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WoodEMA i.a.

DIGITALISATION AND CIRCULAR ECONOMY: FORESTRY AND FORESTRY BASED INDUSTRY IMPLICATIONS

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EDITORIAL

In the year of its 75th anniversary, the Union of Scientists of Bulgaria (USB) was honored to host the 12th WoodEMA annual international scientific conference, titled "Digitalisation and Circular Economy: Forestry and Forestry Based Industry Implications". The conference took place in the premises of its International House of Scientists "Frederic Joliot Currie" – Varna, St. Constantin and Elena resort, in September 11th–13th 2019. The Economic sciences division at the USB was the main organizer, under the auspices of WoodEMA, i.a.

The aim of the conference was to contribute to a better understanding of contemporary concepts of digitalisation and circular economy and their implications on production organisation, production and business economics, marketing, production management, personal management, quality assurance and quality management, innovativeness, information systems, renewable energy for forestry and forestry based industries.

The research interest to the topic of the conference was rather big. As a result the recent proceedings contains 53 papers of 113 authors from 14 countries – Bulgaria, China, Croatia, Czech Republic, Germany, Finland, North Macedonia, Poland, Russia, Serbia, Slovakia, Slovenia, Turkey, USA.

The first part of the proceedings is devoted to theoretical background for discussing the conference topic. Then the circular economy and digitalization implications are on the focus, followed by innovation and management challenges, good practices and policy solutions for forestry and forestry based industries.

The members of the Scientific Board and Reviews and of the Organization Committee believe the proceedings and discussions based on them will enable the exchange of valuable knowledge and ideas, useful for implementation in education, research, and good policy measures and practices of forestry and forestry based industries.

Acknowledgement: I have to thank Denis Jelačić – general secretary of the Woodema i.a. for his professionalism and support during period of organising the conference and publishing proceedings.

2nd of September, 2019 Rossitsa Chobanova
Sofia

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Part 1
THEORETICAL BACKGROUND

FROM LINEAR TO CIRCULAR ECONOMY: THE ROLE OF FORESTS (Survey of WoodEMA associated publications)

Rossitsa Chobanova, Maria Kotseva, Milkana Mouchurova

Abstract: The paper aims to bring a better understanding of the WoodEMA society contribution to identification of the role of forests in the transition from linear to the circular economy. It is based on Woodema associated publications.
Starting point of the work is understanding that the circular economy means an economy where raw materials and their value are employed as efficiently and wisely as possible. The objective is to create more income with fewer resources and in the most environmentally friendly way.
The key issues discussed concern identification of new problems and solutions unlocking the potential of sustainable value chains for forest products. Among them are:
• stronger governance to ensure sustainable forest management and increase forest cover;
• tacking corruption and illegalities and strengthening tenure;
• creating an enabling environment for investments;
• put in place public policies which enhance markets for legal and sustainable wood;
• increase innovation and improve resource efficiency along the supply chain;
• increased awareness and marketing for sustainable wood;
• investment in science, research and technological innovation.
Keywords: forest, circular economy, linear economy, WoodEMA

1. INTRODUCTON

The transition from linear to circular economy is a subject of accelerating number of contemporary research and policy papers and actions. In this respect this paper attempts to contribute to a better understanding of the concept of circular economy, assuming general theoretical and methodological issues and focussing on the role of forests in transition from linear to circular economy. To achieve such goal firstly paper suggests characterization of the concept of circular economy, incl. some methodological issues like indicators for measuring its development, based on assumption of literature survey provided by the Organization for Economic Cooperation and Development (OECD – G 20), G-7 and the European Commission (EC). The role of forest in transition from linear to circular economy is identified on the base of a literature survey of the Woodema society contribution to identification of the problems (challenges) and solutions (policy measures and best practices) in the transition from linear to the circular economy. It is based on conference proceedings of Woodema[1] online publications, excluding its three books, which are not available online.

2. UNDERSTANDING THE CONCEPT OF TRANSITION TO CIRCULAR ECONOMY

The concept and policy for circular economy development are discussed on different levels. Their review could be derived from three groups of publications:

- From academic reviews (including waste management policies).

[1] WoodEMA, i.a. is an international association for economics and management in wood processing and furniture manufacturing establihsed in the year 2007. The main goals of the association is to promote science and results of scientific and professional work of its members. See publications: http://www.woodema.org/publications.html

- From official documents of the European Commission[2], which collects many of the recent initiatives, OECD, G-7, etc.
- From charities and NGOs, most prominently, the Ellen McArthur Foundation[3].

2.1. Theoretical background

Contemporary academic rethinking of the progress within the limits of the planet has contributed to development of different theoretical and methodological dimensions of a concept for transition from linear to a circular economy (Geisendorf, S.,2017,Ghisellini, P., Cialani, C., & Ulgiati, S.,2016, etc.). This concept aims to redefine growth, focusing on society – wide benefits. It transforms all the elements of the take-make-waste system how to manage resources, how to make and use products, and what is done with the materials afterwards (See: Fig.1).

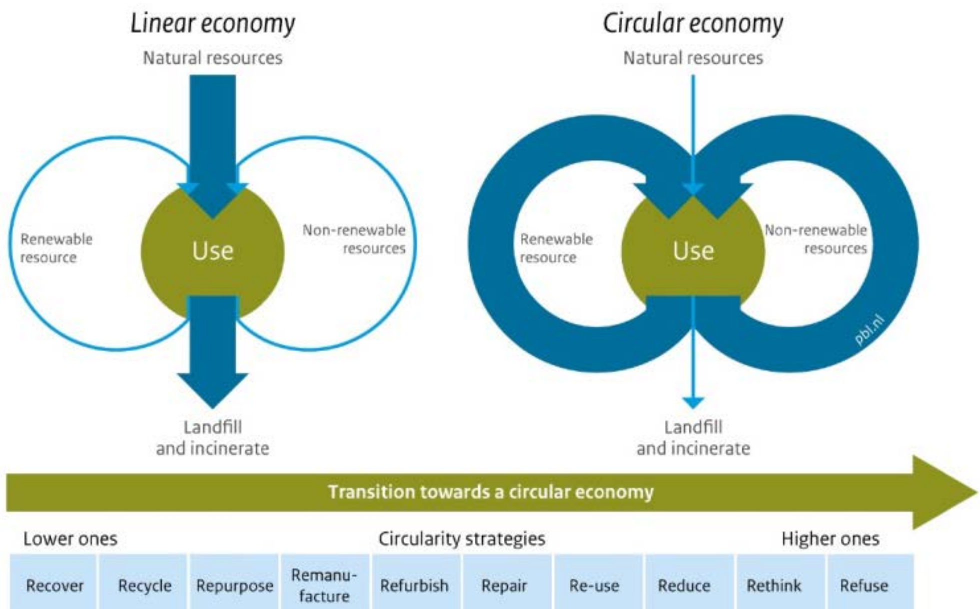

Fig.1. From linear to circular economy

Source: Mayank Chaturvedi. https://chaturvedimayank.wordpress.com/tag/bio-waste/, visited on 6th of July, 2019

The concept of transition to a circular economy explores how trough a change in perspective to re-design the way out economy works. It recognises the importance of the economy to work effectively at all scales – for large and for small businesses, for organizations and individuals, globally and locally.

The literature suggests different methodologies to be applied for collecting and interpreting data and defining policy measures for circular economy development. There are a variety of indicators, although most have limitations.

The OECD and G-7 generally use two indicators: for resource productivity and resource

2 See: http://ec.europa.eu/environment/circular-economy/index_en.htm, visited on 7th of July,2019.

3 See: https://www.ellenmacarthurfoundation.org/, visited on 7th of July,2019

efficiency. The first one is measured as GDP divided by domestic material consumption as an indicator for analysing resource use. The second one means using the Earth's limited resources in a sustainable manner while minimising impacts on the environment. It allows to create more with less and to deliver greater value with less input and is measured in EU resource efficiency scoreboard[4], as EU eco-innovation index recycling rates[5], through the amount of municipal waste per capita, or amount of waste per GDP output.

2.2. Policy actions

In 2015, the EC adopted an action plan to accelerate Europe's transition to a circular economy, strengthen global competitiveness, promote sustainable economic growth and create new jobs. The action plan contains 54 measures to "close the loop" of the life cycle of products – from production and consumption to waste management and the market for secondary raw materials. The plan also identified five priority sectors to accelerate the transition along the value chain (plastics, food waste, critical raw materials, construction and demolition, biomass and bio-based materials). It focuses on building a strong foundation to thrive Investment and innovation. Today EU institutions have a clear resource efficiency agenda; Roadmap to a resource efficient Europe; The Circular Economy package; Amendments to renewable energy policy that seek to address resource issues.

The circular economy discussion was also on focus during the 2019 Annual Meeting in Davos. Four key priorities emerging for the year ahead: a) Leadership is critical; b) Leverage the potential of the Fourth Industrial Revolution; c) Circular material value chains; d) Collaboration is key.

2.3. The role of forest and forest based industries

The forest and the forest based industry are unique in that they rely on natural resources and cycles as their primary inputs and using / depleting these resources beyond sustainable limits undermines the future of these sectors and the benefits they generate for society. Therefore, it is needed to be more resource efficient in the way use and re-use resources. The businesses completing that need are becoming more economic and more sustainable in the long term by: reducing external risks linked to oil and commodity prices; reducing the pressure on (natural) resources; opening up new revenue streams; and fostering innovation and collaboration between sectors and industry.

In conclusion, moving towards a more circular economy means less natural resources use, reduce pollution, tackle climate change, enhance consumer satisfaction, while also improving the bottom line. Taking into account the rational path not always the path of least resistance, shifting the system will take leadership, collaboration, innovation and commitment to break the status quo. There is a common understanding that the forest and forest based industries are crucial for the transition to an innovative circular economy.

[4] The EU Resource Efficiency Scoreboard indicators illustrate the progress towards increased resource efficiency of individual Member States and the European Union as a whole. Available for 2013, 2014 and 2015. See Eurostat data: https://ec.europa.eu/eurostat/web/environmental-data-centre-on-natural-resources/resource-efficiency-indicators/resource-efficiency-scoreboard, visited 6.7.2019

[5] See: Eco-Innovation of products: Case studies and policy lessons from EU Member States for a product policy framework that contributes to a circular economy, 2018, https://ec.europa.eu/environment/ecoap/sites/ecoap_stayconnected/files/documents/eio_report_2018.pdf, visited 6.7.2019

3. WOODEMA DISCUSSIONS

Starting point of WoodEMA society understanding of the circular economy is that it is an economy where raw materials and their value are employed as efficiently and wisely as possible. Or in other words, the main research question is how to create more income with fewer resources and in the most environmentally friendly way. Practically all eleven WoodEMA conferences published online are devoted to answering that question, focusing on its different aspects. Historically the main topics, discussed by conference participants concerning transition to a circular economy, could be grouped as follow:

The conference in 2009 focused on competitiveness of wood processing and furniture manufacturing in linear economy, however, some articles cover topics and practical implication related to circular economy such as value chain principles, supply chain optimisation and information technologies, end-user awareness of environmentally appropriate wood products. Papers published in 2010 and 2011 also cover some practices indirectly related to circular economy – analyses of wood removals, issues affecting timber products markets including technical innovations and environmental considerations. In 2012 some trends and challenges in the transition to circular economy are identified by WoodEMA conference participants. Among them are practices concerning the application of open innovations, innovations in small and medium sized enterprises, supply chain management, as well as the public policy suggesting better cooperation between universities and enterprises with emphasis on knowledge transfer and commercialisation. The topic is also covered in 2013. The creation of clusters between universities and companies of woodworking industry are essential to foster the spreading of new knowledge. Through information technologies the interested parties can be joint together and share their experience. In 2013 the bamboo and pellet are described as effective ways for energy production and for other ecological materials. The biomass and wood are seen as opportunities for rural economic development.

In 2014 the participants evaluate the sustainability of forest economy and the tools for its management. In 2015 the reports highlightmore practical trends in respect to increase of the energy effective uses, new techniques in the construction, the application of wood pellet. In respect to policy issues the role of wood clusters in wood and biomass promotion is essential for stimulating innovations in the sector, which is the key to a better positioning of the companies in foreign markets.

In 2016 the main issues concerning the circular economy are discussed concept of cascaded use of wood and the intermunicipal and intersectoral cooperation. They also are very important elements of the alternative green development opportunity for the countries.

In 2017 the title of the conference was „More Wood, Better Management, Increasing Effectiveness“. The topics that concern shift to circular economy are focused on public policy issues availability of beech raw wood and its usage for more valuable processing process; wood biomass contribution to renewable energy production. It also covered broad policy topics such as green growth and sustainable development, industry 4.0 concept, competitiveness and productivity corresponding to female employment, green properties of paper products and end-user awareness.

In 2018 a lot of papers deal with producing wooden products, i.e. new packaging materials, building materials, fertilization, clothes hangers, as well as interesting public policy issues that have to be understood and integrated in the policy of transition to circular economy.

Generalising the brief overview of topics discussed it could be concluded the key issues discussed concern identification of new challenges unlocking the potential of sustainable value chains for forest products in order to create more income with fewer resources. The solutions or policy and best practice measures include: stronger governance to ensure sustainable forest management and increase forest cover; tacking corruption and illegalities and strengthening tenure; creating an enabling environment for investments; put in place public policies which enhance markets for legal and sustainable wood; increase innovation and improve resource efficiency along the supply chain; increased awareness and marketing for sustainable wood; investment in science, research and technological innovation. Some of the challenges and measures in transition to a circular economy are presented in table 1.

Table 1. Challenges and measures in transition to circular economy

Problem (challenge)	Solution (measure)
Multifunctional application of wood and the necessity to balance its utilization	– Cascading, which can help to optimise the use of wood in the whole chain of its processing and utilisation[6] – Multifunctional forest management concept consistent with sustainable development principles on the harvesting of raw materials[7] – Forest complexes activities within promotion of sustainable forest management and protection of natural resources in the forests[8]
Growing energy consumption in parallel to the increase of CO2 emissions	– Wood pellets are cleaner burning, have a higher energy density, and are easier to handle than firewood wood chips, or other forms of wood fuel[9] – Croatian households and the possibilities of pellets future consumption incensement[10] – Houses with low energy demands which do not harm the environment[11]. – Promotional activities for changes regarding pellet selling and consum-ption[12] – Wood biomass cancontribute significantly to renewable energy production within the EU-28[13] – Wood biomass potentials for energy, consumption of wood energy and its contribution to achieve the national renewable target- Serbia, 2020[14]
Sustainable production and consumption	– Certification, brands of quality, introduction of goods on market following the required procedures for assessing conformity and control of their use[15] – Eco-labels usage[16] **…**

6 Parobek, J.; Paluš, H., 2016, The Concept of Cascaded Use of Wood in Slovakia
7 Katarzyna Mydlarz, Marek Wieruszewski, Zbigniew Malinowski, 2018, Selected Economic and Material Aspects Behind the Use of Wood by the Timber Industry in Poland and in Selected European Union Countries
8 R. Stasiak-Betlejewska, 2014, Products Quality in the Area of Wood Processing Industry as Part of Eco-Efficiency
9 Mikuláš Šupín, 2015, Wood Pellet Global Market Development
10 Andreja Pirc Barčić, Liker Branko, Darko Motik, Maja Moro, 2015, Possibilities of Increasing Renewable Energy Resources in Croatia – Wood Pellet
11 Marek Potkány, 2015, The Concept of Facility Management in the Focus of Energy Effective Houses
12 Ana Dijan, Marijan Kavran, 2013, Promotion of Wood Biomass and Pellet in Croatia and Other Countries of Southeast Europe
13 Šupín, M.; Kaputa, V. Parobek, 2017, Wood Biomass as a Renewable Resources Market Development in the EU
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15 R. Nováková, E. Habiňáková, 2014, Products Quality in the Area of Wood Processing Industry as Part of Eco-Efficiency
16 Andreja Pirc Barčić, 2018, Environmental Labeling: Obsticle or Advantage in Recognizing Wood Producsts in International Markets
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18 Hyytiä, K. A., 2017, Sustainable Development – International Framework – Overview and Analysis in the Context of Forests and Forest Products – Competitive Business with Quality
19 Stanisław Borkowski, Renata Stasiak-Betlejewska, 2011, Timber Products Market in European Countries – Characteristics and Trends
20 Kristina Bicanic – Krešimir Greger – Tomislav Grladinovic – Ivana Peric – Vanja Cošic, 2012, Certification Documentation for Responsible Forest Management in Practice

Problem (challenge)	Solution (measure)
	… – Wood raw material production and consumption should meet environmental, economic, cultural, social, and other needs. Green growth indicators should be analysed together[17] – Business and private sector has an important role in the sustainable development globally. Green international and national approaches represent collaboration in and towards sustainable development[18] – Certification – European market for "verified legal" and "verified legal and sustainable" solid wood products[19] – FSC certification[20]
Policy encouraging sustainable development and innovations	– Cooperation between local government authorities and economic entities – cases from the forest and wood-based sector in Poland[21] – Innovations in the sector as the key to a better positioning of the companies in foreign markets through wood clusters[22] – Better cooperation between universities and enterprises[23]
Innovation for higher efficiency	– The contribution of wood construction to mitigation of climate change[24] – Alternative materials used in the building construction[25] – Wood clothes hangers[26] – Wood packaging materials[27] – Development of bio-based facilities in rural communities will strengthen the economy through increased revenue and taxes[28] – Bamboo fibre is biodegradable textile material. As a natural cellulose fibre, it can be 100% biodegraded in soil by microorganism and sunshine[29] – Using wood ash during two vegetation periods, the relative increase were 16% higher than the reference area without fertilization[30] – Improving management of supply chain based business network development applying contemporary ICT[31] – Implementation of the Industry 4.0 concept – Slovakia case[32] …

[21] Chudobiecki, J.; Potkański, T.; Wanat, L., 2016, Intermunicipal and Intersectoral Cooperation As A Tool of Supporting Local Economic Development: Selected Examples from the Forest and Wood-Based Sector in Poland
[22] Raoul Cvecic Bole, M. Kavran, 2015, The Role of the Croatian Wood Cluster in Wood and Biomass Promotion
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[25] Loučanová Erika, Nosáľová Martina, Olšiaková Miriam, 2018, Comparison of Materials for Building Construction and their Innovations in Terms of Sustainable Growth
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[30] M. Lieskovský, M. Gejdoš, 2018, Production Of Salix Viminalis (L.) With Using Alternative Methods of Fertilization
[31] Chobanova, R.; Popova, R., 2017, Improving Forestry Sector Management in the Region of Blagoevgrad and Kyustrndil in Bulgaria
[32] Remeň, O.; Sujová, A., 2017, The Conception Industry 4.0 in the Environment of Wood Processing Companies in Slovakia

Problem (challenge)	Solution (measure)
	… – IT applications can help to optimize wood products supply chains from the forest to the end consumer[33] – Open innovation system as a new concept of cooperation among firms in the furniture industry[34] – Community Based Innovation (CBI) in small and medium-sized enterprises[35]
Better usage of natural and human capital	– Usage of beech wood – partial use of this material in wooden constructions, which are dominated by coniferous tree species. There are other alternatives available using this raw material for more valuable processing purposes[36] – Female employment in forestry of Bulgaria[37] – End-user awareness about green properties of paper products[38] – Apply value analysis principles for increasing competitiveness, improve product quality, service, shorten the research and development period[39] – End-user awareness of environmentally appropriate products[40] – Different strategies for wood removals[41] – Integration and implementation of supply chain management practices[42]

Sourse: www.woodema.org

The above brief summary of new challenges and measures to meet them defines area of research interest and competency of the WoodEMA society members in the area of transition from linear to circular economy for the forestry and forestry based industry. The WoodEMA participant's contribution to a better understanding the current transition to circular economy could be summarised as follow:

- Most articles are devoted to the practical issues in the wood and timber industry that could have positive impact and drive the circular economic principles to be integrated in the *production processes with high benefit*.
- *Microeconomic, mainly on firm level*, problems and possible solutions are dominating among practically orientated studies. The high value added innovative solutions can give stimulus for new ideas creation and implication of good practices in different countries.

[33] Richard P. Vlosky, 2009, , Information Technology Driven Supply Chain Optimization in the Wood Products Industry
[34] Anna Zaušková – Adam Madlenák, 2012, The Application of the Open Innovation Concept in the Furniture Industry
[35] Katharina Rodharth, 2012, Chances and Boundaries of Community Based Innovation in Small and Medium-Sized Enterprises – Based on the Study of Wood-Processing Companies
[36] Gejdoš, M., Potkány, M., 2017, The Potential of Beech Wood Use in Selected Countries of the Central Europe for Valuable Processing Purposes
[37] Chobanova, R.; Georgieva, D., 2017, Women in Forestry Sector in Bulgaria
[38] Kaputa, V., Paluš, H., Dzian, M., 2017, End-Users' Views on Selected Green Properties of Paper Products
[39] Marek Potkány, 2009, Increasing of Competitiveness in Furniture Manufacturing by the Value Analysis Principles
[40] Hubert Paluš, H. Maťová, 2009, End-User Awareness of Environmentally Appropriate Wood Products in Slovakia
[41] Roman Svitok, 2010, Sustainable Development – International Framework – Overview and Analysis in the Context of Forests and Forest Products – Competitive Business with Quality
[42] Kristína Štefanciková, 2012, New Trends in the Integration of Supply Chain Management and its Use in the Woodworking Industry

- The traditions in wood and timber industry in Woodema countries allow developing of a wide range of interesting *good practices* for efficiency increase as a result of circulation of raw materials.
- Mostly in 2017 and 2018 the research put an accent upon the *policy issues* and the importance of renewable energy, construction and paper industry development in a circular way.

4. CONCLUSIONS

The transition to a circular economy is a subject of vast majority of work of WoodEMA society members. Circular economy is understood as an academic concept and a policy for economic development focusing on society wide benefits. This concept is aimed to "close the loop" of the life cycle of products – from production and consumption to waste management. Forestry and forestry based industries are characterised as priority ones that could accelerate the transition to a circular economy.

The main problems of transition identified concern:

- Multifunctional application of wood and the necessity to balance its utilization;
- Growing energy consumption in parallel to the increase of CO_2 emissions;
- Sustainable production and consumption;
- Policy encouraging sustainable development and innovations;
- Innovation for higher efficiency.

A special focus is put on the management of the transition from linear to circular economy. IImplementing such transition has required transition from dominating fragmented management approaches, where engineers have taken the leading role, to integrated ones, taking into account all technical, social, economic and environmental aspects. In this respect WoodeEMA society has significant contribution. The focus on economic side has shown set of good practicies how the value of products, materials and resources to be maintained in the economy for as long as possible, and the generation of waste to be minimised. On the other hand, it was shown the circular economy allows better synergy of forestry and unproductive ecosystem services, achieved through optimization of land usage, increase of resources for production, technological and other types of innovations.

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   2018 Increasing The Use Of Wood In The Global Bio-Economy;

2017 More Wood, Better Management, Increasing Effectiveness: Starting Points and Perspective;
2016 The Path Forward for Wood Products: A Global Perspective;
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2014 Position and Role of the Forest Based Sector in the Green Economy;
2013 Innovation as the Source of Values in the Forestry, Wood Processing and Furniture Manufacturing;
2012 Wood and Furniture Industry in Times of Change – New Trends and Challenges;
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2010 Wood Processing and Furniture Manufacturing: Present Conditions, Opportunities and New Challenges Proceedings;
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CIRCULAR ECONOMY & SHARING COLLABORATIVE ECONOMY PRINCIPLES: A CASE STUDY CONDUCTED IN WOOD-BASED SECTOR

Andreja Pirc Barčić, Manja Kitek Kuzman, Eva Haviarova, Leon Oblak

Abstract: Wood products sector together with forestry and forest-based sectors plays a central role in a bioeconomy, because it provide material resource, bioenergy and wealth. On the other hand, circular economy concept and sharing economy concept can be also related. Sharing collaborative models are one segment of the circular economy picture. The argument is that circular economy and sharing collaborative economy principles in relation to wood based sector are two promising domains which should be taught together in order to play a role in extending product life cycle. However, the supporting policies are still loosely connected and there is a need for better synergy. The aim of this paper it to address components of circular economy and sharing collaborative economy principles in the wood-based sector. Additionally, examples of the circular and sharing collaborative economy within wood-based sector regarding consumer to consumer connections (C2C), business to consumer connections (B2C) and business to business connections (B2B) will be investigated.
Keywords: circular economy; sharing economy, collaborative economy principles, wood base sector

1. INDTRODUCTION

Bioeconomy and circular economy (CE) are concepts which complement each other. Further more, wood based sector together with forest and forest-based sectors plays a central role in a bioeconomy, because it provide material, bioenergy and a wealth. More precisely, bio-based industries have a long history of discussing and partly realizing cascade use of wood. On the other hand, circular economy concept and sharing economy concept can be related, too. Sharing and collaborative models are one part of the picture of a circular economy. They can play a role in extending the amount of time a product is in use, while maximizing utilization. Cascade use of wood is a concept with a long history of debate and analysis in EU bio-based industries. Cascade use of wood is the smart way to use a natural resource – putting it to good use before it is reused, recycled and finally burnt for energy. It strongly overlaps with CE ideas. To be able to link this two concepts, production and consumption systems need to transform towards sustainability. We argue that collaborative and sharing economy concepts and wood based sector are two promising domains which require to be thought together in order to play a role in extending the amount of time a wood-based product is in use, while maximizing its utilization. However, the supporting policies are still loosely connected, and more synergy could be created. And more, at the moment renew and repair schemes for durable wood-based (bio-based products), such as furniture, are still an exception. Their effect on material demand will in any case largely depend on consumer response and rebound effects. On example that highlight collaborative and sharing economy principles in the field of wood furniture is IKEA. IKEA has been piloting various initiatives across its European stores to see how they can build circularity into their offer to customers with aim to support customers to care and repair, rent, share, bring back and resell their IKEA products to prolong product life. The terms "Sharing Economy" or "Collaborative Economy" have been commonly used in recent years to refer to a proliferation of initiatives, business models and forms of work.

The objective of this work is to present the contribution of wood bases sector to the sharing economy and collaborative economy. In detailed, the aim of this work is to present the sharing economy and collaborative economy examples regarding consumer to consumer connections (on-line platforms, marketplaces, …) business to consumer connections (retail stores, and business to business connections (associations, clusters, …) within wood industry sector.

1.1. Circular economy & sharing economy

In the past ten years technology has dramatically changed our lives (e.g. the Internet, mobile technology) and social media have revolutionized the way we communicate and collaborate with each other in ways that weren't possible, before now (Smith et al. 2015). Nesta (2014) observed that the sharing economy has become a popular term to describe a range of various business models, activities and organisations in order to get a new perspective on the social, environmental, and economic value that can be created from a number of assets and skills, in innovative ways.

According to Codagnone and Martens (2016) there is no 'shared' consensus on what activities comprise the 'sharing economy'. Further more, the activities and organizations that are today commonly referred to as the 'sharing economy' have also been labelled as 'collaborative consumption' (Botsman, 2013; Botsman and Rogers, 2010a; Botsman and Rogers, 2010b). The sharing economy represents a fundamental shift in how consumers value products. In the current commercial economy, consumers value ownership which causes a lot of conspicuous consumption which results that many products are wasted which contributes to our high demand for natural resources. Collaborative consumption can mitigate these negative effects, but poor communication and small social networks have traditionally limited it (Smith et al. 2015). According to Coyle (2016) the sharing economy offers a quick and cheap way of matching supply with demand for goods and services. The main innovation in the business model of the sharing economy lies in the technological platforms and mobile apps which bring demand and supply together and group them in a way which was not possible before (quicker, cheaper and on a bigger scale), including in geographical areas or services sectors where the concentration of players is lower and where new commercial opportunities are now arising (Basselier 2018). Veleva and Bodkin (2018) noted that according to World Economic Forum (2016) it is estimated that the circular economy will provide an economic opportunity of over $1 trillion as well as significant social and environmental benefits. On the other hand, according to European Commission Report (2018) on collaborative economy overall size of the collaborative economy in the EU-28 in 2016 is estimated to be EUR 26.5 billion. Additionally, the collaborative economy offers about 394,000 jobs across the EU, representing about 0.15% of total EU-28 employment. The largest markets for the collaborative economy can be found in France (25% from total collaborative EU-28 market), UK (17%), Poland (10%) and Spain (10%). These top four countries also offered the most jobs in the collaborative economy (approx. 74,600, 69,400, 65,400 and 39,700, respectively) in 2016. In general, the seven largest collaborative economy markets in the EU (France, UK, Poland, Spain, Germany, Italy and Denmark) represent about 80% of total collaborative revenues in the EU-28 in 2016.

Vaughan and Hawksworth (2014) interpreted that 'sahring economy' concepts are seen as closely related to the 'circular economy' and/or the 'collaborative economy', but with no clear distinction between consumption and production activities.

2. A CASE STUDEIS CONDUCTED IN WOOD-SECTOR

2.1. Business-to consumer connections

An examples of the collaborative and sharing economy within wood- based have been traced – FURNISHARE – KOIYO, New York, US; FURLENCO, Bangaluru, India; M'Sora, Ljubljana, Slovenia, MELU – Luče ob Savinji, Slovenia; Saviola – Viadana, Italy.

2.1.1 Furnisure – Kaiyo, New York, US

Kaiyo is an online marketspace committed to great design, exceptional customer care, and a more sustainable planet.

Figure 1. An example of business-to consumer sharing principle – Kayio, US

They believe that buying well-made, pre-owned furniture is a better choice than buying new, because great design is sustainable design — meaning it's timeless, accessible, and built to last for a lifetime of good vibes. They try to connect a love of great design with a greater love for the environment by keeping furniture out of landfills and in customer (our) homes as long as possible.

2.1.2. Furlenco, Bangaluru, India

Furlenco is the largest and best furniture rental company in India. Their mission is to enable the urban Indian to live better today in their homes, swapping of furniture when needs change, relocation across cities, pausing of subscriptions and deep cleaning services as a part of the subscription.

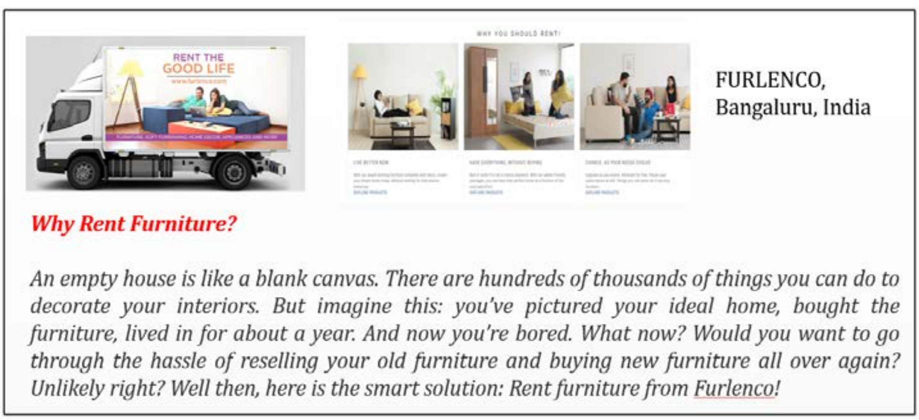

Figure 2. An example of business-to consumer sharing principle – Furlenco, India

So when somebody wants to rent a fridge in Bengaluru or get a study table on rent, he knows where to look. Furniture rentals in Bengaluru are picking up and turning into a way of life. According to company managers, life is just easier without having to deal with heavy furniture that is difficult to get rid of, especially if you're bored of it or moving homes. Plus, people just like having the option of changing their furniture at will or returning it when they want something else. Furlenco has everything, from furniture on rent or appliances, so customer can choose from a variety of packages – living room, bedroom, dining room, balcony, and the kids room too.

2.1.3. M'Sora – Ljubljana, Slovenia

The Slovenian company M SORA developed a prototype of a timber window ReWin made of disposed timber windows which were up to even 50 years old. Window scantlings, from which the ReWin window is made, are produced of spruce and larch wood. The ReWin window is a unique example of a product that was developed by recycling the disposed timber windows that would otherwise end up at a landfill, and represents a completely fresh idea and innovation in the field of builders' joinery. ReWin windows is one outcome of the international project CaReWood – Cascading Recovered Wood, funded by the European Commission and several national EU partners.

Figure 3. An example of business-to consumer sharing principle – M'Sora, Slovenia

The project "Development of an application for collection of waste wood" (RecAPPture) is dedicated to the development of a mobile and web application that will connect users who want to get rid of the waste wood and M SORA, which will use the wood for the production of wooden windows.

2.1.4. MELU – Luče ob Savinji, Slovenia

The joinery MELU follows to sustainable policy. Care for quality already starts in grow phase-high quality product has to be made of healthy tree. MELU is a family company that was established in 1933 by Rajmund Selišnik and is new leaded by third generation of joiners. The internal doors Vino are built from French oak wine barrels, which lend the product a special touch. The doors are made entirely from solid wood, brushed and oiled and therefore safe, as well as human and environmentally friendly. With their contemporary design and superior quality they are able to meet the highest expectations of modern living.

Figure 4. An example of business-to consumer sharing principle – MELU, Slovenia

2.1.5. Saviola – Viadana, Italy

The technologies used by the Saviola Groups are able to process all the collected wood waste (packaging, manufacturing scraps, broken furniture, construction material, etc.). With the network of Eco-legno (Eco-Wood) collection centre spread all over Italy. Saviola is able each year to produce over 1.5 million tons of used wood to process.

Figure 5. An example of business-to consumer sharing principle – Saviola, Italy

CONCLUSION

To increase the level of wood used in residential and public construction, interior design, and outdoor design results and information conducted during this work can help in the process of implementing the collaborative economy principles to the wood based sector and to wood product consumers. In this way we shall increase the common knowledge regarding the circular economy and sharing economy which will be used in the development of the actions need for the cascade use of wood, wood products and utilization of wood following ‘circular’, ‘sharing’, and/or ‘caring’ principles in the Middle and Southeast Europe bio-based sector. Cascading use of wood is the smart way to use a natural resource – putting it to good use before it is reused, recycled and finally burnt for energy. It strongly overlaps with CE ideas. To be able to link this two concepts, production and consumption systems need to transform towards sustainability.

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ANALYSIS OF THE SOCIAL INNOVATION MODELS ORIENTED ON THE CIRCULAR ECONOMY AND THEIR IMPACT ON THE WOOD PROCESSING INDUSTRY

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Abstract: Perception of the circular economy in the society is mostly linked with the industrial innovations. In the wood industry we are talking about the new technologies allowing better utilisation of the wood along the whole lifecycle.
This article presents other point of view on the innovations in wood industry – social innovations. It presents the results of the qualitative research made on the social networks (Twitter and YouTube). The research was focused on the sentiment analysis of the social networks where the object of the analysis was related to the circular economy and wood industry.
Keywords: circular economy, social innovation, social media

What we are doing to the forests of the world is but a mirror reflection of what we are doing to ourselves and to one another.

Mahatma Gandhi

1. INTRODUCTION

The industry today is facing two challenges: transition to the Industry 4.0 through the massive digitalization of the processes and transition from the linear economy to the circular economy. Both relate on the industrial innovations of this century. Parallelly with those innovations we register also movements in the society, that are reflected mainly on the social media. These movements are leading to the social innovations with much stronger influence on our life as we can acknowledge. They have and are influencing traditional business models and offering alternatives for example as sharing economy. What has started as a result of the social media initiative is today a concept adapted by industry giants like Ikea starting this year a renting business model and recycling business model for refurbished furniture (The Guardian 2019).

2. QUALITATIVE ANALYSIS OF THE SELECTED SOCIAL MEDIA FOR CIRCULAR ECONOMY APPROACH

As it was stated, social media has the power to initiate social innovations leading to the changes in industries business models. We have selected three social medias for the qualitative analysis: Youtube and Twitter. The selection of the social media was based on their orientation and impact. The research was conducted during the period January – March 2019.

For the data analysis we have set up a framework of the key words and hashtags related to the circular economy and wood industry.

2.1. YouTube

According to the statistics published by the Dave Chaffey (2019) YouTube have 1900 millions of active users.

For the period for the data analysis we have selected one year. We have analysed channels and videos and their popularity.

Keyword: Circular Economy

Number of channels: 39

Top 5 channels:

1 Ellen MacArthur Foundation: 9,318 subscribers, 256 videos

2 Circular Economy Awards: 403 subscribers, 233 videos

3 GA Circular: 148 subscribers, 95 videos

4 Circular Economy: An Introduction: 149 subscribers

5 Circular Classroom: 95 subscribers, 36 videos

Top 10 videos:

1 DIF: Ken Webster, the economy is not a force of nature. Disruptive Innovation Festival – DIF. 105K views

2 "Circular Economy". Sajeevnair. 53K views

3 DIF: Measure the circular economy. Disruptive Innovation Festival – DIF. 43K views

4 Jessi Baker – How blockchain enables the circular economy. 2018 Summit Ellen MacArthur Foundation. 35K views

5 Julie Wainwright – The first billion dollar circular economy company? 2018 Summit Ellen MacArthur Foundation. 26K views

6 Ellen MacArthur – Momentum building towards the circular economy. 2018 Summit Ellen MacArthur Foundation. 21K views

7 Google Cloud and SAP. Circular Economy 2030 Contest. Google Cloud. 21K views

8 Unleashing Circular Economy: Enel X case. The Business Debate. 20K views

9 Andrew Morlet – How do we make the circular economy happen? 2018 Summit Ellen MacArthur Foundation. 19K views

10 DIF: What might the circular economy mean for developing countries? Disruptive Innovation Festival – DIF. 17K views

As for the sentiment analysis we have selected the video with the highest number of comments from the top 10 list: "Circular Economy". Sajeevnair, with 86 comments. Collected data in the form of a text was analysed by QDA (Qualitative Data Analysis) software MAXQDA, which provides a lexicon approach with evaluating metrics for opinion mining. For the needs of comments content analysis with the QDA software we apply VADER (Valence Aware Dictionary and Sentiment Reasoner) lexicon. It is a professionally predefined lexicon containing 7517 words as well as emoticons to perform text analysis. Sentiment analysis based on the VADER dictionary calculates input sentiment score. VADER is a model used to analyse a text sentiment that is sensitive to polarity (positive / negative) and intensity (power) of emotions. It was put into practice in 2014. VADER is an open-source license (MIT license or X11 license is a free software license created by the Massachusetts Institute of Technology), and each word has been evaluated by ten expert evaluators. VADER sentiment analysis uses a human-based approach that combines qualitative analysis and empirical validation with human evaluators and the wisdom of the crowd (Calderon 2017), (Hutto, Gilbert 2014), (Babčanová et al. 2019).

The content of the comments was quantified according to the word occurrence in the comment text using the MAXQDA software with implemented VADER dictionary. Each word frequency of occurrence was multiplied by the average weight of the word in the VADER dictionary. The results are presented in the Figure 1.

As we can see top ten words with the highest frequency of the occurrence are the words with the positive connotation.

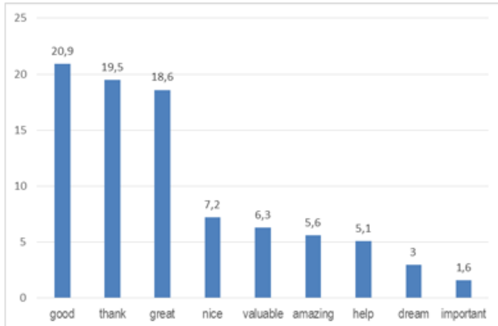

Figure 1. Top ten words with the highest positive score (Source: Author)

2.2. Twitter

Twitter does not represent the social media with the highest impact (335 million of subscribers), but it presents condensed interpretation of opinions, values and attitudes.

For the analysis we have used same keywords "circular economy" and hashtag circulareconomy.

During the 7 days period there have been 1687 tweets containing the phrase „circular economy" and 1923 tweets containing the #circulareconomy. As in the YouTube comments content analysis, also text of the tweets was analysed according to the frequency of occurrence of the word and the average weight assigned in the VADER dictionary. Table 1 presents top ten words with the positive connotation and frequency of occurrence. As we can see from the table there are not major differences between the top ten words for the #circulareconomy tweets and "circular economy" tweets. Difference is visible between the content of the Youtube comments and tweets. It is evident that content of comments is more emotional as the content of the tweets where we can see more rational words like innovation, energy, opportunity.

The second phase of the tweets content analysis was oriented on the relationship between the circular economy and wood industry. We have analysed occurrence of key words: wood, forest, furniture in the context of "circular economy" tweets. There have been only 10 tweets from 1687 tweets where selected keywords have been present. As for the previous analysis we again apply VADER dictionary and quantitative data of the word frequency, but this time we concentrated on the 5 words before and 5 words after the occurrence of the key words (see Table 2).

Obtained results show, that in the case of the occurrence of the words with the positive connotation in the context of the tweets containing the keywords related to the wood industry, top ten words have dynamic connotation (encourage, engage, create, opportunity etc.).

Table 1. Top ten words with the positive connotation and frequency of occurrence (Source: Author)

#circulareconomy		Circular economy	
Word	**Frequency**	**Word**	**Frequency**
great	110	innovation	87
innovation	92	energy	78
energy	71	good	59
like	50	great	56
value	50	support	50
good	49	opportunities	36
thanks	42	create	32
solutions	74	value	32
support	33	want	31
create	29	growth	28

Table 2. Top ten words with the positive connotation and frequency of occurrence in the tweets containing keywords wood, forest and furniture (Source: Author)

Circular economy	
Word	**Frequency**
engaging	2
increase	2
support	2
create	1
encouraged	1
energy	1
great	1
opportunity	1
responsible	1
solution	1

3. CONCLUSION

Qualitative analysis of the social media on the approach toward the circular economy has been conducted in three phases: sentiment analysis of "circular economy" on YouTube and Twitter, sentiment analysis of selected keywords realted to wood industry on Twitter and analysis of social innovations realted to the wood industry on YouTube. From the presented data we can make following conclutions:

Sentiment analysis of the context of comments on YouTube reflects the attitude of the reviewers mainly toward the video presentation and presenter and less to the content.

Sentiment analysis on the Twitter shows higher frequency of occurrence of the words less emmonational and more rational.

In the case of the tweets that have been aslo related to the wood industry, the sentiment analysis show the shift to the dynamic words like encourage, create, opportunity, etc..

From the basic quantitative date from the YouTube (number of subscribers) is evident, that the circular economy theme is not widle recognised on the social media (see Ellen MacArthur Foundation with 9,318 of subscribers), never the less individual videos are counting thousands of viewers.

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CIRCULAR ECONOMY FROM THE PERSPECTIVE OF SCIENTIFIC RESEARCH PAPERS IN THE FORESTRY AND WOOD-BASED SECTOR IN POLAND

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Abstract: The search for the possibility of implementing a circular economy ideas by the forest- and wood-based industry sectors is a challenge for scientific research. The authors identified the main research topics by Polish scientists and the results were published in the years 2008-2018. The analysis covered selected bibliographic databases and impact factors of analyzed papers. Finally current recommendations for the development of research in this area have been made.
Keywords: circular economy, scientific papers, forestry, wood-based sector, bibliometrics, Poland

1. INTRODUCTION

The forest and wood-based sector is one of the leading branches of the Polish economy. This fact, combined with the significant potential of forest resources at its disposal, entitles it not only to undertake research in this area, but also to monitor their effects and directions of development Ratajczak, 2001; 2013a; 2013b; Strykowski and Gałecka, 2015). Identification of leading research directions in forest sciences, including forestry and timber disciplines, is an opportunity to assess the state of these disciplines and the possibilities of their development and cooperation with practice (Chudobiecki et al., 2016; Wanat, 2016; Maciejczak, 2018; Wanat et al., 2018b).

In the period from June 2009 to January 2011, the Institute of Wood Technology in Poznań carried out the project "Foresight in the wood science and industry – research development scenarios in Poland until 2020". The project was co-financed by the European Regional Development Fund under the Innovative Economy 2007-2013 Operational Programme. It applied a "scenario" approach, programming the next steps in the field of research in the forest and wood sector.

The subject of the project included not only research works, but also projects specific to the foresight method. On the basis of identification of key forces and trends expected in the forest-based sphere of science and research and development (R&D), followed by research using the Delphi method[1], cross impact analysis and other auxiliary techniques, the main development trends in scientific research in woodworking were identified (Ratajaczak et al., 2010). In addition, the method of strategic analysis was applied, enabling the assessment of conditions related to the macroeconomic environment of the forest-wood sector and the sphere of science in the wood industry, including economic, legislative and institutional, social and technological factors[2].

In foresight studies, on the other hand, subjective and intuitive methods were used, based on expert knowledge, experience and intuition, with the inclusive participation of various social groups. Scenarios for the development of research in woodworking as a whole, as well as in research areas such as: mechanical wood processing, wood composites, paper-making, wood protection, bioenergy, wood economics, forest environment protection and its social aspects were elaborated. Both the success scenario (optimistic variant) and the threat scenario (pessimistic variant) were proposed and the most probable (real) implementation scenario was selected. Such a starting point was set by wood and forest foresight on the threshold of 2011, without referring directly to the circular economy

[1] The DELPHI method is a specific forecasting process framework based on the results of multiple rounds of questionnaires, sent to a panel of sectoral experts in the forest- and wood-based industry (Ratajczak et al., 2010).
[2] PEST Analysis (Political, Economic, Social and Technological) was used inter alia. This is a management method whereby an organization can assess major external factors, that influence its operation in order to become more competitive in the selected sectoral market (Ratajczak et al., 2010).

paradigm or even the green economy.

From the perspective of the decade that has passed since the beginning of the project implementation, an attempt of analysis and evaluation of the main research directions undertaken in forest sciences, including forestry and timber disciplines, has been made. The justification of the research undertaken is not only the curiosity or the attempt to assess the accuracy of the forecasting, but above all the intention to have a current look at the condition and directions of scientific research in the sector based on wood, reflected in the publication activity (Adamowicz and Szramka, 2017; Ratajczak et al. 2018a, 2018b; Maciejczak, 2018; Młynarski et al. 2018; Paluš et al., 2018; Wanat et al., 2018a; Grzegorzewska, 2019).

This is because science is evaluated and then financed through this prism, which, as Józef Rivoli noted, is sometimes even very distant from life practice and still remains the most effective stimulus for this practice (Broda, 2004).

2. SCENARIO AND METHOD OF THE RESEARCH

Scientific journals are still an important platform for modern scientific communication, which also supports knowledge-based forest management. In addition, to traditional methods, the researcher's workshop complements the tools of science and, above all, bibliometrics using international bibliometric indicators. This makes it possible to compare journals and, consequently, to identify the most influential titles and research topics that shape the state and development prospects of a given field of knowledge.

In the paper, based on statistical and bibliometric secondary data, and referring to the literature on the subject, an attempt was made to indicate influential Polish titles in the area of forest sciences. Various bibliometric assessment methods used in the selected global databases (including Web of Science, Scopus, Google Scholar, Index Copernicus) have been used for this purpose. The analysis was conducted on the example of the selected Polish forest science periodicals. Some bibliometric techniques were used, including Impact Factor, Hirsch Index, SCImago Journal Rank, Index Copernicus Value. The collected data were compared and interpreted in a bibliometric paradigm, referring to the level of citations and the so-called "scientific impact" of journals (Materska et al., 2019).

Descriptive and exploratory applications of bibliometry were used to observe phenomena and tendencies in the development of forest and wooden scientific journals. Moreover, elements of advanced techniques requiring support of specialized software were used, including tech mining, database tomography, Literature-Based Discovery, TRIZ methodolgy (Theory and Innovative Problem Solving) and methods of identifying new trends and creating research maps (e.g. mathematical graph theory, data clustering, time series analysis and hybrid methods) (Materska et al., 2019).

3. SELECTED RESULTS

This paper presents – necessarily briefly – selected results of the analysis of secondary data. Using the comparative and descriptive approach, the data relating directly to the thematic scope of forest sciences, in particular forestry and woodworking, were ordered and aggregated. The data were compiled in tabular form, and the most important conclusions were then formulated in the summary of the article.

The categories and positions (according to the Web of Science and Scopus) of analyzed Polish natural and forest magazines with Impact Factor[3] (IF) values in 2017 are presented in Table 1 and in Table 2.

