produce high-purity dissolving pulp after alkaline pulping*. Bioresource Technology 135: pp. 665–71.
4. Cardona, E.; Rios, J.; Peńa, J.; Rios, L. (2014): *Effects of the pretreatment method on enzymatic hydrolysis and ethanol fermentability of the cellulosic fraction from elephant grass*. Fuel 118: pp. 41–47.
5. Cavalett, O.; Chagas, M.F.; Junqueira, T.L.; Watanabe, M.D.B.; Bonomi, A. (2017): *Environmental impacts of technology learning curve for cellulosic ethanol in Brazil*. Industrial Crops and Products 106: pp.31–39.
6. Cornejo, A.; Alegria-Dallo, I.; Garcia-Yoldi, I.; Sarobe, I.; Sanchez, D.; Otazu, E.; Funcia, I.; Gil, M.J.; Martinez-Merino, V. (2019): *Pretreatment and enzymatic hydrolysis for the efficient production of glucose and furfural from wheat straw, pine and poplar chips*. Bioresource Technology 288: Article number 121583, 13 pp.
7. Hamelinck, C.N., van Hooijdonk, G., Faaij, A.P.C. (2005): *Ethanol from lignocellulosic biomass: techno-economic performance in short-, middle- and long-term.* Biomass and Bioenergy 28 (4): pp. 384-410.
8. Harmsen, P.; Huijgen, W.; Bermudez, L.; Bakker, R. (2010): *Physical and chemical characteristics of lignocellulosic biomass.* In: Literature review of physical and chemical pretreatment processes for lignocellulosic biomass. Wageningen UR Food & Biobased Research, Wageningen, 7-20.
9. Hernández-Beltrán, J.U.; Hernández-De Lira, I.O.; Cruz-Santos, M.M.; Saucedo-Luevanos, A.; Hernández-Terán, F.; Balagurusamy, N. (2019): *Insight into Pretreatment Methods of Lignocellulosic Biomass to Increase Biogas Yield: Current State, Challenges, and Opportunities*. Applied. Sciences 9 (18): Article number 3721, 29 pp.
10. Isikgor, F. H.; Becer, C. R. (2015): *Lignocellulosic biomass: a sustainable platform for the production of bio-based chemicals and polymers.* Polymer Chemistry 25 (6): pp. 4497-4559.
11. Kruyeniski, J.; Ferreira, P.J.T.; Carvalho, M.G.V.S.; Vallejos, M.E.; Felissia, F.E.; Area, M.C. (2019): *Physical and chemical characteristics of pretreated slash pine sawdust influence its enzymatic hydrolysis.* Industrial Crops and Products 130: pp.528 – 536.
12. Kumari, D.; Singh, R. (2018): *Pretreatment of lignocellulosic wastes for biofuel production: A critical review.* Renewable and Sustainable Energy Reviews 90: pp. 877-891.
13. Lee, I.; Yu, J.H. (2020): *The production of fermentable sugar and bioethanol from acacia wood by optimizing dilute sulfuric acid pretreatment and post treatment*. Fuel 275: Article number 117943, 8 pp.
14. Li, P.; Sakuragi, K.; Makino, H. (2019): *Extraction techniques in sustainable biofuel production: A concise review.* Fuel Processing Technology 193: pp. 295–303.
15. Linganiso, L.Z.; Buthelezi, T.; Motaung, T.E. (2019): *A Comparative Study of Sugarcane Bagasse and Soft Wood.* Wood Research 64 (2): pp. 273-280.
16. Maleki, M.; Shahraki, M.F.; Kavousi, K.; Ariaeenejad, S.; Salekdeh, G.H. (2020): *A novel thermostable cellulase cocktail enhances lignocellulosic bioconversion and biorefining in a broad range of pH.* International Journal of Biological Macromolecules 154: pp. 349–360.
17. Mirmohamadsadeghi, S.; Karimi, K.; Horváth, I.S. (2016): *Improvement of solid-state biogas production from wood by concentrated phosphoric acid pretreatment*. BioResources 11 (2): pp. 3230-3243.
18. Nitsos, C.K.; Choli-Papadopoulou, T.; Matis, K.A.; Triantafyllidis, K.S. (2016): *Optimization of hydrothermal pretreatment of hardwood and softwood lignocellulosic residues for selective hemicellulose recovery and improved cellulose enzymatic hydrolysis*. ACS Sustainable Chemistry & Engineering 4(9): pp.4529–4544.
19. Njoku, S.I.; Ahring, B.K.; Uellendahl, H. (2012): *Pretreatment as the crucial step for a cellulosic ethanol biorefinery: Testing the efficiency of wet explosion on different types of biomass.* Bioresource Technology 124: pp.105–110.
20. Saritha, M.; Anju Arora, A.; Nain, L. (2012): *Biological Pretreatment of Lignocellulosic Substrates for Enhanced Delignification and Enzymatic Digestibility*. Indian Journal of Microbiology 52(2): pp.122–130.
21. Siracusa,V.; Rocculi, P.; Romani, S.; Rosa, M.D. (2008): *Biodegradable polymers for food packaging: a review.* Trends in Food Science and Technology 19 (2): pp. 634-643.
22. Sjöström E.; Westermark U. (1999): *Chemical Composition of Wood and Pulps: Basic Constituents and Their Distribution.* In: Analytical Methods in Wood Chemistry, Pulping, and Papermaking. Springer, Berlin Heidelberg, 1-19.
23. Stoffel, R.B.; Neves, P.V.; Felissia, F.E.; Ramos, L.P.; Gassa, L.M.; Area, M.C. (2017): *Hemicellulose extraction from slash pine sawdust by steam explosion with sulfuric acid*. Biomass and Bioenergy 107: pp. 93-101.
24. Tian, D.; Shen, F.; Yang, G.; Deng, S.; Long, L.; He, J.; Zhang, J.; Huang, Ch.; Luo, L. (2019): *Liquid hot water extraction followed by mechanical extrusion as a chemical free pre-treatment approach for cellulosic ethanol production from rigid hardwood*. Fuel 252: pp. 589–597.