[3] The structured data are curated by a international team who continuously evaluate (...) the collections of journals, conference proceedings and books, covered in the Web of Science Core Collection (WoS) to ensure accuracy in evaluating journal impact. These expert insights enable researchers (...) to explore the key drivers of a journal's value for diverse audiences, making better use of the wide body of data and metrics available in the JCR, including the Journal Impact Factor (JIF) (https://www.researchinformation.info/ [accessed: 07.07.2019]).

Table 1. Categories (according to the Web of Science and Scopus) of analyzed Polish natural and forest magazines with Impact Factor (IF) in 2017

Journal title (in Web of Science)	Category (scientific discipline)	The number of journals in the category [WoS (Scopus)]	Position based on the Journal Impact Factor [WoS (Scopus)]
Mammal Research	Zoology	166 (385)	64 (110)
Polish Journal of Ecology	Ecology	158 (591)	135 (430)
Acta Biologica Cracoviensia, Series Botanica	Plant science	222 (404)	170 (156)
Acta Societatis Botanicorum Poloniae	Plant science	222 (404)	144 (216)
Archives of Environmental Protection	Environmental science	241 (192)	190 (59)
Dendrobiology	Forestry	66 (139)	47 (38)
Sylwan	Forestry	66 (139)	51 (90)
Drewno-Wood	Forestry Engineering	66 (139) -- (323)	58 (70) -- (164)

Source: authors' own elaboration based on (Materska et al., 2019)

Table 2. Number of quotations in Scopus of articles published in Polish forest science journals (2018)

No.	Journal	Citation count	Docu-ments	Cite Score	SJR	SNIP	IF
1.	*Mammal Research*	188	132	1,42	0,644	0,774	1,119
2.	*Polish Journal of Ecology*	107	158	0,68	0,253	0,436	0,590
3.	*Acta Biologica Cracoviensia, Series Botanica*	89	62	1,44	0,473	0,928	1,111
4.	*Acta Societatis Botanicorum Poloniae*	120	126	0,95	0,281	0,509	0,718
5.	*Archives of Environmental Protection*	231	135	1,71	0,489	1,011	1,689
6.	*Dendrobiology*	147	96	1,53	0,375	0,990	1,262
7.	*Sylwan*	397	501	0,59	0,321	0,592	0,691
8.	*Drewno-Wood*	78	95	0,82	0,324	0,504	0,857
9.	*Folia Forestalia Polonica, Series A*	81	139	0,67	0,312	0,569	-
10.	*Central European Forestry Journal*	54	79	0,68	0,180	0,399	-

Source: authors' own elaboration based on (https://www.scopus.com/ [accessed: 07.07.2019])

Among the Polish forest-related journals listed in the Scopus database, the highest value of SJR index in the years 2015-2018 was obtained by Dendrobiology journal. In turn two journals namely: Sylwan and Drewno obtained the similar value of the SJR index. The highest Hirsch index in the years 2015-2018 was also achieved by Dendrobiology magazine (Table 3).

Table 3. Size of the SJR: Scientific Journal Rankings-Scimago index for Polish forest magazines (2018)

No.	Journal	SJR	H Index	Total Docs. 2018	Total Docs. 3 years	Total Refs. 2018	Total Cites 3 years	Citable Docs. 3 years	Cites/ Docs. 2 years	Ref./ Doc. 2018
1.	*Dendrobiology*	0,375	14	17	96	959	146	96	1,77	56,41
2.	*Drewno-Wood*	0,324	9	25	95	730	77	95	0,85	29,20
3.	*Sylwan*	0,321	8	99	220	3195	129	220	0,59	32,27
4.	*Folia For. Pol. (A)*	0,312	8	30	88	917	59	88	0,60	30,57
5.	*CEFJ*	0,180	2	23	24	1219	14	24	0,58	53,00

Source: authors' own elaboration based on (Scientific Journal Rankings – Scimago, 2019)
Signs: (4) Folia Forestalia Polonica, Series A; (5) CEFJ: Central European Forestry Journal

ICI Journals Master List 2017 has only 15 indexed Polish forestry journals (and those on similar topics). Among them, the highest ranked Polish Journal of Plant Protection Research and Forest

Research Papers (directly in forestry). It is worth noting that it was the only journal with such a high ICV index in this category (Table 4).

Table 4. Size of the ICV index (Index Copernicus Value) for Polish selected magazines: topic 'forestry'

No.	Journal	ICV 2017	IC Citation	GSI 2019
1.	*Journal of Plant Protection Research*	121,70	498	277
2.	*Archiwum Fotogrametrii, Kartografii i Teledetekcji (Archives of Photogrammetry, Cartography and Remote Sensing)*	96,35	677	1410
3.	*Leśne Prace Badawcze (Forest Research Papers)*	94,71	437	1150
4.	*Acta Scientiarum Polonorum Silvarum Colendarum Ratio et Industria Lignaria*	92,81	349	131
5.	*Intercathedra*	89,60	128	563
6.	*Progress in Plant Protection*	88,12	2590	5080
7.	*Journal of Research and Applications in Agricultural Engineering*	86,14	1328	2270
8.	*Ecological Questions*	83,73	91	198
9.	*World News of Natural Sciences*	82,84	3	44
10.	*Annals of WULS – Forestry and Wood Technology. Zeszyty naukowe SGGW (Annals of Warsaw Agricultural University – Forestry and Wood Technology)*	80,40	275	1050
11.	*Forestry Letters*	71,28	24	103
12.	*Technika Rolnicza Ogrodnicza Leśna (Agricultural, Horticultural and Forest Engineering)*	53,60	619	1,53
13.	*Przegląd Leśniczy (The Forestry Review)*	51,62	154	1830
14.	*Studia i Materiały Ośrodka Kultury Leśnej (Studies and Materials of the Forest Culture Centre)*	45,58	1	222
15.	*Chrońmy Przyrodę Ojczystą (Let's Protect Our Indigenous Nature)*	42,46	1140	3360

Source: authors' own elaboration based on (https://journals.indexcopernicus.com/ [accessed: 03.06.2019])
Signs: ICV – Index Copernicus Value (2017); GSI – Google Scholar hit frequency index (2019)

The main research topics in forest sciences, which in the studied period (2010-2018) were undertaken in the works and publications of Polish scientists, included works on: forest breeding (around 349 topics of keywords), nature protection (5380 keywords), but directly forest protection (334 keywords), hunting management (1700 keywords, directly 21), forest management (1010 keywords), forest use (245 keywords, directly 59) and forest tourism (47 keywords, incl. 21 directly silvaturistics) (State Forests…, 2019; Google Scholar…, 2019). Meanwhile, the topics of forestry economics appeared relatively rarely in research programmes, most often in the ecological context or renewable energy (including green economy, use of wood waste, and marginally "second life of wood").

It is worth noting that the dominating keyword in the analysed scientific publications on forest sciences was 'ecology', including 'bioresources' in the discipline of forestry and 'furniture' in the discipline of wood science and technology[4]. The concept of 'circular economy' appeared directly in the analysed period only in 34 cases (Google Scholar…, 2019).

4. CONCLUSIONS

On the basis of the conducted analyses, the following conclusions were formulated:

1) The subject matter of circular economy, although directly related to the paradigm of sustainable development originating from forest sciences, is present in Polish scientific publications on forestry relatively rarely, most often indirectly, fragmented.

2) Popularization of current research directions in forestry is served by scientific journals in the field of forest sciences, Polish and foreign. Unfortunately, the position of these journals, analysed from

[4] Of course, the key words 'wood' and 'forest' were excluded.

the perspective of their presence and prestige in recognised world bibliographic databases, is low. This means, first of all, that a relatively small influence in the international scientific environment is played by foreign-language publications of Polish authors in the field of forestry, including those from the field of economics of forestry. Moreover, what is particularly important, also the impact of publications on forest sciences in Polish is marginalised, as it is not worthwhile for scientists to publish their papers in the national language from the point of view of the value of scientific achievements under evaluation. Foresight forecasts were therefore only partially fulfilled.

3) The biggest influence from the point of view of the international position of scientific journals in forest science is played by the journals 'Dendrobiology' and 'Sylwan' (forestry), and also 'Drewno-Wood' (in woodworking). Scientific journals that have the highest number of quotations registered in databases popular in Poland (Google Scholar, Index Copernicus, Publish or Perish) are: "Sylwan", "Leśne Prace Badawcze" and "Przegląd Leśniczy" (2018). From the perspective of leading global databases (Web of Science, Scopus), the quotation lists are only present in: "Dendrobiology", "Drewno" and "Sylwan".

4) The main research topics in the field of forest science in Poland include the following areas: forest breeding, nature conservation, forest protection, hunting management, forest management, forest use and forest tourism. On the other hand, the subject matter of forestry economics is marginally present in research programmes.

The issues of sustainable forest management were taken up, indeed, in the context of nature protection, fragmented in the thematic scope of green economy and effective management of wood waste, as well as partly in relation to the research on international competitiveness of the wood-based sector selected branches, including mainly the furniture sector. This observation is a challenge for greater research activity and integration of research programmes (Francis, 2015) combining science and practice in the field of forest management, forest- and wood-based sector economics and, finally, circular economy.

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DILEMMAS OF TECHNOLOGICAL INNOVATIONS ON THE EXAMPLE OF SELECTED PRODUCTS BASED ON OAK WOOD

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Abstract: The paper discusses the importance of selecting of the type of processing technology of the raw oak wood material on the quality of semi-finished timber (cladding). The influence of the importance of innovation and efficiency factors in the technological and economic aspects was verified. The comparative analysis of various, including traditional and innovative technologies, allows for the conclusion that new investments are justifiable in the wood-based industry.
Keywords: oak wood, technological innovations, lumber processing, cladding, Poland

1. INTRODUCTION

European timber resources keep changing. High-quality wood raw material becomes increasingly less available due to climatic change and deficiencies in woody crops management. The decline in European oak resources is further driven by changing land use patterns, tree root diseases and increased demand for products made of valuable species, including European oak and European ash (Ozyhar et al., 2018). Therefore, efforts are made to control the ongoing disappearance of proper genetic forms of oak forests (Schroeder et al. 2016) and to establish crops intended to ensure a gradual increase in the harvest of valuable wood in Central and Western Europe (Bobiec et al., 2011; Pretzsch et al., 2013). Oak wood is broadly used in the production of furniture, wood joinery, stairs and floor materials. Today, oak means wood which, though expensive, offers qualities that justify the high price of products made of it. This is particularly noticeable for floor materials. High demand for oak raw materials translates into search for solutions designed to increase the surface fraction of valuable materials in the production of sandwich cladding panels (Orłowski and Walichnowski, 2013; Kujawińska et al., 2017). Extremely high prices of oak wood and environmental concerns are the reasons why producers seek to maximize the use of oak raw materials. A number of studies was carried out to address this issue and optimize the use of materials (Hruzik, 2006, Paluš et al., 2018; Wanat et al., 2018a, 2018b). The above provided grounds for initiating research into the performance of oak lumber processing and the efficiency of using lamella panels as cladding material.

2. PURPOSE AND SCENARIO OF THIS STUDY

The purpose of this study was to assess the selected methods of oak lumber processing into lamella and cladding components. The benchmarking was based on the material and qualitative efficiency of target elements. As a consequence, an attempt was made to indicate the most reasonable method for making semi-finished products used in the production of lamella panels. The method was also expected to guarantee the appropriate qualitative and dimensional structure of semi-finished oak products. The study was carried out in 2017 with establishments processing oak wood into cladding materials based on innovative solutions for making boards by cutting fresh lumber.

Two technologies were considered:

1. making boards of pre-dried lumber, referred to as the “dry method” later in this paper;

2. making wet boards from fresh lumber to be subsequently dried and cut into elements of appropriate dimensions, referred to as the “wet method” later in this paper; compared to the traditional method for making boards from pre-dried lumber, it offers better performance indicators for lower-quality lumber.

The main objective of the “wet” technology is to reduce the damage to lumber during the drying process, especially including: considerable horizontal and vertical deformation of boards; drying cracks; and large material losses in the process of drying lumber of lower quality classes.

3. MATERIAL AND METHOD

This study focused on oak roundwood (*Quercus robur L*. and *Quercus petraea L*.) for producing boards used to make single-strip boards, and on hardwood lumber used to make multi-strip boards, grouped in 11 research batches. In the dry technology, 131.245 m^3 of lumber were processed into a total of 8226.184 m^2 of single-strip boards. In the wet technology, 88.62 m^3 of lumber were processed into a total of 8526.310 m^2 of single-strip boards.

3.1. Dry technology

In the dry technology, it takes 38–39 days to dry the lumber. The process starts after the chamber is filled with lumber batches. Ca. 45 m^3 of lumber can be dried in one process. After drying, the basic problem is the quality of lumber which changes its dimensions and geometry during the process. Sometimes, if bent or distorted, it cannot be further processed into single-strip boards due to the risk of damage to machinery. Table 1 shows a detailed summary of the resulting product range and its value.

Table 1. Quantity, surface, fraction and value of different product groups made using the dry technology

Product range length [m] / width [mm] /quality class	Items	Surface [m^2]	Surface fraction [%]	Unit price [EUR/m^2]	Value [EUR]
1.107/186/B	409	84.30	1.02	14	1180.20
1.107/186/B1	2194	451.68	5.49	15	6775.20
1.107/186/C	6991	1439.40	17.50	10	14394.00
1.107/186/E	5970	1229.25	14.94	7.15	8789.14
1.107/186/F	1831	377.05	4.58	6	2262.30
1.815/186/B	95	32.03	0.39	17	544.51
1,815/186/B1	724	244.46	2.97	18	4400.28
1.815/186/C	3100	1046.54	12.72	14	14651.56
1.815/186/E	3410	1151.32	14.00	9.2	10592.14
1,815/186/F	1593	537.82	6.54	7.8	4195.00
2.215/186/A	0	0.00	0.00	20	0.00
2.215/186/B	0	0.00	0.00	17	0.00
2.215/186/B1	238	98.03	1.19	18	1764.54
2.215/186/C	902	371.52	4.52	14	5201.28
2.215/186/E	2094	862.51	10.48	9.2	7935.09
2.215/186/F	729	300.26	3.65	7.8	2342.03
Total [m^3]					131.235
Total [m^2]					8226.184
Manufacturer standard [m^3/m^2]					0.0160
Value [EUR]					85027.27

Source: own study

The analysis focused on the distribution of lengths of 186-mm-wide boards made using the dry technology. A very small proportion (13%) of long boards (2215 mm) suggests the material utilization rate was low. This is because the lumber bends when drying, resulting in improper processing and in improperly planed boards in the final production stage. A large proportion (57%) of short boards (1107 mm) results from the manipulation of defective (improperly planed) boards. An auxiliary analysis of performance ratios found that lumber was not efficiently used due to a decline in its quality after the drying process.

3.2. Wet technology

The drying process of boards made of fresh lumber takes ca. 5 days and begins when the chamber is filled with boards loaded in twelve bins. Table 2 shows a detailed summary of the resulting product range.

Table 2. Quantity, surface, fraction and value of different product groups made using the wet technology

Product range length/width /quality class	Items	Surface [m^2]	Surface fraction [%]	Unit price [EUR/m^2]	Value [EUR]
1.107/186/B	2	0,41	0,00	14	5,74
1.107/186/B1	1623	334.18	3.92	15	5012.70
1.107/186/C	2378	489.63	5.74	10	4896.30
1.107/186/E	1185	243.99	2.86	7.15	1744.53
1.107/186/F	1346	277.14	3.25	6	1662.84
1.815/186/B	0	0.00	0.00	17	0.00
1.815/186/B1	171	57.73	0.68	18	1039.14
1.815/186/C	525	177.23	2.08	14	2481.22
1.815/186/E	408	137.74	1.62	9.2	1267.21
1.815/186/F	469	158.33	1.86	7.8	1234.97
2.215/186/A	0	0.00	0.00	20	0.00
2.215/186/B	0	0.00	0.00	17	0.00
2.215/186/B1	888	365.85	4.29	18	6585.30
2.215/186/C	4650	1915.75	22.47	14	26820.50
2.215/186/E	4322	1780.62	20.88	9.2	16381.70
2.215/186/F	6281	2587.71	30.35	7.8	20184.14
Total [m^3]					88.616
Total [m^2]					8526.323
Manufacturer standard [m^3/ m^2]					0.0104
Value [EUR]					89316.29

Source: own study

A large proportion (ca. 51%) of 2215-mm-long E-class and F-class boards results from a good utilization of materials and from the absence of geometric distortions after the drying process. The analysis of the percentage share of boards of different quality classes (all lengths combined) also confirms the good utilization of materials. The outcomes of the wet technology were analyzed separately for each research sample and as the average value for all samples. The wet technology was found to make a more efficient use of materials and to be more productive than the dry technology, as also confirmed by the comparison of material consumption standards.

4. RESULTS

The key difference between the dry and wet technologies is the duration of the drying process. In the traditional dry technology, the materials are dried for 38 days whereas only 5 days are required in the new, innovative wet technology. Despite a small unit load (9 m^3) being dried, the performance of the wet technology is by more than 50% higher as the drying time is very short (5 days) compared to the dry technology. This is possible because of a higher batch turnover rate and a higher fragmentation of dried material (larger surface exposed to drying). Furthermore, in the wet technology, the quality of dried material is considerably higher. This has an effect on the performance of the entire process: the wood is not bent and the cracks do not grow as big as in the dry technology. The differences between the drying processes used in both technologies are shown in Table 3.

Table 3. Drying time and volume of dried material

	Technology	
	DRY	**WET**
Drying time [days]	38	5
Input volume for one drying cycle [m^3]	45	9
Drying performance [m^3/day]	1,184	1,800

Source: own study

Based on output data, as compiled in Table 4, a comparative analysis was carried out for the outcomes of the dry and wet technologies.

Table 4. Summary of the quantity, surface and percentage share of different product groups made using the dry and wet technologies

Product range length/width /quality class	**Items**		**Surface [m^2]**		**Surface fraction [%]**		**Value [EUR]**	
	Dry	**wet**	**Dry**	**wet**	**Dry**	**Wet**	**Dry**	**Wet**
1.107/186/B	409	2	84.30	0.41	1.02	0.00	1180.20	5.74
1.107/186/B1	2194	1623	451.68	334.18	5.49	3.92	6775.20	5012.70
1.107/186/C	6991	2378	1439.40	489.63	17.50	5.74	14394.00	4896.30
1.107/186/E	5970	1185	1229.25	243.99	14.94	2.86	8789.14	1744.53
1.107/186/F	1831	1346	377.05	277.14	4.58	3.25	2262.30	1662.84
1.815/186/B	95	0	32.03	0.00	0.39	0.00	544.51	0.00
1.815/186/B1	724	171	244.46	57.73	2.97	0.68	4400.28	1039.14
1.815/186/C	3100	525	1046.54	177.23	12.72	2.08	14651.56	2481.22
1.815/186/E	3410	408	1151.32	137.74	14.00	1.62	10592.14	1267.21
1.815/186/F	1593	469	537.82	158.33	6.54	1.86	4195.00	1234.97
2.215/186/A	0	0	0.00	0.00	0.00	0.00	0.00	0.00
2.215/186/B	0	0	0.00	0.00	0.00	0.00	0.00	0.00
2.215/186/B1	238	888	98.03	365.85	1.19	4.29	1764.54	6585.30
2.215/186/C	902	4650	371.52	1915.75	4.52	22.47	5201.28	26820.50
2.215/186/E	2094	4322	862.51	1780.62	10.48	20.88	7935.09	16381.70
2.215/186/F	729	6281	300.26	2587.71	3.65	30.35	2342.03	20184.14
Total					100.00	100.00	85027.27	89316.29

Source: own study

As shown by the analysis of the share of boards of different lengths, the wet technology produced four times more long boards (2215 mm) with a smaller number of short (1107 mm) boards. In the wet technology, the less desired 1815-mm-long boards had a share of only 6%, compared to nearly six times more (36.6%) in the dry technology. The wet technology is more advantageous for making long boards, has a better material utilization rate, and generates less waste and smaller amounts of boards that require intervention. Also, it is less labor intensive and causes less wear and tear of machinery.

The comparison of the mix of different quality classes of boards made using both technologies also proves the wet method to be more advantageous as it delivers a dominant share of desired long E-class and F-class boards. The comparison of both technologies in terms of board classes shows that the dry technology produced more C-class and E-class boards whereas the wet technology delivered much more F-class boards which use D-class lumbers as the input material. Once again, this confirms that the wet technology makes a better use of dedicated materials. The analysis of total consumption standards in both technologies (0.0160 m^3/m^2 and 0.0104 m^3/m^2 for the dry and the wet technology, respectively) revealed that the wet technology provided a nearly 40% improvement in consumption standards. The material utilization rate (consumption standard) is the final decisive parameter which allows to conclude that the wet technology is more material-efficient and offers a better qualitative performance in the production of single-strip boards.

As a summary of this study, Table 5 shows a comparison of the dry and wet technology by different criteria. It indicates the positive aspects of processing under the assumption that lower-quality lumber is used.

Table 5. Comparison of various aspects of the dry and the wet technology

Criterion	Technology	
	Dry	Wet
Energy efficiency of the drying process	High (1)	Low (0.25)
Material stresses	High	Low
Drying process	High risk posed by thicker materials; slow moisture drainage; risk of discoloration, cracks and deformation	Low risk, slick materials; rapid moisture drainage
Post-drying defects	Frequent discoloration (post-drying stains) of materials, cracks and deformations related to stresses in wood	Low risk of post-drying defects such as discoloration, cracks in strips and permanent deformations related to material stresses
Shape and thickness of processed strips	Boards are formed into blocks and are cut into strips; vulnerability to deformation; a non-linear shape of strips after cutting is particularly troublesome (a part of the material is affected by that issue); transverse distortions; uncertain distribution of thickness of strips after the production process is complete	Once dried, the strips are processed separately; low risk of deformation after processing; high precision in setting the width and thickness of strips; better parameters for further processing; better quality of finished products
Production of D-class strips	Very difficult, high material consumption	Normal, just as in any other class; lower material consumption compared to the dry technology

Source: own study

5. CONCLUSIONS

The production of strips based on the dry technology is a relatively simple method employed by most timber companies. However, it demonstrates some limitations and defects, including: poor performance and quality ratios, and low precision in setting the dimensions. This makes the producers look for solutions that are both relatively simple and innovative. In this case study, the technological limitations of the dry method resulted in the need to verify whether switching to the wet technology is a good option. The study allowed to verify the processing ratios depending on the technology used, and to formulate the following conclusions:

1. The wet technology delivers higher performance because the drying of slick strips reduces the risk of deformation caused by material stresses.
2. The wet technology is primarily intended for lower-quality lumber types, enabling an optimum use of materials when processing wood into single-strip components.
3. Compared to the wet technology, the dry technology has a highly energy-intensive lumber drying process.
4. In the dry technology, the lumber drying process is conducive to the formation of strips made of wood of non-uniform colors. The discoloration has a strong detrimental effect on the appearance of the floor and is the basis for complaints.
5. A lot of material is lost when preparing lumber in the dry technology due to defects occurring in the drying process and to changes in the geometry of lumber.
6. The production process of single-strip boards in the wet technology allows the products to remain dimensionally stable which is crucial for further processing and repeatability.
7. Products made using the wet technology demonstrate a greater dimensional stability in subsequent processing stages (after the strips are dried).
8. The materials made using the wet technology form a class of boards with a better structure which is more consistent with the assumptions.

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FSC AND PEFC CERTIFICATION IN THE CONTEXT OF INTEREST IN THE ENVIRONMENTAL PERFORMANCE OF PRODUCTS AND THEIR LINK TO THE CIRCULAR ECONOMY IN FORESTRY

Jakub Michal, David Březina, Dalibor Šafařík

Abstract: With the growing interest of international organisations in environmental activities, it is often spoken openly about the need for measures to ensure sustainable management of resources provided by ecosystems which should be adopted by the society as a whole. The society can participate in such activities by means of direct or indirect support. While a direct support entails active participation in creating such activities, an indirect support is shown by appraising such activities in the form of financial or a non-financial assistance. In short-term visions, however, the global societal interest in environmental aspects is losing importance and its effect is only perceived as a temporary stimulus (see one-off subsidies). Supposing some activities related to environmental interests were anchored in law, it would represent a significant progress in this area. An interesting example of such activities which have the legislative basis is certifications. This article reports on the results of the research surveys of the FSC and PEFC certification systems conducted in the Slovak Republic and in the Czech Republic. The criteria for the examination of the obtained data mainly include the interest in the products with the added value in the form of the environmental aspects of the products and the criteria which affect consumers' buying decisions.
Keywords: sustainability; consumer behaviour, Czech and Slovak consumers, FSC, PEFC, circular economy

1. INTRODUCTION

The key issue addressed in this article is the perception of sustainable development matters by the society as a whole expressed with respect to the FSC and PEFC certifications, the effectiveness of the use of forest ecosystem resources and their link to the circular economy in the selected countries.

The increasing fears of environmental and climate changes together with the deepening social unevenness and poverty have been drawing attention to the concept of so-called "sustainable development". (Giovannoni E., Fabietti G.; 2013). It is evident that the contemporary society will be compelled to place more and more emphasis on resources management while taking into account nature and landscape conservation, which is supported by the fact that sustainable development has been regarded as the only scenario of further development of the human society since the 1980s. (Koubská a Hralová, 2006). The matters of sustainability have been addressed in several important documents. Examples might be the UN Conference on Sustainable Development (The Future We Want declaration), whose Chapter II appeals to enterprises and industries for developing strategies which would contribute to sustainable development, the UN resolution set in 2015 (Transforming Our World: the Agenda for Sustainable Development) or the Conference of the Parties (COP) because sustainability was addressed at almost all its 14 meetings since 1994 (the last conference took place in Egypt in 2018). The strategy of sustainable development also includes circular economy. The definition of circular economy can vary depending on the context as it is a rather broad and holistic approach. Essentially, it supposes complex changes in the economic system from the status quo. A combination of, at first sight, very conflicting interests represented by economic profit and nature protection makes the circulation economy an area which has recently been drawing attention of businesses, too, which had been unusual in the industry spheres in the last decades. This approach draws inspiration from natural ecosystems, which are based on perfect functional cycles of organic nutrients and technical raw materials (INCIEN, 2018). McKinsey & Company (2015), an American consulting company providing services to the Government as well as to non-profit organisations, has calculated that if the principles of circular economy were adopted, it could generate an annual benefit of Eur 1.8 trillion by 2030 and save Eur 0.600 trillion on the annual expenditures. According to the European Commission, industrial sectors would consequently create 2 million jobs. The timing of circular economy is perfect. Environmental issues enjoy the increased attention and changing consumer behaviour. For example, a survey carried out by CSR & Reputation Research (2016) showed that 68% of Czech population would pay increased price for an eco-friendly product. Still circular economy must overcome the cultural, market, technological and regulatory barriers before it becomes a standard part of the economic system. However, it is necessary to raise awareness of both general public and academic researchers and to reinforce education which would take account of the current climate-related challenges and would search for community-led sustainable development approaches at the local level as this is the only way in which it will be possible to create functional ecosystems, in which the circular economy makes great sense.

Provision of national or international sustainable development strategies (or of circular economy as a part of those strategies) depends on the interest shown by the society as a whole and on the stimulation of general public's willingness to meet the objectives of those strategies. According to the last global study conducted by KPMG (Survey of Corporate Responsibility Reporting 2017), more than 43% of businesses of the sample of G250 and 39% of the sample of N100 (samples of respondents by KPMG) adopted the responsible business activities linked with sustainable development goals (SDG) within less than two years since their launching. As for the goals of the 2030 Agenda, the Goal 12 which requires to "Ensure sustainable consumption and production patterns" and the Sub-goal 12.2, "By 2030, achieve the sustainable management and efficient use of natural resources", directly depend on consumer buying behaviour and on the use of resources by businesses. The matters of sustainability and nature and landscape protection were addressed in the questionnaire surveys carried out in the Czech Republic and in the Slovak Republic in 2016 and 2017. The objective of both the surveys was an analysis of consumer behaviour in the wood products segment with respect to consumers' interest in consumption of products made of certified raw wood material. The part of questionnaire surveys dealing with sustainability matters related to wood products concentrated on the FSC and PEFC certifications, which represent the interests of sustainable development by the virtue of their criteria.

2. MATERIAL AND METHODS

Consumer behaviour in opting for or preferring environmental interests in wood products is an important parameter in the assessment of the society's interest in sustainability matters and resources management. Answers to the questions which the respondents filled out in the questionnaire helped identify their positions on this issue. The research concentrated on the analysis of consumer behaviour in deciding on preferring/not preferring certified products as well as on a clarification of the reasons for opting for certified or non-certified timber products.

The method of the preparation of the outputs was divided into several areas, which should ensure the relevance of the obtained data. In the first stage, the size of the sample of working-age respondents from the chosen countries was identified. This was subsequently used to set the statistically significant sample of respondents. In the case of the Czech Republic, the calculation of the representative sample of respondents built on the last assessed information about the working-age population of 2015 (ČSÚ, 2016), namely the population of 6,997,700. For the Slovak Republic, the sample was determined on the basis of the population of 2017 and of the consequent percentage of the working-age population in the given year, which was calculated by the Statistical Office of the Slovak Republic and expressed for the year 2017 in the form of age composition indexes in % (these data are available at the Statistical Office of the Slovak Republic). In that year, the working-age population accounted for 68.87% of the total population, i.e. for 3,743,321. In both countries, the working-age equalled the age category of 15-64 years of age, which was also the target group of the questionnaire survey. The error rate percentage was set to 5% as to the standard value used in statistics. Based on the calculations, the representative sample was set to 384 respondents in both cases (the online calculation is available at www.surveysystem.com). The questionnaire was filled in by 404 respondents in the Czech Republic and by 709 respondents in the Slovak Republic. The questionnaires were distributed in paper form by means of personal meetings with the respondents as well as online using a questionnaire form by Survio. Some fundamental aspects of the assessment of the situation in the researched issue were used in this article. The outputs were interpreted on the basis of the hypotheses provided in Table 1, which were evaluated using a contingency of questions and answers selected from the questionnaire.

Table 1. Hypotheses which set the frame for the questionnaire survey of consumers.

	Hypothesis
H_0 (1)	The preference of the environmental interest in the products made of wood and wood materials depends on gender.
H_0 (2)	The consumer’s income is a decisive factor in their willingness to pay a price premium for a value-added product.
H_0 (3)	Knowledge of the FSC and PEFC certification systems influences the interest in the environmental aspects of products.

3. RESULTS

Regarding the results of the analyses performed in the Czech Republic and in the Slovak Republic, some outputs can be mentioned which inform about the consumers’ willingness to value environmental protection related activities by means of preferring certified products. The first criterion was the gender of the respondents, which was assessed in the contingency with the answers to the question: “Are you interested in the environmental aspect of the goods made of wood or wood materials (recycling, the material used, processing method, etc.)?”. The set hypothesis aimed to compare the results of the research conducted by Strapcová and Zeman (2017) from the Institute of Sociology (SAV) in the Slovak Republic, who analysed the opinions on environmental protection. In the case of the Czech Republic, the results of the representative opinion poll on Czech public’s relation to nature and environment conducted by Krajnhanzl et al. (2018) were considered. According to the results of the research carried out by the SAV and based on the collected answers, women are more interested in the matters related to dealing with environmental problems. The outcome of the research carried out in the Czech Republic, which had almost equal representation of men and women in the sample of respondents, indicated that the female respondents showed more interest in environmental aspects expressed by means of the scale of ecological attitudes (NEP). (Krajnhanzl et al. 2018) The data from the research surveys carried out by the team of authors and shown in Figure 1 demonstrate the interest in the environmental aspect of products made of wood or wood material in the Czech Republic and in the Slovak Republic.

The H_0 (1) hypothesis shall be rejected because the percentages of the respondents in both cases are not significantly different and the answers of the respondents in both countries almost do not differ despite the notably different number of respondents. The minor deviation in the interest expressed by men in the Slovak Republic was probably caused by the more uneven representation of men and women compared to the Czech Republic, where the representations in the addressed sample of respondents were almost equal.

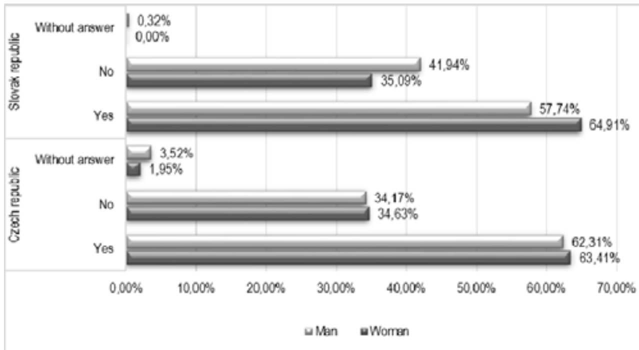

Figure 1. Results of the questionnaire survey for the H0 (1) hypothesis

The objective of the H_0 (2) hypothesis is to confirm or reject the presumption that mainly people with higher income are willing to accept a more expensive product with a value added in the form of its environmental aspect. i.e. that a respondent's income affects the choice. The data presented in Figure 2 are based on collected answers to the question: "If you could choose between a wood product (furniture paper products, wood material, wooden houses) which is more expensive but eco-friendly, would you prefer it to a cheaper one with no added value?" The answers were assessed in the contingency with the income of the respondents.

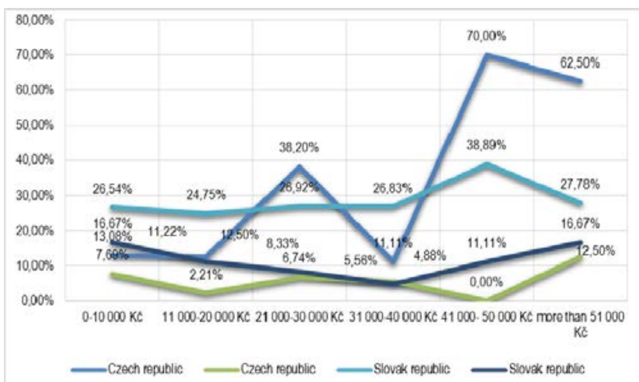

Figure 2. Results of the questionnaire survey for the H0 (2) hypothesis

Considering the data presented in Figure 2, the H_0 (2) hypothesis can be clearly not rejected. It has to be noted that the answers shown in Figure 2 only account for 35% of the total number of answers while the remaining 65% represent the answers "I would prefer it providing there is a verified expert justification for it" and "It would depend on the price difference". The reason for omitting these answers was their ambiguity in relation to the set hypothesis. The confirmation of the hypothesis also seems to justify the interpretation of the already published outcomes of the research conducted by Michal et al. (2019). Those results indicated sensitivity of income groups to preferring the environmental aspect of products made of wood or wood material. This preference is prevailingly linked with the higher income groups of the respondents in both countries. Despite the lower number of respondents, there was a higher percentage of the preference depending on the income group in the Czech Republic. Supposing that the environmental aspect in the form of a value added to the product had no effect in the pricing, it can be said that the consumers' interest would be reflected by the actual buying behaviour.

The last output of the questionnaire analysed in order to reject or not reject the H_0 (3) hypothesis was the answers to the question "Do you know the logo of the FSC or the PEFC?". The answers were assessed in a contingency with the answers to the question "Is it important for you that a product which is made of wood material or wood is also made in line with nature protection and conservation?".

Table 2. Results of the questionnaire survey for the H0 (3) hypothesis

Answer to question 1	**Indicators of economic efficiency (profit) in CZK**					
	Yes, it is a priority	Yes, if somebody recommends it to me	No, I am not very interested in it	No, unless I see it written somewhere	I sometimes take interest in it	Yes, if there is a verified expert justification for it
"I know the logo and its meaning"	**17**(17) **28%**(16%)	**8**(7) **12%**(5%)	**5**(2) **8%**(2%)	**2**(2) **10%**(3%)	**19**(24) **15%**(20%)	**16**(6) **25%**(6%)
"I have some idea what the logo means"	**6**(19) **10%**(18%)	**12**(19) **18%**(15%)	**8**(8) **13%**(7%)	**4**(8) **21%**(13%)	**20**(36) **16%**(17%)	**12**(22) **18%**(23%)
"I only know the logo"	**12**(13) **20%**(12%)	**11**(14) **16%**(11%)	**6**(13) **10%**(11%)	**3**(3) **15%**(5%)	**25**(31) **20%**(14%)	**10**(17) **15%**(18%)
"I know neither the logo nor its meaning"	**21**(50) **35%**(49%)	**35**(82) **53%**(65%)	**38**(87) **60%**(75%)	**10**(46) **52%**(76%)	**57**(113) **47%**(53%)	**24**(45) **37%**(47%)
Number of respondents	**60**(102)	**66**(126)	**58**(115)	**19**(60)	**121**(211)	**64**(94)

The data presented in Table 2 support not rejecting the H_0 (3) hypothesis. The figures shown in bold in the table were obtained from the respondents from the Czech Republic and are expressed in population units and in the percentage of the total number of respondents. The data presented in regular are specific for the respondents from the Slovak Republic. It is clear that the highest ratio of disinterest in the environmental aspect prevails in the respondents who know neither the logo nor its meaning. Therefore, it can be concluded that the awareness of the FSC and PEFC certification systems has an impact on increasing the interest in the environmental aspect of products and in nature and landscape protection.

4. SUMMARY

The aim of the article was to point to the need for stimulation of the interest in the sustainability matters by means of selected tools and of monitoring of their actual impact in the society. The article also aimed to set a basic range of potential opportunities for application of the principles of circular economy in practice in Czech forestry in relation to the addressed issue. In forestry, key opportunities for supporting development of circular economy lie in wood processing and in production of wood products with high added economic and environmental value. An important aspect is the maximum possible decrease in transport distances as mapping the CO2 footprint of materials is a current trend. By its virtue, wood is a positive material which improves the value thanks to its ability to bind CO2 in its structures. Taking account of the EU55 plan to shift towards a low carbon economy, energy recovery is only an additional option since CO2 is released when materials are used for energy production. Specific opportunities are summed up in the following three key segments:

1. Use of quality timber in building constructions: The CLT technology seems to bring most prospects; it is applied in a number of EU countries and it also plays a role in the current advanced trend in multi-storey wooden houses.

2. Furniture eco-design – a shift to renewable resources and design: The use of wood in furniture making appears to be a matter of course. However, it was in this segment where the idea of using wood ran into problems with the requirements of processing subjects. The biggest companies which make furniture and hence demand wood from Czech forests apply transnational commitments to prefer wood from sources with the FSC certification.

3. Agroforestry – use of waste biomass in production of enhanced fertilizers: Appropriate technologies could be found which would enhance degraded biomass with digestate, for example. Digestate cannot be applied in many areas because of the absence of organic mass and its high nitrogen content. The digestate-enhanced biomass is a new idea of a fertilizer which would solve problems in both forestry and agriculture at the same time.

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THE OPPORTUNITY OF USING CHAIN OF CUSTODY OF FOREST BASED PRODUCTS IN THE BIOECONOMY

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Abstract: The article focuses on the opportunity of the use of requirements of sustainable chain of custody of forest based products when fulfilling the principles of bioeconomy. Formulation of requirements for chain of custody system comes out from the requirements of international PEFC C-o-C standard (PEFC ST 2002:2013). Fundamental requirements and formulated principles of above mentioned standard within the framework of technological and social approaches in bioeconomy are analysed. The analysis of the surveyed requirements clarifies the role of chain of custody system in the bioeconomy. The environment of the Czech Republic represents the political, economic and social framework for the analysis. The results of the analysis and related conclusions are usable also in other countries..
Keywords: bioeconomy, chain of custody, forest based products

1. INTRODUCTION

Before considering opportunities of use of the requirements of sustainable chain of custody of forest based products (C-o-C) within the bioeconomy principles, it is necessary to define the basic terms. First of them is „chain of custody of forest based products“. If we come out of PEFC system approach (Programme for the Endorsement of Forest Certification), it deals with “*Process of handling of information on the material category of forest based products which allows the organisation to make accurate and verifiable claims on the content of certified material.*“ (PEFC, 2013). Certified material is *„Raw material which is covered by the chain of custody claims“*. Specifically it means that certified material is (PEFC, 2013):

(a) forest based material delivered with the supplier’s claim “x % PEFC certified” by the supplier with either:
i) PEFC recognised certificate or
ii) a document confirming that the supplier is covered by the PEFC recognised certificate.
(b) recycled material (other than products delivered with the “PEFC certified” claim).

The overall goal of the PEFC chain of custody is to provide customers of forest based products with accurate and verifiable information on the content of material originating in PEFC certified, sustainably managed forests, recycled material and controlled sources (PEFC, 2013).

Criteria for sustainable forest management evaluation in the Czech Republic are defined by an standard (within the PEFC system it is TD CFCS 1003:2016).

The second term is “bioeconomy”. Many definitions are to be found. We use a definition by European Commission which is as follows: *„The bioeconomy comprises those parts of the economy that use renewable biological resources from land and sea – such as crops, forests, fish, animals and micro-organisms – to produce food, materials and energy“* (EC, 2012). Bioeconomy represents the European way to use our natural resources, as arises from the „Action plan 2018“ (EC, 2018). According to this document, also the bioeconomy principles come out – *„The bioeconomy covers all sectors and systems that rely on biological resources – animals, plants, micro-organisms and derived biomass, including organic waste – as well as their functions and principles. It includes and interlinks: land and marine ecosystems and the services they provide; all primary production sectors that use and produce biological resources (agriculture, forestry, fisheries and aquaculture); and all economic and industrial sectors that use biological resources and processes to produce food, feed, bio-based products, energy and service. To be successful, the European bioeconomy needs to have sustainability at its heart and be circular by definition. The purpose of the updated European Bioeconomy Strategy is therefore to further develop a bioeconomy that valorises* *and preserves ecosystems and biological resources, drives the renewal of our industries and the modernisation of our primary production systems through bio-based innovation, involves local stakeholders, protects the environment and enhances biodiversity".*

Attention within the bioeconomy area is now aimed at sustainable future. Action Plan 2018 (EC, 2018) says that an update of the original Bioeconomy Strategy is necessary to accelerate the deployment of a sustainable European bioeconomy so as to maximise its contribution towards the 2030 Agenda and its Sustainable Development Goals (SDGs), as well as the Paris Agreement.

2. METHODS AND RESULTS

Bioeconomy approaches can be divided into two groups as follows (Secco et al. 2016):

- the traditional, technological approach,
- the emerging, social approach.

Main fundamental differences are shown in this table 1:

Table 1

	Technological approach	Social approach
Focus on	- Technological innovations - Large scale investments - Value chain perspective - Sectoral development - Vertical integration	- Social innovations - Small scale - Networks - Cross-sectoral development - Horizontal integration (forests and agriculture as the green infrastructures for rural development)
Input/output diversification	- 1 or more inputs - Diversification in outputs	- Diversification in the use of inputs - High added value products & services
Market power	- Increasing role of business owning/controlling the (new) technologies	- Role of networks, groups, associations, public-private partnerships…
Model regions	- Northern EU (UK, Scandinavian countries)	- Southern EU (Mediterranean region)

Source: Secco et al. 2016.

Technological approach represents an adaptive strategy with a conventional wisdom of innovation generation. Focus on forests, agriculture, fishery as raw materials providers with biotechnology being the engine of the growth. Social innovation approach represents bioeconomy as an opportunity to re-think to our consumers' patterns. It not only considers the protection of natural capital, but it stresses as well the importance of addressing equity and social inclusion challenges in moving toward a green economy (Secco et al. 2016). Technology-based and socio-ecological approaches are mentioned also in Priefer et al. (2017).

Chain of custody system requirements come out from an international PEFC C-o-C standard (PEFC ST 2002:2013) and can be divided into following areas:

- Identification of the material category of material/products
  – Identification at delivery (incoming) level
  – Identification at supplier level
- Minimum Due Diligence System (DDS) requirements
  – General requirements
  – Gathering of information
  – Risk assessment
  – Substantiated comments or complaints
  – Management of significant risk supplies

- No placement on the market
- Chain of custody method
- General
- Physical separation method
- Percentage based method
- Sale and communication on claimed products
- Documentation associated with sold/transferred products
- Usage of logos and labels
- Minimum management system requirements
- General requirements
- Responsibilities and authorities
- Documented procedures
- Record keeping
- Resource management
- Inspection and control
- Complaints
- Subcontracting
- Social, health and safety requirements in chain of custody
- Scope
- Requirements
- Specification of the PEFC claims
- Implementation of the chain of custody standard by multisite organisations

Detailed requirements in the above mentioned areas are stated by PEFC C-o-C standard, where they are presented.

Based on the analysis of C-o-C system requirements in the above mentioned areas and two stated bioeconomy principles we can conclude that PEFC C-o-C standard is usable in a very good way for fulfilling the principles in the traditional and technological approach in bioeconomy. The reason for that is, that this principle considers the use of raw materials (wood, wood chips etc.), where C-o-C standard defines clear requirements.

Social approach is less tangible by PEFC C-o-C standard, the use of this standard is highly limited. Beside the tangible side of stream in chain of custody (like in technological approach), social approach needs to be considered also in terms of intangible aspects, that are sometimes hard to measure. PEFC C-o-C standard cannot properly evaluate e.g. the social acceptability, gender issues and discrimination, distribution of income etc. in detail.

3. DISCUSSION AND CONCLUSION

If the Updated bioeconomy strategy 2018 deals with sustainable and circular bioeconomy (EC, 2018), than exactly criteria and indicators of sustainable forest management and subsequently the requirements of chain of custody of forest based products are of basic foundation of future bioeconomy in forestry and wood-processing industry.

Aiming the attention to determine the incentives of forest owners for sustainable forest management certification is appropriate. Paluš et al. (2018) deals with this issue in conditions of Slovakia. Besides, we can agree with the conclusions made by Šupín and Dzian (2018), where for consumers, the bio-economy means an opportunity to choose a more sustainable lifestyle.

Relationships in chain of custody of forest based products have an impact on the marketing. According to Halaj, Brodrechtova (2018) the marketing decisions of heating plants significantly influence the marketing decision making framework of forest enterprises and contractors.

Chain of custody of forest based products (in this article presented by PEFC C-o-C standard) is primarily based on the evaluation of requirements considering the tangible flow of forest based material. Also an intangible flow – information – is tied with that.

On one hand, social acceptability, gender issues and discrimination, distribution of income etc. is not a matter of evaluation by PEFC C-o-C standard. Exactly these and other impact categories could belong under the evaluation within the social approach in bioeconomy at the same time. This consideration follows on from papers dealing with social life cycle assessment (see e.g. Falcone, Imbert, 2018), where such an impact categories are taken into account within the bio-based economy.

On the other hand, PEFC C-o-C standard can be used within the technological approach in bioeconomy. It suitably follows on the criteria and indicators of sustainable forest management. PEFC C-o-C standard subsequently enables monitoring the share of certified material in chain of custody and minimize the risk, that a raw material from controversial sources would get into the chain of custody.

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ENSURING ECOSYSTEM SERVICES OF FORESTS WITH THE EMPHASIS ON THEIR PRODUCTION FUNCTION

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Abstract: Forests are one of the important elements of the concept of sustainable development. They represent an important component for rural development, a place for rest, recreation and regeneration. At the same time, forests are the basis for wood production. They fulfil ecological, environmental and production functions important from the point of view of providing ecosystem services. The main aim of this paper is to describe and classify forest ecosystem services based on available literature resources. Additionally, it describes their impact on the production and consumption of goods that cause costs and revenues in the form of externalities. A detail attention is paid to the issue of ensuring the production function of forests (production of wood as a material, biomass for energy production) under the conditions of regulatory (legislative) and voluntary tools of forest policy in Slovakia.
Keywords: forest ecosystem services, production function of forest, externality, forest certification

1. INTRODUCTION

Based on the global increase in uncontrolled use of scarce resources, the society has begun to promote ideas of sustainable development. Such development preserves the natural functions of ecosystems and at the same time, the diversity of nature is not reduced. It is a complex targeted as well as synergistic process affecting all areas of human life over a long period (Paluš, 2013). Forests are one of the important elements of the sustainable development concept. They fulfil the ecological, economic and social functions needed to create a human environment. Forests and other tree species communities perform important, irreplaceable and ecological functions of landscape. The rational use and sustainable development play an important role in essential landscape-forming and eco-stabilizing (Čaboun et al. 2009). At the same time, forests are also the basis for wood production (MacDicken, 2015). It is necessary to raise support and implementation of sustainable forest management, conservation and reasonable use of all wood and non-wood forest products (Paluš, 2013).