25. Yin, F.; Li, D.; Ma, X.; Zhang, Ch. (2019): *Pretreatment of lignocellulosic feedstock to produce fermentable sugars for poly(3-hydroxybutyrate-co-3-hydroxyvalerate) production using activated sludge*. Bioresource Technology 290: Article number 121773, 6 pp.
26. Zabed, H.; Sahu, J.N.; Boyce, A.N.; Faruq, G. (2016): *Fuel ethanol production from lignocellulosic biomass: An overview on feedstocks and technological approaches*. Renewable and Sustainable Energy Reviews 66: pp.751–774.
27. Zhang, P.Y.H.; Ding, S.Y.; Mielenz, J.R.; Cui, J.B.; Elander, R.T.; Laser, M.; Himmel, M.E.; Mcmillan, J.R.; Lynd, L.R. (2007): *Fractionating recalcitrant lignocellulose at modest reaction conditions*. Biotechnology and Bioengineering 97 (2): pp. 214-223.
28. Wang, P., Liu, Ch., Chang, J., Yin, Q., Huang, W., Liu, Y., Dang, X., Gao, T., Lu, F. (2019): *Effect of physicochemical pre-treatments plus enzymatic hydrolysis on the composition and morphologic structure of corn straw*. Renewable Energy 138: pp.502-508.

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INFLUENCE OF DIFFERENT MACHINING ON THE SURFACE ROUGHNESS OF BEECH WOOD SAMPLES

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Abstract – The quality of machined surfaces is an important parameter for the quality of wood products. Especially, the surface roughness has an effect on bonding quality and surface treatment of wood products. This paper presents the research on the surface roughness of beech wood samples machined by two different processes and the influence of machining parameters on surface roughness. The samples with radial grain were planed and sanded in combination with milling. Tools for planing had four blades and feed rate was 10, 15, 20, 25, and 30 m·min^{-1}. The depth of the planing was 1.00 mm and blade rake angle γ = 15°. The tool diameter was Φ = 125 mm and rotational frequency 8000 min^{-1}. The other machining process was performed on the automatic milling and wide belt sanding machine with a head of milling tool with a diameter of Φ = 250 mm and sanding roller with P80 granulation. The rake angle of blades was γ = 15° and feed rate 10 m·min^{-1}. The depth of milling and sanding was 1.50 mm. Surface roughness was measured using an electro-mechanical profiler Mitutoyo SJ-500. Measured parameters are Ra, Rz, and Rq, according to ISO 1997 standard. The lowest roughness had samples planed at a feed rate of 10 m·min^{-1}. The differences between the obtained values of surface roughness are significant. The highest roughness had samples which were machined on automatic milling and widebelt sanding machine. Measured results showed that the surface roughness obtained by sanding closest corresponds to the roughness obtained by planing at a feed rate of 30 m·min^{-1}.

Keywords: surface roughness, feed rate, planing, sanding, processing conditions.

1. INTRODUCTION

In the technological processes of wood processing, surface quality takes an important place. It significantly affects on quality and strength of the bonded joint and also on the subsequent surface treatment. The surface roughness of wood and deviations from the ideal overall geometric shape are geometric irregularities (Aydin, 2003). Surface geometry is always defined on the basis of irregularities resulting from macroscopic, microscopic, and submicroscopic characteristics (Dornyak, 2003). Surface roughness depends on the inherent morphological structure of wood and the way of processing (Temiz et al., 2005). The quality of the milled wood surface depends on the anatomical structure and the type of wood section, and processing parameters (cutting depth, feed rate, cutting speed and blade angle). It is assumed that the surface roughness of the cut hardwood surface, increases with increasing of the blade radius (Keturakis, 2007). Previous research has shown that the size of the grain during grinding affects the surface roughness (Aslan, 2008). In his researches Škaljić (2010) concluded that with increasing feed speed surface roughness increases. The way the wood was machined and wood species are the factors that significantly affect surface roughness (Laina, 2017).

This paper presents the research of the surface roughness of beech (*Fagus sylvatica* L.) wood samples machined by two different processes and the influence of machining parameters on the surface roughness. Beech wood is mostly used for the production of finger-joint panels and surface quality of beech elements is important for the bonding process.

2. MATERIALS AND METHODS

Measurements for this research were carried out on beech (*Fagus sylvatica* L.) wood samples. Dimensions of the samples before planing were: 42×47×550 mm. The average moisture of samples was 9%, before planing they were conditioned at 20 °C, in relative humidity of 65 ± 5%. The samples were planed and sanded in combination with milling on the radial section.

The first group of samples with radial grain was processed with planing (peripheral milling).

Peripheral milling is one of the most common methods of wood machining that are widely used in wood processing as well as wood-based products processing (Kvietkova., 2015). The samples were planed on a Weinig POWERMAT 600 machine. Tools for planing had four blades and feed speed was 10, 15, 20, 25, and 30 m·min^{-1}. Feed speed has an important influence on the roughness of the machined surface (Varrano, 2002; De Moura and Hernandez, 2006). The depth of the planing was 1.00 mm and the blade rake angle was γ=15°. The tool diameter was Φ = 125 mm and rotational frequency 8000 min^{-1}. The second group of samples with radial grain were machined on the automatic milling and wide belt sanding machine. Milling head had a tool with a diameter of Φ=250 mm and four spirally twisted rows of cutting blades. In one row there were 180 cutting inserts with dimensions 14×14×2 mm. The rake angle of blades was γ=15° and feed speed 10 m·min^{-1}. Sanding roller with P80 granulation was working with pressure of 6 kg/cm^2. Granulation of sanding tool takes an important role in the sanding process and directly affects surface roughness (Gurau, 2005). The depth of milling and sanding was 1.5 mm.

Surface roughness is considered as the main parameter for assessing surface quality after planing or sanding (De Moura and Hernandez, 2005). After machining the samples, surface roughness was measured using an electro-mechanical profilometer Mitutoyo SJ-500. The device consists of a central measuring console with a vertically placed test needle, with a radius of 10 μm. The test needle moved at a constant speed of 1 mm/s, converting a vertical displacement of 17,5 mm into an electrical signal. Table 1 shows the main technical data of the device for roughness measurement, with recommended cut-off value of 2,5 mm with 7 sampling lengths.

Table 1. Setup of measuring device for roughness testing (Mitutoyo SJ-500)

Evaluation length	17.50 mm
Cut-off value	2.5 mm
Number of sampling lengths	7
Traverse speed	1.00 mm/s
Stylus tip radius	10.00 μm
Stylus tip angle	90°

The roughness measurement was performed in six tracing lengths on one sample, and the total sum of samples for each feed rate was five. The parameters Ra, Rz, and Rq were measured, according to the ISO 4287:1997 standard. This method can be used to compare and assess the difference in surface roughness created by planing and grinding (Kilic, 2006).

3. RESULTS

Table 2 shows the values of the measured surface roughness on samples of beech wood, planed on Weinig Powermat 600, and samples machined on an automatic machine with aggregates for milling and sanding. The values of standard deviation are also given in the same table.