Human civilizations depend on natural ecosystems (Han et al., 2017) that are beneficial for them in many ways. Ecosystems as well as forests and also their related processes offer a number of goods and services for human society (Kindler, 2016). Societies can benefit from the forests in the form of goods and services such as wood, food, clean water, energy, recreation or many cultural values. These benefits are known as forest ecosystem services (Čaboun et al. 2009).

As the rapid growth and development of economic societies leads to the global conversion of ecosystems it is very important to protect ecosystems to ensure their services at the time of developing the economy and improving quality of life (Han et al., 2017). Many people believe that the services of nature are free and then they are of little or no value. Although they are not paid, they are reflected in their loss in terms of increased illnesses, reduced soil fertility, wastewater treatment facilities and losses in those images of nature contributing to human basic happiness (Summers et al., 2012).

All these mentioned losses are called externalities. An externality is an economic term, when the production or consumption of a specific good or service impacts a third part. But third part is not directly related to the production or consumption of that good or service. Most of them have a negative character and are well known as negative externalities, e. g. pollution (Kenton, 2019). Other examples of negative externalities of forests are losses in biodiversity and landscape value that occurred due to plantation forestry, the losses of recreational value arisen from poor management and intensive plantation forestry etc. (EFI, 2000). On the other hand, there are also positive externalities that arise when an individual or firm provides benefits for which it is not compensated (OECD, 2006). Türker et al. (2003) mentions some positive externalities provided by forests such as increasing landscape quality, increasing water quality etc. It is assumed that only part of us understands the well-being benefits of the natural environment and ecosystem services (Summers et al., 2012).

In the last twenty years, the concept of an ecosystem service has attracted a great deal of attention (Han et al., 2017). The term "ecosystem services" has been applied at the beginning of this century by the Secretary-General of the United Nation. He approved the suggestion of project called the Millennium Ecosystem Assessment (MA). More than 1,360 scientists from all the world participated in this project (Kušíková, 2013). Ecosystem services, in addition to nature conservation, the sale of recreational services (supporting the creation of suitable conditions serving the people) perform also other functions including carbon storage in forest ecosystems, climate regulation, soil retention, improving water quality, etc. (Schwarz, 2013; Tian et. al., 2018; Agrawal et. al., 2008). Wang et al. (2019) mentions ecosystem services underpin human well-being, but their complex synergies or trade-offs are a challenge for matching supply and demand of the ecosystem services. Moreover, they are recognized and accounted for in the assessments of infrastructure development, forestry, agricultural management and sustainable sourcing management (Ramirez-Reyes et al. 2019; Aznar-Sánchez et al. 2019).

2. APPROACHES TO CLASSIFICATION OF ECOSYSTEM SERVICES

As described by Convention on Biological Diversity (CBD) (2019) the ecosystem approach is a strategy for the integrated management of land, water and living resources promoted conservation and sustainable use in an equitable way. Whereas an ecosystem approach is based on the application of appropriate scientific methodologies focused on levels of the biological organization, it is encompassing the essential structure, processes, functions and interactions among organisms and their environment. Therefore, recognizes that humans, with their cultural diversity, are an integral component of many ecosystems. Globally, there are three approaches recognised for categorise ecosystem services:

- Millennium Ecosystem Assessment (MEA);
- Common International Classification of Ecosystem Services (CICES);
- Economics of Ecosystem and Biodiversity (TEEB).

Millennium Ecosystem Assessment (2005) represents an important global study about ecosystems services, which framework is accepted and perceived as a useful starting point. MEA recognizes 4 categories of ecosystem services:

- Provision Services – include products obtained from ecosystems such as food, water, raw materials, energy and genetic resources etc.
- Regulation Services – provide benefits obtained from regulation of ecosystem processes. Mainly include climate, disease, water regulation, water purification and pollination.
- Cultural Services – create nonmaterial benefits obtained from ecosystems. They are tightly bound to human values and behaviour. These include services such as spiritual and religious, recreation and ecotourism, aesthetic, inspirational, educational, sense of place, cultural heritage.
- Supporting Services – offer services necessary for the production of all other ecosystem services (soil formation, nutrient cycling and primary production).

According to the international classification CICES (2018), ecosystem services can be classified as supply (e.g. wood as material, biomass for energy production), regulatory and support (e.g. regulation of soil environment, water, climatic conditions, biodiversity conservation) and cultural (recreational) functions. Czúcz et al. (2018) realized a systematic review of ecosystem services indicators and their classification using CICES. Their findings can be used to help improve CICES to better provide a more robust and comprehensive framework for ecosystem assessments.

The last TEEB approach is based on MEA. The TEEB (2010) study also recognizes four categories of services – supporting; provisioning; regulating and cultural. Despite the MEA considering ecosystem services as the benefits people obtain from ecosystems, TEEB considers them as direct and indirect contributions of ecosystems to human wellbeing. Based on Balmford et al. (2008) a framework for articulating the ecological and economic aspects of the analysis necessary for the valuation of biodiversity loss and ecosystem degradation was proposed.

3. PRODUCTION FUNCTIONS OF FORESTS

In Slovakia, Act on Forests no. 326/2005 Coll. defines the basic concept of forest functions as the benefits, effects and impacts provided by forest as a component of the natural environment and the object of economic exploitation. The forest functions are divided into (i) non-productive functions and (ii) production functions. The forest is able to sustainably produce goods that the society has an interest in (wood; non-wood forest product), which is called a production function. Moreover, production functions of forests are results and benefits from the forests (usually of material nature). In Slovakia the production function is understood mainly as the production of wood and due to the state and possibilities of forests, this understanding is not expected to be changed. The aim of the society is to use the production potential of forests as effectively as possible (forest land as well as forests are too important natural resources to waste their potential) (ForestPortal, 2015). Forest Europe (2019) mentioned that forests are a major resource for social welfare where forests (i) protect us and our infrastructure; (ii) provide us with wood for a wide range of uses and many other goods; (iii) energy from wood resources contributes significantly to achieve the renewable energy targets; (iv) woody biomass is the most important single source of renewable energy in Europe (wood presents for almost as much energy as hydro, wind, solar, geothermal, municipal and industrial waste and other biomass put together). Forest ecosystem services are of great value for humanity, but many of them are undervalued following their degradation (Nguyen et al., 2018). According to Alberdi et al. (2016) the supply of wood in Europe on a sustainable basis is highly relevant for forestry and related policies, mainly for:

- analysing global change mitigation strategies and carbon accounting;
- establishing realistic forecasts and targets for wood resources, biomass and renewable energy;
- assessing and supporting strategies for an increased use of wood.

Based on Šálka et al. (2017) in Slovakia, specific and practically the most and exclusively used voluntary tool is certification related to the concept of sustainable forest management. Moreover, the forest certification is one of the ways to achieve a condition allowing the forest serving for people in the right way. Forest certification is a voluntary and appropriate tool to ensure that sustainable forest management communicate with society and consumers of timber products (Paluš, 2004). The original certification tasks related with ensuring the required quality of management and allowing access to environmentally sensitive markets. However, today´s certification tasks are complemented in relation to other forestry policy tools and forestry governance such as (i) ensuring the legality of wood; (ii) the requirements of public wood purchasing policies, therefore, multi-level governance; (iii) stakeholder participation; etc. (Šálka et al., 2017). As an example, forest certification is recognized by the European Timber Regulation (Paluš et al., 2014). Currently, certification is a globally recognized tool to promote sustainable development in all forest formations in the world. Based on Rio+20 cenference in Certificatťion received global support at the Rio + 20 World Conference on Sustainable Development in Rio de Janeiro in 2012 (UNCSD, 2012). Some certifiaction systems, such as PEFC attemts to adjust certain

The basis of the Slovak Forest Certification System (SFCS), endorsed by PEFC, is the certification of the forest management quality management system in terms of its sustainability. The system includes 7 international principles; 32 national criterions; 59 indicators on regional and 110 indicators on individual level (Štulajter; Paluš, 2016). The national sustainable forest management standard SFCS (TD SFCS 1003:2014) contains several principles and criteria that support the production function of forests. Under the international priciple 3 Maintenance and encouragement of productive functions of forests (wood and non-wood), there are three national criteria: 3.1 Sustainability and continuity of harvesting, 3.2 Roundwood, 3.3 Non-wood forest products and services and one supporting criterion 3.4 aimed at the Forest road network (PEFC, 2014). As an example, full wording of criterion 3.1 is shown in table 1.

Table 1. National criterion 3.1 Sustainability and continuing of harvesting

Criterion title	**SUSTAINABILITY AND CONTINUITY OF HARVESTING**
Full wording of criterion	The volume of timber for harvesting shall be determined differently according to the categories of the forest in order to ensure optimum utilization of the productive potential of forests and maintain sustainable fulfilment of the functions of the forest
Criterion objective	**Uniform** use of standing volume **up to** the **objectively determined** harvesting **indicator level**
Legislative framework	Act NR SR 326/2005 Coll. on forests as amended Decree MP SR 453/2006 Coll. on forest management and forest protection as amended Decree MPRV SR 297/2011 Coll. on forest management records
Regional indicators	The existence of m**echanisms for a** long-term **determining** of **sustainable** harvesting, use of **forests and their functions (**yes / no) **Comparison of the total current increment and timber harvesting** (m^3) **Comparison of allowable cut and timber harvesting** (m^3)
Individual indicators	**Compliance with legislative** principles for timber harvesting **The total volume of timber** harvesting p**rescribed** in FMP shall not be exceeded **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)** **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.
Explanatory note	Proper forest management: the total volume of accidental felling shall not exceed 36% of the total harvesting prescribed by FMP for forest of ownership unit
Sources of information	databases of IS LH NLC, FMP and LHE of forest manager, permission for timber harvesting, results of state supervision, inspection in forest

4. CONCLUSION

Production of wood and non-wood products is one of the most important functions of forest ecosystems. Alongside with other functions of forests the production function is a part of the definitions given by the major world classifications of ecosystem services (e. g. MEA, CICES and TEEB). Usually, the production function (both wood and non-wood products) is categorized under the provision of services. Its main goal is to obtain products from ecosystems and use them as efficiently as possible.

In Slovakia, ecosystem services are considered to be the effects of forest functions. The production function is directly supported by the forestry legislation and in addition by the voluntary national forest certification system endorsed by PEFC. The aim of the production of wood and non-wood products in Slovakia is to focus mainly on the limited use, permanence, balance and support of some nature-friendly principles of forest management, use of ecological technologies etc. In determining harvesting volumes certification aims to ensure optimum utilization of the productive potential of forests and maintain sustainable fulfilment of other functions of the forests. Management of certified forests complies with the highest environmental, social and ethical standards and labelled certified forest products can be easily recognised and identified by the consumers.

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"SOMEONE'S GARBAGE IS SOMEONE ELSE'S TREASURE" – CROSS-SECTORAL INTEGRATION IN CIRCULAR ECONOMY

Gergana Slavova, Maya Ivanova

Abstract: In the age of greater concern about the limited resources and maximizing the efficiency of their use, the "circular economy" would serve as the best solution for closing loops in industrial ecosystems, minimizing waste and recycling the remains of the production process. In this regard a cross-sectoral integration between different industries would deliver more opportunities for mutual cooperation and remanufacturing and reuse of each sector leftovers.
Rural tourism has evolved as an alternative to the mass tourism, and has proved to utilize resources which have been discarded or in waste for the forestry sector (e.g. sawdust used to pave trails; remaining materials used to build benches, or for decoration; old agricultural equipment used in museums, for decoration or for learning workshops, etc.). The fact that tourists appreciate as "treasures" the remaining ingredients of forestry may provide numerous possibilities for both sectors to work in symbiosis and contribute to the circular economy.
The aim of current paper is to explore the opportunities for integration of circular economy models, using the shared resources of forestry and tourism industries. The study will step on secondary research of similar cases, presented by other authors, and will add to this analysis several examples from North-eastern region of Bulgaria. We will start with the exploration of the impacts of forestry on tourism development, and afterwards will propose insights for further proliferation of circular economy activities, based on the current cooperation and integration of both sectors.
Keywords: forestry, tourism, wood remains, wood residues, circular economy, cross-sectoral integration

1. INTRODUCTION: CIRCULAR ECONOMY AND CROSS-SECTORAL INTEGRATION

Circular economy concept grows continuously in popularity, thanks to its universal understanding of efficiency and principles for closed-loop production. It evolved from an academic model to a real tool for achieving sustainable development pillars (environmental, social and economic) (Millar *et al*, 2019). Circular economy might be applied on both micro (products, companies, consumers) and macro level (city, region, country, destination), thus enabling all stakeholders to contribute simultaneously (Kirchherr*et al*, 2017). Circular economy was primarily introduced for policymakers and non-governmental organizations because of its principle for closed loop, meaning to utilize all the waste and residues from industrial production, thus ensuring less resource depletion and pollution. However, such full closed-loop system hardly could be achieved within only one industrial sector. In a full production cycle companies usually seek the highest efficiency, in order to prevent or at least to minimize the leftovers, considered as waste. Afterwards, theresidues might be used as ingredients for other industries, probably not for primary, but for secondary production. The best situation appears when both industries operate in the same or near physical location, which will further minimize any transportation costs. The cross-sectoral cooperation may ensure "win-win" sustainable growth for the two industries, which complement each other in terms of resource utilization and stimulation of economic development. The implementation of such cross-sectoral collaboration, however, starts at lower, micro level, with the simple cooperation/partnership among single companies from different sectors. The synergy of their partnership may result in fulfilling the primary principles of the circular economy, thus establishing the ground for further evolvement and engagement of additional stakeholders. While there are certain concerns about the viability of circular economy implementation (Millar *et al*, 2019), the following study presents good basis for thought and ideas for initial steps in this process.

The current paper aims to explore the opportunities for integration of circular economy models, using the shared resources of forestry and tourism industries. The study steps on secondary research of similar cases, presented by other authors, and adds to this analysis several examples from the North-eastern region of Bulgaria. The next sectionexplores the impacts of forestry on tourism development, and reveals some insights for further proliferation of circular economy activities, based on the current cooperation and integration of both sectors.

2. FORESTRY AND TOURISM INTERCONNECTEDNESS

Forestry and wood industry have deteriorated their development in the recent decades, because of numerous factors, the low selling price of timber amongst the most important of them (Helles&Vedel, 2006). This situation pushed forest owners (and the state itself, being an owner) to search for other models for commercialisation and profit generation (Sikora and Nybakk, 2012). In this regard, certain studies analysed the forestry industry in terms of forestry ownership (Matilainen&Lahdesmaki, 2014), prospective business models (Hengeveld*et al*, 2017) and different strategies for revival of the region (Kajanus*et al*, 2019). Because of the forest potential to offer wide range of entertainment activities and services (Helles&Vedel, 2006), nature-based tourism naturally became crucial tool for providing livelihood of forest-rich rural areas (Rantala, 2010).

Usually, the two industries (forestry and tourism) are associated and explored simultaneously with regard to the negative impacts of tourism on the forest (Kuvan, 2005), and the inclusion of forests as part of the tourist product (Rantala, 2010). Rural tourism evolved as an alternative to mass tourism, and proved to utilize resources discarded or in waste for the forestry sector.

While forestry exploits the tangible resources, tourism, in contrast, pursues the intangible values, like services or indulging experiences (Tran, 2015). However, there are few studies that deal with the tangible resource exchange between the two industries (Tran, 2015). In the context of circular economy presumption that the least waste should remain, our study aimsat filling this gap and examine the residues, coming from the forestry and further utilized in the tourism and hospitality.

The cross-sectoral integration of tourism and forestry may be illustrated in several aspects:

1) Forests are used as environment/space for tourism, with relevant tourist facilities (Kuvan, 2005)

2) Nature-based experiences, taking place within the forest, as part of the tourism product (Li&Lai, 2011; Rantala, 2010)

3) Material items, produced from forest industry residues, that are targeted mainly for tourists – like souvenirs, furniture, amenities, etc.

2.1. Forests as Environment for tourism

Greenery, natural sights and relaxing atmosphere have always attracted people for recreation and tourism. Many destinations rely on their natural landscape as an attraction by itself to people seeking for tranquillity and relaxation (Li&Lai, 2011). In addition, the recent strive for “close-to-the-nature” life enhanced the tourist demand to intentionally choose remote and forested places for tourism. Last, but not least, the emerging wave for environment protection and sustainable utilization of resources led to increasing interest in eco-friendly accommodations, facilities and products (Kuvan, 2005). Thus, the forests serve as the perfect allocation for rural and alternative tourism by their provision of appropriate space and environment.

2.2. Forests used for nature-based experiences

An essential part of the tourism product are the unforgettable emotions, stemming from diverse activities like entertainment, escape, aesthetics (Li&Lai, 2011). Guided tours, climbing, horse riding, mountain bike and hiking are only a few of the activities, bringing the most value and experience for the tourists. The tourist companies realize the potential of outdoor experience and further elaborate team building, training courses, education, nature excursions and birthday arrangements to enrich their supply. All of those activities happen within the forest and use it as premises. The additional decoration and amenities (benches, education boards, signs, climbing frames and jungle gyms) accomplish tourists' experience and make it thorough and holistic.

2.3. Forestry industry residues, utilized in tourism

The first two common aspects between forestry and tourism have received a lot of attention in terms of tourism product elaboration, sustainable development and mutual impacts (Tran, 2015). However, the material exchange and recycling between the two sectors remains quite neglected. Timber production arguably is the primary product of the forest industry. A study of Daian&Ozarska (2009) reveals that during processing, 7% up to 40–50% of the annual supply of wooden raw material become residues. The costs connected directly to these wastes represent 2–8% of the total turnover (Daian&Ozarska, 2009). What happens then with this waste and can it be recycled or returned back for further exploitation?

Surprisingly, there are numerous possibilities for the forestry and tourism to work in symbiosis for material exchange, and thus contribute to the circular economy. Very few examples are presented as explicitly deriving from such cross-sectoral integration (Tran, 2015). Since the forestry industry residues are often considered as “garbage”, it requires proactive behaviour and creativity to transform them into “treasures” for the tourists. Usually, only small entrepreneurs and family businesses see the opportunities for such added value to the “garbage”. That is why, the utilization of forestry residues happens only in small scale and in regions, dedicated to tourist activities.

Below we collected examples of forestry residues, utilized in the tourism activities. The list is not comprehensive, because it is a matter only of creativity and personal entrepreneurship to invent new and diverse application of the wooden remains.

- **sawdust** is used to pave eco trails, mountain bike trails and pedestrian zones within the forest; it is used also as flooring for kid playgrounds
- **plywood** is used for signs and educational boards
- **wooden furniture** is made up from residual **solid offcuts**, sometimes with weird forms and design to keep them unique or to merge with the rest of the environment;
- special outdoor places within the forest for rest and picnic, or education, including both wooden furniture and **learning stations** with the information provided with forest-ingredients evidence;
- **solid offcuts** are used to build thematic and forest adventure parks, survival parks for scouts, etc.
- small pieces of wood are used to make **souvenirs and gifts**, especially as part of the indigenous crafts and traditions;
- shelters, bird houses, birdwatching platforms/stations, animal feeders, wildlife watching experience, all made from **solid offcuts**
- wildlife observation platform is constructed out of **reclaimed urban wood** and stainless steel, showcasing sustainable reuse of materials
- table games, like chess or darts, mini golf, climbing frames and jungle gyms, all made up of **residual wood**;
- small wooden bridges or different wooden figures and attractions, located along the eco trails in the forest

3. CASE STUDY – NATURE PARK "ZLATNI PIASACI"/ "GOLDEN SANDS"

Current study steps on secondary research of available resources, utilized from residual forestry materials for the tourism industry. The case-study region is North-eastern region of Bulgaria, and particularly Nature park "Zlatnipiasaci". The forest regulation in the region is conducted by two regional directorates of forestry – Varna and Shoumen. They encompass 19 local forestry departments, which are 10,44% of all local forestry departments in the country (Ministry of Agriculture and Foods, Bulgaria). The North-eastern region of Bulgaria is not very rich in forests. Instead, it is famous for its tourism development, especially along the Black Sea coast (Ivanov &Dimitrova, 2014). Still, besides the mass "sun-sea-sand" tourism involving lots of foreign tourists, the region offers alternative attractions, which in many cases complement the traditional leisure offer. Table 1 represents the forest-based tourist attractions on the territory of North-eastern region.

Nature park "Zlatnipiasaci"/"Golden sands" (http://www.parkzlatnipiasaci.com) area is 13,2 sq. km, and is the smallest nature park in the country. The forest is 98,2% from the entire territory of the park. Initially planned as part of the forestry resources, later the park enlarges its scope to provide many tourist and recreational services. It is neighbouring the second largest sun-sea-sand resort in Bulgaria, sharing its name as well. The nature park is state-owned and managed, as per the current Bulgarian legislation for protected natural areas. As such, the park is under the regulation of regional forestry directorate Varna and hence, in direct relations with the forest industry. On the other hand, the proximity of mass tourism area provides a unique advantage for the nature park to offer an alternative experience for those who are interested. Additionally, it is located close to the city of Varna, whose citizens often use it for weekend breaks. Being connected both with the forestry and the tourism, nature park "Zlatnipiasaci" embodies the perfect example for cross-sectoral integration of those industries.

The case-study explores mostly secondary data about nature park "Zlatnipiasaci", with special focus on the activities and services, based on the mutual collaboration between the forestry industry and tourism sector. Additionally, two in-depth interviews were conducted with representatives from nature park Zlatnipyasaci, who shared particular examples of cross-sectoral integration. The researched themes encompassed the interconnectedness between the two sectors, particularly regarding the three common aspects – creating appropriate environment for tourism, examples of tourist products, and personal observations about the viability of such integration for the future development of the nature park "Zlatnipyasaci". The research period was May-June in 2019.

Table 1. Forest-based tourist attractions on the territory of the North-eastern region of Bulgaria

Nature parks, reserves and botanical gardens on the territory of the regional directorate	Attractions and facilities, located in the forests
Nature park "Zlatnipyasaci" University Botanical garden "Eco park", Varna University botanical garden Balchik Forest park "Dabovete", Dobrich Park "Residence", Dobrich National history and architechture reserve "Madara" Nature park "Patleyna" Nature park "Dervisha" Natural reserve "Srebarna" Natural reserve "Bukaka" Nature park "Shoumensko plateau"	Thematic park "Happy land", StaroOryahovo Kids park "Eco paradise" "The wooden city", Dobrich Eco trails in Nature park "ZlatniPyasaci" Forest school and learning sections in Nature park "ZlatniPyasaci" Adventure park "Mladost cottage", Targovishte Forest school in Nature park "Shoumensko plateau Eco trail with wooden amenities "Madara"

4. RESULTS AND DISCUSSION

Nature park “Zlatnipiasaci” management has intentionally elaborated diverse tourist facilities, in order to ensure opportunities for leisure and education. In terms of *spatial pattern and environment*, the park has special plan, where the areas for tourist visits and the rest protected places are strictly defined. The ultimate aim of the nature park is to protect the ecosystem and enhance the biodiversity, especially the rare and endemic species, found on its territory. But the nature park has also educational and informational functions to raise awareness about environment care and protection. In this regard, both interviewees confirmed that the park’s management team invests substantial efforts in diverse projects and initiatives, in order to involve more stakeholders and popularize their mission. According to the park manager in 2018 the total number of visitors was over 108 000, from them around 4500 came for weekend tourism, around 21 000were organized eco tourist groups and more than 2200 visitors came for the attractions in the park;more than 80000 visitors, 2/3 of them foreigners, visited the park for its archaeological and natural sights.

There are 5 general and 4 specialized tourist itineraries, adapted to address different tourists’ interests and match larger target audience. Along the trails are created picnic areas, used to rest and relax. Exactly in those places are provided facilities and amenities, constructed by recycled wood, or solid offcuts, which contribute to the atmosphere and holistic experience, e.g. wooden benches, tables, fireplaces, penthouse. All the signs and mark directions are also created from wooden remains or plywood.

The specialized trails aim at attracting people with special interests or needs. These trails might be considered as *special tourist products*, constructed with the ultimate goal to serve tourists. “Jay’s Home” trail, for example, is specially designed for children education, as well as “the Forest’s song” trail, which offers interactive education of birds’ kingdom and ends up as an open-air classroom for the kids. The classroom is made entirely of wooden solid offcuts, there are also platforms for wildlife watching. “Nature for All” trail enables access for people with special needs to explore the park; there are Braille signs provided and wheelchairs may move freely. For this purpose, the alleys are covered with residual sawdust to keep wheels running smoothly. Dendrology trail and Cycling trail present opportunities for deeper exploration and adventure experiences in the park. Educational boards and signage are dispersed around the itinerary to provide information and interesting facts. The entire spatial organization of the nature park complies both to environment aims, and the tourists’ preferences, but also utilizes the most of the wooden residues and integrate them as part of the amenities and decoration.

In the middle of the nature park “Zlatnipiasaci” is located the Visitor Information Centre. Apart from the opulent information, concerning the biodiversity and forestry in the park, the Visitor centre offers a number of tourist services, tours, guiding, consultancy and even movies about the park and its inhabitants. There are special educational “green school” programmes, organized for kids and teenagers to learn more about the nature and species. For all these activities the Visitor centre uses only bio materials, mostly wood, thus illustrating the close interconnectedness between the forest and people. The interviewees emphasized on the important role of the Visitor centre to attract tourists and raise awareness about the environment protection and biodiversity. Still, the manager of the park pointed out that in any way kids need fun – and they find it in the “Monkey place”/”Maimunarnika” rope adventure park, where extreme climbing frames and jungle gyms entertain the youngest visitors. Expectedly, all facilities of the adventure park are made of residuals from wood, ropes and natural materials.

5. CONCLUDING REMARKS

Forestry and tourism industry seem quite far away on the first sight. However, there are multiple example that demostrate that with the proper approach it is possible to make use of the available resources in a sustainable way. “Someone's garbage is someone else's treasure” becomes a truly applicable mantra for the cross-sectoral integration of the forestry and tourism industries and we see its full illustration in the case of Nature park “Zlatni piasaci”.

Future research may go deeper and enlarge the case studies by involving the perspective of the factories and companies producing the wooden products from residues. Additionally, other stakeholders (like local authorithies, educational institutions, tourists and suppliers) may provide their view and implications to be considered.

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Part 2
CIRCULAR ECONOMY:
FORESTRY AND FORESTRY BASED INDUSTRIES IMPLICATIONS

RESPONSIBLE CONSUMER IN THE CONTEXT OF CIRCULAR ECONOMY

Hana Maťová, Vladislav Kaputa, Miroslava Triznová

Abstract: Recently, the concept of the circular economy is widely discussed among scholars and practitioners. There are so-called R – strategies or frameworks (e.g. 3R, 4R, 6R, 9R), to achieve core goals of the circular economy. These frameworks should contribute to accomplishing an effort to shift the global towards sustainability. A circular economy can be seen as an economic system based on "cradle to cradle" concept. The forest-based industry has a great potential to shift from „cradle to grave" towards „cradle to cradle" concept. Forest-based sector processes renewable resources and this is a strong argument to implement such a novel business model in a first line. The shift from the linear economy to the circular economy involves not only business entities but also consumers. Responsible consumer is a part of the "circle" and without such a consumer, it is impossible to bring into life the functional circular economy. The aim of the paper is to describe consumer from "the circular perspective" according to the 6R concept applied by a responsible consumer in the condition of the Slovak Republic. To fulfil this aim, we conducted a survey among 1061 Slovak inhabitants. The results show the differences in intensity of the 6R concept application in their everyday life as well as respondents' willingness to implement changes and participate "in the spinning wheel of the responsible consumption" and thus to contribute to the sustainable future and wellbeing.
Keywords: Circular economy, green consumer, 6R green strategies

1. INTROCUCTION AND LITERATURE REWIEV

Over the last decades, consumption has increased tremendously. Consequences have already appeared: environmental damage, global warming, and increased pollution (Chen and Chai, 2010). There was and still is a need to look for economic growth scenarios based on the so-called green path of development (Lis and Wanat, 2014). The concept of Green economy has a significant influence on the whole society (Parobek et al., 2017) as it deeply changes products' designing and manufacturing and processes.

Companies are shifting to green marketing, which needs a deeper understanding of green consumers and their characteristics (Apaydin, Szczepaniak, 2017). They reduce, recycle and reuse materials and sources, they are using for production. This effort of companies would not be possible without the active participation of the consumers and green consumption. It means, where consumers consider the impact of their buying decision to the environment (Moisander, 2007). These facts might lead both sides: consumers and companies into an inevitable change of behaviour and mutual cooperation in a circular economy.

Circular economy (CE concept) is trending among business practitioners and among scholars as a shift from the linear economy. The shift is from the useful application of the materials, to smarter products use and manufacturing (Potting et al., 2017, p. 15). It can be seen as an "industrial system that is restorative or regenerative by intention and design. It replaces the "end-of-life" concept with restoration, shifts towards the use of renewable energy, eliminates use of toxic chemicals, with impair reuse, and aims for the elimination of waste through the superior design of materials, products, system and, within this business model" (Ellen McArthur Foundation, 2012, p.7). The popularity of this concept is rising. In 2014, there were about 30 articles published on this topic, compared to 2016, where more than 100 articles were published analysing this area (Geissdoerfer, et.al., 2017). Since the concept and its definition was not clearly defined, it's meaning, principles and aim were blur (Kirchherr at. al, 2017).

The circular economy can be seen as an operational concept of sustainable development implementation (Ghisellini at al.,2016; Murray at al., 2017), as well as just theoretical dream (Engelman,2013 p.3). So, comprehensive and systematic investigation of 114 definitions of circular economy was made, in order to define the aim and principles of CE. Most authors saw CE as an avenue to economic prosperity.

They define it from a system perspective and economic prosperity (Kirchherr et.al., 2017).

Within the system, there are so-called R – strategies or frameworks (e.g. 3R, 4R, 9R), to achieve the main goals of the circular economy. Basically, there are three core principles “the 3R framework”, that has been present in the entire sample of 114 definitions of circular economy in the following order: 1. Recycle, 2. Reduce, 3. Reuse (Kirchherr et.al., 2017). Some scholars added a dimension “4. Recover – incineration of materials with energy recovery” (Potting et al., 2017, p. 15) and so "the 4R framework” was defined (Kirchherr et.al., 2017). In some studies, we can find the longer framework, which was defined as “the 9R framework”. In this 9R, another five areas were added: 5. Repurpose, 6. Remanufacture, 7. Refurbish, 8. Repair, 9. Rethink (Potting et al., 2017, p. 15), (Kirchherr et.al., 2017). These areas can be implemented on both sides of the economy, on the companies’ side, who create an offer, and on the consumer’s side, who represent demand in the economic system.

In order to reduce trending pollution, rising consumption, and resource usage, companies need to implement green behaviour in all stages of the product life cycle, so they can be an active part of the circular economy. Jawahir and Bradley (2016) define 6R methodology which could be used by companies: 1. Recycle – converting waste material into new materials or products; 2. Reduce – use of resources in pre-manufacturing, reduced use of energy and materials during manufacturing, reduce emissions and waste during use stage; 3. Reuse – products, or its parts, or material to produce a new product; 4. Recover – the process of collecting products at the end of the use stage, disassembling, sorting and cleaning for utilization in subsequent life cycles; 5. Redesign – next-generation products, which would use components, materials and resources recovered from the previous life cycle; 6. Remanufacture – re-process already used products to the original state, or create a new form of the product and reuse as many parts as possible without loss of functionality (Jawahir and Bradley, 2016).

Some of these areas can be applied to companies only, like the reduction of the materials used in product development and ecological innovations (Loučanová and Olšiaková, 2019). Other dimensions are not functional in the companies, without the active participation of the consumers. For example, if consumers are not active in the recycling process, companies cannot effectively continue in the recycling process. Effective green marketing is the way to inform and invite consumer to cooperate. It is based on high-quality segmentation of green consumers (Apaydin et al. 2017).

In order to act eco-friendly, consumer needs to act consciously. Which means, that consumer must have enough knowledge about environmental issues. This knowledge influences the consumer’s attitude toward these issues. This attitude, in some studies (Dunlap and Jones 2002), also called environmental concern, is psychological tendency expressed by evaluation the perceptions or beliefs regarding natural environment with some degree of favour or disfavour (Milfont and Duckitt, 2010). This attitude toward green issues could be defined as behaviour, which can be seen as green activism, green purchase behaviour or green habits. In researches, green activism is defined as being a member of the environmental group (Edwards and Oskamp,1992), or engaging in political actions (Stern at al., 1995), or being actively involved in environmental organisations (Stern, 2000). Green buying behaviour involves the use of products or services that are environmentally beneficial or recyclable (Mostafa,2007). Green habit is behaviour that is intentional reducing the impact of the personal actions on the environment (Kollmuss and Agyeman, 2002). Some empirical studies have shown, that consumers nowadays are more willing to buy green products (Apaydin et al. 2017), which might lead companies into deeper marketing understanding of consumers and their consumption process, and their attitudes. It is important to explore green behaviour because some studies have shown discrepancies between consumers’ attitudes and green buying practices (Tarner and Kast, 2003; Joshi and Rahman, 2015).

As well as for companies, there are “R consumer frameworks” discussed by scholars. According to Alatervo (2013), consumer sustainable behaviour should be based on the following dimensions: 1. Recycle – separate items in household, 2. Reduce – buy only what they need, reduce products with less packaging, 3. Refuse – don’t generate waste, decrease consumption. 4. Re-use/ Repair – extend items products cycle, 5. Rethink/ Reinvent – consider the consumption of the product. 6. Replace/Rebuy – products with eco materials or certification (Alatervo, 2013).

2. METHODS

There are well described 6R framework strategies for companies attempting to realise environmental concepts of entrepreneurship. Circular economy model counts also on buying behaviour of consumers. In this manner we have described consumer from the “circular perspective” using the 6R concept prism. The k-Means and EM algorithms in the Generalized EM and k-Means Cluster Analysis module of the STATISTICA 12 software were used in the cluster analysis. For the distance measure, a Squared Euclidean measure was used. We have analysed 33 items from the questionnaire. Each item represents one of the dimensions defined by Alatervo (2013) – described in the Chapter 2. Mann Whitney U-test was used to confirm the differences between clusters.

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 questionnaire consisted of questions about the decision-making process for buying consumer goods, green products buying process, questions regarding factors which influence buying process of consumer goods, questions regarding general environmental behaviour and green habits of the respondents. 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).

3. FINDINGS AND RESULTS

Table 1 shows the respondents divided into two clusters. The Cluster 1 (CL-1) consists of respondents (62.96%) who claim positive attitudes only to dimensions Reducing, Recycling, and Reusing and declare neutral attitudes towards Rethink/Reinvent, Replace/Rebuy and Refuse. It could be stated, that they are following classical 3R concept (reduce, reuse and recycle). Thus, we have named this cluster the "Conventional consumers".

Respondents from the Cluster 2 (CL-2) declared positive attitudes even in all the six dimensions (see the modes in Table 1). Thus, we have named respondents of the CL 2 as "Conscious consumers". About 37% of respondents belong to this cluster. The Mann Whitney U-test on 33 statements was conducted between these two clusters. Significant differences between the clusters were confirmed (at level of significance $p < 0.05$) and so, the clusters differ from each other (non-parametric test was used since data was not normally distributed).

Table 1. Results of the cluster analysis (n = 1061)

	Reduce (8 items)	**Rethink /Reinvent (3 items)**	**Replace /Rebuy (11 items)**	**Recycle (4 items)**	**Reuse (5 items)**	**Refuse (2 items)**	**N**	**%**
Cluster I – average	2.49	3.02	3.12	2.74	2.69	3.08	668	62.96
Cluster I – mode	**2**	3	3	**2**	**2**	3		
Cluster II – average	2.01	2.26	2.48	1.94	2.24	2.33	393	37.04
Cluster II – mode	**1**	**1**	**2**	**1**	**1**	**1**		

Further, differences and similarities in answers to statements from the questionnaire are described. Here, just selected significant differences between clusters are introduced. The most significant difference between Conscious (CL-2) and Conventional (CL-1) consumers was found in the statement: "I take to the pharmacy medicines that is after the warranty period", this statement belongs to act of Recycling. The Conventional consumers strictly disagree with the above mentioned statement in comparison with Conscious consumers who strongly agree with this statement.

Results of the cluster analysis show that the Conventional consumers (CL-1) responded in a neutral way on the statements (within the three dimensions) and the Conscious consumers (CL-2) agreed with the statements. The differences were revealed in the three dimensions and the six items (Table 2).

Table 2. Analysed dimensions and statements (n = 1061)

Dimension	Statement
Rethink / Reinvent	"My purchase decision is affecting by: whether a product is environmentally friendly"
Replace / Rebuy	"I try to prefer environmentally friendly products instead of non-environmentally ones"
	"I buy products, which were made ethically"
	"My purchase decision is affecting by: if the product, or its part can be recycled"
Refuse	"I am avoiding buying products from companies acting unethically"
	"I boycott some products and brands"

The similar attitudes of both clusters' respondents could be found in the three dimensions and the nine statements. As for the dimension Reduce (three items) – consumers from both clusters expressed the same opinion and they strongly agreed with following statements: "I don't think ecological problems are boosted by environmental organizations (e.g. Greenpeace, etc.)" and "I try to drink tap water and not to buy bottled water in plastic bottles". In both clusters, the neutral attitude was revealed toward the statement: "I only buy environmentally friendly products".

As for dimension Replace/Rebuy, the neutral attitude (in both clusters) was revealed towards the three statements: "I buy FAIRTRADE products"; "I buy products (e.g. furniture, paper, hygienic handbags) certificated by FSC/PEFC" and "I buy products labelled as BIO or green food." The last similar attitudes were found in dimension – Reuse. The respondents strongly agree with two items from this dimension: "I try to use the products as long as they fulfil their purpose." and "I donate products that I do not use (such as clothes) to friends, family, charity instead of throwing them into the trash." Finally, respondents in both clusters expressed their agreement with the item "If possible, I try to fix things (or let them fix by others), for example, clothing, electronics)".

4. CONCLUSIONS

Supin and Dzian (2018) introduced the bio-economy as an opportunity to choose a more sustainable lifestyle for consumers. In our study, we revealed the two distinct clusters within the sample of respondents: Conventional consumers (CL-1 about 63%) and Conscious consumers (CL-2 about 37%). The Conventional consumers are described as those following the 3R concept – Reduce, Reuse, Recycle. The Conscious consumers expressed more environmentally friendly attitudes also towards activities as Rethink/Reinvent, Replace/Rebuy and Refuse. These three dimensions could be linked with before buying behaviour (precycling activity). Klug and Niemad (2018, p. 128) mentioned in their study that "precyclers comprehensively consider anti-consumption practices for sustainability" and they are conscious consumers focusing on avoiding or minimizing waste: they reject, reduce and reuse. And thus, we supposed that Conscious consumers are somewhat prepared to participate in the 6R strategy and spin the wheel of circular economy. We are also aware that respondents in our study might tend to present a favourable image of themselves, which is known as socially desirable responding (SDR) (Johnson and Fendrich, 2005; Paulhus, 2002).

Rypakova, Stefanikova and Moravcikova (2015) mentioned that the previous political regime (1948-1989 – where demand exceeded supply in many categories of the consumer goods) could affect present patterns of buying behaviour of the Slovak population. Afterwards, a part of population started to enjoy consuming and "non-green consumer behaviour". Simultaneously, many Slovaks (during socialistic regime) had to: reduce consumption, recycle materials, reuse and repair things. We are aware that the causes of such behaviour had not a green but rather economical background, but such habits could persist and later shift buying patterns and behaviour with different than economic motives.

Organisations across all spectrum of sectors (government, NGO's, education infrastructure etc.) should encourage individuals to "re-use" their old habits. Such an effort needs a clear message, proper communication tools, and simulative educational programmes. Simply, a lifestyle of conscious and responsible individual means to be much more citizen then the consumer.

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GREEN SETTLEMENTS – BIO-ECONOMIC PRACTICES IN WASTE MANAGEMENT

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Abstract: Climate change in the future will be the most commonly used words in human life. Climate, this natural element is a concomitant factor for people in their evolutionary development. It still has a direct impact on lifestyle regardless of the individual's adaptability in which climate zone you live in. The large population, its large density per unit area, the differences in infrastructure, social and economic activities between the center and the outskirts, create quite contradictory situations between different social groups. The environmental issue has not yet been resolved despite the various measures, methodologies and applicable systems imposed in urban areas. Large cities, on the one hand, are economic and financial centers that create a huge number of jobs, and on the other hand they are a large consumer society whose needs need to be met. Outdated or exported, the product becomes an unnecessary thing that needs to be thrown out, the huge problem and the global question arises – unnecessary things for what? – The new Green Cities, the future of human civilization, can answer this question. The creation of this type of city is based on philosophy-based factors based on bio-economic development with all of its sub-sectors of the economy centered on these future settlements.
Key words: bio-economy, green settlements and climate.

1. INTRODUCTION

The Paris Climate Conference was signed by 195 states on December 12, 2015, with the agreement coming into force on 4 November 2016. This act is the first global agreement between states for actual measures against the rise in Earth's temperature values. The agreement includes 31 pages with specific quantitative parameters. Which, in turn, needs to strengthen the implementation of the United Nations Framework Convention on Climate Change (UNFCCC) launched at the 1992 Earth Summit in Rio de Janeiro. The Paris Agreement include three major objectives:

1) To limit global warming to less than 2°C by 2050 compared to the pre-industrialization period. The aim is to limit the warming until the end of the 21st century to only 1.5°C;

2) Enhance the ability to adapt to the negative impacts of climate change and promote climate resilience and reduce greenhouse gas emissions in a way that will not hurt food production;

3) Promoting the flow of funds in the field of greenhouse gas emission reductions and the sustainability of climate change;

It is necessary to reduce greenhouse gas emissions and CO2 in the atmosphere from 40 to 70% in order to reduce the temperature rise from anthropogenic activity. In order to keep the Earth's average temperature to 2° C at this stage, further reducing the emissions to 70-90%. The next step is to reach an average temperature for the planet Earth within 1,5 ° C set as a parameter at the Paris Climate Conference in 2015. When signing this agreement, each country must limit emissions into concrete, with every country presenting a plan of implementation every five years. For developing countries, a grant of $ 100 billion has been identified by 2020.

2. MATERIALS AND METHODS

The article applies interdisciplinary approaches related to the sustainable development of settlements, integrating ecology, anthropology of the social. It is attempted by the authors to define a definition of "Green City", applying basic knowledge and methods used in the formation of settlements. In this work, green settlements and bio-economics as a practice used in waste management are considered as a systemic characteristic and micro-level approach consistent with certain principles and factors, as well as the practical approach to collecting and reprocessing waste products from the settlement. The Sustainable Development Assessment System on the four pillars of the Green Cities contains well-formulated and selected principles and factors. The creation of this type of city is based on factors on which the philosophy of the new type of infrastructure development is built in a vertical and horizontal aspect. The Green Settlement Principles must be based on self-managed administrative management, coupled with new technologies that control all levels of functionality, as well as a targeted investment policy and education system.

3. RESULTS AND DISCUSSION

In 1987, the World Commission for Environment and Development adopted a report titled “Our Common Future”, known as the Brundtland report, which became the basis for sustainable development in the next decades of the XX and XXI centuries. The use of the planet's natural resources must be regulated to meet the current needs without harming the next generations, while preserving the social and economic growth of development. In June 1992, the first UN conference on Environment and Development was held in Rio de Janeiro (Brazil), which was adopted “Agenda 21” for 21ST century development. The conference adopted the „Rio Declaration“ on the environment. For the first time raised the issue are the consumption of mankind and the lifestyle. In the "Rio Declaration" in principle 8, the leaders of the countries paid attention to the fact of a profound change in the patterns of consumption, production and consumption of human society. Defining in Agenda 21 is the unification of the pillars for the development of the economic, social and ecological sustainable element. In 1993, the United Nations Conference on Environment and Development, set up a commission for Sustainable Development to monitor the actions adopted under Agenda 21. On 4.02.1991, the Council of the European Community authorised the Commission to participate on behalf of the community in the negotiations on the United Nations Framework Convention on Climate Change, adopted in New York on the 9.05.1992. The Convention was ratified by decision 94/69/EC of the 15.12.1993 and entered into force on the 21.03.1994. The signed Framework Convention (from 122 countries) sets out basic principles in a global context on combating climate change. It defines, in particular, the principle of common but differentiated responsibilities. The Convention does not contain specific, figures-related commitments in terms of reducing greenhouse gas emissions. There is no specifics for any country or region for a particular continent. In order to achieve a greater effect, the leaders of the signatory States Framework Convention decided to gather at a conference in March 1995 in Berlin. The aim is to renegotiate concrete solutions and steps to reduce the emissions of CO2 and greenhouse gases of highly developed industrialised countries for the period after 2000. The long-standing workshops and consultations between the different leaders of the countries and communities of 11.12.1997 in Kyoto was signed so-called. The Kyoto Protocol, which followed the United Nations Framework Convention on Climate Change, is one of the most important international legal documents designed to combat climate change. It contains commitments made by industrial countries to reduce their emissions of certain greenhouse gases that are due to global warming. Total emissions of developed countries should be reduced by at least 5% for the period 2008-2012 to 1990. Council decision 2002/358/EC of 25.04 2002 on the approval, on behalf of the European Community, of the Kyoto Protocol to the United Nations Framework Convention on Climate Change and the joint fulfilment of commitments thereunder.

In Europe there are number of settlements and towns to become an oasis of the new lifestyle. It is likely that the effect of “domino”, near the old town, will emerge to build a new green settlement. The urban ecosystem is a collection of living organisms and individuals of the community living together in a common territory – the urban environment. In the developed material, we offer several sets of factors that are fundamental for the development of the Green Cities, one part applies also to classical cities, of course the discussion about the expansion and acceptance of new ones remains open.

Economic factors present the financial image of the Green City. The development of financial sectors includes: banks, financial and commercial companies, insurance companies, business parks. They are all the economic drivers of the urban environment. On the other hand, they are related to the investment policy aimed at creating a new generation of technologies serving the social and economic sectors of the Green City.

Social factors are the most significant and basic ones on which the philosophy for the development and functioning of the Green City is built as a conceptual doctrine. This type of factor should focus on ecological and social activities serving the city's inhabitants.

Geodemographic factor includes all known and used elements in geodesy – fertility, mortality, natural and mechanical growth, migration mobility. For the Green City an important and necessary element will be the maintenance of an approximately equal number of population. If the population grows, it should be smooth and to some extent regular. Greater impact will be imposed on the mechanical population growth. The measures to be taken in this direction are for the sole purpose of alleviating the city's way of life. The entire system of the city will be based on a certain number of inhabitants, and from here the socio-economic life will be involved with this number as well as all city control and management systems. An important element in the Green City will be the even distribution of the population across the territory, thus avoiding a number of inconveniences in the socio-economic life.

Infrastructure factors are also key to the development and functioning of the Green City. They can be divided into several groups according to the use function: underground and above ground. Regardless of the type, the entire infrastructure must be connected electronically to the central management to have continuous visual and physical control over the processes.

The climatic factor is the subliminal reason for creating this type of city. Climate change as a result of overuse of Earth's natural resource potential has led to the introduction of new paradigms in the socio-economic way of life. Climate change globally has happened many times on the planet, but in the last 30-40 years, there have been very sharp changes and a large number of abnormal climatic phenomena. Building Green Cities and their functioning on a natural-peculiar way of life may delay the apocalyptic paintings of an ecological disaster on the planet.

The environmental factor will be indicative of the Green City, maintaining the ecological environment throughout the urban area at the horizontal and vertical levels will be a major function of the whole system. Recycling of all types of waste products, whether domestic or industrial, will be mandatory based on certain locations. Their processing will be related to new technologies. It is the duty of every resident of the urban area to adhere to certain norms to maintain a clean urban environment. In this sense of reasoning, production capacities and transport in all its forms will meet certain requirements, norms and standards, subject only to the ecological way of life in the Green City.

The philosophy of building a Green City should be based on principles that have to be respected to function this type of city. Of course, as authors of this material, we will offer our vision, and the topic under discussion remains debatable and subject to development.