Table 2. Measured values of surface roughness, Ra, Rq, Rz and standard deviation of beech (Fagus sylvatica) samples

Descriptive Statistics Surface Roughness							
	N	Ra [μm] Means	Ra [μm] Std. Dev.	Rq [μm] Means	Rq [μm] Std. Dev.	Rz [μm] Means	Rz [μm] Std. Dev.
10 m/min	30	4,470333	0,995547	5,794667	1,295956	29,60133	6,722552
15 m/min	30	5,303667	0,990568	6,957000	1,288440	36,76600	6,975347
20 m/min	30	5,802000	1,141093	7,467333	1,428428	36,93333	6,549912
25 m/min	30	5,699000	0,863890	7,431000	1,080601	39,32033	6,819919
30 m/min	30	6,120667	0,973971	7,924000	1,247700	40,57167	6,394470
Sanding P80	30	6,597333	1,507766	8,516667	1,838037	45,32667	9,133802
All Grps	180	**5,665500**	**1,272126**	**7,348444**	**1,605741**	**38,08656**	**8,514009**

Figure 1, 2 and 3 show diagrams with summary results of measured roughness parameters Ra, Rq and Rz of beech samples processed at different feed speeds, and machined on automatic machine with aggregats for planing and sanding (Viet opera).

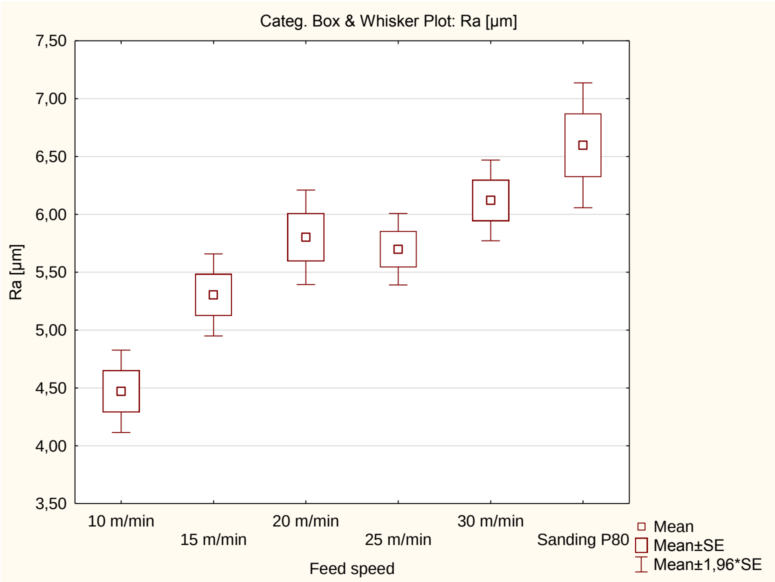

Figure 1. Statistical values of surface roughness Ra andstandard error of the mean value of beech samples

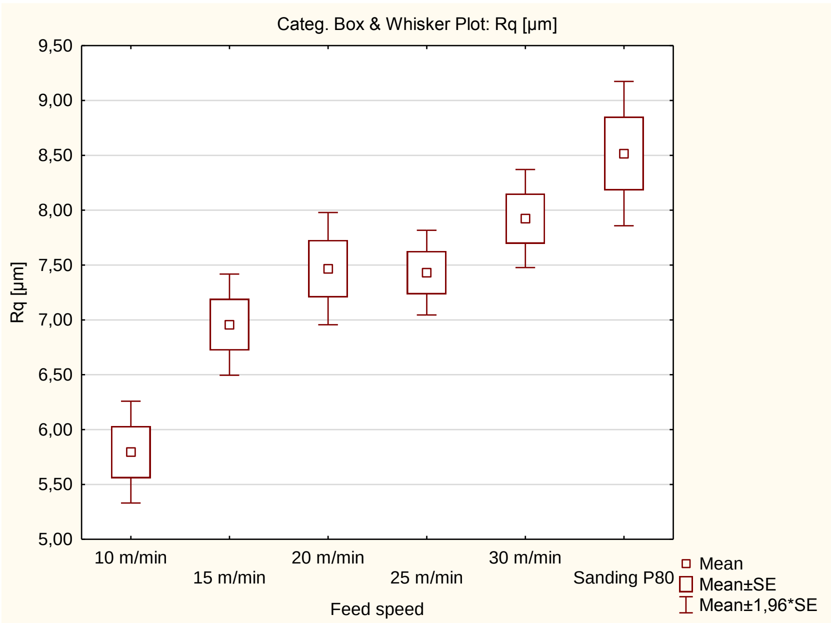

Figure 2. Statistical values of surface roughness Rq and standard error of the mean value of beech samples

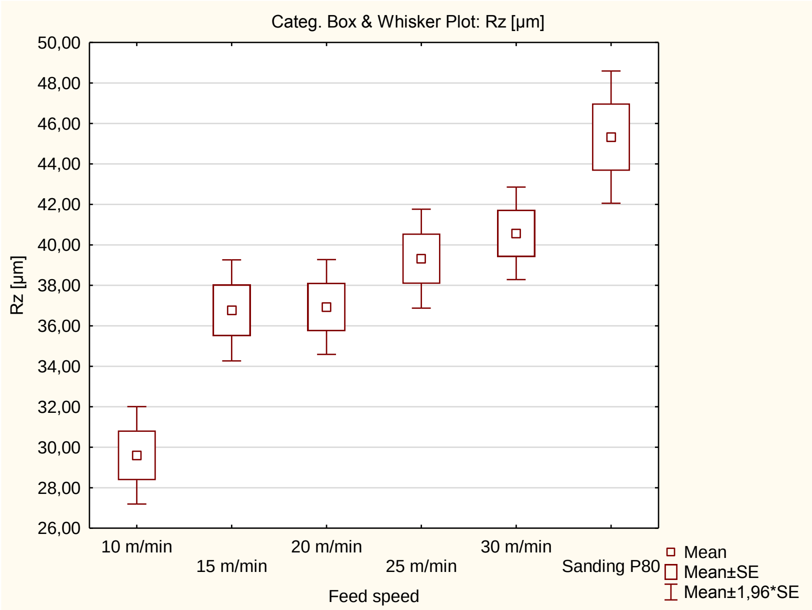

Figure 3. Statistical values of surface roughness Rz and standard error of the mean value of beech samples

The Analysis of Variance is presented in table 3. Table 4 shows results of Tukey test. Every marked difference is significant at $p < 0.05$.

Table 3. Analysis of Variance of surface roughness measured values Ra, Rq, Rz

Analysis of Variance, Marked effects are significant at p <0,05000								
Variable	SS Effect	dS Effect	MS Effect	SS Error	dF Error	MS Error	F	P
Ra [µm]	79,638	5	15,9275	210,039	174	1,20712	13,1946	0,00000
Rq [µm]	128,532	5	25,7065	333,002	174	1,91380	13,4321	0,00000
Rz [µm]	4055,69	5	811,139	8919,71	174	51,2627	15,8231	0,00000

It can be seen that all observed parameters of surface roughness increase with increase of feed speed.