The green city must be an administrative autonomous unit as a mode of management within the boundaries of the land. The city is separated from the other territorial units of the country (provided that the other settlements do not have such a type of government). If a centralized management is imposed in the country, the Green City should be excluded from such a scheme. Self-management is important in making decisions about the city. The mode of management will be quite different from the rest of the settlement systems known to date. As a management model, peripheral center can be applied, the connection is bi-directional, the flow of information from all spheres or spheres through the basic software base. Thus, the link between the central and peripheral parts (movement of people, commodities, capital, traffic, etc.) will be constant and, in the event of an imbalance, optimal solutions can be made on the specific issues. The population will be optimally located between the center and the periphery, and there will be no differences in service and service.

Administered city management must be electronic. In this way both information and communication technologies will be used in managing and disseminating information to citizens as well as their services. In this case, all administrative services will be linked in a common system that provides information and at the same time benefits civil society. Management will be committed to promoting work efficiency and improving the quality of the services provided by the executive.

The application of new technologies and technological solutions must be tailored to the environmental lifestyle of people. They have to solve the problems of citizens related to their way of life. Their application should be in the fields of transport, recycling of any type of waste product and, last but not least, in industrial activities.

Full control at all levels. It should include the entire computer system to which all systems and subsystems are connected. The human factor in the form of administrative management must have access to all databases in the socio-economic life. The proper and accurate functioning of the urban area at all levels is a vital process affecting all residents.

All subsystems (administrative and social) are linked in one base system, so controlling and managing the urban area will be easier. Uninterrupted information about ongoing events and processes. This will facilitate the service and information of the citizens. When a problem arises in social or economic activity, it can be easily localized and eliminated.

Investments in Green Cities should focus on the creation of new technologies mainly related to the processing and recovery of waste products in industrial sectors and households. The investment should also affect urban transport by its varieties, depending on the type or species to be used. This will largely apply to personal and service cars. Buying new technologically advanced vehicles will be vital to the functioning of Green City.

The education system should be aimed at forming a new type of thinking and consciousness. The new knowledge must give answers and ask questions aimed at rediscovering the Planet as a living system and symbiosis between man and nature. Education is a priority sphere targeted at all age groups.

Giving a precise definition of a Green City at this stage is rather difficult and likely to be inaccurate due to the practical reason that nowhere in the world there is no such settlement that fully satisfies its needs and needs through alternative energy or processes over 95% of household waste products, industrial activity, transport or others. activities.

The authors present their definition of Green City, based on the above-presented factors and principles: “Urbanized synergy, fully bound to a unified technological system, subject only to the environmentally-friendly lifestyle of the socio-economic sphere of the people.“

The principles and factors are identical and accompanying Greenland settlements, they are linked in the system of sustainable waste management "acquired" in the urban environment by households and economic activities. The authors of the scientific paper offer their concept in waste management bio-economy, based on three main practices:

1) Separate collection of waste products;

2) Composting;

3) Combustion of biomass. This is a new look at the emerging issues in the settlements of the planet;

Separate collection of waste products can be done by households and by all types of business. The process involves the separate collection of different types of non-food waste and its disposal to the relevant recycling bins. The separate collection of waste and its subsequent processing results in the formation of gross added value and re-pollution of the urban environment. The economic scheme can be considered as a three-stage process: Waste collection; Technology for their processing; Offering products from their processing.

Composting is a process that includes aerobic and anaerobic digestion of waste products derived from households, agriculture and food processing. In order to obtain good compost, it is necessary to provide conditions for the activation of microbiological processes with a view to decomposition of the starting products. The resulting substance is an organic fertilizer derived from biochemical processes in a favorable environment, in the mixing of waste products. To conduct the composting process it is necessary to have the factor on which to base the chemical process – providing the possibility of warming in the initial process of composting; Good air permeability of the material; Respect the correlation between carbon and nitrogen, as well as maintaining optimal humidity. The entire technological process is applicable in an urbanized environment.

Biomass combustion can be used for energy production at different scales-energy for industrial needs, small thermal heating projects for domestic and business needs. Biomass is a byproduct of household products and includes by-products of the agro-food industry. Biomass sources range from grains to stems of cereal crops, from soy and radish oils to animal fats. Biomass equals 1.5% of total electricity delivered and the total share of electricity from wind and sun is 0.1%. According to the International Energy Agency, approximately 11% of the world's energy is produced from biomass.

4. CONCLUSIONS

The functioning of the green city should be based on the synergy between the different principles built on the basis of the factorial development. Any system or subsystem must evolve and operate solely in the direction of an environmentally sound lifestyle. A symbiosis between the socium and the natural environment can function in an urban environment, provided the person does not destroy the habitat. The urban ecosystem can be destroyed as a result of economic activities, but its recovery is essential for the inhabitants of the area. The ecosystem can be disrupted/destroyed as a result of climate change, which in turn will change the entire microclimate. The importance of the urban ecosystem is to provide a healthy environment for living organisms, as well as for the socium as a whole. Technology and technological activities must be fully focused on natural resources. The closed cycle in the reprocessing of waste products (in all varieties) should cover the entire territory of the city.

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SUSTAINABLE CUT OF OAK COPPICES IN BULGARIA

Ivailo Markoff, Erik Findeisen

Abstract: By 2015, Bulgaria had 1 350 000 ha of conversion forests, i.e. coppices being in a process of conversion into high forest, with an important growing stock of 158 000 000 m³. These forests are dominated by oaks (1 020 000 ha) followed by beech and hornbeam (250 000 ha) and occupy 35% of the forest area. Nevertheless, the maximum sustainable harvest of these forests is unknown. Officially prescribed methods to determine the sustainable harvest consider high forests only, i.e. the forests, issued by seed. The known public figures of yearly harvest in the conversion forests (2 020 000 m³) are planned "according to the single stand condition", i.e. rather on intuitive base. In the present work, an internationally recognized method is applied to calculate the sustainable harvest for Bulgarian oak conversion coppices based on public forest-inventory data. Related topics such as appropriate growth and yield models, dieback symptoms and climate change are discussed.
Keywords: allowable cut, conversion coppice, oak

1. INTRODUCTION

Most of the coppices in Bulgaria (74%) are in process of conversion into high forest by aging, incl. all oak and beech coppices. Exception is made only for black locust plantations and Oriental hornbeam shrubs. As a direct consequence of the policy of conversion, conversion coppices are indeed aging. Their average age is 55 years. Most of them (80%) have reached their official rotation age and are considered mature. Moreover, during periods of drought they give signs of dieback (Popov et al, 2018; Hinkov et al. 2005).

In Bulgaria, the conversion began fairly late – the main efforts started in the early 60s – and has not yet finished. This policy aimed to improve both productivity and quality of forests. Nowadays, rising prices of energy wood give cause to reconsider this policy. Firewood prices rise in Bulgaria, too (Glushkov, 2007). However, because of the aging, simply resuming the coppicing in Bulgaria is hardly possible. Recently, private forest owners were permitted to clear-cut small forests relying on a regeneration with shoots, and they often do so, but the aged coppices re-sprout as poorly as foresters expected. It can be said that the conversion process has come to a point where there is no going back. In conclusion, the idea to resume coppicing is promising but the first thing to do is to finalize the conversion.

There is no dispute among the Bulgarian foresters that the conversion of coppices into high forests should be carried out (Kostov, 2018; Popov et al, 2018). Other arguments for the same are the climatic changes and the condition of the root system of the Turkey oak (*Quercus cerris* L.).

Turkey oak dominates the plains and the hills of the NE and the Central North. Nevertheless, it forms secondary forests that have displaced the pedunculate oak (*Quercus robur* L.) long ago and later on also the Hungarian oak (*Q. conferta* Kit.) as a consequence of negative human intervention. Unlike other oaks, Turkey oak is less durable and is quite prone to decay. Recent studies in the Central North have revealed that the Turkey oak stands have lost their tap roots (Popov et al, 2018). The result is instable shallow-rooted forests. The sustained management of such forests requires making use of their abundant fructification to renew the root system.

The cerris problem is aggravated by progressing climate warming, which, perhaps to a lesser extent, is also a threat to other oaks. Climatic change is perceived in Bulgaria as increasingly frequent snowless winters and summer droughts. An indirect evidence give the expansion of Mediterranean insects (Mirchev et al, 2017). Unfortunately, the oak coppices are located in the belt of plains and hills –

their altitude is rarely above 1000 m – which coincides with the vulnerability zone of climate warming (Raev et al, 2011).

The usual way of planning the harvest in coppice forests, including oak coppices, was in line with the national decision to postpone final cut for about 60 years until they lose their re-sprouting ability. The expiration of this period requires a serious criterion for planning their use.

2. MATERIALS AND METHODS

2.1. Data

Based on the electronic models of the state forest offices (Forstämter) published on the web-site of the Executive Forest Agency (http://www.iag.bg/), a database of single-stand level inventory data was compiled and used for analyses. All forest stands have been included, i.e. there was no sampling. Because the study is based on comprehensive data, only descriptive statistics have been applied.

2.2. Method

As it is known, if the same quantity of wood is harvested every year in a forest, over time it will be either depleted or normalized, i.e. either disapear or become a normal forest (Clutter et al, 1995). A quantity that does not lead to the depletion of the forest is sustainable use. Sustainable use can be varied within a wide range – in every case, there is one such quantity (the maximum sustainable harvest), which can not be exceeded without forest depletion. All values lower than this are sustainable. However, the choice of the level of use has a significant impact on forestry and forestry.

In the present work, we determine sustained harvest by computer simulation. To that purpose, the oak coppice forests were subdivided into 5 strata according to site class (Ertragsklasse). For each stratum, using the database, the distribution of the area and the volume by age was determined

$$\begin{array}{lllll} a_0, & a_1, & a_2, & ...., & a_M \\ 0, & v_1, & v_2, & ...., & v_M \end{array} \quad (1)$$

v_j – growing stock aged j years.

a_j – area associated with the stock v_j

a_0 – area of the clearings emerging during the year.

M – maximum age of a stand = 204 years.

Classical simulation (Fortschreiben) by growth and yield tables was used to model the results of growth and harvesting. It assumes that the oldest stands are the first to be cut and that all clearings are immediately afforested or regenerated in another way.

The method can easily be adapted to conversion forests or to another type of succession. For each step of the succession a separate data set like (1) is used, e.g. for the natural oak stand that should replace the conversion coppice. The conversion is modeled by feeding the regeneration area of the natural oak a_0 with the cut off area of the conversion coppice forest $a_n + ... + a_M$.

2.3. Models

For the simulation, the growth model used in forest planning since the 1990s was applied, except that we used the known local site index curves of Nedialkoff instead of the officially recommended ones (after the German author Wimmenauer for oak high forests and after the Russian author Shustov for coppice oak). Bulgarian foresters have been long aware that Wimmenauer and Shustov exaggerate oak growth in Bulgaria. This was considered tolerable for short-term predictions but is intolerable for long-term predictions like the present one. It is interesting to note that this mismatch is probably due to the difference between the growth of oaks in Central Europe and the Balkans.

In order to select an adequate model, the known curves (Krastanov et Raikov, 2004) were compared with the actual distribution of forst stands by age and height (Figure 1). The curve fan in Figure 1 represents the site index curves of high forest oak after Nedialkoff. dark diamonds mark the combinations of age and height, which are represented in at least 10 forest stands and can be considered reliable. Hollow diamonds and dots mark rare or single cases, which are likely to be data errors and are better ignored.

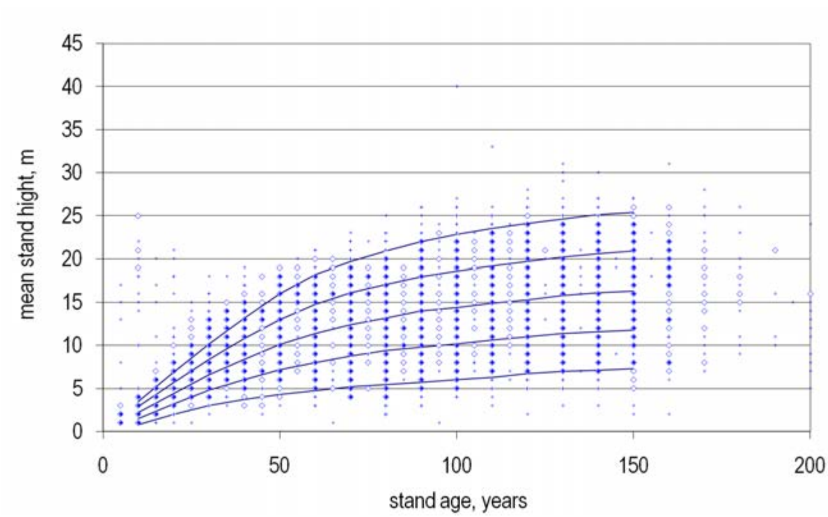

Figure 1. Site index curves for oak high forests compared to inventory data

3. RESULTS

Two variants of oak forest management have been investigated. Both variants assume the regeneration of the existing conversion coppice by seed, so the second generation is always a high forest. Under the first variant, which is the main one, all subsequent generations are also high forests issued from seed. This variant (the variant “high forest”) responds to the traditional system of values and the ecological preferences to a forestry, possibly closer to nature. Under the second variant (the variant “low forest”), the third and all subsequent generations are again coppices. This variant may make sense if the technology of the future changes the value system, for example by making biomass production a priority.

Figure 2 shows the development of oak forests of the 1st site class (*Ertragsklasse I*) over a 500-year period. The length of the period is selected long enough to cover at least 3 rotations. In the case of the "high forest" variant, the value of 200 000 cubic meters was chosen for the annual harest. This value is selected so that, in the final state of the simulation, the age of the oldest forest stands is close to 140 years. With this sufficiently long horizon of the simulation, this final state is a normal forest with a rotation of 140 years. The latter figure is the rotation of oak stands of the 1st site class adopted today, which is considered to be optimal, at least in today's system of values. Under the low forest variant, the value of 420,000 cubic meters was selected for annual harvest. Similarly to the first variant, such annual harvest corresponds to the rotation age (40 years), which is accepted in Bulgaria for low forests of the 1st site class.

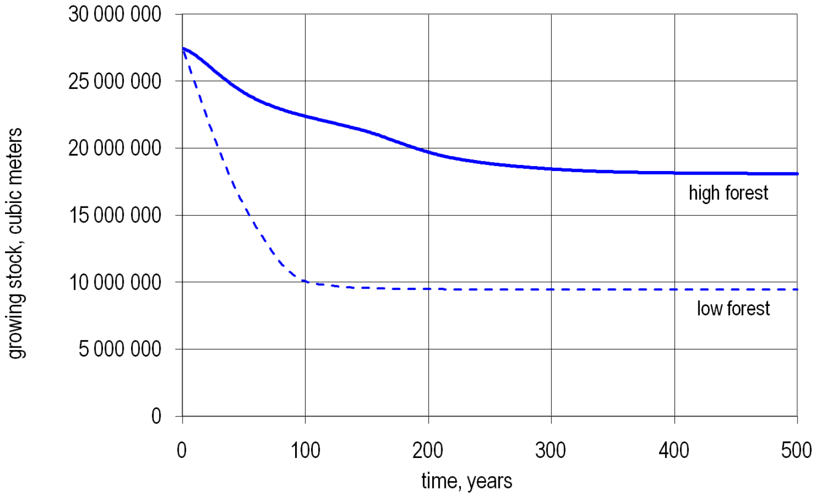

Figure 2. Evolution of growing stock

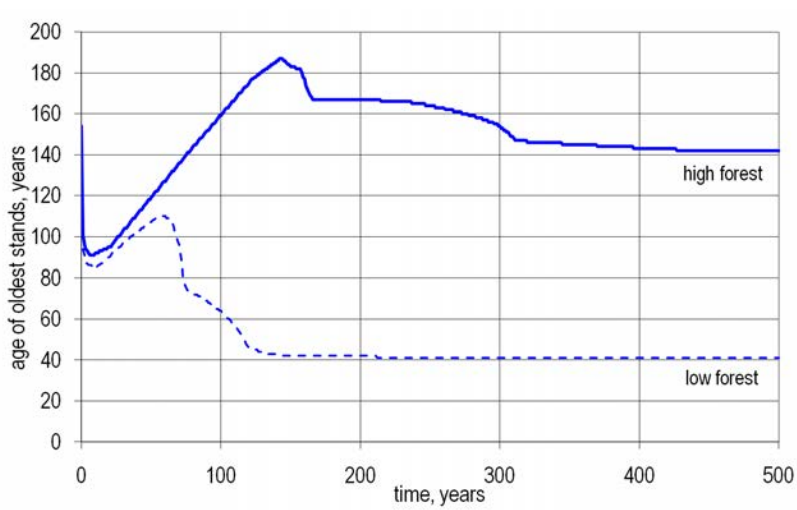

Figure 3. Възраст на най-старите насаждения

Under the first variant, the growing stock is stabilized in about 300 years at 18 million cubic meters, which is much less than the current 27 millions. This is expected because a normal forest can hardly have the growing stock of an old one. Under the second variant, the growing stock is stabilized in about 120 years at nearly 10 million cubic meters. This variant is characterized by a double annual harvest but the second variant keeps twice as much of a growing stock. Under both scenarios, growing stock stabilizes at some positive level, so both can be considered sustainable.

Figure 3 shows the age of the oldest forest stands and its change over time. In the first option, this age at any time remains over 60 years, which is beneficial to natural regeneration by seed. Under the second variant, the age of mature forests remains high only while the conversion of existing coppices lasts. Then it quickly falls below 60 years, which is a condition for regeneration by shoots.

Table 1 gives an estimate of the annual harvest for all copiices under consideration. For each site class, the annual harvest is determined so that the rotation of the resulting normal forest is equal to the rotation accepted for Bulgaria for this site class.

Table 1. Overview of results

variant	1, "high forest"			2, "low forest"		
conversion	coppice to high forest			copp. to high forest and again to coppice		
site quality	annual sustained use	final growing stock	resulting rotation time	annual sustained use	final growing stock	resulting rotation time
	m³	m³	years	m³	m³	years
I	200 000	18 100 000	142	420 000	9 500 000	41
II	370 000	32 800 000	138	770 000	17 400 000	41
III	360 000	26 400 000	118	770 000	9 200 000	22
IV	155 000	11 600 000	121	350 000	4 000 000	22
V	90 000	6 900 000	121	200 000	2 400 000	22
total	1 175 000	95 800 000		2 510 000	42 500 000	

Under the first variant, an annual harvest of 1 200 000 m³ / year is obtained, which is almost the same as the actual harvest in these forests at present. Under the second variant, however, twice as much biomass is harvested yearly. Both variants predict a significant reduction in the growing stock as a result of normalization of the age structure. This relationship is natural and can be expected with any other reasonable choice of sustainable use.

The maximum sustainable harvest was calculated as 2 100 000 m³ / year under the first variant and 3 400 000 m³ / year under the second. In both cases, a very low rotation of the resulting normal forest is obtained – less than 10 years. Unfortunately, these are not reliable figures because the available growth and yield tables are hardly valid at such a low age.

4. DISCUSSION

The method applied assumes that the oldest stands are harvested. In practice, there are numerous deviations from this assumption for the various well-known reasons. Because old stands have almost no increment, felling one stand instead of another has minimal impact on the development and storing of the forest biomass.

In all calculations made here, the stocking rate of all regenerated clearings is assumed to be 70%. In the course of the simulation, this stocking rate is transferred to mature ages. This is quite plausible for Bulgaria because, according to the available data, all conversion coppices in Bulgaria are characterized by an average stocking of 70%, regardless of their age.

Bulgarian oak coppices are dominated by two oak species – the Turkey oak (the east and the central north) and the Hungarian oak (the west). In the calculations here, we do not differentiate between them, because in Bulgaria it is accepted to model them with the same growth and yield table.

5. CONCLUSIONS

The method considered here can be easily adapted to conversion coppices or to other cases of conversion and natural succession of species. There are other such methods and indicators, e.g. such as HDZ or Haubarkeits-Durchschnittszuwachs, (Speidel, 1972). Their relative perspectives and merits are difficult to judge, but the need to have such methods is obious.

Although not based on a strict numerical criterion, the actual actual use of Bulgarian oak coppices did not prove to be exhausting. However, this does not mean that it is optimal.

Upon completion of the conversion of extant Bulgarian oak coppices into high forests, future generations may have reason to reintroduce low forests to appropriate sites in order to increase the harvest of biomass.

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INNOVATIVE DESIGN OF THE LOW-COST STRUCTURAL SYSTEM FOR WOOD-BASED HOUSES

Pavol Sedlák, Dominika Búryová, Jozef Štefko

Abstract: There are number of structural systems for timberframe houses, which differ in materials used in an external wall assembly and, in some cases more importantly, in level of pre-fabrication. Traditional systems would mainly consider light-frame (two-by-four) or heavy-frame (post and beam) structures built on site, or the same systems with minor alterations, but pre-fabricated into wall panels. The on-site systems require excessive manual labour and skills, while pre-fabricated panels put high demand on heavy machinery on site and are therefore limited to inaccessible places.
The paper describes development of innovative wood based external envelope which should satisfy all aspects of requirements (strength, insulation, cost, safety). The system uses short-sized timber, usually considered as waste cut-off's, and is created by small 3D modules easily handled by workers. Thus innovative approach is significantly saving material and labour costs, and is effective for structures with difficult transport accessibility.
The results describe the development of the low-cost system, together with the prototype, laboratory, in-situ testing and computer simulation in order to satisfy required procedures and standards.
Keywords: timberframe house, low cost, innovative, structural system, modular design, passive house standard, computer simulation

1. THE REQUIREMENTS

At the very beginning, there were goals to achieve for the structural system:

- high standard of insulation, in order to use this system for low energy and passive house standard buildings
- simple assembly on site, without use of heavy lifting machinery
- recycling – possibility of simple dismantling and reusing [7]
- minimal impact to the environment
- low energy demand during production
- lower than, or at least similar final price as other comparable structural systems
- possible use of a short-size timber

2. DESCRIPTION OF THE SYSTEM

The system consists of 3D modules made of OSB and short wooden battens, filled with insulation. The dimensions are 1200x410x300mm (module for the partition walls is half thick) and weight is 25kg including the insulation.

The parts are assembled together as a brick wall, and are stabilized by the groove-and-tongue joint and by additional nailed vertical battens. The walls are than sided with optional additional insulation. The system allows using conventional floor, ceiling and roof structures.

The system was later patented and is used under „ f-ha“ brand now.

The main advantages are quick assembly time on site, no need for cranes and therefore suitable for self-assembling and social housing, use of cheap short-sized timber and cut-off's.

Figure 1. Base and supplementary modules (shown without insulation), very first prototype pieces built by author

Figure 2. The modules assembly on site

3. INSULATION PROPERTIES

Insulation thickness was designed in order that the modules itself (without siding) achieve high thermal resistance. Based on 3D calculations and simulations, confirmed by laboratory testing in protected thermal chamber, it showed value of 6,55 m^2KW^{-1}, and therefore satisfied passive house standard (U value of 0,15 W $m^{-2}K^{-1}$). In real situation (see below), this value is enhanced by siding with additional insulation [1]. Such a wall shows R=7,69 m^2KW^{-1} (U=0,13 W $m^{-2}K^{-1}$), according to Slovak standard STN 73 0540, and achieves future standard from 2021 [6] .

4. DEVELOPMENT OF THE DESIGN

Insulation properties were tested in the protected thermal chamber, at steady state. Apart from U-values, there were also surface temperatures and heat flows evaluated, through the insulation and thermal bridges. To do this, previous extensive analysis by 2D and 3D computer modeling needed to be performed, also taking water vapor transition into account by 2D simulation techniques.

There was special attention paid to analysis of characteristic details with thermal bridges, with following optimalisation and alternation of the details.

The example is shown, for foundation detail:

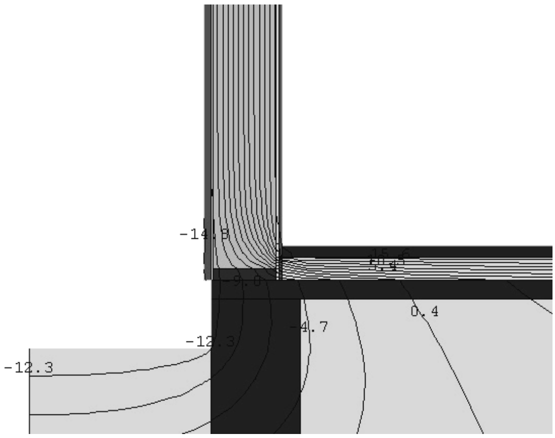

Figure 3. The temperature distribution in the foundation detail (one of the detail's multiple options)

There was also infrared analysis performed on an object (see below) built of this system by ThermaCAM E4 apparatus. It confirmed the problematic places on the structure. The wall itself is compact enough, with minute random thermal bridges. The foundation detail was reported as the weakest, due to thermal field deformation, enlarged by warm air leakage from the interior at this place. Similar situation occurred at the window jamb, as there were not used window frames to satisfy passive house standard.

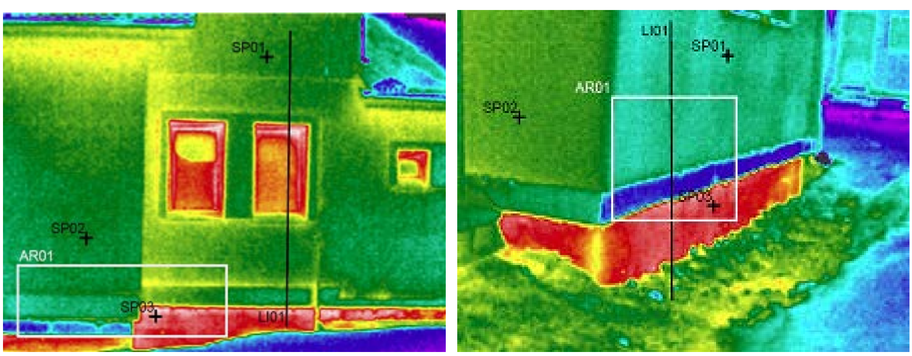

Figure 4. Infrared pictures of the house

The wall structure was tested for strength, as per STN 73 2030, considering compression, combined compression and bend, and shear load bearing capacity. The tests were performed in accredited laboratory "Lignotesting" in Bratislava, Slovakia. The results are: partial safety factor y_{exp} = 3,0 for ULS (Ultimate Limit State) and factor μ = 0,156 for SLS (Serviceability Limit State).

Figure 5. Strength tests in the laboratory

5. ENERGY CONSUMPTION FOR REFERENCE OBJECT

There was a reference house monitored, to verify the thermal insulation of the system, energy consumption and properties of the wall.

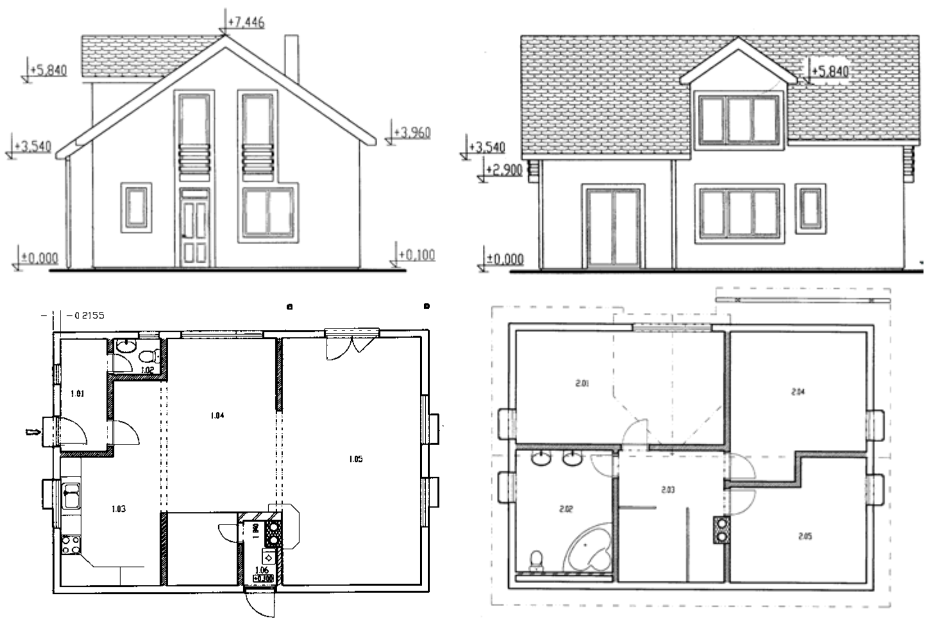

Figure x. Elevations and layouts of the built reference object

There were parameters of indoor and outdoor environment recorded (ambient and surface temperatures), together with energy consumption. The temperature sensors were installed in living areas in the interior, and on shaded external surfaces.

In order to effectively use and analyze data, we created detailed model in ESP-r application, to simulate conditions during the monitored period. The model was defined by geometry, shading, thermal properties of all structures, ventilation, heating, occupation, etc.

The simulation results allowed changing the design prior the building process, in order to maximize energy and cost effectiveness. As an example, there was analysis of heating systems performed (for floor, wall, conventional and air heating), assessment of additional external envelope insulation, and analysis of using different windows to be installed.

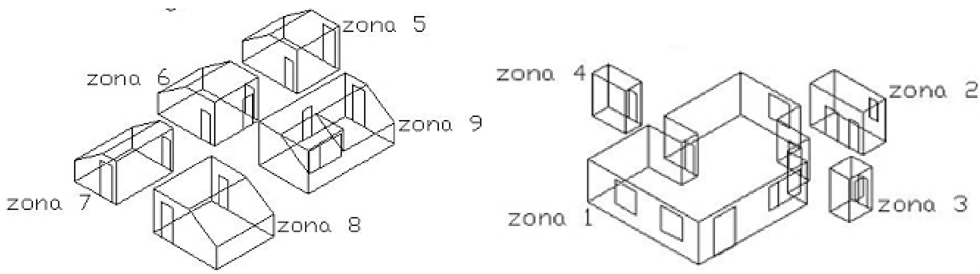

Figure x. Zones of the model, ESP-r application

Computer modeling enabled complex analysis of thermal comfort, as well as recommended design changes. The thermal comfort is usually described by resultant interior temperature, which combines air temperature and surface temperature of walls. An air change rates were modeled with relevant time profiles rather than with openable windows, to avoid possible instability during simulation period [5] .

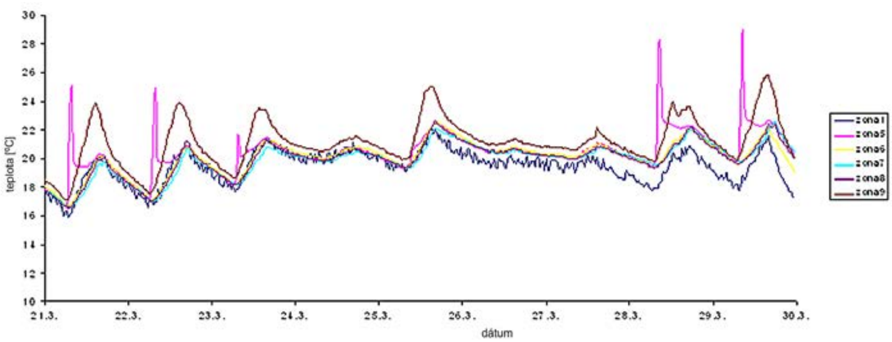

Figure x. The output – interior temperatures, ESP-r application

Based on calculations and simulations, the house should have achieved higher energy consumption. But according to measurements and after calibrating the model, it achieved 43,5 kWh/(year.m^2) – a better value than Low Energy House Standard. It must be noted there was no mechanical ventilation with heat recovery installed, which is considered crucial for further heating energy reduction.

6. CONCLUSION

After later analysis by means of computer simulation on real house, for such a house with mechanical ventilation using heat recovery it should not be difficult to achieve Passive House Standard, as the ventilation heat loss proved to be the highest and relatively easily reduced. All other components –

installed windows [3] and external door, heat exchangers, ventilation units need to meet the Passive House Standard as well.

As there are also requirements to airtightness level of an external envelope, this structural system is expected to perform little worse than panel systems due to small module's dimensions. We therefore plan to focus on airtightness analysis by means of Blower Door apparatus on selected houses, and locate and later eliminate possible air leakages, as these usually decrease ventilation heat recovery efficiency significantly.

The conclusions presented at this paper have a great potential to influence the competitiveness of the wooden building sector on the Slovak market, though other factors must be taken into account at the same time and could have higher importance, as presented in various other studies [4] .

Successful companies realize that the benchmark for success is to meet or exceed customer requirements [2]. The problem is that quality of a house does not depend only on structural system used, but also on complex other variables. It is therefore necessary not only use appropriate systems and materials, but also to communicate with the client to ensure his original requirements.

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COMPUTATIONAL LIGHTWEIGHT CONSTRUCTIONS – HIGH-TECH ARCHITECTURE

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Martina Zbašnik-Senegačnik[2], Tomaž Kušar[3], Manja Kitek Kuzman[3]

Abstract: The use of different light weight materials, such as engineered wood products (EWPs) and glass, makes it possible to implement nature-inspired and bio-based solutions in the building sector. An adaptive robotic fabrication process makes possible the necessary scaling-up and handling of the complex interrelations between the patterning shapes and the material behaviour. In contrast to repetitive manufacturing processes, where automation relies on the execution of predetermined and fully defined steps, sensing technology is employed to enable a workflow that synthesizes material computation and robotic fabrication in real time. In this process, the shape of the tailored work piece is repetitively scanned. The segments contain previously made connections in the form of markers that are tracked live to generate the robotic movement. A custom digital modelling design tool is used to derive a porous, undulating, triple-layered system that coherently integrates material properties, fabrication constraints and assembly sequences. The transfer of light-weight principles such as a high degree of differentiation of material and structure, in combination with the development of computational design, simulation, and fabrication methods, enables novel constructional typologies in architecture. Some contemporary case studies will be presented.
Keywords: architecture, timber construction, digital design, wood processing, glass

1. ORGANIC DESIGN

Organic architecture is a philosophy that promotes the harmony between human habitation and the natural world through design approaches that are sympathetic and well integrated into the site, such that buildings, furnishings, and surroundings become part of a unified, interrelated composition. Let the design be inspired by nature and be sustainable, healthy, conserving, and diverse, unfold, like an organism, from the seed within. It should exist in the "continuous present" and "begin again and again", as well as following the flows and be flexible and adaptable. It needs to satisfy social, physical, and spiritual needs. It must grow out of the site and be unique. Celebrate the spirit of youth, play and surprise. Express the rhythm of music and the power of dance [5]. In other words, nature and modernity in perfect harmony [7].

With the inspiration coming from the wood itself, the aim is to offer a wide selection of live edge wood furniture boasting organic shapes and natural flaws that add to the innate beauty and the sensory experience. The easy machinability of wood makes it an ideal material for digitally controlled processing portals. For this reason, the timber industry is well equipped with such machinery, and timber is taking on the status of a high-tech material [3, 8], Figure 1.

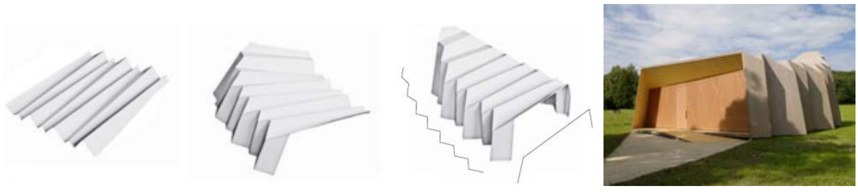

Figure 1. The tectonics of timber architecture in the digital age (folding, bending, weaving) (left), Temporary chapel for the Deaconesses of St-Loup, Hôpital de St-Loup, Switzerland, 2008 (right)

1.1. The tectonics of digitally designed timber furniture: the organic forms in wood

It is possible to show how parametric design tools can be created that are specifically tailored to timber and its material properties. Tectonics – the interplay of architectural expression, efficiency and the construction of support structures. New wood-based materials (liquefied wood, modified wood, densified wood, wood-plastic compostes…) and processing technologies, along with the new possibilities for depicting and calculating the support structures, play an important role here. The aim is an efficient interlinking of the design and construction that integrates the architectural, support-structure-related and production requirements, leading to sustainable and high-quality solutions [4]. The digital architecture is a new representation of visual information design and interactive environment which is leading furniture design towards a new approach with interactive 3D, Figure 2.

Figure 2. Organic shape furniture (left) and a parametric armchair made of playwood Bounce 3D model (right)

2. DIGITAL DESIGN AND ADVANCED PROCESSING AS FUTURE TRENDS

Digital design and production using CAE (computer-aided engineering), CAD (computer-aided design) and CAM (computer-aided manufacturing) have allowed timber construction to forge ahead into new dimensions of design. Innovative connections, modern wood-based materials and cutting-edge CNC milling offer entirely new possibilities and shape wood into almost any conceivable form. The producers already offer all the stages of the construction process: from technical development to construction, service and maintenanc, Figure 3.

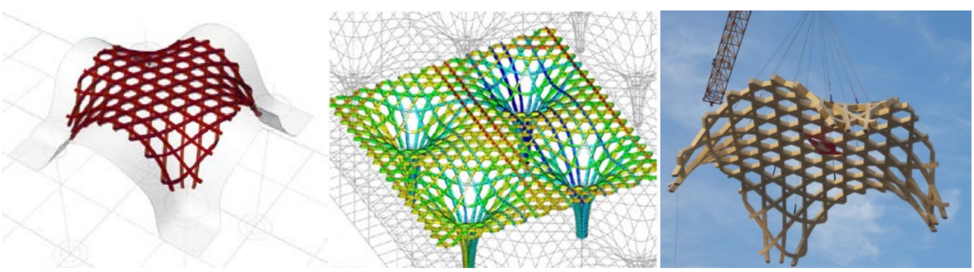

Figure 3. Digital simulation of the construction and a part of the The Yeoju golf clubhouse roof in Korea during assembly

The coordination of the various steps, such as architectural design based on geometric structures, structural engineering, production, logistics, site facilities, installation and follow-up work, is a core element of contemporary project management. In the new planning process, the production companies are becoming IT specialists, providing services and solving interfaces, while carpenters coordinate the building processes. There are intelligent machines: software components, machine technology, knowledge, production space, logistics concepts and available engineered raw material. The digital planning process (CAD-interface CAE and CAM) still needs a lot of detailed planning, Figure 4.

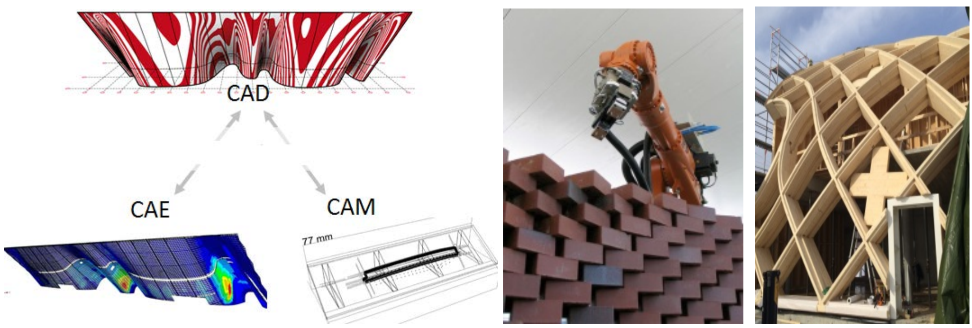

Figure 4. Digital planning process CAD-CAE-CAM interfaces: New dimensions in complexity in timber construction (www.blumer-lehmann)

Complex timber constructions can compete with traditional constructions but this requires a new modern production philosophy where components are planned and produced quickly, flexibly and precisely with digital processes in the factory: complete 3D modeling, static evaluation of complex building design, solving complexity within the factory, and pre-assembly of parts of the whole structure close to production. This will result in the rapid erection of the building on the building site with a low degree of complementary work.

In contemporary timber structural architecture, the structure remains visible. The structure is the dominant factor of the architectural expression, and is often based on the principles of nature. It shows a perfect match for timber and its variety of advanced possibilities.

Creating exceptional free-form structures requires an intensive and close cooperation between specialists. Developing the geometry, designing the supporting framework and generating production data are all decentralized, yet interconnected, processes. An integrated exchange of data with clearly defined interfaces makes seamless project management possible.

2.1. New modern production philosophy – production with minimum tolerances and maximum flexibility – free-form structures

The framework for producing components is full of mathematically exact, parameterized models of the structure and its components, which ensure that tolerances are kept to a minimum in the construction, processing and installation phases. 3D modeling, high-quality code and error-free information for CNC machines are also critical for prototyping parts and in the management of 3D printing. These models are part of the entire process from project development, feasibility studies and design, over the CAD/CAM processes, to the construction in service life.

Depending on the type and complexity of the structure, specialists on CAD and CAM software are needed to convert graphical data into machine codes, in general for steering of 5-axis CNC joinery machines. Programming expertise and skill in handling this equipment are needed to ensure the flexible and precise production of double-curvature timber structures.

Modern design and production methods open up many possibilities where complex structures and buildings become real. Free-form structures are distinguished by their cellular supporting structures and the unique nature of each component. They are exceptional – from the initial idea through to the design, production and installation with the required quality, in the specified time frame and on cost-effectiveness from the perspective of the investor and builders.

3. CASE STUDIES

University of Stuttgart engineers have harnessed the natural shrinking process of wood as it loses moisture to create this world-first self-twisted tower in Germany, Figure 5. The structure is made using a new, non-energy-intensive process that involves predicting how wood will shrink as it dries out. Based on this technique, the flat timber panels are designed to warp into the desired shape. The 14-metre-high Urbach Tower marks the first time that this process has been used in the construction of a building.

The ICD and ITKE describe the method as a way of "programming" wood to take on a specific shape, and say that the timber is in effect "self-shaping". "While making this work is relatively simple, predicting the outcome is the real challenge," said ICD head Achim Menges. "Being able to do so opens up many new architectural possibilities."

A key advantage of self-shaping is that it requires little energy, avoiding the need for the kind of heavy machinery that would usually form these kinds of timber components. The process starts with 5-by-1.2-metre panels of cross-laminated timber (CLT) made of bilayered spruce wood sourced from Switzerland. The panels were manufactured flat and with a high wood-moisture content of 22 per cent. Engineers control the shape the timber will take when it dries by altering the panels' specific layup.

Figure 5. The university's Institute for Computational Design and Construction (ICD) and Institute for Building Structures and Structural Design (ITKE) built the Urbach Tower in the Rems Valley for the Remstal Garden Show.

The Bowooss Bionic Inspired Research Pavilion is a collaborative research project into bionic inspired wooden shell structures, Figure 6. The product was a temporary pavilion, inspired by the material-efficient construction methods found in nature. Free-form design improve classic, closed mathematically recordable form. Nature has developed solutions for itself over time through complex networks. This strategy can be confirmed as being successful in comparison with more technical, “linear” optimizations. In contrast, natural optimization succeeds through reproduction, mutation, recombination, and selection, as well as the use of failure as a means of improvement [6].

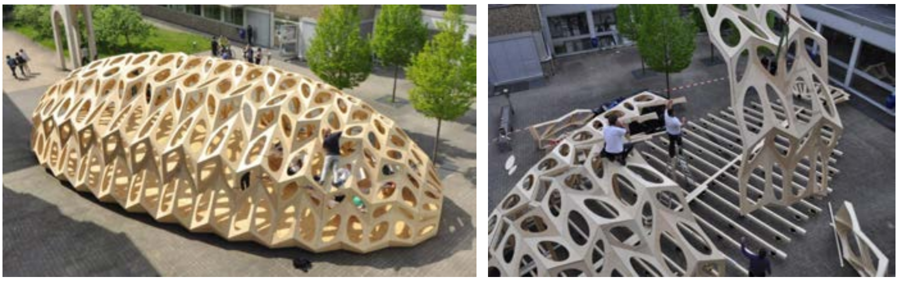

Figure 6. The Bowooss Bionic Inspired Research Pavilion at the School of Architecture at Saarland University, Germany

BUGA Fibre Pavilion is a structure that offers impressive architectural experience and it is a result of many years of biomimetic research in architecture at the Institute for Computational Design and Construction (ICD) and the Institute for Building Structures and Structural Design (ITKE) at the University of Stuttgart, Figure 7.

Combining cutting-edge computational technologies with nature principles, the Pavillion enables the progress of authentically digital building systems. The pavilion's load-bearing structure is robotically produced from advanced fibre composites only, which is not only highly effective and exceptionally lightweight, but it also provides a characteristic yet authentic architectural expression and an ramarkable spatial experience. The most load-bearing structures in nature are fibre composites, as for example cellulose, chitin or collagen, and a matrix material that supports them and maintains their position. This biological structures have amazing performance and unrivalled resource efficiency. This biological principle of load-adapted and thereby highly distinguish fibre composite systems is transferred into the architecture through BUGA Fibre Pavilion. Composites, such as the glass or carbon-fibre-reinforced plastics were used for this building and they are ideally convenient since they have same fundamental characteristics as natural composites. [2].

Figure 7. BUGA Fibre Pavilion, University of Stuttgart

4. CONCLUSION

A major obstacle for next generation innovation in architecture and the building sector is the compartementalised nature of research on digital technologies. They separately addresses either the area of design and engineering methods, fabrication and construction processes, or material and building systems.

In order to explore the full potential of computation for ground-breaking advancement, it is vital to adopt an integrative research approach that innovates across all these areas simultaneously. Trends in the future are looking into developing an overarching methodology of “co-design” of methods, processes and systems, cross-sectoral socio-cultural studies and building demonstrators. Presented case studies show how computational design and simulation enables us to work with the material and to unfold specific form from it, rather than forcing it into shape. The transfer of light-weight principles in combination with the development of computational design, simulation, and fabrication methods, enables innovative constructional typologies in architecture.

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IMPACT OF THE CIRCULAR ECONOMY ON THE USE OF WOOD IN MODERN SLOVENIAN SACRAL ARCHITECTURE

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Abstract: The circular economy has become a major global trend that cannot be stopped. The influence of the transition to a circular economy is reflected in various fields, including the use of wood in modern Slovenian sacral architecture. In the article, we present the influence of this trend on modern wooden sacral architecture as a modern art, which derives from the traditionally religious environment. Wood is recognized as technologically perfect material through the coordinate of time in various articulations, and the coordinate of space in the architectural diversity of the liturgical complexes with a symbolic connotation that touches the universal spiritual history of mankind. The research aims to enhance the use of wood, which is considered as a part of contemporary architectural creation through the liturgy.
Keywords: circular economy, wood, modern sacral architecture, Slovenia

1. INTRODUCTION

In 2015, the European Commission adopted the Circular Economy Action Plan, which includes measures that will stimulate Europe's transition towards a circular economy (EC, 2019). The actions planned should contribute to strengthening Europe's global competitiveness, modernizing its economy and industry in order to generate new jobs, protect the environment and foster sustainable economic growth. Europe has enormous potential for sustainable growth, and the development of environmentally friendly industries. Many of the measures in the plan have been or are being implemented, and some results are already here. In 2016, more than four million workers were employed in sectors relevant to the circular economy, which is 6% more than in 2012. The strategy also opens up new business opportunities. In 2016, circular activities, such as repairs, re-use or recycling, generated an added value of almost 147 billion euros, while the value of investments amounted to approximately 17.5 billion euros. Within its plan, the European Commission also supported circular, sustainable products (EC, 2019).

In Slovenia, one result of the abovementioned Circular Economy Action Plan is the Decree on Green Public Procurement, which entered into force in early 2018 and replaced the Decree on Green Public Procurement from the year 2011 (PIS, 2019). Its purpose is to reduce the negative impact on the environment by publicly procuring environmentally less burdensome goods, services and constructions, to improve the environmental characteristics of existing offers and promote the development of environmental innovation and the circular economy. Consideration of environmental aspects in public procurement procedures is also mandatory for the construction of buildings. The proportion of wood or wooden composites in buildings have to be at least 30% of the volume of installed materials, unless the regulation or the purpose of use prohibits or prevents it (PIS, 2019).

Wood is one of the most important natural resources, and for Slovenia is without a doubt the most promising material, since it is the only raw material the country has in abundance. Due to its natural features, Slovenia is one of the most forest-covered countries in Europe, being in third place in the European Union, right after Sweden and Finland. Slovenia is thus a land of forests and wood, rich and still living heritage of wood construction, as well as state-of-the-art design and technologies for wood processing. Despite the fact that in Slovenia we have plenty of tradition, experience, ideas and knowledge in the field of wood processing, a relatively small share of such products have high added value. The construction sector is extremely important economically in Slovenia, but in view of the country's natural resources, wood plays rather insignificant role in this segment, and this raw material was much better exploited in the past. However, around the world wood is experiencing a renaissance and becoming a material of the 21st century. More and more countries are aware of its sustainability and reproducibility, as well as its construction and aesthetic functions (Oblak, 2010).