Tukey THD (Honestly Significant Difference) test result shows us single step multiple comparisons between observed surface roughness of samples machined at different feed speeds and samples sanded with the granulation of P80 on Viet Opera. As shown, there is a significant difference in surface roughness when the samples were milled and sanded with granulation P80 in comparison with samples machined by planing at feed speeds 10 and 15 m/min. Also, planing of samples at feed speeds 20 and 30 m/min did not give statistically significant different surface roughness than sanding with granulation of P80. This means that the quality of the wood surface is approximately the same but with significantly higher capacity in the process of wood planing.

Table 4. Tukey Honestly Significant Difference test results

Tukey HSD test; Variable: Ra [µm]						
Feed speed	[1] M=4,4703	[2] M=5,3037	[3] M=5,3037	[4] M=5,6990	[5] M=6,1207	[6] M=6,5973
10 m/min [1]		0,038856	0,000057	0,000229	0,000020	0,000020
15 m/min [2]	0,038856		0,494089	0,731005	0,045891	0,000091
20 m/min [3]	0,000057	0,494089		0,999179	0,871891	0,056869
25 m/min [4]	0,000229	0,731005	0,999179		0,673050	0,019241
30 m/min [5]	0,000020	0,045891	0,871891	0,673050		0,544892
Sanding P80 [6]	0,000020	0,000091	0,056869	0,019241	0,544892	

4. CONCLUSION

If we look at the surface roughness in relation to the change of the feed speed during planing, then we see that beech samples planed at feed speed of 10 $m \cdot min^{-1}$ have the lowest measured roughness.

The next value of the measured roughness is at feed speed of 15 $m \cdot min^{-1}$, then at feed speed of 20 $m \cdot min^{-1}$. At feed speeds of 25 and 30 $m \cdot min^{-1}$, the measured roughness was the highest, which is mostly the expected research result.

On the second technological process of wood machining, on an automatic machine with aggregates for milling and sanding (Viet opera), the measured roughness of beech samples was the highest, which can be seen from diagrams shown earlier. Also much higher producivity could be achieved by planing at feed speed 20 and 30 m/min with the same wood surface quality.

By analyzing the variances, we see that there is a significant diffrences between the roughness of measured samples. After analysing the roughness results of different group of beech wood samples with the Tukey test, we can see significant differences between individual groups.

Based on the obtained results, research should be continued with involving new parameters of machine processing control, increasing of number of samples or possible dislocation of testing samples in two or more independent different production with the same machining parameters.

REFERENCES

1. Aydin I.; Colakoglu G. (2003): *Roughness on wood surfaces and roughness measurement methods*. Research gate publication
2. Aslan S.; Coşkun H.; Kiliç M. (2008): *The effect of the cutting direction, number of blades and grain size of the abrasives on surface roughness of Taurus cedar (Cedrus Libani A. Rich.) woods.* Building and Environment 43, pp. 696-701
3. Carrano, A.L.J.B.; Taylor, R.; Lemaster, R. (2002): *Parametric characterization of peripheral sanding*. Forest Products Journal 52 (9): pp. 44-50.
4. De Moura, L.F.; Hernandez, R.E. (2006): *Effects of abrasive mineral, grit size and feed speed on the quality of sanded surfaces of sugar maple wood*. Wood Science and Technology 40 (6): pp. 517-530.
5. De Moura, L.F.; Hernandez, R.E. (2005): *Evaluation of varnish coating performance for two surfacing methods on sugar maple wood*. Wood and Fiber Science 37 (2): pp. 355-366.
6. Dornyak O.R. (2003): *Modelling of the Rheological Behavior of Wood in Compression Processes*. Journal of Engineering Physics and Thermophysics, 76, pp. 648-654

7. Gurau, L.; William, M.; Irle, M. (2005): *Processing roughness of sanded wood surfaces*. Holz als Roh und Werkstoff, 63 (1): pp. 43-52.
8. Keturakis, G.; Juodeikiene, I. (2007): *Investigation of Milled Wood Surface Roughness*. Materials Science (Medžiagotyra), 13 (1).
9. Kilic, M.; Hirizoglu, S.; Burdurlu, E. (2006): *Effect of machining on surface roughness of wood*. Science direct, Building and Environment 41: pp. 1074-1078).
10. Kvietkova, M.; Gašparnik, M.; Gaff, M. (2015): *Milled Beech Roughness.* BioResources 10(3), pp. 4226-4238.
11. Laina R.; Sanz-Lobera A.; Villasante A.; Lopez-Espi P.; Martinez-Rojas J.; Alpuente J.; Sanches-Montero R.; Vignote S. (2017): *Effect of the anatomical structure of wood on surface roughness*. Maderas 19_2: pp. 203-212.
12. Škaljić N.; Beljo Lučić R.; Čavlović A.; Obućina M. (2010): "*Effect of Feed Speed and Wood Species on Roughness of Machined Surface*". Drvna Industrija 60 (4).
13. Temiz, A.; Yildiz, U.C.; Aydin, I.; Eikenes, M.; Alfredsen, G.; Colakoglu, G. (2005): *Surface roughness and colour characteristic of wood treated with preservatives after accelerated weathering test*. Applied Surface Science 250 (1-4), pp. 35-42.

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ENERGY EFFICIENCY OF WOODWORKING MACHINES AND SURFACE ROUGHNESS OF MACHINED SURFACES IN THE SECONDARY PROCESSING PLANT OF SPAČVA D.D., VINKOVCI

Đukić, I., Jovanović, J.

Abstract: The article presents the results of a research on the energy efficiency of woodworking machines and surface roughness of machined surfaces after machining on the machines in the secondary processing plant of the company Spačva d.d., Vinkovci. As a part of the project, the aim of this part of the research was quantification of energy efficiency and surface roughness of every machine in the secondary processing plant that is used for production of the elements that are used in later processing stages for door production. The electrical power and electrical energy requirements were measured on every machine during representative working conditions and surface roughness was measured in laboratory conditions on the representative samples of workpieces from the production. From the measured electrical power the average specific cutting energy and average total energy needed for unit production was calculated. For roughness assessment the R_a, R_q and R_z parameters were measured and for waviness the W_a, W_q and W_z parameters were measured. The results show that most of the machines that were inspected have specific cutting energy that is in line with previous research. Some of the machines are overloaded with intermittent high spikes of electrical current. The results of surface roughness and waviness show great deviation of the results (on one sample and between samples) and poor surface quality. The results indicate that the main driver of surface roughness in this case is not the kinematics of cutting (tooth marks on the machined surface), but other factors such as tool geometry, lateral cutting forces, errors in workpiece feed.
Keywords: wood cutting, secondary wood processing, energy efficiency, surface roughness.

1. INTRODUCTION

In order to quantify the efficiency of wood machining systems, different methodologies can be used. The machinability is often used, but there is no standardized, widely accepted procedure for machinability determination. Generally, machinability can be defined as the property of the material to be processed by chip removal process (Šavar, 1990). As a criteria for machinability determination several parameters are usually measured and machinability of a given material can be expressed as a combination of those variables, usually in relation to some reference material, e.g. wood species. Parameters that are usually measured are the cutting force (power) and machined surface roughness ("quality"), but according to literature (Šavar, 1990) other parameters as the tool life, tool temperature or chip type are also useful, but in wood machining research, this parameters are rarely measured. It is obvious that there is a difference between what is generally meant by efficiency and the efficiency of wood machining expressed through machinability. According to Astakhov (2014) this "old notion" of machinability can mean "all things to all men", so the new concept of machinability was proposed, which has a dual meaning.

The machinability of work material, which is directly related to the properties of work material and process machinability, which is related to specific machining process, should be distinguished. The machinability of work material should be quantified through some material property that is relevant to quantification of machinability and fracture energy is proposed. If there is no change of material in the experiment, then machinability of work material can be assumed to be constant.

The machinability of work material is directly correlated to process machinability. On the other hand, process machinability depends on a lot of variables (cutting speed, feed speed, tool geometry, tool material, etc.) and can be used as a measure of machining economy.

Astakhov (2014) suggested the specific cutting energy (E_n) as a quantity that can be used to represent the correlation between work material and process machinability, e.g. as a quantity that represents process machinability.

Specific cutting energy represents the average energy consumed for cutting in relation to unit production (Goglia, 1994). Different formulas for the calculation can be used (Goglia, 1994), but from standpoint of theory of cutting (Šavar, 1990) and according to recommendations, specific cutting energy can be calculated as

$$E_n = \frac{P_c}{V_h} \tag{1}$$

P_c - average cutting power,
V_h - material removal rate.

It can be shown that specific cutting energy is directly proportional to specific cutting pressure (k_c) (Goglia, 1994) which is defined as

$$k_c = \frac{F_c}{A_s} \tag{2}$$

F_c - cutting force,
A_s - undeformed chip cross section.

Specific cutting pressure has also been introduced into engineering practice as a quantity that could represent resistance of the material to cutting (Zdenković, 1965) and it has also been in use for many years in wood machining (Afanasjev, 1962). This connection enables us to compare old results with new results obtained on newer machinery, with new tool materials and in cutting conditions that were not available before.

In order to determine energy efficiency of the whole machine, the total energy required for machining of given unit production (E_b) can be used. In accordance with expression (1) it can be calculated as

$$E_b = \frac{P_{tot}}{V_h} \tag{3}$$

P_{tot} - average power required for machining (usually it is the average electrical power required by the machine for a given unit production).

This total energy required for machining of given unit production is used by some authors (Wittstock and Paetzold, 2013) as a parameter for energy efficiency classification of machine tools in accordance with the ISO 14955. The combination of specific cutting energy and total energy required for unit production can be used for comparison of energy efficiency of different types of machines used for the same wood machining operation (Đukić, 2005). Different versions of equation (3) can be used in engineering practice and the main difference is in the denominator which can represent different measures of unit of production, depending on what is practical for given machining operation (Faletar et al., 2016). So, one has to be careful not to compare different things, because the wrong conclusions can be drawn.

The other quantity that is usually measured as a parameter for wood machinability is surface roughness, which is also used as a measure of a "quality" of machined surface. The standard procedure for surface roughness measurement relies on contact profilometers, which can only be used offline and measurements are relatively slow. In order to incorporate the machined surface roughness as a parameter for on-line control of wood machining operations non-contact methods can be used and research on implementation of this type of measurement and its implementation in industry has been going on for some years now, but it is still not incorporated as a standard part of quality control in wood machining (Lemaster and Dornfeld, 1982; Nasir and Cool, 2019; Sandak et al., 2020). In the interpretation of surface profile obtained by contact or non-contact methods, the same parameters in accordance with ISO 4287 are usually used.

As a part of the project with company Spačva d.d., Vinkovci, in order to quantify the energy efficiency and surface roughness of machined surfaces after machining on the machines in their secondary part of primary processing plant, the measurements of electrical power and surface roughness were conducted.

2. MATERIALS AND METHODS

Measurements were carried out during representative working conditions on the woodworking machines according to the Fig. 1, on the workpieces from common oak (*Quercus robur* L.) e.g. Slavonian oak, as this is the primary material that is processed on that line. The moisture content of the wood was above the fibre saturation point, 50 % moisture content on the average. All of the machines, except optimizing cross-cutting saw Dimter OptiCut 350-4, were 30 or more years old. For the measurements newly sharpened saws were used and all the parameters needed for the calculations were measured on the tools and the machines.

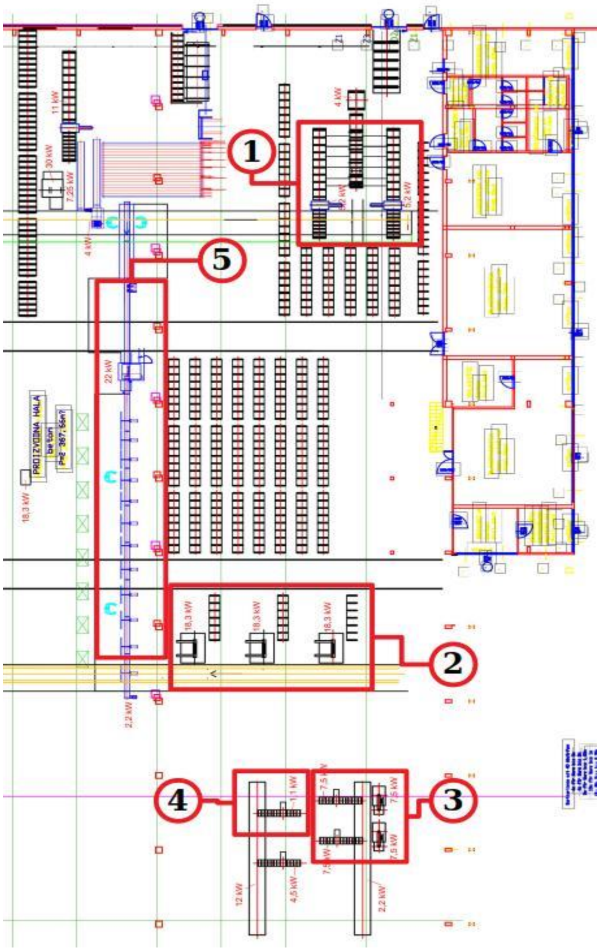

Figure 1. Ground plan with the machine layout in the secondary part of primary processing plant of Spačva d.d. (1 - radial arm saws (PKP), 2 - single-blade circular saws for edging and ripping (AC), 3 - bandsaws (TP9), 4 - pendulum saw (BKP), 5 - optimizing cross-cutting saw (OPC))