Wood is the basic material in architecture. The method of wood construction has been a model for building with other materials since ancient times, and the role of wood is closely linked to the history of mankind (Kuzman Kitek, 2015). With a comprehensive knowledge of this versatile material, careful observation and strict discipline in its processing, many different structures and object have been created around the world. Due to its ability to adapt to different geographical conditions, respecting local architectures and their development, wood is widely used from huts to palaces, from interior furniture to the most expensive bridges. The use of wood has created an architectural language based on a millennia-long tradition. Its flexibility is reflected in its versatile use throughout the world, including many combinations with other materials, such as stone, brick, concrete and steel.

This research aims to enhance the use of wood, which is considered as a part of contemporary architectural creation in the context of sacral buildings.

2. EXAMPLES OF CONTEMPORARY WOODEN SACRAL ARCHITECTURE

Sacral architecture differs from other forms due to the fact that it also expresses something metaphysical, at which the Slovenian architect Jože Plečnik was particularly masterful (Debevec, 2008). Because of its unique purpose, sacral architecture has always been the subject of careful design not only by the creators, but especially by the institutional leaders of particular religions, responsible for keeping intact as much as possible the mediation of the “foundation of faith” to man (Debevec, 2015). Wood is an essential element in the buildings used for modern Christian worship – helping to create a spiritual sanctuary, which in time and space creates a private dialogue between the building and the user. It allows a form of architecture characterized by a freshness of artistic design, with kinaesthetic and textural elements that awaken the memory of eternal time and take into account the ever-changing trends that include new technologies and practices in secular architecture. The projects examined in this study explore the modern possibilities of using wood in sacral architecture. In the following cases, some modern sacral objects in Slovenia are analysed from the viewpoint of using wood.

2.1. The Chapel at the Alojzij Šuštar School in Ljubljana

Figure 1. The Chapel at the Alojzij Šuštar School in Ljubljana

The layout of the chapel in the Alojzij Šuštar School revives the architectural typology of the house inside the house (Fig. 1). An extremely introverted white cube, placed above the entrance of an exceptionally open building, gives the impression of a serious and contemplative house. It only communicates with its surroundings using minimal means of expression. The cross in the middle of the only façade opening is its basic identification. The concave window, which gathers the first rays of the sun from the east, plays on biblical instructions for the construction of Jewish temples, while at the same time rethinks the placement of the holiest space within the Christian tradition.

The bare outer volume is turned into a scattered indoor space through the placing of the wooden entrance niche. The sequence of the path and the passage between the interior spaces, the penetration of walls and the spraying of light from the zenith, the two-tone stone monolith and the untreated traces make up the rest of the creative process, while the scents of eleven local types of wood and the tactility of the handmade surfaces invite to use all the senses. By doing so, the space returns visitors to nature and to themselves.

2.2. The Chapel of Our Lord in the St. Ignatius House of Spirituality in Ljubljana

In 2011, the architect and theologian Robert Dolinar received the design award at the ‘Month of Design” for the chapel in the St. Ignatius House of the Spirituality in Poljane in Ljubljana. The jury, which gave the prize, described his work as an artfully perfected creation, which, in spite of the modern and abstract interpretation of liturgical elements, maintains a dialogue with the tradition of space as a bearer of different meanings in Christianity, with its in-depth and thoughtful symbolic language. The wooden elements in the room are shaped with a chainsaw, which is also very interesting (Fig. 2). In addition to the cross, the central element in the chapel is a crude, untreated tabernacle. The author explained his idea with the biblical words: “'The light will shine from the darkness”. In his opinion, the view of the raw material allows contact and opens up a dialogue of the interior of the room with the outside world. Relief furniture makes the aesthetic in the St. Ignatius House of Spirituality in Poljane even more mysterious and at the same time pleasantly domestic.

Figure 2. Chapel of “Our Lord” in the St. Ignatius House of Spirituality in Ljubljana

2.3. The Square and Open-air Alter in Brezje

The square and the open-air altar in front of the pilgrimage church in Brezje (Brezje na Gorenjskem) is a continuation of the best of Plečnik's tradition and his understanding of architecture, which is reflected in an entirely contemporary interpretation of the interior of the altar, dressed in birch wood (Fig. 3). A natural light penetrates from the ceiling, creating a clean and tranquil atmosphere with its play on wooden surfaces. The arrangement and selection of materials in combination with a simple box-shaped room give a touch of Finnish design and create an excellent background for the richly decorated religious objects that adorn the walls and altar table. The design of the square is also simple: the surface is paved with concrete slabs, since the original plan of the completely covered surface with stone proved to be too expensive. Only the stairs leading to the square and the altar itself are made from the local stone. Over time, the two materials, concrete and stone, may acquire the same colour, so the original idea of one continuous, unified surface may become a reality.

Figure 3. The Square and Open-air Alter in Brezje

2.4. The Chapel on Rogla

Figure 4. The Chapel on Rogla

The space of the church is formed by two snail-shaped curved walls, separated by the conical shape of the belfry (Fig. 4). The curves of the walls in the ground plan of two composite ellipses bend into the chapel. The construction of the bell tower is based on six steel brackets, which are conically rising to the roof of the belfry. The complete construction is "wrapped" in a façade sandwich. On the construction of the bell tower is woven a marlin supporting construction of laminated timber beams. The lower peripheral part of the wooden supporting construction in the curved wall is coated with sandwich façade with slate, over which the waist of the windows runs and with which the façade line of the slate is diagonally cut. Over the window line the roof is covered with shingles. With this composition of the architectural elements the floating edge of the sacral object is subtly placed into the natural environment.

2.5. The Rog Memorial Chapel in Kočevski Rog

The Rog Memorial Chapel in Kočevski Rog is of a symbolic form and stands alone, near the abyss in the centre of the burial ground. It is intended to perform worship at memorial ceremonies and special occasions. Its semi-circular shape is spread through the front wooden movable wall into the forest area, which allows the mass to be carried out in the open (Fig. 5). It is conceived as a restrained and modest architecture, which is marked in the exterior by a wall of untreated stone, a movable membrane and floating roof, and in the interior, alongside the co-creation of light and wood, a movable altar, an altarpiece with a candlestick, an eternal light on the base and bench. The interior space is formed from a stone supporting wall, a construction of a floating roof and façade net. The front side of the chapel closes with a swinging door and sliding grid, which is made of steel galvanized profiles with inserted larch battens. The construction of the roof made of laminated wood is raised from the ground and is connected with steel struts and other connecting elements. The perimeter and inside of the chapel protects the wide jutting roof. Falling and fading light creates a sacred atmosphere. The composition of the architectural elements of the chapel allows everyone to understand the symbolic form, which is sealed and protected, and opens inward towards the human.

Figure 5. The Rog Memorial Chapel in Kočevski Rog

2.6. A place for Final Farewell

The village of Zgornji Tuhinj is located in the heart of the Tuhinj valley at the foot of the Kamnik-Savinja Alps. An old cemetery, divided in two levels, is located on the outskirts of the village and accessible through a sightseeing path that runs along the slope of a hill with an end to the ridge. At the place where the original chapel of the rest stood, a modern, object was built in the form of a simple, uniform volume (Fig. 6). The main sacral area represents one third of the building, while the rest is distributed between two funeral chapels and their service rooms. The perimeter and inside of the chapel protect the wide jutting roof. Both funeral chapels are directly connected to the central space via transparent walls. Falling and fading light creates a sacred atmosphere. In the case of strong winds, sliding panels are provided, which are, if necessary, opened or closed, thus protecting people in the central area. The arrangement of architectural elements enables a clear understanding of the symbolic shape, which is closed off to the outside world and open to people inside.

Figure 6. A Place for Final Farewell, Zgornji Tuhinj

3. CONCLUSION

Due to its aesthetic, structural and environmental characteristics, wood will remain one of the most important building materials in the future (Kuzman Kitek, 2015). This can be supported by the fact that the circular economy in Slovenia has been placed among the country's strategic development priorities, and wood is recognized as an important natural resource within this context. The transition to a circular economy is a systemic process. At the global level, we are confronted with limited natural resources and a growing population, and thus resources should be kept in the production and consumption cycle for as long as possible. It is crucial for the economy to preserve the value of products, raw materials and resources, and to limit the production of waste as much as possible. It is important to formulate products with the idea of how we will preserve their value – to maintain, repair, upgrade, and finally recycle them in the last phase of their lifecycle. This is also very important in the construction of sacral objects and buildings. The article presents the use of wood in contemporary Slovene sacral architecture, which is growing partly due to the transition to a circular economy.

Many of our deepest perceptions of the world and architecture derive from the use of wood. Contemporary Slovenian sacral architecture is subtly placed between the coordinates of time and space, which gives to a man a recognizable sensual expression, the implementation of a vision, and an understanding of more freely designed liturgical spaces.

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CIRCULAR ECONOMY AND CULTURAL HERITAGE: THA CASE STUDY OF RESTORATION OF 19TH CENTURY WOODEN TABLES IN DUBROVNIK

Margarita Bego[1], Luka Milančec[2], Anteo Bibić[3], Jelena Dubčić

Abstract: Nowdays, many discussions are related to the role of cultural heritage in circular economy and sustainable development, but they develop only on theoretical level. Can wooden furniture that presents a cultural heritage of one country or one geographic area play a role in the concept of circular economy? Traditional tehnological processes and materials in the resoration od wooden artefacts are the basis for the preservation of the rich cultural heritage of Dubrovnik and its surroundings. Tables belong to different furniture styles within a specific historical period. Each period of the 19th century is characterized by specific style of the table tops, wood they are made of and materials used in traditional restoration procedures. Styles define the table shape, as visible on the table top decorated with inlays and on the table legs which vary in shape. This paper tries to go beyond the reach of thinking and not a cost. The aim of this paper is to illustrate by using the examples of resoration of the19th century tables, from Neoclassicism to Secession, that the concept of the circular economy can be applied to cultural heritage resoration.
Key words: circular economy, cultural haritage, wood restoration, styles of furniture, tables

1. CULTURAL HERITAGE IN THE CONCEPT OF CIRCULAR ECONOMY AND SUSTAINABLE DEVELOPMENT

A lot has been said and written on the topic of the importance of preservation of cultural heritage, proposals and projects have been made in order to make sure that material and nonmaterial heritage is adequatly protected, preserved and restored for future generations which is one of the key components of sustainability. Therefore, the following question arises: can wooden furniture, as a part of cultural heritage of a country or a geographic area play a role in the conept of circular economy?

Throughout the19th century, traditional understanding of life came down to the policy of taking, exploiting and rejecting, to the return to nature and objects from nature as well as to reusage of already used items and objects. The development of the society that satisfies human needs with available resources without endangering natural systems and environment ensures the longevity of human society and its surroundings. Various economic benefits can result from cultural heritage preservation such as generating revenue, jobs, development and maintenance of different skills and promotion of small scale economies.

According to D. Rykeme (2006) preservation of cultural heritage ensures environmental sustainability, cultural sustainability and economic sustainability. Material and nonmaterial cultural heritage is an example of sustainable development through usage of existing natural materials, practice, knowledge and skills. Preservation of cultural heritage is not just a means to preserve cultural values. It is also an encouragement to strenghten cultural diversity, a community identifies itself and maintains its distinctive features that reflect diversity and identity of a place, but also an encouragement to strenghten cultural diversity. Preservation of diversity represents a long term goal based on dynamic integration.

The basic principle of circular economy that everything is subject to reusage in a different way can be applied to cultural heritage preservation,“ waste is non-existent“. Cultural heritage preservation ensures promotion and contribution to sustainable development through heritage as a component of the quality of life. (Grazuleviciute,I. 2006)

2. EXAMPLES OF THE RESTORATION OF THE 19TH CENTURY TABLES

„History is created by every passing minute, and everything that is created becomes a part of history".

Many valuable artefacts which have been forgotten and abandoned in inadequate conditions for years, are restored and reunited with the cultural heritage of a geographic area for future generations. Cultural heritage represents the 4th crucial principle of development together with economy, environmental protection and social development. However, it has frequently been neglected even though it might be the most authentic of all the above mentioned principles especially in the domaine of sustainable development because it is generated from recycled or alredy used materials and resources through application of traditional techniques and tecnologies that have been passed from generation to generation. Eventually, it connects the other three principles of sustainable development in a way which is not obvious at first glance, but which can be clearly identified through comparative advantages to economy (tourism), society (cultural identity) and environmental protection (waste does not exist) while providing multiple benefits for future generations.

According to Agenda 21 –The Global Agenda od Local and Regional Govermments for the 21 st Century- association UCLG United Cities and Local Govermments (2016.) cultural heritage represents one of the fastest growing branches of global economy – Why is that so? It can be stated that if managed wisely, cultural heritage can provide revenue for future generations, it can ensure nonprofit benefits, social engagement, inclusion of local population into economic trends, usage of microlocations as resources through skills and knowledge of restorers employed to care for cultural artefacts, as well as local resources, in this case wood. Cultural heritage in the context of sustainabe development, if managed wisely, can ensure economic revival of a region, in this case of Dubrovnik and its surroundings.

Restoration of tables from the island of Mljet, Zupa dubrovacka and Dubrovnik can contribute to the development of economy on local level if they are exhibited in museums. In that case they can contribute to sustainable development if they are recycled and restored in a way that is conducive to environmental protection, job creation in museums which also creates a social dimension through generation of revenue.

Two centuries ago, wooden tables were made by using special skills and knowledge passed on from generation to generation. Practice, knowledge and specific skills are still unexplored as a way of promoting and contributing to sustainable development. Therefore, this article will be based on wood and wooden objects that have been restored and preserved as such for future generations. (Halbertsma, 1999)

Example of a wooden table from the turn of the 19th century from Dubrovnik decorated with inlays which represent cubes if looked at a particular angle. Wooden structure of the table is made of fir, veneer: walnut, maple and oak. The table was stored in the attick of a private house in poor microclimatic conditions. Original state of the table: damage caused by insects, unstable table structure, missing parts of the structure, missing veneer and polishing in poor condition. (Figure1.2.3.4.)

Figure 1. Damage caused by insects

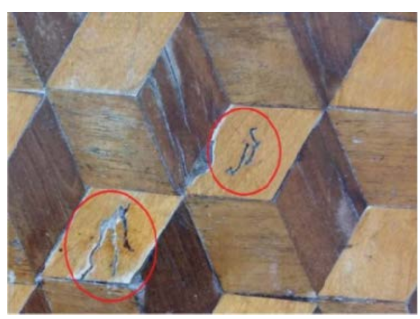

Figure 2. Cracked veneer

Figure 3. Bottom adhesion of veneer

Figure 4. Tabletop after restoration treatment

Knowledge, practice and skills in restoration are specific, therefore the restoration treatment included retouching of faded pieces and of missing parts on inserted veneer by using natural coffee solution. After the treatment the table became a functional part of cultural heritage and as such it has been preserved for future generations.

The following example is from the period of Historicism which resulted form the 19th century romantic awakening of interest in the past and intense care for the preservation of cultural monuments. Historicism finds guidance in artistic forms of previous styles. It comprises a wide range of neostyles which are marked by a prefix „neo" (Neoromanticism, Neogothic, Neobyzantium, Neorenaissance, Neobaroque etc.) all of which appear throughout the 19th century and find their foundation in adopting structural and decorative elements of the previous artistic styles.(Brdar, Mustapić, 2000).

Example, a Neobaroque table from Župa dubrovačka, made of walnut, walnut root and spruce, was found dismantled and functionally completely useless. The table top with a thick walnut root veneer required a precise bottom adhesion and veneer insertion. (Figure 5.6.)

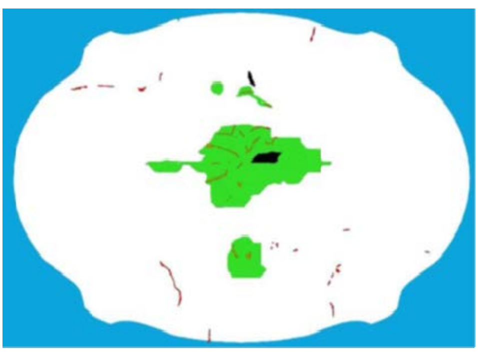

Figure 5. Tabletop before restoration

Figure 6. Graphic representation of damage

The support and the legs of the table were subject to special treatments of consolidation using a mixture of acetone and paraloid B72 in different ratios, in pools specially made for better control of the process itself. (Horie, 1987) (IFigure 7.8.)

Figure 7. Unstable table top support

Figure 8. Broken legs of the table

Using existing materials and specific skills, the table emerged as a beautiful and well preserved artefact representative of the period as well as of the cultural heritage of Dubrovnik. (Figure 9.)

Figure 9. Table after restoration

After an increasing need to preserve tradition, furniture in the style of German Neorenaissance called Altdeutsch was manufactured towards the end of the 19th century. It is characterized by a recognizable regional style, with carved decorations, made of heavy and hard wood, predominantly walnut (Umney, Rivers, 2003). An Altdeutsch table, from the island of Mljet, represents a typical example of the phrase "waste does not exist." Acquired in poor condition, it was brought back to usage through knowledge and special skills of conservators and restorers and returned to the island of Mljet as an example of cultural heritage preserved for future generations. (Ifigure 10.11.12.)

Figure 10. Loosened table

Figure 11. Dismantled table

Figure 12. Table brought back to use

3. CONCLUSION

Throughout the19th century changes in the manufacturing of wooden artefacts took place. Already existing materials such as wood, resins and natural adhesives were used together with the knowledge passed on through generations resulting in the manufacturing of artefacts for future generations. Observing these artefacts two centuries after they were made, desire, effort and tendency to preserve material and nonmaterial cultural heritage for future generations using existing materials are obvious. Diversity and abundance of cultural heritage united with the skills of restoration practice of the 21st century represent an unexplored space suitable for contribution to sustainable development and its promotion.

This short outline of table restoration contains a lot of practical work, knowledge and skills and strives towards maintenance and preservation of cultural heritage of a geographic area, in this case Dubrovnik and its surroundings. It could be used to outline the feasibility of the principles on theoretical level of the role of cultural heritage in circular economy and sustainable development. Traditional technological treatments applied to the 19th century tables only confirm the thesis that „waste does not exist" and that history is created by every passing minute, and everything that is created becomes a part of history. A community identifies itself and maintains its distinctive features that reflect diversity and identity of a place, but also an encouragement to strenghten cultural diversity. Restoration of cultural heritage in the 21st century can be regarded as an investment for future generations. Restoration of tables from the island of Mljet, Zupa dubrovacka and Dubrovnik can contribute to the development of local economy, in case they are exhibited in a museum they can contribute to sustainable development by being recycled and restored in a way that is conducive to environment protection, jobs in museums can be created which also contributes a social dimension through generation of revenue. If they are reused as tables in a hotel, family owned farm business, they can create long term benefits through sustainable development perspective.

Using the knowledge and skills of conservators-restorers, wood technologists, art historians and economists, it is possible to maintain the rich historical and cultural heritage of a geographic area with minimal financial investments.

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IDENTIFICATION OF THE BARRIERS TO THE CIRCULAR ECONOMY – THE CASE OF THE FURNITURE INDUSTRY

Shteryo Nozharov

Abstract: The main purpose of the paper is to identify the barriers that impede the circular economy development in the EU. There will also be analyzed the possibilities of circular economy implementation in the furniture industry. The methodology of new institutional economy will be applied in the study. There will be used statistical data for Bulgaria which has been an EU member-state for over 10 years. The analysis will be focused on the furniture industry and the effectiveness of the extended producer's responsibility. The framework of the analysis will be based on the clear distinction between circular economy and recycling economy. In most of the publications so far, it is made only a distinction between circular economy and linear economy. In this way the particular stages of the transition process to circular economy will be identified. The findings of the study have three aspects. On the first place, it will add knowledge to the publications, which analyze the barriers that impede the development of the circular economy in Europe. This will allow the circular economy concept to be developed. On second place, the publication will study how the circular economy concept will be implemented in the furniture industry from the viewpoint of the extended producer's responsibility. On third place, the publication will bring further information about the relationship between social and transaction costs. This will help the measurement of these costs to be developed.
Keywords: furniture industry, circular economy, barriers

1. INTRODUCTION

The circular economy is still an unclear conceptual vision which could be difficultly put into the practice. There are many definitions for the term circular economy. What is common amongst these definitions is that all of them comprise of the following key elements: reuse, remanufacturing, recycling, disposal. The main accent is put on the cyclic movement of the material and energy flows in the economy. The main purpose of the aforementioned movement is resources preservation with minimum interaction (Korhonen, Honkasalo, and Seppälä, 2018; Kirchherr et al., 2018).

The broaden vision of the circular economy covers not only the efficient resources usage, concerning the design of products, increasing the productiveness, products' durability, product repair availability, accurate identification of the substances they consist and etc. This broaden vision of the circular economy covers also the consumption prediction, predicting the pollution of the environment in all phases of the products' lifecycle, predicting what will be the threats for the humans' health at all of the phases of the products' lifecycle, establishment of a secondary market of end-of-life products, reducing the amount of landfill waste (Hughes,2017).

The main purpose of the current study is to be identified the barriers that impede the circular economy development in the EU. In this way the process of implementation of the circular economy into the practice will be speeded up. As a result, the transaction costs of the inefficient institutional structures will be decreased,

The focus of the study will be put on the furniture industry. This sector is of interest for number of reasons: there are a lot of large and small enterprises, innovative models and craft technologies are implemented, defragmented supply chain and high ecology standards are existing.

2. THEORETICAL BACKGROUND

The theoretical background will be done in the following fields. First of all, there will be made a clear distinction amongst linear, recycling and circular economy. In this way, there will be avoided possibilities to be mixed the main concepts of circular and recycling economies. Secondly, there will be presented the barriers that impede circular economy implementation, identified by other authors so far. This will help the current study to upgrade and to expand the theory in this field. On third place, there will be presented what are the specifics of the furniture industry in order to be understood by the readers why this economic sector is chosen for the purposes of the research.

2.1. Distinction amongst linear, recycling and circular economy

There are many scientific publications which make readers perceive that circular economy is the next stage of the development of nations after the linear economy (e.g. Garza-Reyes et al., 2019). These implications come from the direct distinction between linear and circular economy, which is incorrect. The EU linear economy is out of date since many years and it is replaced by the recycling economy. And the attempts the circular economy concept to be implemented is the next stage of development of nations after the recycling economy. According to the linear economy concept, the production and consumption model is based on the relationship extract-produce-use-dump. However, this model is unstable, because it studies the nature as one of the main production resources (Garza-Reyes et al., 2019; Korhonen et al., 2018).

In the recycling economy, the focus is put on the efficient usage of the raw materials through manufacturing and burning of energy. In this way, great amount of the products' economic value is lost. The process of products recycling needs enough energy for the functioning of the recycling machines, however in the process of repeated usage of products in the circular economy, this energy is saved. (Korhonen et al., 2018). The recycling economy is not efficient enough. According to a document of the European Commission (2018), only 0.6 bln. tones out of 2.2 bln. tones generated waste have been recycled in 2014. The other 1.5 bln. tones left are waste. Consequently the recycling economy is not efficient and its model of functioning needs to be changed.

In the circular economy, the accent is put on the secondary usage of products and their components, the possibilities of products' renovations, repair and modernization. It is also established a new consumption culture, which covers leasing and sharing of products. (Korhonen et al., 2018). The main purpose here is the value of products to be saved at the maximum through extending the duration of products usage in their original type. This purpose could be achieved through cradle-to-cradle design during the products' projection phase (Braungart, McDonough and Bollinger, 2007; European Commission,2018). To a certain degree, the circular economy concept is based on the model of industrial symbiosis (Chertow and Ehrenfeld, 2012). In this way, the recycling is considered as the ultimate option and landfill is excluded. Consequently, there will be no need to import scarce resources from third countries.

2.2. Literature review of the barriers that impede the circular economy concept implementation

According to Korhonen et al., (2018), the barriers that impede circular economy concepts could be defined as its limits. He summarizes them in six categories: Thermodynamic Limits, Spatial and Temporal System Boundary Limitations, Limits Posed by Physical Economic Growth: Rebound Effect, Jevon's Paradox and the Boomerang Effect, Path Dependencies and Lock-in, Intra-organizational VS. Inter-organizational Strategies and Management, Definition of Physical Flows.

Having in mind the main purpose of the current research, some of these categories could be applied in the study. The first one is Path Dependencies and Lock-in. The existing technologies which are used in the recycling economy, have stable market shares, nevertheless they are inefficient in comparison to the modern technologies, used in the circular economy. The competition between these two types of economy will be based both on the number of clients and on the waste flows. As a result, the time necessary to redeem the new technologies will be slowed down and the conventional recycling technologies will have better market positions because of their core competence – economies of scale. This happens, because in the recycling market there are imposed supply chains, structures, culture and best practices and it will be much difficult for the participants in the market to change them. In the case of the circular economy, there is information asymmetry and most of the market participants will concern the new technologies as risky ones.

The second criteria are Thermodynamic Limits. According to Korhonen et al., (2018), in the utilization process of forest residues from cuttings as a resource for renewable energy production in the circular economy, there will be some negative effects. This nutritional resource for the forestry ecosystem will be removed from it. As a result, the forest growth and the biodiversity will be aggravated. The third criteria, Intra-organizational VS. Inter-organizational Strategies and Management means that new relationships in the supply chain management and between business and customers should be established. The many lifecycles of the products in terms of their renting, leasing and sharing amongst many customers imposes the roles and obligations of all participants to be clearly defined.

According to Ritzén and Sandström (2017), barriers are financial (profitability could hardly be measured), structural (unclear distribution of responsibilities), operational (changed supply chain), attitudinal (unclear perception of the term circular economy) and technological (complexed design of the products). These barriers emerged as a result of the challenges that enterprises face in the XXI century: resource scarcity, environmental impact and simultaneously increasing economic benefits. In the circular economy concept the business model is changed – from products selling towards services selling through extending the lifecycle of products usage.

According to Kirchherr et al., (2018), the main barriers that impede the circular economy concept are: Cultural (lack of information and customers interest), Regulatory (Limited circular procurement, obstructing laws and regulations, lacking global consensus), Market (lack of profitability of the circular-type business activities, lower prices of the virgin materials), Technological (lack of proven technologies for the implementation of the circular economy).

2.3. Specifics of the furniture industry in the circular economy context

According to Chobanova and Popova, (2015), the furniture industry is characterised by: resource and labour intensity, competitiveness amongst local craft enterprises and large global enterprises, fragmented supply chain, low barriers to enter the sector. Key issue in this sector is the increasing global competitiveness of forestry raw materials. For these materials, the competition emerges between the furniture and bio-energy sectors in the conditions of contonuously incresing role of the forests in the prevention policies for climate change. This leads both, to restricted access to the forestry raw materials and to increase in the resources prices. Because of the innovations and the role of forests in the climate change policies, the significance of small craft enterprises, producing wood is decreasing. The same happens to the enterprises, producing high quality pieces of furniture. Furniture enterprises from EU are forced to respond to the requirements for sustainable wood materials (certified forests), while their competitors from Asia and other continents imply eco-dumping Gechev, 2017). This leads to unfair competition from the one side, but on the other – encourages innovations in the EU. The significance of new materials, such as MDA, RTF, ICT, glass, polymers, nanoparticles is growing. The creation of new materials has an important role in the process of circular economy implementation, especially materials, which could substitute the nature resources.

The needs of personalising and ergonomy of furniture products encourage the process of products design innovations. This is good basis for the development of multi-use product design, which is one of the main requirements of the circular economy. The furniture industry functions in the conditions of monopolistic competition and the product diferentiation makes the design a leading factor. At the same time, the modern trends for creation of furniture of modular panels allows from these panels to be assembled new and different pieces of furniture, which could be used repeatedly. This could makes the furniture industry one of the leading industries in the circular economy.

3. STUDY AREA, METHODS AND RESULTS

One of the barriers, identified in the literature review, is the Regulatory. It is defined as Limited circular procurement, obstructing laws and regulations, Lacking global consensus. The current study will focus on the quality of the institutional environment in the EU, related to the waste management, identified as a barrier which impedes the circular economy concept implementation and its influence over the development of the furniture industry. There will be used the methods of quality analysis and elements of the indicative statistical analysis.

The main purpose of the quality analysis is to be studied to what extent the inefficiency of the extended producer's responsibility could be a barrier to the impementation of the circular economy. At the very beginning of the implementation of the extended producer's responsibility principle in the EU, many critical publications have emerged. The interesting thing is that EU has not rejected this principle but has slightly expanded the legislation in the so called "circular economy package, 2015" (European Commission, 2015), without changing the conceptual model. One of the first critical publications in this field is that of Sachs, (2006). According to him, the principle has been implemented in Europe since 2002. He considers that the alternatives of the expanded producer's responsibility could be much more efficient (recycling fees, paid at the place of bargain, taxes for using virgin natural resources by the producers, tradable pollution limits, eco-labeling, green public procurements). The author makes the following critics. First of all it is not clear for him, who is the polluter. If the polluter is not the producer, then how the expanded producer's responsibility will be based on the polluter pay principle. If the consumers create waste in the environment and the producers create positive effects, then whose will be the responsibility for the pollution and which side will pay the costs. Secondly, for products with lower prices, the transaction costs will exceed the ecologic benefits and the better solution in this way is they to be assigned to the communal systems for waste management. On third place, the EU directives for waste management grant member-states wide discretion on their transposition on national levels. In this regard, they apply the "race to the bottom" principle in order to be attracted foreign investments. Fourthly, the expanded producer's responsibility does not abolish the necessity consumers to participate as they are the main subject who generate waste. However they are not motivated to bear any responsibility for the generated waste, the only benefit they could receive is to be part of the green consumption. On fifth place, the producers are not motivated to use a sustainable design of their products, because their products are taxed on quantity, depending on the product type, but not on their unique construction characteristics.

The aforementioned critics are confirmed in many other studies in the last years (Mayers and Wassenhove 2018; Massarutto 2014). The authors mention other arguments in help of the statement that producers are not motivated, such as that costs for waste collection and logistics are two-thirds of the total costs and that is why there is no stimuli for the producers to develop the product design. Moreover, the existing unfair competition as a result of the illegal waste disposal, is another argument.

The effects of the expanded producer's responsibility in the furniture industry could be examined by an example for production of particleboard. In this production activity, the following waste flows are generated in accordance with Regulation (EC) No 2150/2002 (European Parliament, 2002): 07.52 Sawdust and shavings, 07.53 Other wood wastes (waste bark), 12.41 Waste from flue gas purification (flue gas dust), 12.41 Waste from flue gas purification (flue gas dust), 06.11 Ferrous metal waste and scrap (ferrous metal filings and turnings), 01.31 Used motor oils, 01.32 Other used oils, 03.14 Spent filtration and absorbent materials, 08.41 Batteries and accumulators wastes (lead batteries), 08.43 Other discarded machines and equipment components (fluorescent tubes and other mercury containing waste).

Having in mind the diversity of the waste flows in the furniture industry, it is necessary to be used the services of the Producer Responsibility Organisation (PRO). However the economic activity of these organizations is inefficient (Nozharov, 2018). The inefficiency of the PRO and the expanded producer's responsibility are barriers to the implementation of the circular economy concept.

The effectivenes of the waste management in the furniture indsutry could also be examined through a quantitative (statistical) analysis. The relationship between dynamics in the generated waste volumes and production growth of furniture industry will be examined by means of the linear regression model. The dependent variable is: Generation of wood wastes (tonne) and the independent variable is: Secondary wood products (thousand euro). For the purposes of the analysis it is used the EUROSTAT Eurostat (2019) database for period of eight years (2008-2016). The regression analysis is made for Bulgaria, which is a EU member-state since 2007. The calculations show the following values of the main coefficients: correlation coefficient R – (0,69), determination coefficient R^2 – (0,47), and significance F – (0,03). There is a strong relationship between the variables. It could be concluded that if the generated waste flows are almost constant, the profits generated by the furniture industry will increase. Approximately 47% of the aforementioned statement could be explained by the better management of wood waste. The remaining 53% due to the usage of new artificial products (not made of wood). This is also an indication to the implementation of better design of the products which help virgin wood materials to be preserved. On the other hand, we can not significantly reduce the generated wood waste, which according to the circular economy concept need to be entirely utilized in the production process or recycled. This confirms the statement that the existing recycling model is not eficient enough in order to allow transition to circular economy.

4. CONCLUSIONS

The findings of the study are in the following aspects. On first place, it shows that the expanded producer's responsibility could be examined as a barrier to the implementation of the circular economy concept. Secondly, the effectiveness of wood waste recovery in the furniture industry is not high enough. This means that the existing model for functioning of the recycling economy is not applicable to the furniture industry. That is why, the research papers needs to be focused on the conceptual differences between circular and recycling economy, but not between circular and linear economy. There is a real risk the failures of the recycling economy to be reproduced in the model of the circular economy.

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URBAN FORESTS: BIOECONOMY AND ADDED VALUE

Mihaela Mihailova

Abstract: Implementing bioeconomical methods into social norm is the goal for better a future. By the end of 20-th century the circular economy has become the focus of everyday life and was integrated in it with policy crated by the institutional environment. The focus of this paper is the added value in bioeconomy by creating urban forests.
The objective of this research is to calculate and trace the change of added social and economic value if urban forest are created and become part of the urban infrastructure. In the research we use economic and social models to measured social value and discuss the different problems and strong points. The ToSIA – Tool for Sustainability Impact Assessment is used to measure wellness by bioeconomy and urban forests. The economic added value is calculated by social system of added value where, air pollution reduction, electricity efficiency and health benefits are the focus of urban forest creation. Many issues regarding the Millennium Development Goals and EU policies can be resolved by creating urban forests.
Key words: bioeconomy knowledge, social added value, economic added value, urban forests
JEL codes: Q01, Q51, P25

1. BIOECONOMY AND URBAN FOREST DEFINITION AND THEORY

The European Commission defines the bioeconomy as "the production of renewable biological resources and the conversion of these resources and waste streams into value added products, such as food, feed, bio-based products and bioenergy (European Commission: 2019). The forecasted changes in climatic conditions and increasing depletion of fossil fuel sources require the economy to be based preferably on renewable resources. Securing global nutrition also demands an increase in productivity with due regard to protecting resources and the environment. Urban forest play a significant row in reaching our goals for sustainable future. Some authors highlight "the responsibilities that Homo sapiens have for preserving the human living environment" (Yovchevska 2008: 25). The objective of this paper is to show how urban forest and greener landscape can make cities better habitats for humans and have an impact not only on social but economic aspects. The object of this research is urban forest impact on Sofia – city.

Historically for urbanization, the idea of functional zoning of cities was formed at the beginning of the industrial revolution. In the inter-industrial period, cities were a relatively homogeneous entity with intertwining of different functions (Aleksandrov 2006: 109). For the first time, the concept of the functionally zoned city is set out in the project of (Tony Garnier 1903). The basic set of the Athens Charter is the definition of the the four functions – living, working, recreation and transport as "key" urban functions. Proper interconnection of the areas designed for these functions and their good connection are the basis of the city's good and hygienic planning. Urban forest even if taking part of recreational zone as part of the four function, partake in other important roles in urban structures and added value for habitants.

An **urban forest** is a forest or a collection of trees that grow within a city, town or a suburb. In a wider sense it may include any kind of vegetation growing in and around human settlements that includes: grass, flowers, trees, etc. Urban forests play an important role in the ecosystem of human habitats: they filter air, water, sunlight, provide shelter to animals and recreational area for people. For better functioning ecosystem, humankind like animals need habitat that is in best way fit for their daily needs. The urban forest better the habitat as it: moderate local climate, slowing wind and storm water, shading homes and businesses to conserve energy. They are critical in cooling the urban heat island effect, thus potentially reducing the number of unhealthful ozone days that plague major cities in peak summer months. The create added value by reducing health cost, reducing energy consumption, pollution and providing shelter and better biodiversity. An urban forest help the cities to create a microclimate that is closer to the natural climate surrounding the city.

2. MODEL OF VALUE ADDED FROM URBAN FORESTS

For this research paper ToSIA model – Tool for Sustainability Impact Assessment will be used to measure social added value by using a system of quality and quantity measures. The model uses five different indicators to measure wellness and added value for society. We will see what are the effects of urban forest:

Table 1. ToSIA model Indicators

Social benefits	Recreation opportunities, improvement of home and work environments, impact on physical and mental health. Cultural and historical values of green areas.
Aesthetic and architectural benefits	Landscape variation through different colors, textures, forms and densities of plants. Growth of trees, seasonal dynamics and experiencing nature. Defining open space, framing and screening views, landscaping building.
Climatic and physical benefits	Cooling, wind control, fine particles reduction from erosion, impact on urban climate through temperature and humidity control. Air pollution reduction, sound control, glare and reflection reduction, flood prevention and erosion control.
Ecological benefits	Biotopes for flora and fauna in urban environment, keeping a larger ecosystem that helps pest control.
Economic benefits	Value of market-priced benefits, less health cost for government (in social type of country with healthcare), increased property values, tourism

Benefits and uses of urban forests and trees (adapted from Tyrväinen 1999)

2.1. Research and results

Table 2. City Profile Sofia

Polpulation	1,2 million
GDP per head, PPP	24,871.68 lev
CO2 emissions per head	4.32 tones
Energy consumption per head	80.71 gigajoules
Percentage of renewable energy consumed by the city	1.39%
Total percentage of citizens walking, cycling or taking public transport to work	75,4 %
Annual water consumption per head	188.52 m3
Share of waste recyded	0,02%

European Green City Index Assessing the environmental impact of Europe's major cities

Sofia, is the political and economic centre of the country. With about 1.2 million inhabitants, or around 16.5% of Bulgaria's population, Sofia contributed approximately 33% of the country's GDP. The population has risen noticeably since 2001, in contrast to the national demographic trend, as the city has flourished during the transition period, attracting more than 60% of Bulgaria's total foreign direct investment. Sofia's economic growth has also led to overcrowding on public transport and traffic congestion on the city's main roads. Sofia ranks 29th in the European Green City Index, with a score of

36.85 out of 100. The city is also located towards the bottom of the income scale in the index, a factor that appears to be correlated significantly with environmental performance.

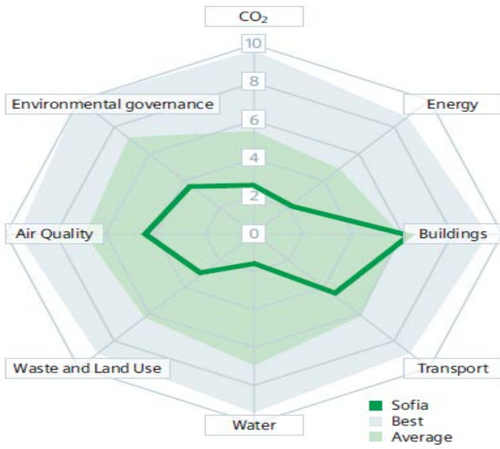

Figure 1. Factors for green city index
Source: European Green City Index Assessing the environmental impact of Europe's major cities

Social Benefits – Improvement of mental and physical health. The air pollution and fine particles from soil corrosion are one of the main health risks for people living in urban areas. Their existence help society battle this problems. Exposure to large expanses of urban green space (e.g., parks and trails) has been found to improve human mental health and cognitive function. The practice of "forest bathing" has also been researched for its health benefits (Lee 2009). In a 2001 study researchers found an association between green play settings and milder symptoms in children with Attention Deficit Disorder (ADD) compared to children who played indoors with no access to green spaces (Taylor, Kuo, and Sullivan 2001). Study results indicate that green spaces may help to improve attentional functioning in children with ADD. In a British study researchers analyzed the mental health effects of moving from less green urban residential areas to greener areas and vice versa (Alcock et al. 2014). The study found that people who moved to greener areas experienced overall improvements to their mental health while people who moved to less green areas experienced a temporary decline in mental health. A New York City study found a connection between street trees and the prevalence of asthma in children (Lovasi et al. 2008). Results showed "an increase in tree density of 1 standard deviation was associated with a 24-29% lower prevalence of asthma in young children" (Lovasi et al. 2008). A number of studies have examined the relationship between urban forests and crime rates. Most have found a correlation between increased tree coverage and decreased crime rates, even after adjusting for a number of other variables, such as median household income, level of education, or rented versus owner-occupied housing in the neighborhoods that were studied (Gilstad-Hayden et al. 2015; Troy, Grove, and O'Neil-Dunne 2012). A study on the effect of nearby parks on property values in Baltimore, MD discovered that property values are higher in correlation with park proximity only when the neighborhood's crime rate is below a certain level.

Ecological benefits – Trees are proven to absorb carbon. After removing it from the air, it is stored as cellulose in their trunks, branches, and leaves (a process called sequestration). Planting trees remains one of the cheapest, most cost effective means of drawing excess carbon dioxide from the atmosphere (Tina Prow, "The Power of Trees"). A single mature tree can absorb carbon dioxide at a rate of 21.6 KG/year and release enough oxygen back into the atmosphere to support 2 human beings. Research has also shown a 60%

reduction in particulates from exhaust fumes in tree lined streets. *(Green Blue Urban, 2015). Sequester one ton of CO2 per year at a cost of $25 (£15) /ton (Intergovernmental Panel on Climate Change). Yield positive energy benefits by reducing heating and cooling costs through shading and sheltering buildings. A well-placed mature tree can reduce annual air conditioning costs by 2% to 10%. Its cooling effect is equivalent to 10 air conditioning units running 20 hours a day. Help reduce urban heat island effect that causes urban areas can be as much as 8°F – 10°F warmer than adjacent rural areas. As a part of bioeconomy, the urban forest help preservation and strengthening biodiversity and ecosystems. By planting more trees and making the cities greener we are countering effects of the forest-based sector. Urban forest and greener cities are a major contributor to climate change mitigation.*

Economic benefits – The amount of energy required to heat and cool buildings depends on their thermo physical properties, occupant behavior and local climate. By modifying local climate, urban forests can increase or decrease building energy use (Heisler, 1986). Measured (Meter, 1991) and simulated (Huang *et al*., 1987; McPherson, Herrington and Heisler, 1988) energy reductions caused by vegetation around individual buildings generally range from 5 to 15 percent for heating and 5 to 50 percent for cooling. Since Sofia is hot in the summers and cold in the winters that will help save a great amount of energy. A computer simulations indicate that three 7.6 m trees around a well-insulated new home would reduce annual heating and cooling costs by 8 percent (113,472 lv) compared with those for the same building without trees. Annual savings created per tree would be broken down as follows: reduced cooling requirements in summer as a result of shade (37 percent); reduced cooling requirements in summer as a result of evapotranspiration-lowered air temperature (42 percent); reduced heating requirements in winter as a result of lowered wind speeds (21 percent). (D. J. Nowak and E. G. McPherson 1993). *A tree cooling effect is equivalent to 10 air conditioning units running 20 hours a day. An air-conditioned runs on 600 – 1500 kw/h for 12hours a day, the effect of trees around the building will save 19,06 lv /32,97 lv a month in the months of extreme cold and hot, depending on how much electricity it consumes. The calculations are made for both a low energy consuming air-conditioner 600 kw/h and a high consuming one. Annual savings created per tree would be broken down as follows: reduced cooling requirements in summer as a result of shade (37 percent); reduced cooling requirements in summer as a result of evapotranspiration-lowered air temperature (42 percent). Saving around 36,59 lv a winter and 41,54 lv a summer (for a 3 month period of using heating and cooling).*

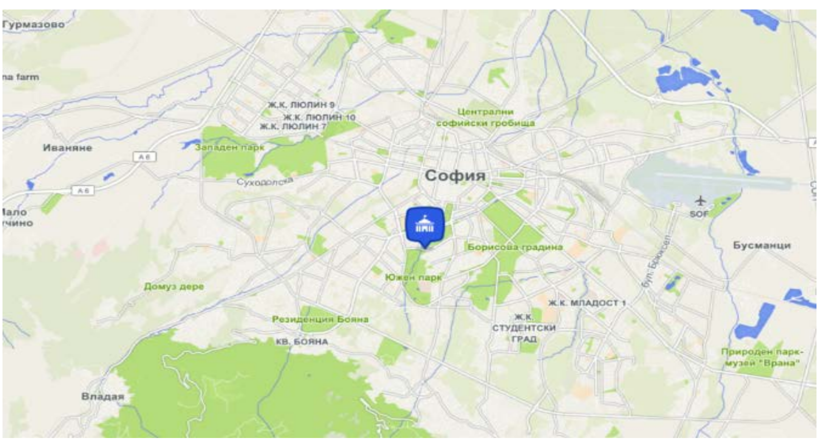

Figure 2. Map of Sofia green infrastructure
Source: Green Atlas Sofia I regiona

The cartographic rendering method is a qualitative background. Classification of green areas is in the categories of the Urban Atlas. To solve the complicated task of establishing the real share (by mapping, calculation and visualization) or the foreseen share (by acquiring attributes and visualization) of the landscaping according to the development zones envisaged under the Master Plan of the City of Sofia was pilot-solved with the use of additional scientific research by an international team, which is engaged in remote sensing (eng) and an increase in the classification nomenclature of the components involved in remote sensing Enata system versus those which are set in the City atlas. When increasing the nomenclature of components of the green system (green areas in residential complexes, green areas in individual residential properties, etc.), additional "manual" processing of satellite images is extracted with 57% more green areas. Adding the street vegetation (trees, shrubs, chips), vertical landscaping (despite its insignificant share and the lack of documented studies), % greening would increase. From the balance we can conclude that in the outskirts of Sofia per inhabitant (base of 1188692 inhabitants) there are an average of 48.3 m2 of green areas, of which an average of 14.4 m2 "Urban green areas" (parks and gardens for wide public use with forests). For every 1 lev spent on trees, Sofia city would save 7 levs in healthcare, energy and environmental costs. (WHO 2018) The biggest problem for heating and changing the microclimate of the city are roads. The roads in Sofia city have a combined length of 3400 km, the roads that are first class are the one that have little or none greenery or trees around them. The length of this roads class 1 is 428 km. tall trees have to be planted 4 meters apart by law. That makes planting additional 1,712 trees possible or planting vertical garden. The benefits will be equal to 599 200 lev when investing 85 600.

Property prices – A property with trees is valued 5% to 15% higher than a comparable lot with no trees (Center for Urban Forest Research). All of the most expensive neighborhoods in Sofia are near cities biggest parks – Lozenets is near South Park with prices from, Iztok is near Borisova garden etc.

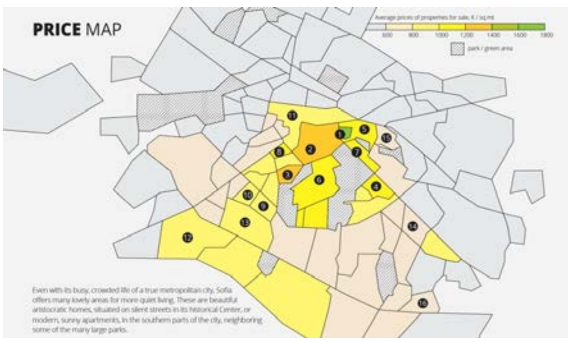

Figure 3. Map of real estate in Sofia city
Source: First estate – properties

Table 3. Neighborhood property prices

№	Name of neighborhood	Price €/sq. m.	% Green from 100%
1	Doctor's garden	€ 1719	75% Green
2	Top Center	€ 1325	0 % Green
3	Ivan Vazov	€ 1246	100% Green
4	Iztok	€ 1163	100% Green
5	Oborishte	€ 1110	25% Green
6	Lozenets	€ 1097	50% Green
	Yvorov	€ 1078	75% Green
8	Medical Academy	€ 1045	100 % Green
9	Gotse Delchev	€ 912	50% Green
10	Borovo	€ 903	75% Green

3. CONCLUSIONS

Sofia city even having big green parks and 48.3 m2 per person green spaces can benefit greatly from new green life. A policy that helps green infrastructure and tree planting can make the city less polluted, with better climate and help lessen the money spend for health and mental care. Planting more trees can rise property values for neighborhoods. More outdoor spaces will benefit communities to be stronger and take better care of both the environment and human population. Urban forest play crucial part in sustainable future and in the bioeconomy by helping biodiversity and ecosystems

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SUSTAINABLE DEVELOPMENT – INTERNATIONAL FRAMEWORK – OVERVIEW AND ANALYSIS IN THE CONTEXT OF FORESTS AND FOREST PRODUCTS – BUSINESS OPPORTUNITIES AND COMPETITIVENESS – A LITERATURE REVIEW

Annika Hyytiä

Abstract: Resources are important for competitiveness in business. Business models and innovation can provide new opportunities. The value chain and innovations in the sustainable development of the forest sector provide opportunities for competitiveness and business. Quality is part of competitiveness. It can provide a sustainable image to customers.
This is a qualitative research based on research articles and literature including academic sources, 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, forest products, competitiveness, CSR, business models

1. INTRODUCTION

In Finland, industrial requirements have a stable roundwood supply in the forestry service market. It has been widely supported by the forest owners, the industrial buyers, and the national forest policy. (Mattila, O. 2015)

Demand and policies are among drivers for diversification and renewal of industrial sectors based on the renewable resources globally (Mattila, O. 2015). The global forest sector is increasingly diverse and interlinked with other sectors (Hurmekoski, E.; Hetemäki, L. 2013).