On the radial arm saws (PKP) the circular saw blades with spring set teeth were used with parameters: - saw diameter D = 390 mm, plate thickness a = 2,8 mm, set amount e = 0,6 mm, the cutting width b = 4,0 mm, number of teeth z = 80, rake angle γ = 17°, clearance angle α = 28°, rotational frequency n_v = 2992 min^{-1}. Main electrical motor power P = 5,2 kW. On the single-blade circular saws for edging and ripping (AC) the circular saw blades with spring set teeth were used with parameters: - saw diameter D = 390 mm, plate thickness a = 2,8 mm, set amount e = 0,4 mm, the cutting width b = 3,6 mm, number of teeth z = 36, rake angle γ = 20°, clearance angle α = 12°, rotational frequency n_v = 2993 min^{-1}. Main electrical motor power P = 15 kW. On the pendulum saw (BKP) the circular saw blades with spring set teeth were used with parameters: - saw diameter D = 350 mm, plate thickness a = 2,8 mm, set amount e = 0,6 mm, the cutting width b = 4,0 mm, number of teeth z = 80, rake angle γ = 16°, clearance angle α = 26°, rotational frequency n_v = 2997 min^{-1}. Main electrical motor power P = 1,1 kW. On the optimizing cross-cutting saw (OPC) the circular saw blade with tungsten carbide (TCT) teeth with alternate bevel was used with parameters: - saw diameter D = 400 mm, plate thickness a = 2,5 mm, the cutting width b = 3,6 mm, number of teeth z = 96, rake angle γ = 5°, clearance angle α = 13°, rotational frequency n_v = 4750 min^{-1}. Because main electrical motor power could not be determined, only the total machine power of P = 22 kW was known. On the bandsaw (TP9) the bandsaw blades with spring set teeth were used with parameters: - blade width B = 65 mm, blade thickness a = 1,2 mm, set amount e = 0,3 mm, the cutting width b = 1,8 mm, tooth pitch t

= 20 mm, rake angle □ = 20°, clearance angle □ = 12°, cutting speed v_c = 28 m/s. Main electrical motor power P = 7,5 kW. Only optimizing cross-cutting saw and single-blade circular saws for edging and ripping had mechanized feed and all other machines had manual feed.

On every machining group measurements of electrical power during cutting were conducted on 10 workpiece samples. Dimensions of samples were measured and average cutting height on all of the machines was between 27 mm and 30 mm. Samples were also taken for further analysis of surface roughness in the laboratory.

2.1. Electrical power measurement

The electrical power was measured with Fluke 435-II Three Phase Power Quality and Energy Analyzers. The measurements were conducted on the main electrical motor, except on the optimizing cross-cutting saw (OC), where it wasn't possible in the given circumstances, so the total electrical power of the whole machine (which during cut is dominated by power required for cutting) was measured. As all of the main drive electrical motors were induction motors, the average power required for cutting, e.g cutting power (P_c) was calculated as

$$P_c = P_{tot} - P_0 \tag{4}$$

P_{tot} - average power during cutting,
P_0 - average power required for idling of the machine.

Average power during cutting (P_{tot}) and average power required for idling of the machine (P_0) were calculated from the measured electrical active power during cutting and idling, by converting measured electrical power to mechanical power on the output of electromotor with the help of approximate linear relation between this two quantities, based on circle diagram of induction motor.

2.2. Roughness measurement

Roughness and waviness of machined surfaces were measured with surface roughness tester Mitutoyo SurfTest SJ-500. Stylus tip radius was 10 □m. Filter cut-off for roughness measurements was 0,8 mm and evaluation length was 4,0 mm. For waviness measurements filter cut-off was from 0,8 mm to 8,0 mm and evaluation length was 40,0 mm. The stylus was traced over surfaces in the direction opposite of feed speed, but parallel to it (perpendicular to the tooth marks). For roughness and waviness, in accordance with ISO 4287, the R_a, R_q, R_z, W_a, W_q and W_z parameters were calculated. Those parameters were chosen because they are usually used, but their usefulness in determination of tool and machine impact on wood machined surface roughness, especially on ring-porous species may be questionable, because of high impact of structural roughness of wood on final results (Csanady and Magoss, 2011). On every sample taken from production, five measurements of roughness parameters and five measurements of waviness parameters were measured. From those measurements the mean value and standard deviation of the sample mean were calculated for every workpiece in order to see the variability on one sample and between samples.

3. RESULTS AND DISCUSSION

From measured electrical power during cutting and idling, maximum mechanical power required during cutting for all of the samples and for every machine was recorded. This power was required just for a short period of time. The results can be seen in Table 1.

If the results from Table 1. are compared to nominal power of electromotors for all of the machines, it can be seen that for single-blade circular saws for edging and ripping (AC) and bandsaw (TP9) the main drive provided more than enough power, even under the greatest load, so it can be concluded that the main motor is oversized for production requirements and its efficiency in accordance with that is lower than what it could be if the proper electromotor was chosen. For other machines, e.g cross-cut saws the situation is different and especially for radial arm saws (PKP) the peak power is much greater than rated electromotor power. For the optimizing cross-cutting saw (OC) the results are given as a maximum value that was required during the period in which the measurements were conducted and it can be seen that even under the highest load the machine had enough power.

Table 1. Maximum required power during cutting for every machine group tested

Machine	Maximum required power during cutting, (kW)
TP9	2,6
BKP	3,5
OPC	23,8
AC	5,2
PKP	9,7

The average power required for cutting (P_c) on every machine tested can be seen in Figure 2. It can be seen that for cross-cut saws with manual feed there is a great variation in average power required for cutting, so automatic feed should be preferred.

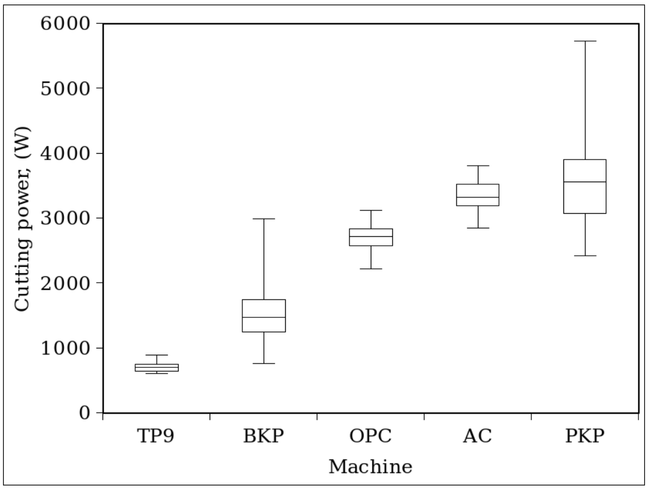

Figure 2. Average cutting power (P_c) required for sawing on all of the machine groups that were tested

In order to evaluate the energy efficiency of the machines, specific cutting energy (E_n) was calculated, according to formula (1) where material removal rate (V_h) for sawing is calculated as

$$V_h = v_f \cdot h \cdot b \tag{5}$$

v_f - feed speed,
h - cutting height,
b - cutting width.

The results can be seen in Figure 3.

If the results obtained from required cutting power and specific cutting energy are compared, we can see that, although the bandsaw on the average required the least power, it is not very efficiently used. It has one of the highest energy expenditures per unit of removed solid wood and from the analysis of measurements it was concluded that the main driver for this is low feed speed, which results in thin chip thickness. The same was concluded for a pendulum saw. Although the radial arm saws had high power requirements, because the feed speed was high enough to have more favorable chip thickness and despite using climb cutting, the required specific cutting energy was quite low. In the case of single-blade circular saw for edging and optimizing cross-cutting saw, it can be seen that despite their higher power requirements, that power is pretty efficiently used. The results for optimizing cross-cutting saw should be taken with reservation, because of the measurement method that was used, which was different than for other machines, and because of the measurement equipment limitations due to the smallest averaging interval of 0,25 s which was used and the time required for one cut. The possible impact of this limitation on the accuracy of cutting power measurements on optimizing cross-cutting saw remains to be determined.

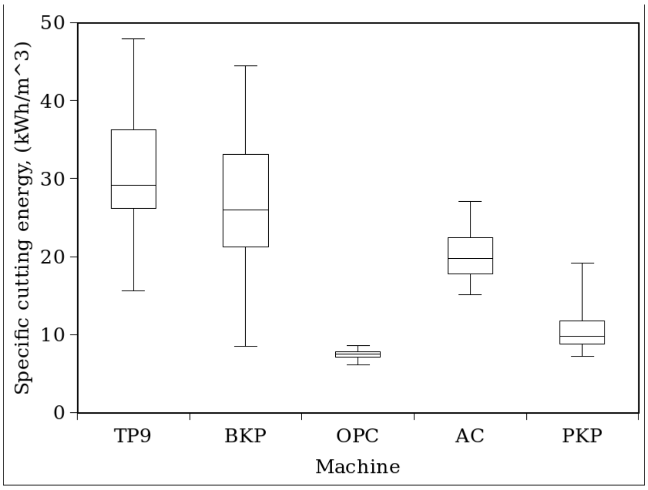

Figure 3. Specific cutting energy (E_n) for all of the machine groups that were tested

The total energy required for machining of given unit production was calculated in order to see what is machine efficiency in given machining conditions and to have a base for cost calculation, which can be easily done by multiplying that value with electricity cost per kWh. The results can be seen in Figure 4.

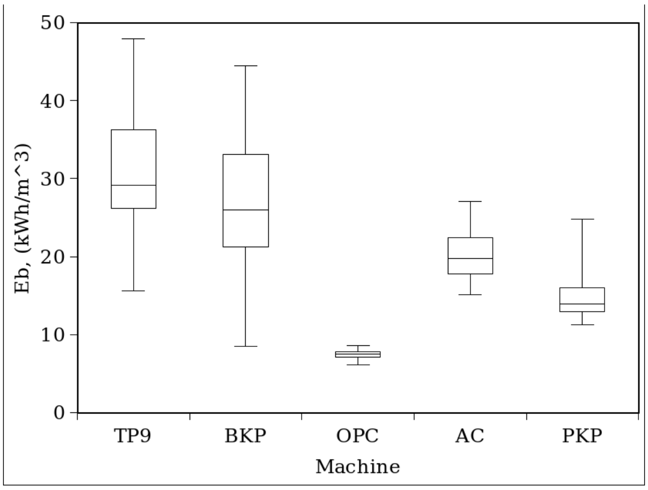

Figure 3. The total energy required for machining of given unit production (E_b) for all of the machine groups that were tested

The ratios of specific cutting energy and total energy required for machining of given unit production, which represent the machine efficiency in given machining conditions can be seen in Table 2.

Table 2. The ratios of specific cutting energy and total energy required for machining of given unit production for every machine group tested

Machine	Machine efficiency in given machining conditions
TP9	0,3
BKP	0,8
OPC	0,5
AC	0,7
PKP	0,7

From this data it can be seen that bandsaws have poor efficiency which is the result of small feed speeds and oversized machines for machining that is carried out on this group of machines. For the optimizing cross-cutting saw, again, because of the measurement setup and machining conditions obtained data should be further checked, but lower values were expected, because the total energy expenditure on this machine accounted also for the whole transportation line and auxiliary equipment that is part of the machine and was included in measurements. Actually, what we are looking for from this data is to have the smallest possible value of specific cutting energy realistically possible in given circumstances and the smallest difference between specific cutting energy and total energy required for machining.

Results of measured machined surface quality, expressed through roughness parameters R_a and R_z, and waviness parameters W_a and W_z can be seen in the next figures.

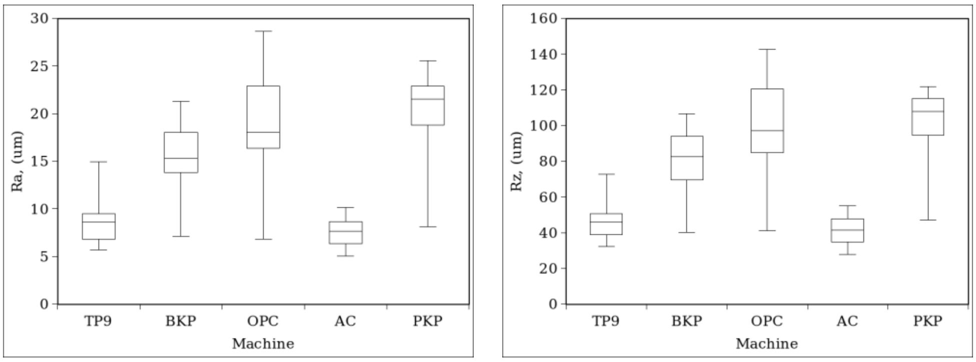

Figure 4. Machined surface quality for all inspected machine groups expressed through roughness parameters R_a and R_z

From theoretical perspective, surface roughness after sawing should be defined as tooth marks left on machined surface and a measure of surface roughness could be given by maximum tooth mark height which is a function of feed per tooth (f_z) and radial clearance angle, so the *z* or *t* parameters associated with roughness or waviness could be used. From measured data it can be seen that the same conclusions about machined surface roughness in this case can be drawn, if one uses R_z or R_a parameter. The worst surface roughness was for cross-cutting saws as was expected, but there is very high variability of measured values between samples and also on each sample. This is the result of wood surface structure, especially wood pores in oak wood, where the results are highly dependent on the selection of surface section for roughness measurements and in this case buy surface fuzziness and surface irregularities caused by poor feed movement and non optimal tool parameters.