All forest-based sector services in Finland have extensive opportunities. New wood-based products have markets in demand along traditional products. (Hetemäki, L.; Hänninen, R. 2013)

2. THEORETICAL BACKGROUND

International market pressures are among influencing factors. Certification systems with standards may act as incentives in the markets and for market access. Policy and market can be influenced with market mechanisms, for example certification with a third-party system. (Cashore et al. 2012)

Forest certification has an important role in promoting a comprehensive concept of the sustainable forest management. The forest certification impact has a role to enhance a holistic concept of sustainable forest management. It constitutes an incentive driven approach which can be utilized in different applications. (Rametsteiner, E.; Simula, M. 2003)

3. SUSTAINABLE STRATEGIES IN THE EU AND COMPETITIVENESS, QUALITY AND BUSINESS MODELS IN THE BIOECONOMY

The EU Forest Strategy (2013) supports sustainable development, enhances Green Economy, contributes to Bio-based economy and combatting illegal logging, and fosters the competitiveness of the forest industry at the EU (COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS – The New EU Forest Strategy in 2013). The Strategy for years

2014-2020 was developed by the EU Commission in cooperation with the EU countries and stakeholders. It promotes sustainable forest management, enhances ecosystem services, Bioeconomy and competitive Green Economy. (Forest Strategy 2014-2020)

The Bioeconomy Strategy and its Action Plan for Europe aim to a society that is more innovative, resource efficient and competitive including the sustainable use of renewable resources for industrial purposes at the same time ensuring environmental protection. It provides opportunities and resources in the framework of climate change and for sustainable economic growth. (COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS Innovating for Sustainable Growth: A Bioeconomy for Europe 2012) The objective of the Finnish Bioeconomy Strategy is to generate new economic growth. The vision of the first Finnish Bioeconomy Strategy is the following: Finnish well-being and competitiveness based on sustainable bioeconomy solutions in the future. The strategic goals of the Bioeconomy Strategy are: A competitive operating environment for the bioeconomy; New business from the bioeconomy; A strong bioeconomy competence base; Accessibility and sustainability of biomasses. (Finnish Bioeconomy Strategy 2019). Nordic bioeconomy is of great economic importance. It includes industrial raw materials and products from the value chains to the markets and resource efficiency. (Co-operation Programme 2017–2020). In Finland, the role of sustainable forest management and Bioeconomy and collaboration with the United Nations, with the Agenda 2030, is highlighted in the new Finnish Forest Strategy. Quality, competitiveness, service and the role of policy is highlighted. (Kansallinen metsästrategia 2025 – päivitys VALTIONEUVOSTON PERIAATEPÄÄTÖS 21.2.2019)

4. SUSTAINABLE FOREST-BASED INDUSTRY PRODUCTS AND BIOECONOMY

The emerging wooden multistory construction, in the Nordic countries is the most evident construction-related new business opportunity in the emerging bioeconomy (Toppinen A., Röhr, A., Pätäri, S., Lähtinen, K., Toivonen, R.).

The rising Bioeconomy is a significant opportunity for innovations, for new products, exploring and developing new markets for forest sector enterprises. Business models of enterprises offer new products and services. Product innovation is high at the beginning of an industry's life cycle; process innovation is initially later in the life cycle (Hansen, E. 2016). Bioenergy and biomass-based products offer huge new opportunities for diversifying business in the forest cluster. There is a high demand for innovativeness and extensive thinking for the forest sector. Forest industry is the largest bioenergy user and producer in Finland and provides opportunities for the future. According to the research results, the most important competences that are needed in the forest cluster and biorefineries are product and technological innovation, knowledge of new markets, and business know-how. (Hämäläinen, S.; Näyhä A.; Pesonen H. 2011)

The circular economy belongs to the key contemporary policy goals both in Europe and in Finland. Wood products can serve as carbon pools during their life cycles and after. (Husgafvel et al. 2018) Policy measures to support secondary building materials should aim at the entire life cycle and different circular strategies. (Nußholz, J., L., K.; Rasmussen, F., N.; Milios, L. 2019) Circular economy is a regenerative system. (Geissdoerfer, M.; Savaget, P.; Bocken, N., M., P.; Hultink, Erik J. 2017)

Sustainable development appear to have growing importance in the marketplace. (Toppinen A., Röhr, A., Pätäri, S., Lähtinen, K., Toivonen, R. 2018)

Sustainability can be defined as a balanced integration of economic performance, social inclusiveness, and environmental resilience, to the advantage of present and future generations. (Geissdoerfer, M.; Savaget, P.; Bocken, N., M., P.; Hultink, Erik J. 2017)

5. CONCLUSIONS

Markets and trade have a significant role taking into consideration sustainable development and competitiveness. Customers are stakeholders in the sustainable development and green business.

Circular Economy constitutes a business model creating markets. Stratgical innovation has a key position in the Bioeconomy.

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Part 3
DIGITALISATION: FORESTRY AND FORESTRY BASED INDUSTRY IMPLICATIONS

3D PRINT APPLICATION IN FURNITURE MANUFACTURING

Jaroslav Svoboda, Jiří Tauber, Martin Zach

Abstract: 3D print technology is a new trend not only in furniture design but also in the field of automotive industry and engineering manufacturing. In 3D technologies (additive manufacturing field), 3D printing is at the forefront of technological innovations. The same applies for furniture and interior accessories. To create mecanical characteristics of a shaped component there can be several technologies used and several materials e.g. plastic, metal, ceramics etc. Some technologies allow colourful printing. 3D printing technology is rather linked to less traditional methods of machining (additive manufacturing field) but it is not a typical machining (conventional methods), where the material is removed from its semi-finished product. Here, on the other hand, the material is being placed in layers and the final product arises from that. 3D connections are therefore convinient in case a fast disassembly is needed, if one needs to reduce weight of the product or wants vaster variability of objects or colours. The products then function as a building set, which can be easily and quickly assembled and disassembled or transformed to a different variation. Checking of mechanical attributes concerning products made by 3D print technology is very important so the main attribute, which is functionality, can be fulfiled. Practical examples of 3D printing usage in design are covered in this article and 3D printing technology is applicable in educative process.
Keywords: design construction, furniture design, 3D print, prototype, materials

1. INTRODUCTION

The 3D print is unconventional machining method. It is not a classic machining process, where the material is removed from the blank, but instead it is added to the emerging part. It is technology of additive production. The final product is made by the gradual application of the material after very thin layers, which can be joined together, for example by gluing or melting. Unlike conventional production methods, 3D printers can create complicated shapes and designs that cannot be made by any other methods. The 3D printing is especially suited for the quick preparation of production for pieces and small-lot production. It is mostly used for prototype production.

Different types of 3D printers use different printing technologies that process different materials in different ways. It is important to know that the type of the 3D print and used material are the most basic limitations of 3D print – there is no universal solution suitable for all types of applications. For example, some types of 3D printers are processing powder materials (nylon, plastic, ceramics, metal), some are using light or heat source to cure (melt) merging individual layers of powder to form a defined shape. Other 3D printers use a liquid photopolymer, which is then cured by light or laser beam into extremely thin layers.

Figure 1. Mountain bike MX-6 Evo with titanium frame, which was made on SLM 3D printer. [1]

2. RAPID PROTOTYPING

With 3D printing, Rapid Prototyping (RP) is often closely associated. RP is a progressive set of technologies based on the principle of creating a computer model, spreading the model into thin layers and then processing it into a real product using a 3D printer. The data is created using 3D CAD programming systems. This technology is used in many industries – consumer, engineering, medicine, aviation, and it is being used in the furniture industry.

Figure 2. Alien chair, ABS-PC, author: Ing. Martina Šebková [2]

Table 1. Basic technologies of 3D print – Rapid Prototyping (RP). [8]

Basic technologies of RP	Shortcut	Model material
Stereolithography	SLA, SL	Photopolymer
Solid Ground Cutting	SGC	Photopolymer, nylon
Selective Laser Sintering	SLS	Polyamide, nylon, wax, metal powders
Laminated Object Manufacturing	LOM	Paper with one-sided binder
Fused Deposition Modelling	FDM	ABS, wax, polycarbonate
Multi Jet Modelling	MJM	Thermopolymer, acrylic photopolymer

The producing process is often divided to three main parts – pre-processing, processing and postprocessing. The first part includes all steps related to data preparing. For example, transfer of data from CAD software to STL file, where the geometric shape is divided to file of polygons. Final object is formed by tiny layers (0,2–0,05 mm) step by step as already mentioned and therefore it is necessary to secure the so-called supporting structure of the layers in a more complicated building to avoid collapse or deformation during printing itself. Supporting construction is not necessary for all 3D printing methods.

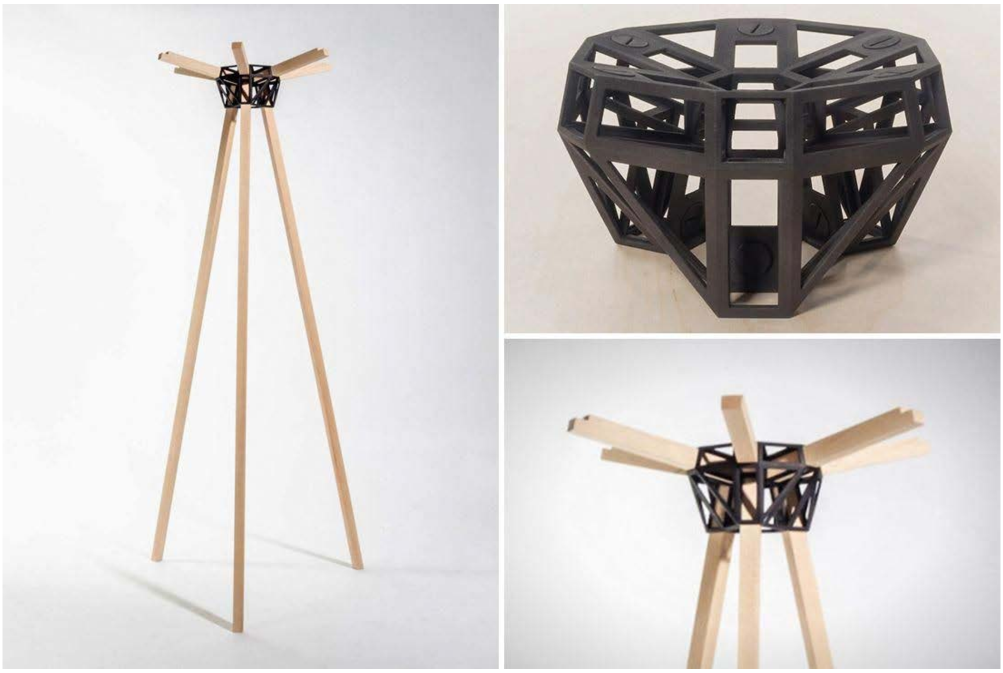

Figure 3. Example of printed 3D joints (Keystones). [3]

3. TECHNOLOGICAL ATTRIBUTES AND FIRMNESS CHECKING

Metodology of firmness checking: In phase 1, samples of various materials are being checked with full filling (100 % filling) and impact toughness values are being compared to results of solid wood (alder tree). In phase 2, 2 representing materials are being chosen (PC-ABS a PC), the materials are not expensive and correspond with alder tree impact toughness results. For each material, samples with 3 stages of filling are made (V1; V2; V3) and these samples are being tested and their firmness is checked. Afterwards, the results are evaluated.

The main requirement for sufficient firmness of the products is a fact that the printed components have the same firmness as the parts made of solid wood. One possible way of stressing the material is impact toughness, because it has significant influence on firmness and during this test (using Charpy's hammer, see figure 5) the breakage of particular layers of the material is being watched. That is why the samples printed on 3D printer were compared to wooden samples concerning the impact toughness (results measured during the testing). It was measurement (number of tests: 5 samples for each tested material) which compares checking of materials firmness due to impact toughness (acU) and values of absorbed energy are being watched at the same time.

To validate the test and its results, the measured values of absorbed energy must be in range of 10 – 80 % of nominal energy created by the hammer that has been used. In the testing, at least 10 samples are being researched. If the resulting variation coefficient (%) is lower than 5%, the number of samples is lowered to 5 peaces. In view od the fact that it is an experimanetal testing, it is convinient to carry on testing materials that are being used for 3D printing.

Nowadays, several wood manufactories also use a 3D printer called FDM. It is a model equipment using CNC milling machine and 3D printer as well. Printing by this method is based on using polymer materials (ABS, PLA, PET), however it is possible to use also carbon fibres or steel strings. [5]

Basic requirements for 3D printed parts cover mechanical endurance, dimensions precision and stability as well as roughness of the surface. Specific demands (mechanical demands, safety, ergonomy and dimensions, demands on stability) and exams needed due to EN are made based on the place of usage of the product and its function.

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Table 2. Overview of mechanical demands (technological characteristics)

Order of the demands	Mechanical demand	Measured value	Machine used for testing
1.	Impact toughness	acU [kJ.m-2]	Charpy's hammer – Impactor II machine
2.	Stability	Force F acting upon overturning (F[N]; M [N])	Exams due to ČSN EN 1022
3.	Roughness of the surface	Ry, Ra, Rz, Rmax [μm]	Machines measuring roughness ; Large-area 3D microscope

The testing sample was constructed in a way that it meets all demands of regulation ČSN EN ISO 179-1 and the testing of impact toughness is made following this regulation. To create samples with full filling from 3D printer (Fortus 400 mc machine), following materials were chosen: ABS, PC, PC-ABS, Nylon 12, Nylon 12CF. [4]

The basic condition of the process is leaving the samples in the printer for some time afrer the printing process is finished (to stabilize them), because it lowers their temperature. In case the samples are removed from the printer too hot, it might cause cracking and deformation due to temperature shock.

Before testing the impact toughness, the non-wooden samples were put into an air-conditioned chamber for 6 weeks in phase 1 and for 5 days in phase 2.

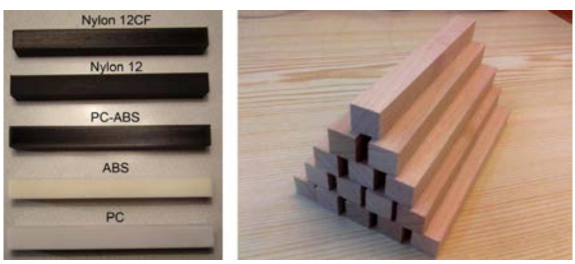

Figure 4. a) Testing samples on 3D printer; b) Wooden alder tree samples [4]

The most common wooden parts for creating model equipment are: alder tree (OL), pine tree (BO), spruce (SM) and birch tree (BR). For the testing we made, alder tree was chosen. Alder tree belongs to the most used woody plants for models equipment. Its positive characteristic is good manual and machine- operated processability and also its shape and dimensions stability. Before testing the impact toughness, the samples were placed into an air-conditioned chamber for 6 weeks, so the absolute humidity of the wood after drying was 12 %. [4]

The testing was made following the ČSN EN ISO 179-1 regulation. The core of this testing is to breake a sample placed horizontally. The hitting is made by impact hammer, which is led through the middle part in between the props. The tested body is being broken by a constant speed. The result is knowing the exact energy we need to break the sampple, which is called impact toughness. [9]

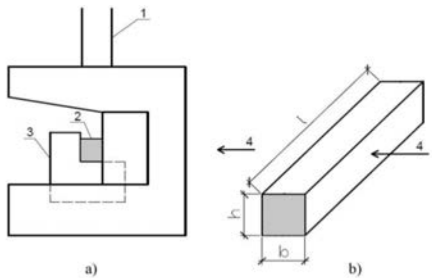

Figure 5. Scheme: a) Charpy's hammer at the point of the impact, b) Tested sample (ČSN EN ISO 179-1) Legend: 1 – The impact hammer pole, 2 – Tested sample, 3 – Support, 4 – Direction of the impact b – width of the sample, h – thickness of the sample, l – lenght of the sample [9]

As already mentioned, the testing was made in order to verify the firmness of the materials chosen for 3D printing with full 100% filling. This testing was used likewise when verifying firmness of materials with printing filling of 60 %, 50 %, 42 %. The reason is to find out the firmness of the material, but more importantly to verify the construction joint of any product. We will talk about this in the next chapter.

The results and its evaluation from the faze 1 are following: The longest brekage happened with the alder tree. ABS and PC-ABS have tooth shaped breaking. PC, Nylon 12CF and Nylon 12 have smooth breaking. Watching the surface of the breakage of PC and Nylon 12 we can see that the fibres are not very visible and the sample seems to be more compact compared to others. On the other hand, observing ABS and PC-ABS samples, we can visibly see the fibres on the surface of the breakage. Nylon 12 CF shows layers of the material, but we can not clearly see the fibres itself (Figure 6). [4]

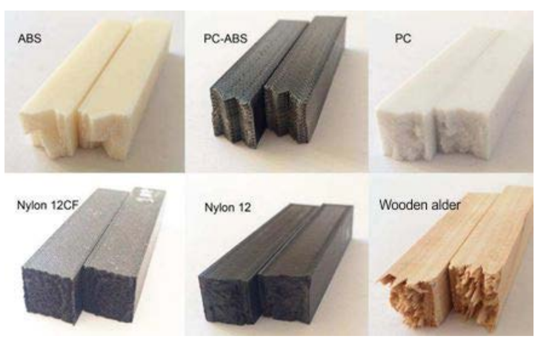

Figure 6. Broken samples and point of the breakage [4]

In the next step (phase 2), 3 variations of printing were chosen (V1; V2; V3). Variations of 3D print have different percentage of filling of the sample: V1 has 61% filling, V2 has 50% filling and V3 has 42% filling (figure 7).

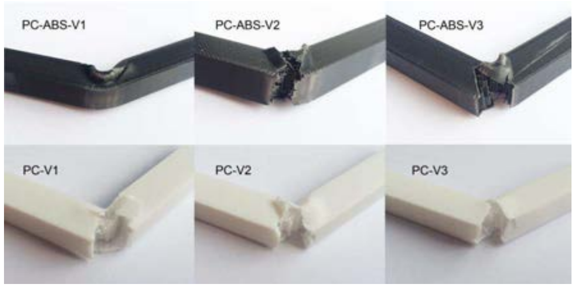

Figure 7. Cracked samples and point of the breakage [4]

In figure 7 one can see broken samples. The breakage was complete with most of the samples. As one can see on the pictures, the unbroken part was only the one hit by the hammer. Samples PC-ABS-V1 were only deformed but not completely broken (Source: Hracki,2019). The resulting values from the phase 2 are shown in table 3. Testing for impact toughness was made for chosen materials (PC-ABS, PC) and their printing variations (V1, V2, V3).

Table 3. Values of impact toughness testing and statistical processing.
Source: Personal contribution according to Hracki (2019)

Number of the sample	PC-ABS-V1			PC-V1		
	Ec [J]	Abs.en. [%]	a_{cU} [kJ.m^{-2}]	Ec [J]	Abs.en. [%]	a_{cU} [kJ.m^{-2}]
1	17,93	71,99	102,68	18,30	73,20	105,28
2	20,35	81,71	116,53	10,81	43,25	62,20
3	18,20	73,10	104,25	9,97	39,89	57,37
4	21,65	86,94	124,00	9,00	36,01	51,79
5	20,88	83,83	119,60	2,68	10,72	15,42
6	23,84	95,35	136,83	2,54	10,14	14,59
7	24,56	98,26	141,00	10,30	41,22	59,28
8	24,86	99,45	142,71	14,71	58,85	84,65
9	24,91	99,64	142,99	9,47	37,87	54,47
10	24,91	99,63	142,97	21,54	86,16	123,92
Average	22,21	88,99	127,36	10,93	43,73	62,90
Direction deviation	2,64	10,43	15,27	5,72	22,87	32,89
Var. koef. [%]	11,89			52,30		
	PC-ABS-V2			PC-V2		
	Ec [J]	Abs.en. [%]	a_{cU} [kJ.m^{-2}]	Ec [J]	Abs.en. [%]	a_{cU} [kJ.m^{-2}]
1	14,03	56,07	80,28	16,19	64,76	93,29
2	12,88	51,52	73,71	11,30	45,21	65,13
3	13,82	55,28	79,09	9,64	38,57	55,56
4	14,76	59,06	84,50	9,55	38,22	55,06
5	14,04	56,18	80,37	8,03	32,11	46,25
6	13,53	54,10	77,40	7,84	31,36	45,18
7	13,66	54,66	78,20	6,01	24,06	34,65
8	12,02	48,09	68,80	4,19	16,74	24,12
9	16,07	64,30	91,99	6,76	27,04	38,95
10	11,67	46,69	66,80	6,96	27,83	40,08
Average	13,65	54,59	78,11	8,65	34,59	49,83
Direction deviation	1,21	4,84	6,92	3,16	12,65	18,23
Var. koef. [%]	8,86			36,58		

	PC-ABS-V3			PC-V3		
	Ec [J]			Abs.en. [%]		
1	6,01	24,06	34,47	5,55	22,22	32,03
2	6,30	25,21	36,13	3,01	12,05	17,38
3	5,43	21,72	31,12	3,18	12,71	18,32
4	5,92	23,67	33,92	2,64	10,56	15,22
5	5,68	22,72	32,56	3,14	12,54	18,08
6	5,49	21,97	31,48	3,26	13,04	18,80
7	5,59	22,34	32,02	5,84	23,36	33,67
8	6,06	24,25	34,75	5,38	21,53	31,03
9	4,95	19,80	28,37	3,78	15,12	21,79
10	5,63	22,53	32,29	3,69	14,78	21,30
Average	5,71	22,83	32,71	3,95	15,79	22,76
Direction deviation	0,37	1,46	2,10	1,12	4,49	6,48
Var. koef. [%]	6,41			28,45		

Values of absorbed energy for material PC- ABD are over 80% so it is not really eligible. Values of absorbed energy for the rest of the materials are in range of 10-80 % and the results are valid. PC material shows much larger variability for all printing variations than PC-ABS material. The lowest average values of impact toughness has PC-V3(22,76 kJ.m-2). The highest average values of impact toughness has PC-ABS-V1 (127,36 kJ.m-2). [4]

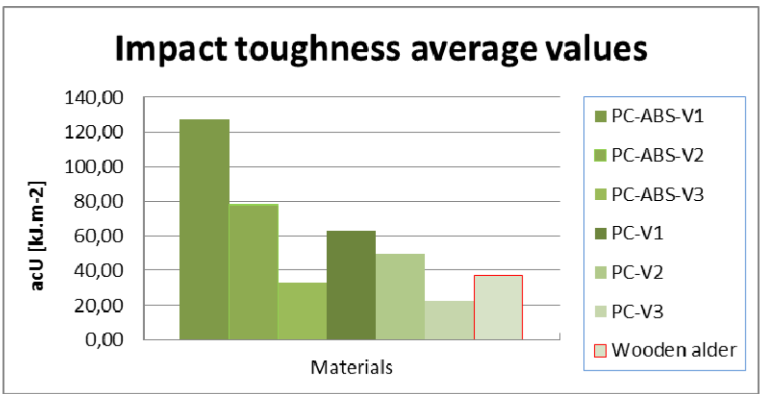

Figure 8. Impact toughness average values. Source: Personal contribution according to Hracki (2019)

Figure number 8 shows impact toughness average values dependence of material PC-ABS and PC for individual printing variations with partial filling V1, V2, V3. According to the testing, materials PC-ABS-V1, PC-V1 and PC-ABS-V2 shows higher values of impact toughness than alder tree samples. In conclusion, we can say that the research gave us these facts and conclusions. It is not convinient to print samples with 100% filling. In general, it is recommended to print with maximal filling of 61%. This option of printing has approximately 35% lower costs for printing than the option with 100% filling and the printing time is shorter as well. At the same time, the firmness of the material is accurate.

4. A NEW PRODUCT DESIGN

A coat rack called Narrow (figure 9) demonstrates using a 3D printed detachable part. This work shows new trends applied in the field of furniture industry. The coat-rack combines two materials, thermoplastic and solid wood. It gives the impression of being very subtle and airy when placed into an interior. It is possible to make it in several colourfull variations. 4 colourful prototypes were created in these colourful variations: white beech + black printed joint, natural beech + brown printed joint, stained beech + white printed joint and black beech + white printed joint. Material and colourful variability is not limited and therefore it is possible to use the coat-rack in a modern interior as well as in rustic interior. The dimensions of the whole product are 1800mm, width of the base part is 600mm, height of the printed part is 250 mm. Better function of hanging was made thanks to notches in the wooden part which are meant to hold loops of the clothes hanging. The coat-rack has good stability even if it looks subtle and even if its fully loaded.

Figure 9. Narrow – coat rack, Author: Martin Holas (2018)

Design and manufacturing of a new construction joint as a furniture part is shown in figure 10 and 11. The construction joint is made thanks to 3D printing technology. To produce this contruction joint, it was neccessary to use 44,12m of filament and the printing took 1 day 5 hours and 43 minutes. The material used for the first experiment of 3D printing was PLA.

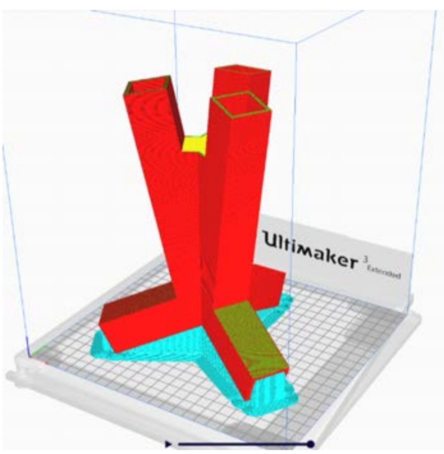

Figure 10. Setting of the printing for the construction joint

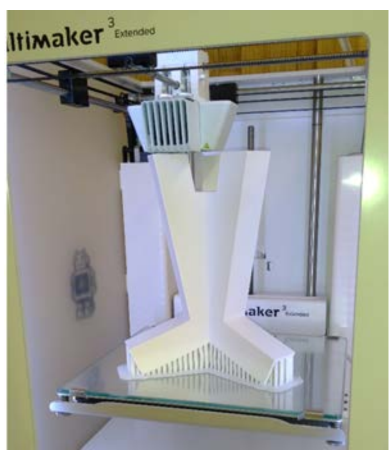

Figure 11. Printing of the contruction joint

5. DESIGNING NEW FURNITURE PRODUCTS WITH 3D TECHNOLOGIES

Several furniture products (interior parts) were designed in the Atelier of furniture models by students. The condition was to create the whole product and use 3D printing for the construction joints of the product. 25 functional models were designed and made and each model is made using 3D technology printing for the construction part. These are absolutely unique student's designs, which will later be tested for firmness according to the future place of usage. The result is a wide range of products – products for hanging clothes, end tables, coat racks, independent solitaires, coat stands and lighting. Example is an elegant coat rack made from solid wood (figure 12); flower stand etc. The authors present through this article the first projects that are using 3D printing in the area of furniture design, especially using of additive production in education process of Mendel University in Brno.

Figure 12. Example of a product from the Atelier of furniture models

6. SUMMARY

The 3D printing is becoming the forefront of technological innovations within the detachable joints. Several technologies and source materials can be used in production so the mechanical properties will depend on the chosen materials. For some technologies, even colour printing is possible. The 3D printer can also produce what is impossible for conventional machine tools. We talk mainly about the shape. For conventional machining, the shape is limited by the shape of the tool, while 3D printing allows to create any complex shape without unnecessary waste, because the incoming material is being layered and the new product is made thanks to 3D printing. Due to demands we have on the final product or construction joint we choose to pring with full filling of partly (hollow) filling. The main purpose of this typological optimalisation is lowering the weight and keeping the same physical properties. It is possible to test the demands of the whole product or its construction joints rigt on the product using appropriate testing method. Or one can use computing softwares, simulate the stress and consider its qualities.

That is the reason why 3D contruction joints are useful for example at places where the demands are fast dismantling, reduction of weight, variability of the objects or colorful variability. The products then work in the basic modul, which can be put together easily, extended or transformed into more variations. Another advantage of 3D printing with partly (hollow) filling is saving the time when printing.

From the economic point of view, for this type of products, it is convinient to use 3D printing using PC-ABS materials (that has not been used widely yet) and PC material (which is being used in modelling department). ABS and Nylon 12CF materials are not convinient due to low values of impact toughness (the values were measured) compared to a standard material which is alder tree sample. The values of impact toughness for chosen materials and its variations of 3D printing are evaluated in chapter 3. The full printed samples have lower variability of values of impact toughness than samples with partly (hollow) filling. The full samples are definitely more homogeneous than the hollow ones. There are big differences in between the variations of 3D printing (V1; V2; V3) of PC-ABS and PC, the PC values reach 5 times higher variation coefficient.

It can be assumed, that if the materials used for 3D printing with full filling have similar values of impact toughness compared to a solid wood, it will be the same with partly (hollow) filling. So the resulting values will be similar even if we use another material with the same thickness of the side filling.

For practical use of PC-ABS material for 3D printing, it is good to choose variation V3, which has similar values of impact toughness as solid wood (alder tree samples).

This article gives a good exaple that additive manfacturing (3D technology printing- FDM method) can be used in education process of university invorenment.

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CONSEQUENCES OF DIGITALISATION ON OFFICE FURNITURE DESIGN

Milan Šimek, Lukáš Fictum

Abstract: The article describes and explains current trends in office furniture design as a result of digitalisation. The main change came about when companies switched to non-paper office, which means support for digitization through electronic documentation. Currently the office layout can be free of cabinets and bookcases as folders and other documents are not stored in paper form anymore and designers focus more on office workplaces, spaces for meetings, relax and eating zones. This trend goes hand in hand with the modified concept of part-time employees who share workplaces (students, mothers with little children or consultants). This brings cost reduction, because nowadays companies can buy less office furniture and save on office lease. These universal workplaces are listed in online reservation systems. The modern workplace that should serve various employees consists of a height-adjustable worktop (sit-stand solution) and an ergonomic chair. Each place should have lighting, acoustics, and monitor position (on adjustable arms). On most installations there are no cabinets for computer clients because employees have their own laptops and within the company they work on a server or in the cloud. Specific examples of the new type of office furniture designs are presented and explained on successful projects.
Keywords: office design, sit-stand desk, non-paper office, desk accessories

1. INTRODUCTION

Work on laptops or desktop computers is an activity that is constantly expanding with the gradual automation of every conceivable production process, and the boom of new office space is ongoing practically all over the world. This brings new challenges for the creators of these spaces – the companies, developers, architects and furniture designers. Increasing demand for quality work environment accelerates the development of new products to enable people to spend time in the office efficiently and pleasantly at the same time.

Computerized administration is growing and, due to global economic growth it is very difficult for many companies to find full-time qualified workers. Thus there are countless part-time jobs and these people no longer have their own offices or personalized cubicles, but often work in open-office common areas where people share work desks, one person in the morning, another in the afternoon. As their entire agenda can be carried with them on their laptops, and corporate data are accessible everywhere through cloud data connectivity. Companies are investing in humanizing the work environment to make workers feel natural and as undisturbed as possible to concentrate on their jobs. In the following article we will describe the reasons for the emergence of new concepts and present the key elements of office design in which companies invest.

1.1. Today's Office Concepts

Thanks to the flourishing of technology and modern research, where the words "productivity" and "efficiency" are still in their infancy, the concept of "office" begins to change. A number of companies employ sociologists, psychologists, designers, managers, recruiters, doctors, and others to explore the work environment to put together the best working environment concept. The issue of workplace noise is being discussed today, and companies are preoccupied with who comes up with a better suggestion.

Another topic is "creativity and flexibility" in connection with new technologies. All these considerations were best conceived and linked by Herman Miller Design Company and their concept presented in 2014 called Living Office (Figure 1). Living Office creates a diverse office landscape and creates a space for workers to look forward to, and to increase their commitment to the company's job target (Herman Miller Inc., 2014). Newly furnished spaces are more similar to blending with the home environment. We can find here places like kitchens with high counters, spaces with sofas for relaxation, such as swings, or for meetings, lots of writing surfaces, rooms where the worker can do sports and many more. One of the examples of creative worklands can be Google's frequently mentioned spaces in Dublin (Figure 1). Google offers its employees diverse colour spaces with greenery and different worklands, where they can do private work, do sports, wash and iron their clothes, choose from several types of catering equipment and the like. It is not typically a workland concept that could be applied everywhere. Google is creating a community but there is also a negative influence, i.e. removing the boundaries between private and working life.

Nevertheless, more and more worklands are being created across the world, both in large corporations and in small and medium-sized enterprises. We must realize that this type of office is very helpful in the development of modern technology and that we can carry our office in a bag with us. In our electronic devices we can have all the applications for collaboration, so we only need a tablet, laptop or cellphone with internet connection and we can work from anywhere. This trend, i.e. home office or work from home, where people spend a week in an office and work weekly from home or from a café, means that work can be performed from anywhere. This situation can save creation of numerous jobs in companies. One such company is IBM, which has begun to provide this kind of working conditions to its employees due to a physical lack of desks and chairs.

However, according to the literature, this style of work is not suitable either, and people often become workaholics, and the boundaries between work and personal life are blurred. The internet and new technologies have connected the world and people have access to data and people all over the world, which leads to the creation of more sophisticated online collaboration tools. Companies use online collaboration silos and, as a result, physically displaced people do not meet their social needs. Therefore, in the last few years a shared workplace of the HUB or co-working spaces began to emerge. Here, people from different disciplines or freelancers rent a desk and can work with other people. These spaces are inspiring and challenging and often serve as start-up fixtures (Myerson, 2016).

Figure 1. Google offices in Dublin and Living Office (Herman Miller)

1.2. The evolution of an office worker

Due to the rapid development of digitalisation and technologies the behaviour of people is changing very quickly and, in particular, the generational differences are deepening. Generational diversity is one of the features of today's workplace. Sociological and demographic surveys divide the human population from the 1940s to the present into the following generations: baby boomers (born between 1943 and 1964), generation X (born between 1965 and1980), generation Y (born between 1981 and 2001) and generation Z (born 2002 and later). Many sociologists are trying to find universal instructions on how to work with the whole population. There are elements of behaviour that can be associated but cannot be generalized.

Generation X (born between1965 and 1980): This is a generation that grew up in Czechoslovakia, in the period of communism. There was a turning point in their productive age when they began their careers, started families and witnessed the fall of the regime and the wild atmosphere of the 1990s, the opening of the market for business and innovation opportunities. With the opening of the market the sales and import of furniture from abroad experienced a huge boom.

This generation is very responsible and independent. People from this generation are looking for long-term work and their turnover rate is low. Within their productive age, there was a technological boom (internet, mobile phone, personal computers, etc.). Quite often, this generation is labelled as a generation of workaholics who cannot separate their personal and private lives. (Colliers, 2012).

Generation Y (born between 1981 and 2001) are the followers of the X generation. They have the opportunity to use modern technologies and interact with them, which they use as leisure activities – various chats, Facebook, Twitter, etc. Some of them started to make money on these platforms. Sometimes this generation is also referred to as a global generation, regardless of the location of the country in which they grew up or find themselves. One of the claims of sociologists about this young generation who is coming to the labour market in their most productive age is that these people are more focused on their free / leisure time and personal development. The reason may be the fact that their parents (i.e. generation X) were often at work and had no time for their children because they wanted financial security for themselves and their descendants. And when the Y generation started working, a crisis came and most of them could not find employment and met with a lack of market interest. They became sceptical, which is often confused with laziness today (Biler, 2015).

Unlike Generation X, Generation Y works differently. They are not so dependent on one job, for them flexibility is substantial, they work interactively with Google discs and other tools, they are better at mastering foreign languages than the previous generation and are used to travelling for work. However, they still keep their personal space (Urban, 2016).

The reason why this phenomenon needs to be dealt with is that by changing the style of work and accessing work together with technology and new information, it is advisable to translate this knowledge into a business company strategy and make it a competitive advantage.

2. CURRENT TRENDS

Working desks and chairs are still the most important furniture in each office and there are a couple of trends that keep appearing among many producers. Due to digitalisation and the effort to save the leasable office space, the desks are reducing their dimensions. In the 20th century, office working tables had to carry large paper folders and deep and heavy monitors at the end of the century, whereas nowadays, with the use of LCD or LED display panels, they can be much slimmer.

Lighting conditions for office work are the alpha and omega not only of the working environment. Light influences our biorhythm and ensures our safety of movement in space. We need to see and be seen and have contact with sunlight, which is a source of light and heat for us. The amount of daylight in the interior is essential for working comfort and performance. However, in the working environment, we often encounter associated lighting, or a combination of daylight and artificial lighting. The point is that people have to do their job regardless of the season, whether it is cloudy or the skies are clear. For the economy of the company and the country, constant work performance with a consistent commitment is essential. That is why many specialists today are concerned with workplace lighting and workers' visual comfort.

Acoustics in the working environment is also a very important issue, because of the fact that noise in the workplace over 65 dB greatly reduces concentration and labour productivity decreases by 71% (GSA Public Buildings Service, 2011). That is why most companies have started to deal with finding a solution for noise in the workplace and create various audio retarders. It is necessary to realize that nowadays acoustics combines with design in two ways: firstly – the sound emitted by the use of the product and secondly, space acoustics – acoustic properties of material from the point of view of creating acoustic well-being (Clapperton, 2014). The next stage, and that is much more frequent, is the adjustment of an unsuitable architectural solution with the help of acoustic elements, such as acoustic screens, vertical and horizontal wall cladding, special acoustic flooring (foot mats), tiles, ceilings or construction of new walls, which will divide the space and absorb the sound. Typical examples of office sounds are PC keyboards, humming air conditioning sounds, computer technology sounds and more (Luscombe, 2016).

During the last half of the century the dimensions of a writing desk came from depth 800, width1800 (2000) mm to narrow ones of depth 700, width 1600 mm. In specific jobs like call centres they even come only to 1200-1400 mm of width. At the same time a base of a desk does not carry built-in drawers for stationery, paper files, personal necessities, but is usually provided by a compact container on rollers and its construction is much easier – a working plate and a couple of steel legs or a bench base.

Figure 2. Layout Studio Exchange (Herman Miller) and Only2 bench (U1)

2.1. Height-adjustable desks

Desks have become height-adjustable and specific designs can be found in each producer's offer, from the economical ones that can be operated manually to more complex ones that work with electricity and can be joined together to bigger groups of 4, 6 or 8 working places (Figure 2, Figure 3).

Human bodies are made to move. Height-adjustable desks promote health and well-being by encouraging a dynamic approach to how individuals work. This is so important because research shows that when human bodies are static, they risk health issues, such as fatigue and musculoskeletal injuries. Prolonged sitting can even lead to long-term conditions, such as heart disease. Nearly 70 percent of all collaboration happens at the desk. To facilitate the free flow of ideas and knowledge sharing, individual workspaces should adapt to the needs of more than one person. Individuals can modify their workspace and stand shoulder-to-shoulder or sit side-by-side, which is unifying and energising (Herman Miller Inc., 2014).

While the traditional solid office desks have the top surface at the level of 735-770 mm, their modern adjustable interpretations can reach a range from 670 to 1200 mm. Former designs of height adjustable desks used to have a variety to adapt between 670 and 850 mm in order to deal with work on keyboard and writing on paper. However, this range only met different requirements on desk height for a sitting person and not for active movement of the body. To deal with the problem the sit-stand solution was developed. It had an influence on the desk design base because the higher the range is, the more robust and stable it must be, nowadays almost entirely made of painted steel profiles.

Figure 3. Desk Skarsta (Ikea) and CDS Workstations (Vitra)

2.2. Modern chairs

In the seventies, people were starting to recognise that sitting in an office all day was not good for them. Back problems were rife, and a solution was needed. The invention of ergonomics office seating happened in around 1970. Chair design suddenly became a scientific rather than a business concern, and in 1976 Ergon led the way for ergonomically designed chairs. Years of research had yielded information about how our backs need support when we are sitting, and now there were chairs that could provide it for us (Figure 4). The original Aeron was released in 1994 by Herman Miller Design Company. It introduced a revolutionary new fabric to the world of office chairs – Pellicle mesh. This fabric allowed the air to circulate through the chair, letting workers' skin breathe and keeping them cool. Not only that, but it looked fantastic; a futuristic vision in mesh and chrome. The iconic design is still revered today and seen as a symbol of status and power.The latest wave of must-have office chairs are not chairs at all, but alternatives designed to promote what has been coined 'active sitting'. Things such as over-sized exercise balls, saddle chairs and perch stools are all being used across the globe as a healthier alternative to sitting still. These seats keep the core muscles gently active throughout the day, relieving tension and preventing spine compaction (Lovell, 2016).

Figure 4. Chairs Ergon, Aeron, Cosm (Hermann Miller) exercise ball chair and a treadmill desk

The modern designs of the office chair work with the fact that most of the users rarely use the fine adjustments for the seat and the back and only know how to adjust the height of the chair overall. This is more obvious in the offices where few workers share the same chair. This design came into being in Herman Miller Cosm Chairs (2018) – Auto-Harmonic Tilt. The tilt instantly and automatically provides balanced support and movement, depending on the sitting human body and posture (Figure 4). As a future trend, there is the integration of a load sensor into the chair seat that gives the building management system current occupancy and the output of ventilation and air condition is optimized.

This is already integrated in Herman Miller Cosm Chairs for 2019 in North American market and coming to European countries in 2020.

2.3. Monitor arms

Monitor arms were developed for adaptiveness and usability, allowing for simple synchronicity between devices. They can combine a screen and a laptop and enable mobile/hybrid workers to use their laptops as a secondary screen when in the office. Improving ergonomics and efficiency, the monitor stand is the perfect addition to the modern workplace. Integrated into a 3-point format to create a neat and tidy workstation (Figure 5), the dual monitor arm setup promotes efficiency through modern aesthetics and workplace design (Colebrook, 2019).

Figure 5. Monitor arms (Colebrook Bosson Saunders)

2.4. Phone booths and small acoustic spaces

To improve acoustic conditions in offices, and especially in open areas, it is recommended to use phone booths and small acoustic spaces. These meeting pods and phone booths absorb and block noise, but their main function is to decrease the conversational noise. When employees use pods for making calls or for participating in video conferences, they have the privacy for themselves, preventing any disturbing of their colleagues. Larger meeting pods are a good place for confidential meetings, brainstorming sessions and important one-on-one discussions without disturbing the whole office – or the office being a disruption (Framery, 2019). Acoustic pod placement within offices is also a social cue. Pods are meant to be placed close to people, where the pods will act as a social cue. In doing so, ad-hoc meetings are welcomed and making phone calls from inside is endorsed. People should be encouraged to meet spontaneously and make the most of these meetings. Sudden, unexpected discussions are highly efficient as we generally take time only as long as needed in these situations (Figure 6).

Figure 6. Booths by Framery and Silent-lab

3. CONCLUSION AND DISCUSSION

Digitalisation has brought about a change in office use, higher user demands for comfort, and more frequent shifting on desks. In addition, there is a growing demand for designing and furnishing complementary parts, such as relaxation zones, hot seats for hybrid / mobile workers, or acoustic measures to separate telephoning workers either in open space by dividers or moving them into separated telephone booths. Spatial acoustics can be taken into account at an early stage with architectural design of offices through the use of noise absorbing material and also by spatial solutions, such as avoiding giant auditoriums, monolithic concrete and open space offices where the sound is usually very bad and people are in long-term stress. Another situation, and that is much more frequent, is the adjustment of an unsuitable architectural solution with the help of acoustic elements, such as acoustic screens, vertical and horizontal wall cladding, special acoustic flooring (foot mats), tiles, ceilings or construction of new walls which will divide the space and absorb the sound.

From the furniture point of view, we see a new wave of requirements for the redesigning of traditional elements, such as chairs and desks. This influences their design and construction, but adds new features, enhancing their comfort qualities and, last but not least, better compensating for long unhealthy sitting that is unnatural to the human body. Bad posture, organ damage and soft bones – sitting for too long and sitting improperly causes a wide range of potential side effects. While a good office chair can certainly help to combat some of these consequences, workers also have to make a conscious effort to stand at their desk, walk and stretch throughout the day. Moving forward, it is likely that the office chair will return to being more of a tool for productivity than a place where we spend most of our waking hours.

Digitalisation speeds up the development of the traditional furniture industry. Specifically, the furniture market is expecting the emergence of new furniture elements, above all those related to acoustics and equipment of small relax zones or non-traditional spaces for meetings and communication and, last but not least, office accessories (monitor holders, interactive writing boards, etc.). Thanks to research and trends in the development of offices, it is possible to predict that the appearance of the office in the next decade will change considerably in view of the technological revolution in which we find ourselves.

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FIRE BEHAVIOUR OF 3D PRINTED PLA AND WOOD/PLA COMPOSITES

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Abstract: Additive manufacturing technologies have achieved great development in last decade on area of technology and printing materials. Special emphasis is placed on the development of materials that would be cheaper, from natural sources, without releases of harmful substances during the manufacturing process and usage, with the possibility of using waste materials and recycling after service life. Wood or wood residues are one of the potential raw materials that could be used for 3D printing in combination with natural and synthetic polymers. It is anticipated that with the development of additive technologies, the use of wood-plastic composites will also expand to the area of structural elements, for example, in the construction of prefabricated houses. The fire behaviour of 3D printed wood/PLA specimens was determined according to ASTM E 2058 standard and microscale combustion calorimetry (MCC) with ASTM 7309-13.
Key words: reaction to fire, cone calorimeter, wood, polylactic acid, filament, 3D printing

1. INTRODUCTION

Polymers are known for their relative high flammability attribute and tendency to produce toxic gases, as compared to their counter parts, upon combustion [1,2]. Polymers used in wood-plastic composites (WPCs) burn and drip in case of fire, resulting in a very risky scenario. Burning plastics may produce hazards such as the evolution of toxic gases, loss of physical integrity, and melting and dripping, thereby providing other ignition sources [3]. Fire safety engineers use the heat release rate (HRR) of objects and components to predict and model fire spread in a room. The heat release rate of materials in a room will dictate how fast the area becomes untenable. In the last 30 years, the development of novel numerical models for fire characterization has been supported by the use of modern experimental devices like ISO 5660-1 (similar to ASTM E1354) cone calorimeter, which can be considered as the most significant bench scale instrument for fire testing and for measuring the heat release rate (HRR) of a specific material. The HRR evaluation is based on the oxygen consumption principle, which states that, for complete combustion of a wide range of fuels, 13.1 (5%) kJ of energy is produced for every gram of oxygen consumed by the fire [4]. 3D printing is an attractive technology that offers numerous new possibilities for the manufacturing of products. It enables users to create real objects based on a virtual computer model and thus opens up an almost unimaginable number of possibilities. It enables users to create real objects based on a virtual computer model and thus opens up an almost unimaginable number of possibilities [5]. The development of 3D printing has seen extraordinary growth over the past few years. The wood based filaments used in the production of 3D printed specimens are produced from thermoplastics and wood or other plant fibres. As organic materials, i.e., polymers and wood, are sensitive to fire. The raw material type and printing parameters are two important factors affecting the flammability of the 3D printed specimens. Advantages of using wood as reinforcing filler in plastics include low cost, high relative strength and stiffness, low density and the fact that it is a natural resource. In this study, the flammability of the 3D printed neat PLA and commercial wood/PLA specimens were tested using a fire propagation apparatus (FPA) and the results were compared with each other. Mircoscale combustion calorimetry with ASTM 7309-13 was also adopted to test the flammability in microscale.

2. MATERIALS AND METHODS

2.1. Biodegradable polymer-blend based on polylactic acid

Commercially fabricated wood/PLA filaments (30 wt% wood and 70 wt% PLA) having a diameter of 1.75 mm were used in the manufacture of 3D-printed specimens. The commercial wood/PLA filaments were purchased from a 3D filament seller in Slovenia. The polymer was biodegradable polymer-blend based on polylactic acid. Two different colors (ligh brown and dark brown) of commercial wood/PLA filaments having the same contents of wood flour content and additives were used. The 3D printed model was made from solid layers on the bottom, top, and sides, but inside was a mesh structure.

The filament types were used in the experiments are given below:

1. Clear samples:
Neat PLA
Biodegradable polymer-blend based on polylactic acid.
2. Wood PLA Light brown:
Polymer-blend based on PLA filled with 30% wood fibres and additives
3. Wood PLA Dark brown:
Polymer-blend based on PLA filled with 30% wood fibres and additives

2.1. Production of 3D-printed wood/PLA specimens

A Zortrax M200 3D printer (Zortrax, Poland) was used to print our test specimens using 3D printing FDM technique. The printing parameters are given below:

- Layer thickness: 0.19 mm
- Infill ratio: 80%
- Extrusion temperature: 225 °C
- Bed temperature: 50°C

Three specimens with dimensions of 100 x 100 x 10 mm (thickness) were used in the experiments (Fig.1).

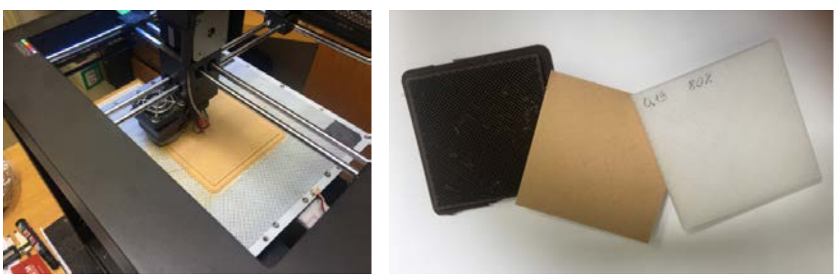


Figure 1. The production of 3D-printed wood/PLA composite material samples using a Zortrax M200 3D printer

2.2. Determination of fire resistance of the 3D printed specimens

Standard test methods for measurement of material flammability using a fire propagation apparatus (FPA), which was ASTME 2058-13a [6] was used. The specimens were conditioned in standard climate before the tests. This fire-test-response standard determines and quantifies material flammability characteristics, related to the propensity of materials to support fire propagation, by means of a fire propagation apparatus (FPA). Materials to be analyzed consist of specimens from an end-use product or the various components used in the end-use product. Results from the laboratory procedures provide input to fire propagation and fire growth models, risk analysis studies, building and product designs, and materials research and development. Ignition of the specimen is by means of a pilot flame at a prescribed location with respect to the specimen surface. Three incident heat flux, 25, 35, and 50 kW/m^2, were used. Three replicate samples were tested for each type of specimen (Figure 2) .

Figure 2. The FPA test set-up

MCC tests were conducted with a MCC-3 located at Nanjing University of Science and Technology, as shown in Figure 3. Specifications of the MCC-3 instrument are as follows,

1. Sample Heating Rate: 0-10 K s^{-1}
2. Gas Flow Rate: 50 to 200 cm^3 min^{-1}, response time of <0.1 s, sensitivity of 0.1 % of full scale, repeatability is ±0.2 % of full scale and an accuracy of ±1 % of full scale deflection.
3. Sample size: 0.5-50 mg (milligrams).
4. Detection Limit: 5 mW.
5. Repeatability: ± 2% (10 mg specimen).

Pyrolyzer heating temperature was from 75 to 600℃, and combustor temperature was set at 900℃.

All tests followed the “Method A” procedure of the MCC. Specimen of MCC test was taken from the sample panels. The specimens were prepared with nominal specimen mass of 2.50 mg. A heating rate of 1.0 K/s was selected.

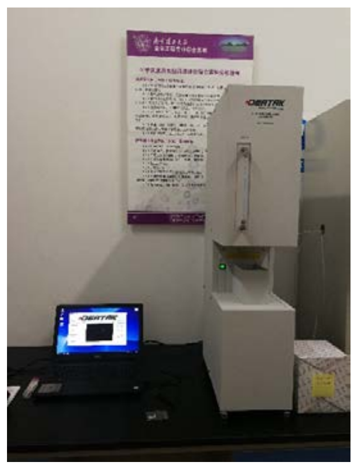


Figure 3. The MCC set-up

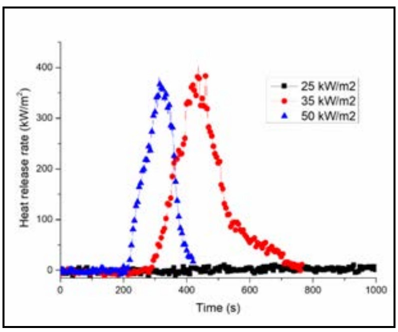
RESULTS AND DISCUSSION

The comparison of the peak heat release rate (pHRR) and total heat release (tHRR) of the 3D printed Neat PLA and two different color wood/PLA specimens are given in Table 1.

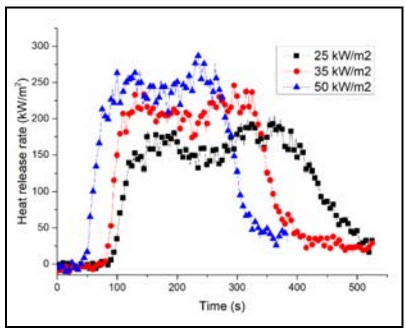
Table 1. Test results of the 3D printed specimens from Fire Propagation Apparatus (FPA).

3D printed sample code	Incident heat flux (kW/m^2)	Time to ignition (s)	Time to flameout (s)	Initial mass (g)	Residue mass (g)	pHRR (kW/m2)	Time to pHRR (s)	Total heat release (MJ/m^2)
Neat PLA-1	25	/	/	/	/	/	/	/
Neat PLA-2	35	272	663	53.17	9.53	403.58	437	60.96
Neat PLA-3	50	200	357	53.36	25.88	381.49	313	33.48
Wood PLA Light brown -1	25	285	656	44.98	1.92	321.02	482	60.98
Wood PLA Light brown -2	35	146	536	48.64	1.15	318.64	385	64.60
Wood PLA Light brown Light-3	50	50	309	48.89	1.19	426.14	260	62.60
Wood PLA Dark brown -1	25	68	474	49.92	5.56	204.82	362	55.54
Wood PLA Dark brown -2	35	65	373	49.47	3.85	245.81	295	55.17
Wood PLA Dark brown -3	50	29	295	49.63	4.54	286.80	235	55.14

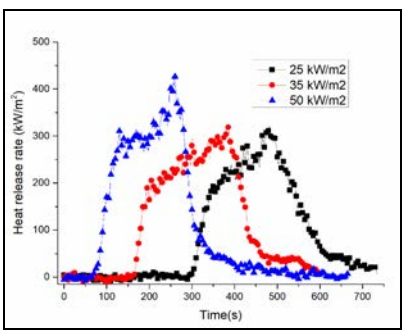
The data of each individual samples (three specimens for each group) are given in Table 2. The time to igniton, time flameout, and residual mass were also measured. At the same incident heat flux level, the fastest ignition was found in the Wood PLA Dark brown specimens. It was followed by primaselect Wood PLA Light brown specimens and Neat PLA, respectively. The results showed that the addition of the wood flour into the Neat PLA decreased the time to ignition. Similarly, the lowest tHRR was found in the Neat PLA specimens, followed by Wood PLA Dark brown and Wood PLA Light brown, respectively. In general, the lowest residual mass was observed for the Wood PLA Light brown, followed by Wood PLA Dark brown and neat PLA specimens. The HRR graphs of the specimens are presented in Figure 4.



1- Neat PLA



2- Wood PLA Dark brown



3- Wood PLA Light brown

Figure 4. Heat release rate of the 3D printed specimens:
1- Neat PLA, 2- Wood PLA Dark brown,3- Wood PLA Light brown

MCC test results are shown in Figure 5, in which Neat PLA illustrates as a typical polymer resin with only one HRR peak. With the additive, the HRR curves show a low peak but wide range of combustion temperarture. The light brown wood PLA shows a wood combustion behavior with a significant char stage during which HRR has a low value, leading to a double peaks format of HRR curve. While in FPA test, the dark brown wood PLA illustrates a wood combustion behavior. The total heat release values of these three materials from MCC are the same, only the peak HRR temperatures are different.

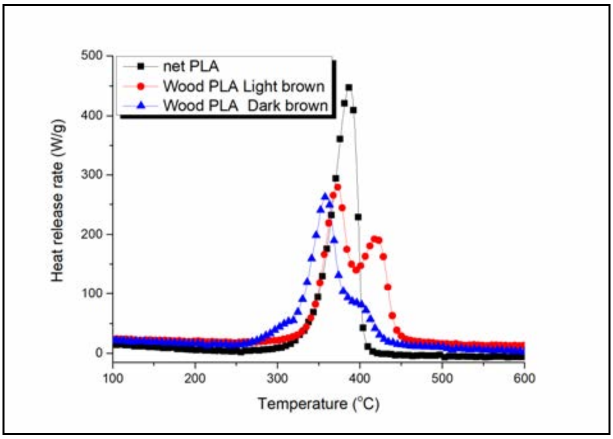


Figure 5. Heat release rate of the 3 materials from MCC

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DESIGN AND MECHANICAL PERFORMANCE OF 3-D PRINTED T-SHAPED ROD CONNECTOR MANUFACTURED BY FDM TECHNOLOGY

Jiří Tauber, Jaroslav Začal, Michal Šustr, Martin Brabec

Abstract: As the Fused Deposition Modeling (FDM) method of 3-D printing provides continuous material deposition in very thin layers fused together by gluing or moulding, a wide spectrum of applica-tions in furniture design can be found. This work aimed to design light-weight and easy de-mountable T-shaped connector for joining two or three rods where an interchangeable colour is considered a priority. The rod construction is intended to be used as a clothing holder or towel horse. The selected design was prototyped in a series and its mechanical performance was as-sessed. The presumed service load was simulated by three-point bending of a simple construc-tion consists of two vertical rods cross-linked by horizontal one mounted together using of two 3-D printed connectors. The compressive single force was applied at the horizontal rod midspan in a quasi-static loading rate until the construction fail signed by a significant drop of applied force. The basic setup for 3-D printer Slic3r PE, which is designated for printing object with 20 % grid volume, was used. The nozzle temperature and used filament material were optimized. The specific issues of these printing parameters in relation to connector shape are discussed. The mechanical tests proved that the prototyped 3-D printed rod connector is able to fulfil the in-tended use.
Keywords: Furniture design, 3D printing, prototype, bending test, T-connector

1. INTRODUCTION

The 3-D printers become a common manufacturing method used in many applications. Nowa-days, the 3-D printer available under 20 000 CZK is already fully equipped including heated printing surface and double extruder. Most of these printers are sold as building block set and the user is recommended to assemble it by himself. 3-D print is namely suitable for a fast pro-duction preparation for individual design production and small-scale serial production. Mostly it is employed in prototype manufacturing.

The main idea of 3-D printing stemmed from the effort to minimize waste production, which is crucial drawback of chip machining (milling and cutting), especially when making products with complex 3-D shape. The versatility of printed product shape comes from the principle of 3-D printing, which consists in deposition of thin caterpillar of plasticized thermoplastic polymer to layers creating a 3-D structure. The printing material is rolled-up in a form of filament onto the spool, from which it is extruded through a set of pulleys into the heated nozzle. Inside the noz-zle the plastic filament is heated to a temperature above its melting point and then it is extruded onto the printing pad. Best known and most commonly used method for Additive Manufacturing (AM) is Fused Deposition Modelling (FDM). This method provides a very cheap and relatively fast production of functional prototypes, which in their properties approach the final products. Models manufactured with FDM method could have almost any shape, including the functional and demountable configurations. The shape complexity of printed products increases with de-creasing diameter of printing nozzle.

The mechanical behaviour of polymeric materials used for 3-D printing is a complex matter. Polymers could behave like a glass, liquid, resin, or like soft and elastic objects. This behaviour highly depends on their molecular composition, internal structure and ambient climatic condi-tions. Polymers consisting of spatial net-shaped structure tend to be fragile. The 3-D printing is mostly conducted using the poly-lactic acid (PLA). This material has a low thermal expansion coefficient, which lowers the deformation effects, when product cools. Advantage of this mate-rial is its low health risks. Most significant PLA disadvantage is its low melting point, which causes the printed parts to deform when exposed to increased temperature environment (already from 60 °C). The acrylonitrile-butadiene-styrene (ABS) is distinctive with a higher firmness, flexibility and durability than objects fabricated from PLA. ABS is widely employed in additive manufacturing for functional applications, because in 80 % corresponds to a conventionally produced material (injection moulding). However, all of that works on expense of a more diffi-cult printing due to its high thermal expansion coefficient. Hence, a significant deformation dur-ing product cooling needs to be taken into account. As the surface of ABS models is coarser compared to other materials only a medium level of printed details can be achieved. A polyethylene terephthalate (PET) is a most commonly used plastic worldwide – bottles, fabric fibres, food packaging, etc.; however, it is not feasible for 3-D printing. Therefore, a modifier known as "modified glycol" was added to material composition in course of polymerization. The result (PET-G) is a filament, which is significantly less brittle and easier to use than PET. PET-G fila-ment combines the properties of ABS (stronger, more resistant to high temperatures, more dura-ble) and PLA (easy printing). Adhesion between layers is usually excellent, risk of warping or a significant contraction is low and an important advantage is its recyclability.

The aim of this work is: (a) to utilize the potential of 3-D printing in order to design light-weight and easy demountable T-shaped connector for joining two or three rods; and (b) to assess the suitability of different printing material (PLA, ABS and PET-G) and mechanical performance of printed product when simulating the service load by three-point bending.

2. Material and Methods

2.1. Printing of T-connectors:

The used FDM 3-D printer (Prusa i3 MK3, Prusa Research s.r.o, Czech Republic) formed the sample in a way that filament is melted in a nozzle with 0.4 mm diameter and applied onto the printing pad in thin layers. Printing head moved in the X-Y plane (horizontally) until the individ-ual layer was printed. Then, the printing head moved along a Z axis (vertically) by the thickness of one layer and printing of a subsequent layer took place. This process was repeated until the printing of an entire sample was finished. The nozzle and pad temperatures were set according to manufacturer recommendation listed in Tab. 1. Perimeter printing velocity (45 mm/s) was set with cooling of a printing area turned on for all of used filament types.

Table 1. Temperatures for sample printing recommended by manufacturer

Printing parameters			
Filament type	PLA	ABS	PET-G
Nozzle temperature	215 °C	255 °C	230 °C
Pad temperature	60 °C	100 °C	85 °C
Printing area cooling	On	On	On
Filling type	Grid	Grid	Grid

Each printed sample has 7 top and 5 bottom coherent layers in a rectilinear pattern and 2 horizontal lateral walls. Layer thickness was set to 0.15 mm for all samples according to default printer setting for normal quality. The sample volume was filled by a grid. Grid density was set to 20 % and the ribs were oriented in ±45° directions in respect to global coordinate system.

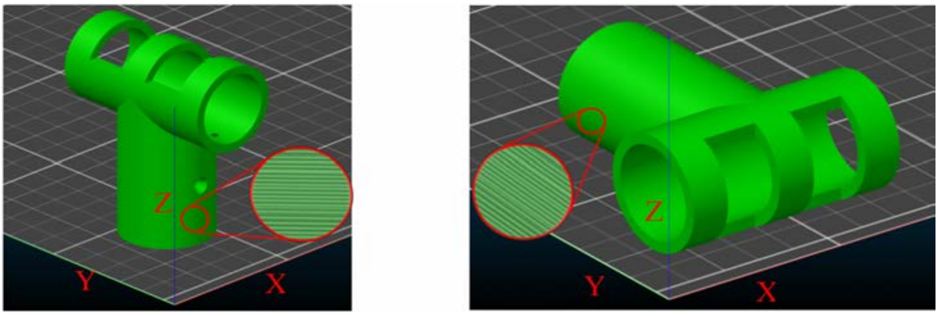

Figure 1. Representation of sample geometry and its position in printer on a heated pad (left vertically, right horizontally)

Fig. 1 represents printing axis X, Y, Z. Z axis represents the vertical printing direction and determines the orientation of individual layers (see magnified window) in a finished printout. In order to discover an effect of layers deposition direction on the resistance of a sample to bending load, the samples were printed in two orientations. For each kind of material and layers deposi-tion direction 5 samples, in total 30 samples, were made (Tab. 2).

Table 2. Type and orientation of used material

Material	Producer	T – connector orientation	Sample count
PLA	Filament PM	Vertically Horizontally	10
ABS	Filament PM	Vertically Horizontally	10
PET-G	Fillamentum	Vertically Horizontally	10

2.2. Mechanical loading of T-connectors

The presumed service load was simulated by three-point bending of a simple construction consists of three 400 mm long rods and two printed T-connectors. Two vertical rods were cross-linked by horizontal one joined together using of two 3-D printed T-connectors (Fig. 2 and 3).

Figure 2. Connection detail with screw

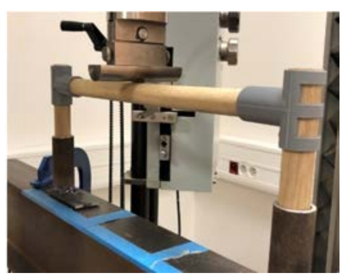

Figure 3. Experimenta Assemble

The vertical rods were made from a beech (Fagus, spp.) and oak (Quercus, spp.) wood conditioned in 20 °C and 65 % relative humidity; meanwhile, the horizontal rod was made from a carbon steel. The construction was prepared in such a way that the vertical rods were firstly pushed through the "open-pipe" part of the T-connectors. The position of T-connectors was fixed by screws. Then, the horizontal steel rod was mounted on the one-sided "closed-pipe" part of T-connectors without additional fixation. The construction was anchored onto support I-beam mounted on the universal testing machine Zwick Z050/TH 3A (Zwick Roell AG, Ulm, Germany) using of steel flanges. The vertical rods were accommodated in the flanges under a preload of 50 N.

The force was applied using a cylindrical load head with a diameter of 15 mm at the horizontal rod midspan in a constant quasi-static loading rate (2 mm/min) until the construction fail signed by a significant drop of applied force. The applied force was measured by a 50 kN load cell and the deflection was captured by a clip-on deflectometer with a resolution of 1 µm. All tests were conducted in a standard room temperature (~20 °C). The experimental procedure was set and controlled by TestXpert I environment (Zwick Roell AG, Ulm, Germany).

Assuming the symmetric loading conditions, the mechanical response of T-connectors to simulated service load was evaluated based on the bending moment for fixed end beam loaded by single force at the beam midspan. The maximal bending moment (Mmax) was calculated accord-ing to Ashby (2010) as:

$$M_{max} = \frac{F_{max} \cdot l}{8} \quad (1)$$

where Fmax is the maximal applied force and l is the length of horizontal steel rod.

3. Results and discussion

For each construction the force-deflection curve was obtained. In order to clearly show the dif-ferences in the mechanical behaviour of individual printing materials, the most representative load-deflection curves for each material are presented (Fig. 2). From the first look, it can be seen that compared printing materials reached different levels of maximum load (Fmax), which pre-ceded the collapse of the T-connectors. When focusing on the collapse mechanism, the differ-ences between individual printing materials and layers deposition direction are apparent. The PLA polymer delivered to T-connectors widest range of elastic behaviour during loading (longest straight part of the load-deflection curve) from all printing material. The smallest portion of elas-tic behaviour exhibited ABS T-connector, which experienced even hardening effect before its collapse. On the contrary, the softening effect was visible on the T-connector made from PET-G polymer. When compared the collapse mechanism from the layers deposition direction point of view, the differences for PLA and ABS can be distinguished. The more successive collapse with more levels of failures was proved for T-connectors with vertical layer deposition direction (Fig. 1); meanwhile the T-connectors printed with horizontal layers deposition direction exhibit-ed more fragile collapse consisting of one main failure. This phenomenon is clear evidence that the layers deposition direction is significant factor influencing the mechanical performance of designed T-connectors, excluding the PET-G polymer, which almost differed in both printing variants.

As indicated by the load-deflection curves in Fig. 4, the maximal load and consequently the maximal bending moments varied across the printing materials (Tab. 3). In a closer look it is possible to see that the PET-G reported the highest firmness, second was PLA polymer followed by ABS, which not fully corresponds with mechanical characteristics of individual printing ma-terials listed in technical documentation. According that the ABS should have highest strength properties, but the opposite is true. The differences are most likely caused by the other features of ABS mentioned earlier such as high thermal expansion coefficient and consequently coarser surface and reduced adhesion between layers.

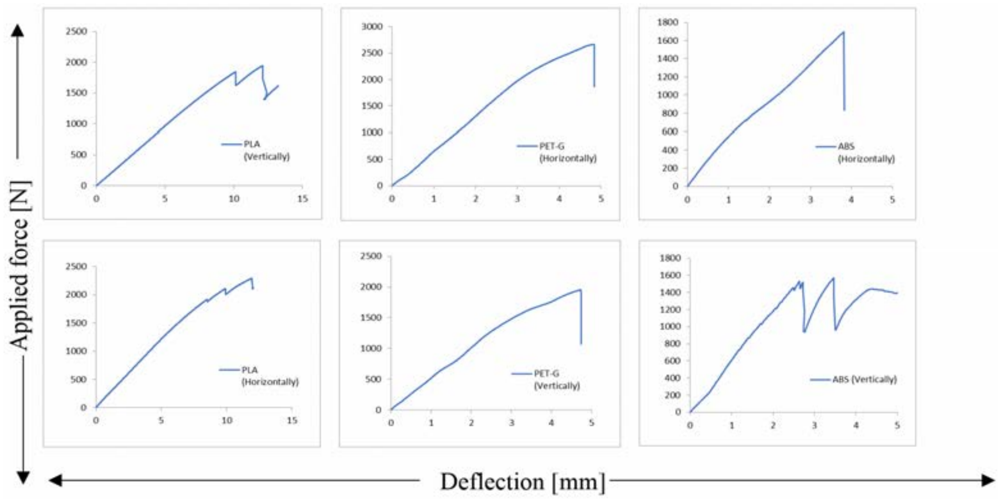

Figure 4. Representative load-deflection curves for individual printing materials

Table 3. Maximal bending moment determined for fixed end beam loaded at the midspan

Material	M_{max} (N.m)
PLA Horizontally	91.6
ABS Horizontally	67.9
PET Horizontally	106.6
PLA Vertically	77.7
ABS Vertically	66.1
PET Vertically	78.2

From the comparison of bending moments with horizontal and vertical layers deposition direc-tion it is clearly visible that horizontally printed T-connectors reached the higher values. Howev-er, the maximal bending moment varied in a higher range for horizontally printed T-connectors than vertically printed ones. It implies that the layers deposition direction influenced beside the collapse mechanism and maximal bending moment also the variability of maximal load within the compared printing materials. Horizontal mode of printing also ensured that the force acts perpendicular to the lengthwise-oriented layers and T-connector was not entirely destroyed (Fig. 3). On the contrary, in case of vertically oriented printout the collapse of the joint occurs by shearing of the layers in direction of printing (Fig. 4).

The results indicated that layers deposition direction should be optimized in respect to loading direction. The model orientation on a printing pad also affects the complexity and time of print-ing. For vertical printing (in Z axis) it is necessary to employ the supporting construction of a printed model. This support keeps the printed model in a vertical posture and prevents it from tilting in course of printing. For printing in horizontal layout the support grid volume will be sig-nificantly lower, which ensures the time saving in course of printing. Regarding the loading di-rection and complexity of printing, the horizontal 3-D printing direction seems more suitable for the T-connectors designed in this work.

4. Conclusion

The connector for joining two cylindrical beams in a mutual perpendicular position (T-connector) was designed and printed with FDM technology. The mechanical performance of T-connectors made from three different polymers such as PLA, ABS and PET-G was determined. The influence of layers deposition direction (printing direction) in respect to loading direction was assessed. The static three-point bending of horizontal beam, fixed on both ends through the printed T-connectors to vertical beams, simulated the service load.

From the comparison of experimental data it was concluded that used material and printing direction to the printing surface have a determining effect on the resulting mechanical perfor-mance of T-connectors. As a most mechanically resistant were proved the T-connectors made from PET-G polymer. From practical point of view the horizontal printing direction, where the layers deposition direction was perpendicular to load direction, seems as ideal for reaching of the desired material characteristics without the necessity to print the large support grid and post-printing treatment of the T-connectors, as well as together with the reducing of material and time consumption.

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DO PREFERENCES FOR WOOD-FRAMED HOUSES' ATTRIBUTES CHANGE OVER TIME?

Vladislav Kaputa, Miriam Olšiaková, Hana Maťová, Eva Drličková

Abstract: Timber achieved an irreplaceable place in constructing since the first settlement of Slovakia, but has been replaced by various silicate construction materials. Wood-framed houses have low market share in spite of favourable production conditions. The main reason are low demand of consumers and legislative restrictions. Consumers have various expectations connected with wood properties. The paper introduces time comparison of findings coming out of the surveys conducted among the Slovak respondents aimed at their preferences for wood-framed houses. The comparison is based on the two surveys carried out in 2008 (Kaputa and Parobek, 2009) and 2018 (Olšiaková et al., 2018). The preferences for the selected attributes of wood framed houses are compared. Respondents strongly consider fire safety, lifespan, and energy efficiency.
Keywords: wood framed houses, consumer preferences, attributes of wooden constructions.

1. INTRODUCTION

The paper title focuses attention at the preferences. The consumer preferences significantly shaped especially highly competitive markets. The market of wood framed houses in Slovakia is however influenced also by other significant factors. Here, besides of consumer preferences (which created buying behaviour and further demand), the most important are: national legislative, state support, and influence of stakeholders.

The *legislation* significantly affects the market with constructions on the basis of wood, i.e. where wood is used as construction material. The economic, technological and environmental advantages offered by this type of construction are not used in Slovakia rich in the wood resources to such an extent as in the other European Union countries, also due to the fire protection restrictions in the building industry (Šupín et al., 2015). Until 2017, the wooden constructions not designated for residential or lodging purposes (e.g. non-production civil, technical or industrial buildings) may had the fire height which corresponds to 3-4 storeys, while the constructions for residential and lodging purposes of max. 2 over-ground storeys. Such legislative state last more than four decades and influenced development on the Slovak wooden buildings market. In many of the European Union countries, the wood construction is permitted to build even over 5 over-ground storeys, when observing certain clearly defined measures capable of the assurance of fire protection of wood construction within the required time. Just in 2017, the revision of the Slovak technical standards of fire safety of buildings brought changes. Wooden buildings could have a maximum of 5 storeys, respectively 12 meters high level of the last floor.

State support is an important factor, especially on the markets where silicate materials are predominantly used in constructions. The share of wooden houses is only up to 10% on the Slovak residential houses market. Around 700 new family houses are built yearly from a wood-based construction system (Reality.trend.sk, 2018). Precise share of wooden-based houses is not known as the relevant statistics is missing. In Slovakia, a dragging problem is a high share of the exported (unprocessed!) roundwood – 2.02 million m^3 in 2017 – although in the most of assortments has decreasing trend since 2014, while import of all the assortment is increasing since 2015 (Moravčík et al. 2018, p. 31-32). Even worst situation is in the Czech Republic with the highest level of the exported roundwood within the EU countries (Dzian et al., 2018). Consequences are missed added value, labour opportunities, energy efficiency and environmental benefits. In 2017-2018, there was initiative of the Ministry of Agriculture and Rural Development of the Slovak Republic to prepare legislative and launch a state support aimed at the processing domestic raw material (wood) into high value added products – wooden houses with low or near zero energy consumption needs. Such kind of support could bring multiple national effects. Potkány and Debnár (2018) mentioned an impact on the level of employment, domestic demand for timber products, increase domestic processing and use of raw wood, following by support of the housing of citizens especially in the rural areas and reducing the energy consumption of buildings. This initiative remains unrealized.

Dealing with pressure of *stakeholders*, the two major lobby groups could be considered: lobby of silicate materials producers/associations and lobby of wooden materials producers and constructors. Among others stakeholders, preferences of architects and designers/constructors could be relevant, but it differs country by country. In Slovakia, the meaningful influence on demand for wooden houses has overall awareness about their attributes. The development is also restricted by slowly change of end-users' attitudes. Here, old prejudices remain or change slowly. Major myths persist among the public regarding the properties of wood-framed house are connected to its short lifespan, inflammability, bad insolation (either acoustic or thermal), and pest and weather resistance.

Preferences are typical in the consumer market, especially those of high competition where consumer choosing among several alternatives. Technological changes, the rise of social media, evolving demographics, and increasing purchasing power of women are just a few factors that wood products manufacturers and retailers must consider in their marketing efforts (Kaputa et al., 2018; Ponder 2013). Summing up such a status quo, after changes in legislation, no shift in a state support and the persistent pressure of silicate materials just proper marketing communication seems to be a right tool to change consumers' preferences and to attract investors for wooden constructions. The paper presents what the attributes of wooden constructions are preferred and if they changed over time.

2. STUDIES ON WOOD-BASED HOUSES MARKET

Current lifestyle trends return to a more natural, more personalized housing that is provided by family homes against the impersonal and often restrictive housing that is typical for living in a block of flats. Preferences are changing and alongside the traditional and long-established construction materials are introduced modern, innovative, and viable construction alternatives where wood-based houses took place too. An application of environmentally and energetically efficient constructions is smart and promoted in modern methods of constructions (Cholujová, 2011 in Švajlenka and Kozlovská, 2018). Sustainable development is a very discussed issue in considering the acceptability and efficiency of solutions based on building and living preferences. There is a significant environmental change in societal values toward sustainability and sustainable development (O'Connor and Dangerfield, 2004; Autio et al., 2009; Maniatis, 2015; Pätäri et al., 2016). These values are reflected in the customer's buying behaviour. This idea could be also applied in a frame of household preferences.

The use of wood in residential as well as in non-residential constructions has increased in previous years, but it is not used traditionally at all (Toppinen et al., 2018). There are different approaches from the perspective of architects and customers regarding the specific country. Roos et al. (2010) dealt with Swedish structural engineers' and architects' perceptions of structural timber in multi-story construction. Wood was perceived as an appropriate building material, but both professions perceived their influence on material selection to be weak and marked developers and contractors as the most influencing over material selection. Swedish architects were surveyed also in study of Hemström et al. (2011). The results show that architects and contract managers see several disadvantages and weaknesses of wood in the area of fire safety, stability, durability, and acoustic properties. In the British study Wang et al. (2014) introduced findings from interview with experts in the UK construction sector. Experts who have sound knowledge of wood as a building material agreed on its superior environmental credentials. However, end-users who may lack information and knowledge of wood products often show strong prejudice against its use. As the major drivers promoting wood as a sustainable solution for green buildings in the UK construction sector were identified: legislation, environmental awareness, attitudes and traditions, market and competition, promotion and communication, and technology and know-how. The trend in wood construction increasingly includes the use of hybrid structures (e.g. combinations of wood and steel) or composites (such as wood and plastic). The study of Toppinen et al. (2013) revealed consumers perception in the Finnish market. The results indicate that the respondents may be segmented based on their perceptions on product level environmental and social sustainability: the most environmentally and socially conscious group can be profiled by gender (female), older age, and summer cottage ownership. According to Toivonen and Hansen (2003), wood is more attractive material compared to many other materials. However, environmental quality is not the main attribute influencing consumers or organizational customers in their choice of construction materials. Also, lots of Slovak consumers in the research done by Kaputa and Parobek (2009) expressed an uncommitted attitude towards the significance of environmental factors while assessing attributes of wood framed houses. According to Hoibo et al. (2015), younger people with strong environmental values were supposed to be the best target group for increasing wood-based urban housing in Norway. The domestic origin of wood materials has been found to associate with environmental quality in Europe (Rametsteiner, 1998), and also in particular in Finland (Toivonen, 2012) and Scandinavian countries.

The study among the architects in Slovakia (Kaputa and Paluš, 2014), showed that a brick is undoubtedly the most preferred construction material in residential buildings (with a share of 80%). Concrete and aerated concrete had lower than half of preferences, and wood and wood products lower than one-third of preferences. According to Maťová and Kaputa (2018) the most of the active architects do not propose wood as a construction material and prefer substitute materials on a silicate base especially in cases of civil and industrial buildings. In Slovakia, mistrust continues to be found towards wooden constructions where fire resistance remains the most negatively perceived property of wood. It is followed by properties as durability of wood, and resistance to weather conditions.

3. METHODS

The research is based on the time comparison of findings coming out of the surveys conducted among the Slovak respondents aimed at their preferences for the selected attributes of wood framed houses. The two considered studies for comparison are those which had been carried out in 2008 (Kaputa and Parobek, 2009) – referred as "S-2008", and 2018 (Olšiaková et al., 2018) – referred as "S-2018" in this paper.

The S-2008 used methodology based on non-probability sampling (purposive sampling) to acquire responses via questionnaire survey. Specific components of the Total Design Method (TDM) described by Dilman (2000) were used in the survey to solve a problem of response rate. It helped and the response rate finally rose to 60% out of primary 39%. The questionnaire contains eight questions regarding consumers' attitudes as well as questions concerning demographic factors and the answers have a form of five-point Likert-type scale. Frequency analysis and contingency tables were used to analyse relationships between the demographic factors and the answers. Here applied the United Factor (Kaputa, 2008; Kaputa and Šupín, 2010; Kaputa, 2013) originates from demographic data and was used in this survey to divide respondents according to the answers specific for each selected subgroup. The analysed sample consisted of 180 respondents.

The S-2018 utilised also questioning as the method for data obtaining. The questionnaire was composed of closed questions. The assessment of preferences was done by consumer satisfaction index (CSI). The CSI was used to monitor and compare differences between the expected and perceived customer satisfaction. Detailed facts about the methods introduces the study (Olšiaková et al., 2018). The survey sample was comprised of respondents aged 18-60 with a particular interest in the economic active respondents. Further, a group of the respondents who expressed willingness to live in a wood-framed house has been selected – only responses of those respondents were analysed. The analysed sample consisted finally of 154 respondents.

The comparison was made based on expressed attitudes towards selected attributes of wood-framed houses in the both over-mentioned studies. The studies dealt with the assessment of the set of attributes of wood-framed houses. However, the stylisation (and meaning) of questions of each study is not the same. So, instead of direct comparison of the results from both studies we have discussed the findings which lead us to supplementary ideas on that issue. While the study S-2008 dealt with the assessment how the respondents perceived certain factor of wood framed house (either positively or negatively), the study S-2018 assessed the importance of factors in choosing wood-framed house (either high or no importance).

4. RESULTS AND DISCUSSION

The attributes which could be discussed (since were used in the both studies) are the following: fire safety, durability, thermal properties, construction costs, environmental friendliness, and acoustic properties.

Consumer preferences often lie on non-material (intangible) criterions also investigated in the S-2008 study. Enjoyable living and aesthetics were perceived very positively in case of wood framed houses. Similar assessment of wood as a construction material was expressed by students of architecture in Slovakia and the Czech Republic (Kaputa and Kalamárová, 2014).

Table 1. Assessment of attributes of wood framed houses in the S-2008 study (n = 180)

Attribute	Answers		
	Very positively, positively	Indifferent attitude	Negatively, very negatively
Enjoyable living	84.3%	12.3%	3.4%
Aesthetics	74.7%	19.7%	5.6%
Thermo-insulating attributes	70.8%	21.9%	7.3%
Acoustic attributes	57.9%	28.1%	14.0%
Environmental factors	51.7%	35.4%	12.9%
Durability	45.0%	37.6%	17.4%
Construction costs	37.6%	36.5%	25.9%
Risk of fire	22.5%	21.3%	56.2%

Source: Kaputa and Parobek, 2009

Over one-third of the S-2008 respondents expressed indifferent attitude towards construction costs of wood framed houses. Considering fact, that up to 70% of the same sample of respondents considered cost saving for a very important criterion of new constructed houses (no matter of material), we could suppose that surveyed respondents had not sufficient information about costs (respectively price) related to construction of a wood framed house. The S-2018 study results show that ratio of price and quality is about middle importance of consumers. Generally, they were aware that wood framed houses (comparing to houses from silicate materials) cost somewhat more in general, but simultaneously respondents from the both studies knew and appreciated attributes as thermo-insulation which relate to a house using (either heating or cooling) and bring costs saving usually.

For respondents of the S-2018 study, the highest weight within the considered requirements on wood-framed houses had fire safety, lifespan, and energy efficiency. Further, heat-insulation properties, ratio of price and quality, and maintenance are considered. The lowest values within the analysed requirements had environmental friendliness, acoustic properties and speed of construction (in descending order).

More than half of respondents (of the S-2008 study) perceived negatively the risk of fire and it is definitely the worst assessed attribute. Simultaneously, the fact that fire safety is the requirement of the highest importance (the S-2018 study) in buying decision clearly indicate one of the most significant barrier for wood framed houses market development.

Table 2. Assessment of the requirements for wood-framed house in the S-2018 study (n = 154)

Requirements for wood-framed houses	Degree of importance	Order
Fire safety	9.05	9
Lifespan	9.01	8
Energy Efficiency	8.93	7
Heat-insulation properties	8.66	6
Ratio of price and quality	8.53	5
Maintenance	8.18	4
Environmental friendliness	7.94	3
Acoustic properties	7.22	2
Speed of construction	6.93	1

Source: Olšiaková et al., 2018

Some attributes of wood framed houses were “in a mist” (unclear) for the S-2008 respondents since significant part of them expressed an indifferent attitude. Concretely, durability and environmental factors as well as construction costs. Environmental factors are very complex as they comprise many issues connected to human mutual relations with environment (e.g. renewability, construction waste, pollution, energy consumption). The S-2018 study revealed that environmental friendliness of wood framed houses is of little public interest. It is often too complicated for consumer to understand mediate information. In this sphere, it is necessary to communicate clearly and properly about the attributes and educate consumers.

5. CONCLUSION

Overall, consumers put the highest importance in their buying decision on fire safety and lifespan and those attributes of wood framed houses (together with construction costs) have also the highest share of negative assessments. Negative perception of fire safety is still one of the most significant barrier – Achilles heel – for the Slovak wood framed houses market development. Lifespan (in the S-2018 study) is considered to be an attribute with the high importance in choosing a wood-framed house while durability is assessed positively by up to half respondents of the S-2008 study. To ensure consumers about long-lasting durability and lifespan, constructors must accomplish adequate technological procedures of each individual project and instruct customers about a proper maintenance. Since beginning stage, suppliers (producers, resp. architects or designers) must deeply understand consumers’ preferences and make an offer within relatively wide portfolio of wood constructions system: log, panel (prefabricated), timber-frame, post and beam, half-timbered or modern Cross Laminated Timber (CLT) (Štefko, 2014 in Kaputa and Kalamárová, 2014).

Studies revealed that environmental friendliness is of little public interest. Review of literature (Chapter 2) and the results of analysed studies shows that the awareness about environmental appropriateness of wooden buildings is rather lower among consumers while still frequently discussed and much more appreciated among professionals (academics, architects, producers etc.). Dealing with consumers’ environmental awareness, paper is perceived to be a wood product of higher environment-friendly properties comparing to other wood products (Kaputa et al, 2017). Within a wide portfolio of wood products, environmental appropriateness of wooden buildings is not to communicated clearly and it is often too complicated for consumer to understand mediate information. It should be dominantly based on renewability, less energy consumption, environmental impacts of product manufacturing, embodied energy in products, and construction waste while highlighting the unique role of wood products in the earth's carbon cycle. It is argued by statement that wood products sequester more carbon than is released during their production. In his way, it is desirable to fix wood's premier environmental status among construction materials.

What significantly changed over the period of 10 years are not the preferences, but rather legislative which is last two years more favourable for development of the Slovak wood framed houses market. Possibility to use wood as construction material for houses up to 5 storeys is not boostering, but at least facilitating precondition for further market development. In spite of fact that domestic material resources are sufficient and residential building industry prosper due to low interest rates of mortgages, the wood buildings sector still plays minority role. Strong sectoral promotion, clear environmental lobby, target groups' education (aimed at public, architects, and designers) and addressing governmental strategy for domestic wood processing industry development are lacking to make distinct progress.

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THE SYMBIOSIS PROSPECTS FOR THE E-COMMERCE BUSINESS AND WOOD-BASED SECTORS – THE CASE OF POLAND

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Abstract: For the creation of industrial symbiosis, the e-commerce and wood-based industry actors must possess an identity and be active as well as other typical creative economic structures. There is a tendency in Poland to create economic societies of pro-ecological targeting, the so-called "green business parks" that are also created in the virtual space. Industrial symbiosis is an opportunity for the development of small and medium-sized enterprises in forestry and wood-based sectors in Poland. This article is devoted to scientific research into the development and competitiveness of industrial symbiosis actors: the Polish wood industry and e-commerce business.
Keywords: industrial symbiosis, e-commerce business, forestry, wood-based sector, Poland

1. INTRODUCTION

In the Polish forest and wood sector there is a special model of the sector market, characteristic for the institutional structure based on a natural monopoly. Therefore, the development of the wood market is not programmed exclusively by the primacy of competitiveness. In this space, a perspective for intersectoral cooperation and coopetition opens up. The paradigm of cooperation transcends the dimension of the traditional industry and also includes virtual space and electronic economy. This reflection is accompanied by a concept of economic symbiosis. This idea is based on partnership cooperation of entities, most often operating in a separate functional area (Wanat M., 2017; Wanat L. et al., 2018b). It combines the experiences of different sectors. Of course, one of the objectives of creating symbiotic links is to achieve measurable economic benefits (e.g. joint management of resources, energy, waste, etc.). The foundation of such programmed cooperation are mutual relations of partners. In this process, it is possible to shape a system within which the activity of entities will be carried out in a closed economic cycle (Francis, 2015). For example, production waste may be reused in another process as a substitute for primary raw material. Wood, as a special, ecological material, can thus, even after the period of use in one form, gain new usefulness and a new life in another, practical application (Mantel, 1973; Chudobiecki et al. 2015, 2016; Kusiak et al., 2018).

In the theoretical concept of industrial symbiosis, it seems necessary to take into account the significance of electronic and virtual space. Virtual reality (space) can be seen as a special example of a functional area or a part of a traditional industrial area. Of course, it is not only a question of reproducing passive features (land, real estate, infrastructure, etc.). Symbiosis means using "something more than just a fragment of an industrialised area" (Doniec, 2011). New structures, including those that include virtual space, need an individual management strategy, new methods and ways of working (Wanat and Lis, 2009; Wanat, 2016). Conditions are created for establishing new industrial communities, which can be described as eco-virtual-business-parks (industrial ecoparks with virtual space). They refer to the already known concepts of searching for relations between Traditional Eco-Industry Clusters and Virtual Eco-Industry Clusters.

2. PURPOSE AND RESEARCH CONCEPT

The accurate identification of an economic chain in a wood-based sector that takes into account not only the generation of by-products but also the capacity of used finished goods to be reused again offers a real perspective for the circular economy. Not only the chain: raw material – process – product, but also the extended or even endless chain: raw material – process – product – (re)raw material – process... etc. (i.e. a series, a geometric sequence of multiple recycling), opens up almost unlimited possibilities for wood-based materials (Mikołajczak et al., 2017). In this perspective, an attempt was made to search for symbiotic relations between traditional resources of the forest sector and new, virtual, but at the same time completely real resources of electronic economy (Wanat et al., 2018a).

This paper analyses the selected examples of existing and possible symbiotic relationships in forestry and wood-based sector with entities and tools typical for electronic economy. Both the current state of the art (knowledge) and the selected case studies that have been analysed have been referred to. In particular, the following examples of symbiotic links between electronic management and forest and wood resources were selected for analysis:

- Forest Data Bank;
- Forest and Wood Portal.

In addition, an attempt was made to assess the possibility of developing economic symbiosis relations for a selected branch of the wood industry (furniture) with the entities of the e-commerce sector. Apart from a multiple case study, the research used the method of comparative and descriptive analysis.

2.1. Forest Data Bank in Poland

The Forest Data Bank (Bank Danych o Lasach, BDL) was established on the basis of the provisions of the Forest Act (Ustawa…, 1991) in the period of 2010-2014. Article 13a of this Act obliges the State Forest Holding State Forests (Państwowe Gospodarstwo Leśne Lasy Państwowe, PGLLP) to conduct a large-scale inventory of forest condition and a database of forest resources of all forms of ownership. The Forest Management and Geodesy Bureau (Biuro Urządzania Lasu i Gedezji Leśnej, BULiGL) maintains the Forest Data Bank in order to carry out statutory tasks. Its objectives include the following: systematic collection, supplementing, updating and storing data on forests of all forms of ownership, information processing and data processing enabling their interpretation, preparation of analyses and forecasting of development of resources and use possibilities on a macro-scale, dissemination and sharing of information on forests and supporting scientific research, development and propagation of standards for collection and processing of data on forest and natural resources.

The Forest Data Bank (BDL) shall be composed of the following: (1) a data warehouse with a spatial information system (GIS) storing all source and aggregated data, (2) of the calculation module, (3) reporting module, (4) a web portal, (5) a set of services making data available to external recipients. The Forest Data Bank shall store all available data on forest areas in Poland. They include as follows: descriptive and spatial source data from forest management plans, simplified plans, inventory of forest condition, including large-area inventory and national park protection plans. In addition, the database (BDL) collects additional information from areas related to the condition of forests: meteorological, hydrological, geological, nature protection, biotic, abiotic and other data.

The calculation subsystem is used for data aggregation and processing, calculation, verification and preparation of output data. An important element of the system is the methodology for forecasting the development of forest resources and the possibilities of their use. Extendable Forest Data Bank reporting module is a tool to generate reports and graphs in different shots. It is an open architecture module, easily expandable (Talarczyk, 2015).

The most important "place" of contact with users is the Forest Data Bank Internet portal. The most commonly used is an interactive map, containing standardized spatial and descriptive data obtained from various types of device documentation. Moreover, the portal offers map layers presenting other types of information (e.g. Geoportal.gov.pl website resources, underlay maps, aerial orthophotomap, reports on forest condition monitoring, a dictionary of forestry terms, a service of source metadata, etc.).

2.2. Forest and Wood Portal (PL-D)

In connection with the reorganization of the State Forests in the early nineties of the last century, changes were made to the rules for the sale of wood (the principle of loco forest was adopted) (Kłapeć et al., 2017). Currently, IT tools for internet auctions and forest-wood portal are used to handle the sale of wood. The Forest and Wood Portal is available in resources available at a separate Internet address in the domain of State Forests, i.e. http://drewno.zilp.lasy.gov.pl.

Wood is currently being sold via web applications and will be sold in the years 2020-2021. Under the basic procedure, a monopolist (PGLLP) offers entrepreneurs a monopoly:

- sales in the Forest and Wood Portal (PL-D), taking into account the current volume of wood purchase (making 80% of the pool available),
- sale in system auctions in the "e-drewno" ("e-wood") application (making 20% of the pool available).

Additionally, in the sales plan for entrepreneurs, the so-called separate sales will be conducted in the "e-drewno" application (providing access to wood raw material, which at the moment of creating the sales offer the State Forests cannot direct to the basic procedure (e.g. small masses, dispersed wood species and assortments).

It is worth noting that the sales system includes the so-called "price corridor", which for 2020 will be maintained for active customers based on data from 2019 with an option to align output prices. Such an organised market structure is characterised by the fact that entry barriers to the market for new entrants are left in place. Moreover, the decision on the final amount of minimum wood prices is a forest inspector's right (Adamowicz and Szramka, 2017; Młynarski et al., 2018).

Electronic sales in PL-D and system auctions are made on an annual or semi-annual basis. Separate contracts of each of the entrepreneurs are subject to automatic consolidation. The history of timber purchase (2 years or 2.5 years established by the monopoly) is valid. The system introduces the amount of the minimum purchase offer that can be submitted by the entrepreneur and the minimum amount allocated by the algorithm (e.g. transport volume). In addition, contractual penalties are applied (10% of the value of uncollected timber) and the amount of the deposit is increased.