It is well known that other factors that affect the lateral movement of saw blades, inaccuracies in feed movement and others, have even larger influence on surface quality and their wavelength is usually longer than what can be measured with roughness parameters. From measured waviness we can conclude that there is no significant difference in surface quality between inspected machines.

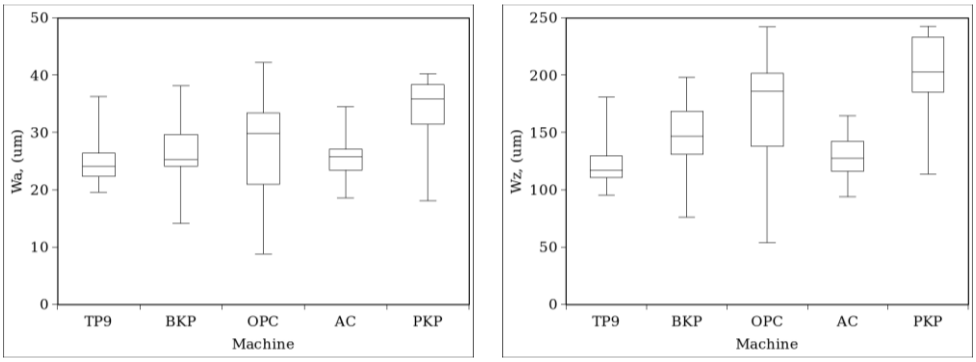

Figure 5. Machined surface quality for all inspected machine groups expressed through waviness parameters W_a and W_z

This data can be used as a reference if changes in tool or machine parameters are to be changed in order to get better surface quality, but the authors would be cautious when comparing this data with data obtained in other machining conditions or on another wood species because of known problems with interpretation of surface roughness measurements, especially on ring-porous wood species.

4. CONCLUSIONS

From conducted research it can be concluded that specific cutting energy can be used as a parameter for energy efficiency and machinability evaluation of woodworking machines. Especially in combination with cutting force or power and total energy required for machining of unit production volume, it can give valuable insights into machining process efficiency. The fact that specific cutting energy is directly related to specific cutting pressure is also of great help in the analysis of results, because of all the data that is provided by previous research on impact of material and machining variables on specific cutting pressure.

After the analysis of given parameters on the machine groups in the secondary processing plant of the company Spačva d.d. it was easy to show which machine groups would benefit most from further optimization. The bandsaws had lowest efficiency and it was concluded that the main driver for such low efficiency is low feed speed and oversized machine.

For the optimizing cross-cutting saw there still remains the problem with measurement of cutting power, because of the very short time period in which the cut takes place. The best solution for such measurement would be to make measurements with measurement equipment that has higher sampling frequencies and shorter averaging periods, but that would increase cost of measurements, so it would be beneficial to develop a test procedure for power measurements with standard equipment in order to get the data with satisfactory accuracy on this type of machine.

The surface roughness quantification still remains a challenge, especially on the ring-porous species. From measured parameters of roughness and waviness, it was concluded that the main drivers of bad surface finish in the given machining conditions were faults in feed movement and tool parameters.

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REFERENCES

1. Afanasjev, P. S. (1962): *Woodworking Machines* (translated from the Russian), Gosudarstvenoe naučno - tehničeskoe izdateljstvo, Moskva.
2. Astakhov, V. P. (2014): *Machinability: Existing and Advanced Concepts*. In: Machinability of Advanced Materials. John Wiley & Sons, Ltd, pp. 1-56. http://dx.doi.org/10.1002/9781118576854.ch1
3. Csanady, E.; Magoss, E. (2011): *Mechanics of Wood Machining*. Department of Wood Engineering, University of West-Hungary, Sopron.
4. Đukić, I. (2005): *Comparison of Ergonomic and Energy Characteristics of the Framesaws and Bandsaws*. Master scientific thesis. Faculty of Forestry, Zagreb.
5. Faletar, J.; Čunčić Zorić, A.; Budrović, Z.; Pađen, T. (2016): *Contribution to Research on Certain Production Costs by Investing into Computer Aided Technology of Production of Wooden Elements with Pre-Planing of Sawn Wood*. Drvna Industrija 67 (2): pp. 177-186. http://dx.doi.org/10.5552/drind.2016.1543
6. Goglia, V. (1994): *Strojevi i alati za obradu drva - I dio*. Šumarski fakultet, Zagreb.
7. Lemaster, R.L.; Dornfeld, D. A. (1982): *Measurement of surface quality of sawn and planed surfaces with a laser*. In: Proceedings of the 7th IWMS. pp. 54-62.
8. Nasir, V.; Cool, J. (2019): *Optimal power consumption and surface quality in the circular sawing process of Douglas-fir wood*. Eur. J. Wood Prod., 77 (4): pp. 609-617. https://doi.org/10.1007/s00107-019-01412-z
9. Sandak, J.; Kazimierz, A. O.; Sandak, A.; Chuchala, D.; Taube, P. (2020): *On-Line Measurement of Wood Surface Smoothness*. Drvna Industrija 71 (2): pp. 193-200. https://doi.org/10.5552/drvind.2020.1970
10. Šavar, Š. (1990): *Obrada metala odvajanjem čestica*. Školska knjiga, Zagreb.
11. Zdenković, R. (1965): *Obrada metala skidanjem - osnovi teorije i prakse*. Fakultet strojarstva i brodogradnje, Zagreb.
12. Wittstock, V.; Paetzold, J. (2013): *Comparison of Machine Tools Regarding Energy–The Difficult Path to an Energy Label*. In: Proceedings of the 1st and 2nd workshop of the cross-sectional group "Energy-related and economic balancing and evaluation of technical systems–insights of the Cluster of Excellence eniPROD". pp. 469-486.
13. ***: Iso standard 4287 (1997): Geometrical Product Specifications (GPS) - Surface texture: Profile method - Terms, definitions and surface texture parameters.
14. ***: Iso standard 14955 (2014-1): Machine tools - Environmental evaluation of machine tools - Part 1: Design methodology for energy-efficient machine tools.

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