The criteria for evaluating offers seem to simulate a market mechanism: in PL-D the only criterion for evaluating offers is the price (in the background there are correction coefficients until the sale offer is exhausted); in the "e-systemic wood" application the offer with the highest price wins, and auctions and sub-issues are conducted according to separate regulations. An algorithm for determining the maximum price based on prices from purchase offers submitted by entrepreneurs has also been developed. In case of surplus of demand over supply (i.e. overfertilization), wood buyers are assigned proportional quantities of wood according to algorithmic scoring (evaluation of the criterion*of the purchase offer), thus reducing the originally planned purchase volumes. Although the price remains the 'only' formal criterion for wood purchase, the system of wood raw material sales is rather an institutionally regulated rationing by one supplier (Wanat, 2009; Wanat and Klus, 2015).

At the same time, it is worth noting that in Poland, in the forest and wood sector, two certification systems have been functioning equally so far: FSC (Forest Stewardship Council) and PEFC (Programme for Endorsement of Forest Certification). The certificate in the PEFC system is held by all regional directorates of State Forests (September 2014). In total, this certificate covered 7.3 million hectares of Polish forests, i.e. about 80% of their total area. Currently, 139 certificates relating to wood products – PEFC-CoC (Chain of Custody) – are also active, 89 of which belong to production companies. They are dominated by producers of rubbed materials (28%) and paper and paper products (27%). Certification according to the FSC standard (as of September 2014) covered 16 out of 17 regional directorates of State Forests and 3 Forest Experimental Plants (in Krynica, Rogów and Siemianice). In the FSC-CoC system 2373 certificates were registered (including 670, i.e. 28% are inactive). Out of 1703 active certificates, 1218 (72%) belong to manufacturing companies. They are dominated by manufacturers of friction materials (342 companies, i.e. 28% of all FSC-CoC certified companies). This certificate is also very important for manufacturers of small wooden architecture products (15% of active certificates), wood haberdashery (15%) and furniture and furniture elements (12%). Certification systems allow the use of traditional and electronic tools for pro-ecological integration of forest management, based on the shaping of the forest-wood value chain according to the concept of circular economy (Paluš et.al., 2018; GUS Forestry, 2018).

2.3. E-commerce in the wood-based sector

E-commerce as a form of trade has been part of the global economy for more than 20 years. Currently, almost 3.6 billion (i.e. about 47%) of the world population have access to the Internet (statista.com). Generation Y, i.e. persons born after 1983, has already entered the age of consumption, and the following generation Z (born at the time of Internet ubiquity) will soon reach that age. For both generations, the Internet and the latest technological solutions are an integral part of everyday life. The value of sales in Polish e-commerce is estimated to be close to EUR 10 billion, while maintaining a steady upward trend (Lewicki, 2018).

Can one therefore speak about similar prospects for the e-commerce market in the wood-based sector? Analyzing the example of furniture industry, it was noticed that the market of furniture and interior design products is one of the fastest growing e-commerce sectors in the world. At the same time, furniture and large-size equipment is one of the most difficult products to sell online. A potential consumer moves smoothly between an online shop and a showroom. Watching the furniture himself/herself, he/she often holds a mobile phone in his/her hand, through which he/she is looking for the best price of the product. Furniture is the category of products least susceptible to shopping impulses. The ability to see the product in person, touch it, check its functionality and convenience are the key factors influencing the customer's decision. Two phenomena can be observed in this space: the ROPO effect (research online, purchase offline) and the reverse ROPO effect (research offline, purchase online). In the case of ROPO, the customer collects information about the product on the Internet, looks at photos, compares, reads user opinions and buys in a stationary shop. In the case of inverted ROPO, the customer wants to see the furniture with his/her own eyes in the living room, compare it with the available offer. The purchase is made online where the client gets the best price. It is also possible to have a third shopping path for demanding customers: ROTOPO (Research Online, Test Offline, Purchase Online). The buyer first looks for inspiration on the internet, then watches and tests the product in the store, and once the decision is made, buys online (Kaputa et al., 2016).

Furniture is still the most frequently purchased products in traditional shops. Ex-post surveys indicate that 80 percent of customers prefer to shop offline, only 11 percent of furniture buyers use online shopping (Grzegorzewska, 2019). In the meantime, however, IKEA has proposed the "Furniture online" programme, offering the collection of goods in special pick-up centres in cities where the company does not have its own shops. In 2018, IKEA recorded an 11 percent increase in sales in Poland in 2018 with a result of nearly EUR 1 billion. Almost 29 million people visited IKEA stores in Poland and at the same time the IKEA.pl website recorded over 97 million visits. In 2018, global IKEA sales increased by 4.7 per cent. Meanwhile, online sales in this chain increased by as much as 45 percent (Koniorczyk, 2015; GUS, 2018; IKEA Portal, 2019). No wonder that the Swedish brand plans to build new distribution centers and smaller stores for the e-commerce channel.

Despite general cautious tendencies, the importance of the Internet as a place to buy furniture is constantly growing. Every third respondent surveyed by IKEA buys furniture online. An even greater percentage, 41% of Poles, consider buying furniture online in the near future. It seems that a similar trend also applies to other wood products, especially small products and wood haberdashery, interior furnishings and elements of the garden programme. As a result, it may turn out that online shopping will become a common form and traditional shopping will have to be classified as luxury and elite forms of spending free time.

3. CONCLUSIONS

On the basis of the analyses carried out, the following conclusions were reached:

1) The ability to initiate economic symbiosis relations between traditional entities and services of the wood-based sector and entities and services of the electronic economy sector is constantly growing.

2) The trend towards digitisation concerns not only those markets that are easy to adapt to e-commerce, but also those where participants have so far preferred only traditional forms.

3) The potential of e-commerce is an opportunity to diversify forestry services. In a situation where on average 90% of revenues from the use of forests comes from the sale of wood, the still unused

resource is the digitalization of the service sector, which may concern information (on the basis of the Forest Data Bank), the wood electronic exchange (on the basis of the Forest and Wood Portal) and the sale of finished products, as well as optimization of other forest services (transport, storage, etc.).

The process of economic symbiosis usually starts with the mutual exchange of surplus resources and the integration of management systems. Market participants imitate nature in this way: nothing is waste within it, and every element is continuously processed and useful. Therefore, it is natural to take measures aimed at using the stream of all wood materials: primary materials, semi-finished products, including those of lower quality, and finally waste, i.e. at every stage of the "product life", still wood, as a reusable raw material. The system of symbiotic connections is therefore developing, transferring natural models to the anthropogenic world, and nowadays more and more often to the virtual world.

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EFFECTS OVER THE FORESTRY-BASED INDUSTRIES AS A RESULT OF THE DIGITALIZATION OF THE TRANSPORTATION SERVICES ON THE DANUBE

Petya Koralova – Nozharova

Abstract: The main purpose of the paper is to assess the digitalization process impact over the forestry-based products. The analysis will be done as a result of studying the cargo flows of forestry products on Danube inland waterways. Econometric models will be used in the research. Based on regression analysis, there will be determined the correlations between key indicators of the forestry-based industries and indicators, marking the dynamics of the cargo flows of forestry products as a result of the digitalization process. It will help to be highlighted the benefits of the speeded up process of electronic data exchange amongst various stakeholders. The current paper will contribute to the following: First of all, there will be identified the correlations between forestry-based industries and digitalization. Secondly, it will be examined if a relationship between the cargo flows of forestry products and forestry-based industries in the Danube region exist. Thirdly, there will be outlined the problems that impede the digitalization of the transportation services of forestry products. Lastly, there will be proposed some ideas how the researchers could develop the studies in this field in the future.
Keywords: digitalization, forestry-based idustries, e-platforms.

1. INTRODUCTION

In the last years, digital technologies got into the global economy at full speed. It is expected that the Fourth Industrial Revolution, which is characterized by artificial intelligence, mass usage, robotization, internet of things and big data usage will develop. There emerged computer networks of fifth generation, the traffic planning is done in real times, consumers have access to much realiable and detailed information about the passenger and freight carrieages in comparison to the transport operators. On the other hand, stakeholders have the opportunity to track their cargos at every separate stage of the transportation process through the deployment of intelligent transport systems.

The main purpose of the current publication is to be studied the impact of the digitalization process over the development of the separate economic sectors, as the accent is put on the effects over the forestry-based industries as a result of the deployment of digital technologies in the transportation process of inland waterway transport on the Danube. The analysis will be based on the comparison between the aforementioned economic sectors, because since 2005 the process of automatization of the transportation services on Europe's inland waterways has started with the implementation of the directive on harmonized river information services (European Commission, 2005), and the forestry-based products are one of the main cargo types, transported on the Danube – their share of the total cargo volumes is approximately 19% (Hasenbichler, H., 2013)

2. PROBLEMS AND PERSPECTIVES TO THE DIGITALIZATION OF THE TRANSPORTATION SERVICES ON THE DANUBE

With the emergence of the digital era, the transportation sector is expected to develop in the following fields (World Maritime University, 2019). **First of all**, automatization of the transportation services; **Secondly** – the implementation of unmanned vehicles and traffic management, which will lead to prequalification of the working force rather than its reduction. **Thirdly**, the digitalization will have positive impact over the demographic situation in the countries, over the economic effectiveness of the transportation companies and safety of the population.

The process of digitalization in the field of inland waterway transport in Europe and especially on the Danube, has started since 2005 through the implementation of the river information services. They are harmonized information services which make the traffic management and planning of the transportation process on inland waterways much easier and the interoperability with the other transport modes possible (European Commission, 2005). These services speed up the process of electronic data exchange amongst various stakeholders in the transportation process through the usage of harmonised and standardised information and communication applications. By the deployment of such services, it could be achieved effective, safe and flexible transportation process management and optimal usage of the existing infrastructure (Alassan, 2006). As a result of the implementation of these river information services the following positive effects could be attained:

- Reduction of the exploitation and administrative costs, concerning the usage of the transport infrastructure;
- Reduction of the green house gas emissions in the atmosphere;
- Reduction of the delivery time of cargos and decreasing the share of irrational and empty runs of vehicles;
- Increasing the safety of passenger and freight carriages and ensuring better working conditions for the crews.

The expected effects of the digitalization process over the transportation services on the Danube are related to the rise of economic benefits to the transport operators (increased safety of the transportation services, labor productiveness and lower sum of the variable costs); port operators (making use of the free capacity of the infrastructure, increasing the number and types of the serviced vessels at the ports); state institutions (reducing the total sum of the fixed costs); customers (decreasing the total sum of the opportunity costs when the transportation process is operated by inland waterway vessels). These statements could be confirmed by the statistical data, characterizing the dynamics in the transportation services of forestry-based products on the Danube. For example, since the implementation of the river information services in the Danube riparian countries in 2008, the total volumes of transported forestry-based products have increased with 61,4 thousand tones averagely every year till 2017. And in 2017 a growth of approximately 8 times in their volumes in comparison to 2008 is observed (EUROSTAT, 2019).

The process of digitalization of the transportation services on the Danube is also related to the airborne and underwater inspection drone technologies (during the transshipment and real transportation processed). In order to be increased the effectiveness of the transshipment equipment at the ports, it is expected to be reached a human-robot collaboration as a result of which crews will perform repair and transportation tasks with the help of robots and they will remotely operate the port facilities (World Maritime University, 2019).

Till that moment, it is still impossible to be fully digitalized the transportation services on the Danube, because the transport operators in the separate Danube riparian countries have not deployed harmonized information and communication applications (Punter, Ir., et. al., 2017). Another problem, impeding the process of digitalization in the inland waterway transport is the national legislation of the countries which regulates the dissemination and sharing of information amongst the various stakeholders. The sharing and transfer of data, concerning the accurate position of the vessel during the transportation process is allowed to be done only amongst the port authorities. This means that if a forestry-based company wants to receive information about a vessel which is transporting forestry products of its own, the request of the company will be canceled. The limited responsibility of the port authorities and transport operators, concerning the process of sharing information amongst the all parties in the transportation contract is another problem that impedes the digitalization process of the inland waterway services on the Danube.

3. IMPACTS OF THE INLAND WATERWAY TRANSPORT ON THE DANUBE OVER THE FORESTRY-BASED INDUSTRIES

The impacts over the forestry-based industries of the inland waterway transport on the Danube will be examined as a result of the implementation of the analytical model of Acar, Eker and Eroglu, (2003). On first place, there will be identified the economic effects over the forestry-based industries. According to the authors 30% of the total costs of the forestry companies are spent for transportation services. Having in mind the exploitation and economic characteristics of the inland waterway transport, its services are definitely much cheaper in comparison to the road transport. The usage of inland waterway transport is also appropriate in the transportation process of heavy, bulky, oversized cargoes and for long distances as the energy consumption of vessels is much lower than the consumption of vehicles in terms of their carrying capacity (Weintraub et al.,1996). Moreover, there are no traffic jams on the Europe inland waterways, no noise and environment pollutions in the cities and the risks of accidents are lower in comparison to the road transport. The increase in the total labor costs in South-Eastern Europe is related to the processes of integration of the region to the European Union and to the globalization. In the conditions of increasing labor costs, the reduction of the transportation costs is an important issue for the companies. On the other hand, the total revenues of the forestry-based indusrties are decreasing as many artificial substitutes of the wood are created. In the furniture industry such types of substitutes are MDF, glass, polymers, which fact directly influence the productiveness of the forestry-based industries.

The second type of effect of the inland waterway transport on the Danube over the forestry-based industries is the technical one. Most of the operations, concerning the loading and unloading of trucks in forests are expensive and need a lot of efforts of the working force and transshipment facilities. What is typical for the forest roads is their large displacement and in certain periods of the year these roads are impassable. In this way, the road transport could loose its core competence on the transport market in comparison to the other inland transport modes – high speed of the transportation services. On the other hand, there are real possibilities for inland ports, located close to the forests, their infrastructure facilities to be constructed in a way which allows much easier transshipment of the forestry products. This will make the process of loading and unloading of forestry products much easier and automated. Moreover, in the forest terrain conditions, inland waterway transport could be much faster than the road transport in the process of transportation and delivery of the products to the final customers. Most of the activities in the inland waterway transport are certified and stansardised, which means that the technical operations and technical maintenance of the port facilities, as well as the quality management and control systems will be at high level.

The third type of effect of the inland waterway transport over the forestry-based industries is the ecologic one. The transportation services in the area of forests create risks of environment pollution (soil, water, flora, fauna, air). Forests, besides main source of wood are also a major factor in the fight against climate change, desertification, water supply. Therefore, forests should not be seen only as a source of wood. The construction of roads in the forests causes significant damages to the bio-diversity and habitats, as well as to the forest lay. On the opposite, the transportation services of the inland waterway transport are carried out in water environment, which is natural environment and it does not damage the forest lay. In the conditions of ever-increasing ecological standards and restrictions on global level, the transportation services of the inland waterway transport will be preferrable by the forestry-based industries.

The fourth effect is the socio-political one. As a result of the transportation services of the road transport, the infrastructure of the forest villages could be damaged because of the large carrying capacity of vehicles. On the opposite, the transportation and transshipment services of the inland waterway transport could increase the employment rate in the residential area of the forests without damaging the roads and creating noise and risks of accidents.

The fifth effect of the inland waterway transport over the forestry-based industry is related to the traffic planning issue. The inland vessels are deployed with GPS and related information and communication applications which allow remote tracking. In this way, the forestry related services will be planned much accurately. Inland waterway transport operates on lower speeds than the road transport, but in a process of better traffic planning, it could be much safer, more reliable and secure in comparison to the road transport. The better traffic planning, based on the digitalization process, allows the port authorities to unite homogenous forestry-based products of many shippers and in this way the prices of the transportation services will be much lower. Inland waterway transport is not dependent on the climate changes in forest terrains, as the road transport sometimes does. In this way forestry-based companies have the opportunity of transportation services diversification in severe meteorological conditions.

4. RESEARCH METHODS AND RESULTS

In order to be examined how the digitalization process of inland waterway transportation services on the Danube influences the forestry-based industries, there will be used linear regression analysis. The statistical data used, is taken from the EUROSTAT database, as well as from the officially published annual reports of the Danube Commission and the private company Via Donau and it characterises the economic activity of the transport and port operators in the field of inland waterway transport. The period of the analysis is 10 years and the data collected, characterises the transportation services with inland waterway transport of all Danube riparian countries, including also these countries, which are EU non member-states. In this case, the independent variable is the supply and production of forestry-based products in mln. euros. This indicator is of great importance for the evaluation of the economic, technological and socio-political effects as a result of the digitalization of the transportation services on the Danube. It will contribute to the increase/decrease of the produced and supplied volumes of forestry-based products. For a dependent variable it is chosen the level of digitalization of the transportation services on the inland waterway transport in the Danube region, based on the volumes of forestry products transported by modern vessels, equipped with information and communication technologies. This indicator is of great importance for the creation of technical and ecological effects over the forestry- based industries.

As a result of the regression analysis, it is ascertained that there is a straightforward relationship between the studied variables:

- Significance F – 0,03;
- Correlation coefficient – 0,71;
- Coefficient of determination – 0,4995

Consequently it could be concluded that approximately 50% of the variations in the values of the forestry-based products, which are supplied at the forestry market and delivered to the final customers via inland waterway transport will depend on the level of digitalization of the transportation services and the equipment of vessels with information and communication technologies

The dependence between both variables could be presented by a linear function, which is the following:

$$\textit{Supply of forestry products} = 8730 + 0{,}028 * \textit{forestry products transported by IWT} + \varepsilon, \quad (1)$$

Where ε is the sum of squared residuals.

The implementation of modern vehicles, which allow movement of vessels at optimal speed and their lower energy consumption will help to be realized economic and ecological effects for the forestry-based industries. Taking into account the aforementioned formula, it could be concluded that if the volumes of forestry products transported via inland waterway transport with the usage of digitalized vessels increase with 1, then the volumes of the forestry products produced and supplied to the market will rise with 3%. Moreover, the usage of such mode of transport in order to be delivered the forestry products to the final customer will contribute to the reduction of the opportunity costs for the transportation services, which is one of the main goals of the policies for digitalization of the transport sector.

5. CONCLUSIONS

Based on the assessment of the effects over the forestry-based industries as a result of the speeded up process of the digitalization of the inland waterway transport, it could be concluded the following. First of all, the problems that impede the full digitalization of the transportation services on the Danube are identified. Such problems are: lack of harmonization amongst the information and communication applications, deployed by the separate Danube riparian countries. Another essential problem is the national legislation of the countries, which limits the dissemination and sharing of information about the traffic of vessels to the third parties. On the other hand, the inland waterway transport is one of the transport modes where the information and communication technologies were deployed for the first time in the transportation process. In this case the benefits created for the customers, including the forestry-based companies are lower opportunity costs when choosing this mode of transport to operate the carriage. On second place, the main effects for the forestry-based companies as a result of the usage of inland waterway transportation services instead of these of the road or rail transport are outlined. These effects are economic, technical, ecological and socio-political. Thirdly, based on indicators, selected by the author, it is presented a correlation between the production and supply of forestry products and the volume of forestry products transported by vessels, equipped by modern information and communication technologies. It is calculated how and with how much the supply and production of forestry products will change if the volumes of forestry products transported via modern and digitalized vessels change with 1. The present publication could be use as basis for future research, related to the studying of the opportunities how the share of forestry products in the total volumes of cargos transported with multimodal transport could be increased, as a result of the interoperability amongst the inland transport modes. Moreover it could be studied how the implementation of e-platforms for the supply and demand of inland waterway transportation services on the Danube will influence the forestry-based industries and what types of effects could be created.

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DIGITISATION IN FOREST INDUSTRY IN BULGARIA – STATE AND PERSPECTIVES

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Abstract: A main objective of the paper is to present the state, current trends and challenges in front of the enterprises in Bulgarian Forest sector, based on the introduction of digital tools and solutions in business and economy as a whole. A subject of analyses is the degree of digitisation of forest sector enterprises based on the implementation and use of online-based applications and electronic catalogs; specialized information and communication management systems and networks; office and warehouse management software. The indicators under analysis are divided into the following groups – "connectivity and digital skills"; "internal processes" and "relationship with customers, suppliers and third parties". In order to achieve comparability of the results, the selected indicators are the same as those officially used by Eurostat. For the purposes of the analysis, secondary and primary data are used as well as publications in the specialized literature, legislation framework and analyzes of statistical data from national and international databases. The paper presents primary results from in-depth interviews with management representatives from large forest industry enterprises, according to the requirements of the Bulgarian Accountancy Act (AA). Good digital practices in the furniture manufacturers are also presented, and some opportunities for development of the Forest industry entities are suggested.
Keywords: digitisation; Forest sector; Forest industry; in-depth interviews; large enterprises.

1. INTRODUCTION

In the context of the fourth industrial revolution, digitisation on economic, social, educational and political level is among the priorities of the European Union (EU) (Digital agenda for Europe, 2014; The EU and the digital single market, 2017). There are fundamental differences between the terms "digitisation", "digitalization" and "digital transformation". "Digitisation" can be in general defined as "material process of converting analogous streams of information into digital bits" (Brennen, J.S., Kreiss, D., 2016). By sharing the idea of Gray and Rumpe, we believe that digitalization „is the use of digital technologies to change a business model and provide new revenue and value-producing opportunities; it is the process of moving to a digital business" (Gray and Rumpe, 2015, p. 1319). Digital transformation in hand is "an organizational change that is caused by the rapid development and application of digital technologies in business" (Slavova, M., 2016, p.142). The causal link between global technological development and the introduction of diverse digital solutions and tools by enterprises is a factor that makes digitalization from a competitive advantage to a need and a basis for economic growth. A main goal of the paper is to outline the current state, trends and challenges ahead of the Bulgarian forestry enterprises, which comes from the implementation of digital tools and online business solutions. An object of more in deep study is the level of digitisation of Bulgarian forestry enterprises, based on the implementation and use of online-based applications and electronic catalogs; specialized information-communication and management systems and networks; office applications and warehouse management software. Subject of analyzes are publications in the specialized literature, statistical data analysis and analysis of collected primary information from in-depth interviews with managers of large-scale forestry enterprises. Some good practices of used digital tools by Bulgarian furniture manufacturers' enterprises are presented as well.

2. CURRENT STATE OF THE "DIGITAL ECONOMY" IN BULGARIA

In a pyramidal structure we can put digitisation at the bottom, digitalization in the middle, and digital transformation at the top of the pyramid. In this respect in order to talk about a digital economy, a high level of digitisation in the government and business sectors of a country must be achieved at first. According to data from the European Commission (2018), Bulgaria is at 26th out of 28 places based on the digital economy and society index (DESI). If we take a closer look Bulgaria is ranked 25th according to the indicator "connectivity", 27th on the indicator "human capital", 26th on the indicators "Internet use" and "Integration of digital technologies" and 23rd on the indicator "digital public services". The impossibility of Bulgaria to reach the average European level on the indicators under review may have a negative effect on the business as a whole. At microeconomic level, the implementation of enterprises' digitisation can be measured by the following indicators – "connectivity and digital skills"; "internal processes" and "relationship with customers, suppliers and third parties" (Monitoring the digital economy & society 2016 – 2021, 2015, p. 13). *The connectivity based on the use of computers and Internet access* is a basic form of digitisation (Jagjit, S., Lorentz, H., 2019, p. 79). According to Eurostat 87% of the enterprises in Bulgaria in 2017 have broadband access to Internet. This is 32 percentage points higher than in 2006. According to data from the Bulgarian national statistical institute (NSI) in 2017 and in 2018, the percentage of enterprises with access to Internet is 94.6% as the dominance is to large companies reporting hundred percent access. We can state that the digital competences of enterprises staff members are a prerequisite for effective and efficient use of the Internet as a tool for building a competitiveness. However, data from Eurostat indicate that the digital skills of Bulgarians are below the EU average. In 2017 people in Bulgaria at the age gap between 16 and 74 with basic or more complex digital skills are 29%, which is 3 percentage points higher than in 2016, but by 2 percentage points less than in 2015. As a reason we can outline the demographic changes in our country. In particular a negative natural growth is recorded in 2017 (-6.5 per 1 000 people) (Eurostat, Population and population change statistics, 2019). In addition, the highest percentage (30.6%) of staff that use Internet is reported by small enterprises compared to the staff of medium and large enterprises. The lack of digital competences is a factor that can have a negative impact on the business and respectively on the economy of our country. *Development of a website* is fundamental for visibility of enterprises, among customers and investors. Over the last five years (2014-2018) there is a gradual increase in the number of businesses that have websites. In 2018, it is 51.1% compared to 48.4% in 2014. Based on the size of enterprises in 2018, 88.2% of large enterprises, 74.1% of the average and 45.9% of small enterprises have a webpage that is advertising their activities. However, the use of social media (9%) and cloud computing services (5.5%) by Bulgarian enterprises is still among the lowest levels in the EU in 2018 (DESI, 2018, p.13). Also, despite the high percentage of businesses that have a website from 2010 to 2018, the percentage of organizations receiving electronically orders from their customers is below 11%. The highest percentage of online sales is reported by the large enterprises compared to medium and small ones. However, in 2018 compared to 2017, online sales has declined by 3.1 percentage points. The *"internal processes" indicator* is generally measured by the percentage of enterprises with automated resource management systems (eg ERP); use of mobile technologies with internal organizational purpose; percentage of enterprises using software applications to manage their customer information (eg CRM) as well as by the percentage of enterprises using RFID technologies. Between 2007 and 2017 the highest percentage (16%) of enterprises that use software applications to manage their customer information is reported in 2014. It is noteworthy that, according to NSI in 2017, compared to the data available for the previous statistical period (2015), there is an increase of the indicator with 1.3 percentage points for small enterprises and 2.9 percentage points for medium enterprises. For large enterprises, however, there is a decrease by 0.7 percentage points. Until 2014 incl. there is a positive trend towards an increase in the number of Bulgarian enterprises using digital resource management systems. In 2017 compared to 2014, there is a decline in the indicator by 3.9 percentage points. If we analyse the NSI data more in deep we can point a gradual increase in the percentage of large enterprises that are using ERP for the period 2010 – 2015 (incl.). In 2017, however, the percentage is 1.6 percentage points less than the reported data in 2015. Enterprise relationships with customers, suppliers, and third parties are generally based on the use of electronic invoices, the development of an online store website, the use of social media, the ability to electronically share supply chain management information with customers and suppliers. It should be noted that large enterprises in our country report the highest percentage (30.7%) in 2017 compared to small and medium enterprises, whose business processes are automated related to those of their suppliers and/or customers. Looking at this indicator for the period 2010-2017, It can be noted that the highest numbers are recorded in 2012, when the percentage of large enterprises using similar systems or digital applications is 41.5%.

Based on the previous data we can state that the degree of digitisation of the Bulgarian economy as a whole is also a prerequisite for low levels of digitalization and digital transformation by enterprises. Although large enterprises are a major pillar of economic prosperity based on greater opportunities for innovation and attracting highly skilled human capital, they do not fully benefit from the opportunities provided by digital technologies. For example, even though 100% of large enterprises in Bulgaria reported use of Internet in 2018, fewer than 89% have their own online page, and less than 16% have a webpage for online sales. This is confirmed as well by data from studies of the business environment in Bulgaria, which indicates poor knowledge of the concept of digitisation and digitalization by enterprises. Because of this, digitisation is primary perceived as a way to optimize resources and processes in organizations (Study on the level of digitisation in Bulgaria, 2018; Innovation.bg, 2018; Chobanova, R., Kocarev, L., 2019).

3. DIGITISATION IN THE FORESTRY BASED INDUSTRY IN BULGARIA

3.1. Profile of the Forest industry in Bulgaria and state of the problem

The Forest industry is a part of the Forest sector, where SMEs are over 97% of all enterprises. The main economic activities in the Forest industry are related to the production of wood products (wood tiles, parquet, joinery, etc.) and production of furniture (upholstered furniture, furniture, mattresses, etc.). ICT are important both for the organization of management and production based on the reduce of labor costs, time of operations and optimization of technological processes. However, the main investments in the industry are primarily focused on purchasing machinery and automating production, rather than on the integration of business processes in enterprises. In this respect, ICT in the sector mainly involves implemetation of websites, e-mails, electronic catalogs and shops, Internet advertising and more. The used digital tools includes: integrated Enterprise Resource Planning systems (ERP); Customized Customer Relationship Management (CRM) Customer Relationship Management (CRM) systems; Supply Chain Management systems (SCM); Computer-Aided Design (CAD), and more. Along with the integration of enterprise management tools described above, companies need software tools at the point of sale. Manufacturers use automated tools to configure products and pricing, and visualize products with dynamic graphics. Virtual reality uses 3D graphics and devices to provide an interactive view, and it offers visual solutions and their correspondence with other items or accessories. (Popova, 2013). The ICT studies in the Forest industry in Bulgaria are mainly focused on SMEs, so a research regarding the used digital systems and tools in large enterprises will show some current trends and could highlight good practices in the field. Previous survey results are indicative that enterprises operating in the Forest sector in Bulgaria have better performance than the average levels of the country mentioned above (Chobanova et al., 2018, p. 164-189). In this respect 92.1% of enterprises participating at the survey use computers and Internet. 61.8% of those which use Internet have fixed or broadband connection. Nearly 91.4% of the enterprises state that a major factor for using Internet in the organization is the need for online interaction with the government institutions. 23.1% of the surveyed enterprises have a website and 17.1% offer possibility for online orders to their customers. 25.7% – have business processes, which are automatically linked to those of their suppliers and customers. From administrative and organizational point of a view, 37.1% of organizations under analysis prepare and issue electronic invoices to their clients while 34.3% use social media (including social networks, blogs, multimedia sharing websites, etc.). 8.6% have implemented cloud services in their activities. As a conclusion, compared to the results of Bulgaria's overall performance, forest sector enterprises report better data, excluding those related to broadband Internet access. Interesting is the fact that only 23% of enterprises have webpage, despite that their online presence can be seen as a factor for increasing sales and confirming their position on the market. This result can be explained by the lower use of ICT in logging and wood processing organizations. At the same time, owners and managers of enterprises in the country point out the need for active implementation of digital tools and trainings related to their use. This is stated as a priority for increasing the organizational efficiency and innovation of enterprises (BCWFI, 2018).

3.2. Survey methodology and results

The subject of the study is the degree of digitisation of Bulgarian forest sector enterprises based on the use of online-based applications and electronic catalogs; specialized information and communication systems and management systems; office applications and warehouse management software. The observation methodology is characterized by: use of officially reported indicators in the EU and the country (Eurostat, NSI); ability to conduct deep interviews and collect detailed, reliable and diverse data; selection of the largest enterprises in various economic activities of the industry (production of upholstered furniture, production of furniture, manufacture of wood panels, production of parquet and laminates, production of mattresses, production of toys, etc.). The used method is in-depth interviews with duration of 20 minutes. The subject of the survey is large enterprises, according to the requirements of the AA. The choice of the target group is in line with the authors' goal to study the level of implemented digital solutions and information and communication technologies among enterprises with diverse economic activities in the forest industry. Observing units are the sixth largest enterprises (over 250 employees), in the respective core economic activities of the forestry industry. The interviews are conducted in 2018. The monitoring questionnaire includes issues aiming to determine the degree of digitisation of enterprises based on the following indicators: *Use of computers and Internet by enterprises* (use of e-mail, website, electronic catalog, e-shop, Internet advertising); *Internal processes* (use of integrated ERP systems, specialized systems such as CRM, SCM, computer networks, office packages); *Enterprise relationships with customers, suppliers, and third parties* (use of inventory management systems, digital supply chain management and supplier relationships, electronic forms of orders or other information systems between suppliers and businesses, unique and automated product identification throughout the supply chain). The use of digital tools and solutions by large enterprises under investigation in this paper is outlined in Table 1.

Table 1. Use of digital tools in the largest forest industry enterprises in Bulgaria

Indicator	*Name of enterprise*					
	Mebel Still	**Videnov**	**Kronoshpan**	**Kastamonu**	**Irelly**	**Ted Bed**
Use of computers and Internet						
E-mail	✓	✓	✓	✓	✓	✓
Website	✓	✓	✓	✓		✓
Electronic catalog	✓	✓	✓	✓		✓
E-shop		✓				✓
Virtual tour with pricing option		✓				✓
Internet advertising		✓				✓
Internal processes						
Integrated systems ERP type	✓		✓			✓
Specialized systems CRM, SCM type			✓			✓
Computer systems, office packets and networks	✓	✓	✓			
Enterprise relationships with customers, suppliers and third parties						
Stock management systems		✓		✓		
Digital supply chain management and supplier relationships		✓				✓
Electronic forms of orders or other information systems between suppliers and enterprises		✓	✓		✓	
Unique and automated product identification throughout the supply chain		✓	✓	✓		✓

It is noticeable that businesses use email and have web pages, electronic catalogs, and office packs. This also determines the level of digitisation as a prerequisite for the active use of ICT tools, technologies and solutions of different types. Internet advertising and e-shop sales are used by businesses whose production is mainly focused on the domestic market. Enterprises that work primary with foreign markets rely on contractual relations and as franchisees have a guaranteed market and sales. It is logical that businesses also actively use logistics and relationship-related capabilities such as electronic forms of ordering and automated product identification throughout the supply chain. This is related to the search for opportunities for shortening delivery times and production operations, as well as optimizing the work with the many suppliers that companies operate.

3.3. Good practices of furniture manufacturers, operating at the territory of Bulgaria

As good practices regarding the level of digitisation by Bulgarian companies we can point out – Videnov Group Ltd., Kronospan Bulgaria Ltd. and Ted – Bed Ltd. Examples of digital systems and tools used in production and management in those enterprises are: CALL customer service center via online orders and sales; specialized electronic catalog with full technological specification, dimensions and materials of wood-based panels, models and schematics of the components; mobile application (KronoDesign), which allows different combinations of scenery, colors and textures, as well as a choice of interior style; corporate blog and B2B business information, incl. franchise opportunities. When we talk about good practices of digital solutions used by foreign forest industry enterprises operating in Bulgaria, IKEA is a good example. Its application called "Ikea Place", functioning in Bulgaria as well, use augmented reality, which help customers to imagine their home with new furnitures, sold in the shop. The 3D digital tool can be used on smartphones.The in-store logistics managers of the retailer use an inventory replenishment management process developed by IKEA called 'minimum/maximum settings' to respond to store-level inventory reorder points and reorder products. The software functions on the base of the number of products that will be sold from the reserve stack of bin in a single day or two-day period. The aim is to minimize the number of stock goods while meeting customers' demands and lowering the cost of lost sales. The data from the software helps managers to forecast sales for the next couple of days and order in the suitable amount of products. Another good digital example implemented in Bulgaria is called Click & Collect. It helps people to buy products online and then to pick them up directly from the stationary shop. This digital tool is offered in our country by IKEA, Mömax, Butlers or DEPOT. Another good practices that is worth mentioning is the 3D animations used by the German furniture retailer MACO Möbel. The tool gives customers a life-size, spatial impression of the planned facility and enables them to interactively intervene in the planning process. In addition to modern websites, social media activities, image films and testimonials, the Forest industry and trade is increasingly discovering influencers for its online marketing activities. An effective strategy, as a significant number of people now base their purchasing decisions on bloggers and influencers.

4. CONCLUSIONS

The survey results of the level of digitisation of Forest sector enterprises in Bulgaria shows better performance than that on the national average, based on officially used assessment indicators in the EU. A main limitation of this conclusion is the fact that these results are based mainly due to the performance of medium and large enterprises. A more detailed study of the best practices of the largest enterprises in the Forest industry shows that they are aware of and apply the opportunities provided by the ICT tools, common and dedicated. The above-mentioned good Bulgarian practices are attended by the 6 largest enterprises with a different subject of economic activity from the industry, of which 2 are with foreign participation. The SMEs in the sector in Bulgaria should work hard to develop and implement them, using the good Bulgarian and foreign practices in this field and their efforts should be focused on: using the online furnishing and pricing options of enterprise sites; the optimization of supply chain and supplier relationships; the exploiting the potential of digital marketing and advertising.

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Part 4
INNOVATION AND MANAGEMENT

INNOVATION OF CALCULATIONS THROUGH THE USE OF MACHINE HOUR RATES IN THE FURNITURE INDUSTRY

Marek Potkány, Monika Škultétyová

Abstract: The aim of the paper is to present an innovative methodical approach to using the calculation of machine hour rates in the conditions of a selected furniture company. The reason for the propose of calculation methodology change is the overhead costs increase of company´s. With the growing trend of automation and mechanization in the production the current approach of absorption costing includes inaccuracy in allocation of the production overhead costs. The practical presentation of the use of the calculation of machine hour rates and its comparison with the current procedure is applied in a company which main business is the production of solid wood tables. The benefit of this paper is the possibility of using an innovative calculation method also in other sectors of industry.
Keywords: calculation, machinery hours, dining table, cost

1. INTRODUCTION

The furniture industry as a partial part of the wood-processing industry in Slovakia is relatively independent from import with active balance of foreign trade built on a domestic resource base of sustainable character. The problem is that this industry does not have the priority position in the hierarchy and support when compared to other industries. The entire industry solves issues associated with financing, competitiveness as well as the potential of product development and cost management.

Traditional calculation methods offer a wide range of applications that, due to changing cost structure and production automation conditions, have limits to the accuracy of information provision. One of the traditional methods is in practice a frequently used absorbing costing. The trend of increasing mechanization and automation makes human manual work increasingly replaced by machine work. This is most noticeable in the sphere of production. This is also evidenced by the change in the cost structure of manufacturing enterprises. While the share of production wages is falling as a direct cost, the overheads cost associated with the machines used in performance generation are increasing significantly. In the context of the use of the absorbing costing, the question arises whether production wages can continue to be an appropriate allocation base for redistribution of production overheads. Assuming that the main part of the work will be done by the machines, the redistribution of costs through direct wages loses functionality. As a result of the changed conditions, two major problems need to be addressed. How to keep the causal principle as far as possible and how to increase accuracy when I still want to use the absorbing costing? One of the solution that would address both of these issues is a calculation using of machine hour rates. Calculation of machine hour rates it represents a specific form of absorbing costing, which is particularly widespread in German-speaking countries. This article provides information on the potential of an innovative methodical approach using the calculation of machine hour rates in the selected furniture company.

2. MATERIALS AND METHODS

The analysed product, subject of the search is dining table STORN (Figure 1), which is produced by selected furniture company in Slovakia. This product is offered in several variations depending on the choice of wood species, surface treatment and construction dimensions. The construction of dining table STORM comprise from table top, additional boards, the outer and inner frame, cover ribs and table legs. The company produces all components within its own production capacities and this product is mainly intended for export in west European countries. In the production participate several manufacturing devices. The most dominant of these are CNC machine tool Homag, which is used for machining table top, additional boards, the outer and inner frame and CNC machine tool Greda, which serves only for manufacturing table legs. The process of calculating machine hour rates will be demonstrated at these manufacturing facilities.

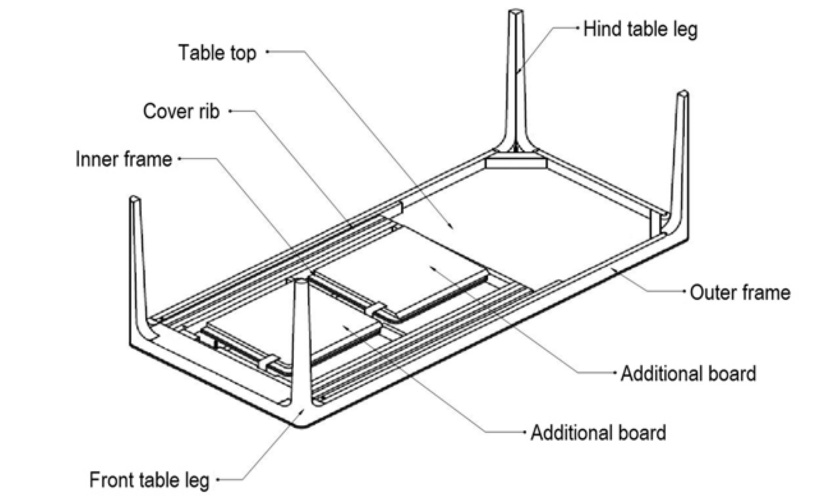

Figure 1. Dining table STORN

Based on the study of available foreign literary sources dealing with the issue (Ostermann, 2010), (Wöltje, 2016), (Mumm, 2015) a (Rockstedt, 2008) it is possible to use the methodological procedure for setting machine hour rates with the following relations of partial rates:

Depreciation calculation rate (DCR): Calculation depreciation is determined after consideration actual reproduction price (RP) (including installation and preparation costs), estimated machine life (ML) and usable time fund in machinery hours (UTF).

$$\mathrm{DCR} = \frac{\mathrm{RP}}{\mathrm{ML} \times \mathrm{UTF}}\ (€/\mathrm{Sh})(1)$$

Where:
RP – reproduction price (EUR),
ML – machine life (years),
UTF – usable time fund (machinery hours).

Calculation interest rate (CIR): Calculation interest is related with the reproductive value of corporate capital and amount of the interest rate. It is usually used current interest rate on long-term foreign capital. For the reason of simplification and comparability of different periods enter into calculation only half of replacement value as it shows in their work Tschätsch (1996).

$$\mathrm{CIR} = \frac{\mathrm{RP} \times \mathrm{R_I}}{2 \times 100 \times \mathrm{UTF}}\ (€/\mathrm{Sh})\ (2)$$

Where:
RP – reproduction price (EUR),
R_I – rate of interest (in %).

Calculation rent rate (CRR): The rental costs are related to the space occupied by the production machine, including the need for work and utility areas. This area is then valued at the rate per unit area.

$$\mathrm{CRR} = \frac{\mathrm{SR} \times \mathrm{R_{UA}}}{\mathrm{UTF}}\ (€/\mathrm{Sh})\ (3)$$

Where:
SR – space requirements (in m^2),
R_{UA} – rate per unit area (EUR/m^2).

Maintenance cost rate (MCR): Costs of ongoing maintenance or repair can be determined differently. Usually they are observed in absolute amount or as a percentage rate applicable to the calculation of depreciation or the replacement cost of production equipment.

$$\mathrm{MCR} = \frac{\mathrm{MC_T}}{\mathrm{UTF}} (€/\mathrm{Sh})(4)$$

$$\mathrm{MCR} = \frac{\mathrm{RP} \times \mathrm{R_R}}{100 \times \mathrm{UTF}}\ (€/\mathrm{Sh})\ (5)$$

Where:
MC_T – total maintenance costs (EUR),
RP – reproduction price (EUR),
R_R – rate of repair (in %).

Energy cost rate (ECR): Energy costs, depending on the type of power, may include electricity, water, gas, fuel costs, and others. The calculation is based on installed capacity adjusted according to its real use.

$$\mathrm{ECR} = (\mathrm{RP_i} \times \mathrm{CP}) \times \mathrm{R_{UE}}\ (€/\mathrm{Sh})\ (6)$$

Where:
RP_i – installed rated power (unit of power),
CP – capacity utilization (in %),
R_{UE} – rate per unit of energy (EUR/ unit of power).

3. RESULTS AND DISCUSSION

The Company uses the type calculation formula (Table 1) to make pricing using the absorbing costing principle. Four cost items enter the final product price. This is particularly the case of direct material, labor and another cost, and also overhead cost through an overhead rate of 130% at the direct labor cost allocation base. The total own cost thus established is the basis for calculating profit, whereby the company requires a 20% return on costs. After including the profit, the price of the final product will be increased by the VAT item, which is currently 20%. Current price of dining table STORN with VAT is 2,136 €.

Table 1. Calculation price of dining table STORN

Calculation item	Value
Direct Material Cost	1,184.38 €
+ Direct Labor Cost (DLC)	112.79 €
+ Another direct cost (32.5% from DLC)	39.69 €
= Total Direct Cost (TDC)	1,336.86 €
+ Overhead Production Cost (130% from DLC)	146.61 €
= Total Own Cost (TOC)	1,483.46 €
+ Profit (20% z TOC)	296.70 €
= Price without VAT	1,780.16 €
= Price with VAT	2,136.19 €

For using the calculation of machine hour rates methodical procedure it is necessary to analyze in more detail the costs of production overhead. It is necessary to classify separately the costs that are caused by production, technological machines and especially the other costs (Table 2). Machinery-dependent costs will be allocated to the calculation unit via machine hours' rates. The redistribution of other costs will require the choice of finding an appropriate allocation base, which can be direct wages or machine hours of all equipment in production.

Table 2. Classification of overhead cost of company

Machinery-dependent costs (MDC)	Value	Machine-independent costs (MIC)	Value
Fuel consumption – saw	91 €	Material Consumption – Abrasives	36,817 €
Energy consumption	139,880 €	Consumer purchases	17,258 €
Repairs and maintenance	84,270 €	Consumption of other material	130,719 €
Lease	173,802 €	Labour costs	714,256 €
Depreciation of property	321,220 €	Working clothes, protective equipment	16,402 €
Interest on leasing CNC	927 €	Insurance machinery and equipment	5,228 €
Interest on loan CNC	4,265 €	Other corporate overhead costs	656,686 €
Total MDC	724,455 €	Total MIC	1,277,366 €

The most important information for using the methodology calculation of machinery hours is specification of usable time fund in machinery hours. After deducting the days of weekends, holidays and maintenance days, within the company, usable time fund in machinery hours is set at 201 days. If we consider a single shift operation of 7 hours and 30 minutes, then the base operating time is 1,507.5 standard hours (Sh). Naturally, this time is adjusted for each production facility. For the HOMAG and GREDA CNC machining centers we have chosen, the resulting operating time is 3,015 Sh, as they are operated in two-shift operation.

The machine hour rate appreciates the work done by the production facility in one hour of its operation (1 machine hour). These rates are determined for each production facility separately (Table 3). The calculation is based on a general relationship whereby the amount of the selected type of cost is first determined, and this is then related to the operating time of the particular machine.

Table 3. The machine hour rate for Homag and Greda

	Type of rate	Value	
		HOMAG	GREDA
DCR	Depreciation calculation rate	28.79 €/Sh	38.68 €/Sh
CIR	Calculation interest rate	6.06 €/Sh	8.13 €/Sh
CRR	Calculation rent rate	0.44 €/Sh	0.25 €/Sh
MCR	Maintenance cost rate	7.47 €/Sh	10.02 €/Sh
ECR	Energy cost rate	12.56 €/Sh	35.45 €/Sh
	Total ($\sum_n^i$ machine hour rate)	55.32 €/Sh	92.53 €/Sh

The amount of machinery-dependent costs per calculation unit can be determined as the product of the specified machine hour rate (Table 3) and the time at which the machine was machined. The CNC machining center HOMAG is used for the production of the STORN table for 55 minutes, which is equivalent to 0.92 machine hour and 40 minutes for the HOMAG CNC, which represents 0.67 machine hour. Table 4 shows the amount of machine-dependent costs determined through an innovative methodical approach using the machine hour rate calculation for the selected product.

Table 4. Machinery dependent cost of Homag and Greda for calculation unit

	Type of machine	
	HOMAG	**GREDA**
Machine hour rate	55.32 €/Sh	92.53 €/Sh
Aggregate machining time	55 min.	40 min.
	0.92 Sh	0.67 Sh
Machinery dependent cost	50.89 €	62.00 €

The machine-independent costs (MIC) calculation is based on a charge for this item when total direct cost of 7,188,247 € is determined by the allocation base, based on the cost of the enterprise over the selected time period. According to the above calculation, the overhead charge was set at 21.94%.

Based on the synthesis of all the data presented, it is possible to present a calculation proposal using the machine hour rates (Formulas 1-6) for the selected company product. The structure of the proposal is based on the original calculation, which is presented in Table 1, and its modified form is presented in Table 5. The resulting price of this product was set at 2,091.67 € excluding VAT.

Table 5. New calculation of dining table STORN

Calculation item	**Value**
Direct Material Cost	1,184.38 €
+ Direct Labor Cost (DLC)	112.79 €
+ Onother direct cost (32.5% from DLC)	39.69 €
= Total Direct Cost (TDC)	1,336.86 €
+ Machinery dependent cost Homag	50.89 €
+ Machinery dependent cost Greda	62.00 €
+ Machinery independent cost (21.94% from TDC)	293.31 €
= Total Cost (TC)	1,743.06 €
+ Profit (20% z TC)	348.61 €
= Price without VAT	2,091.67 €
= Price wit VAT	2,510.00 €

4. CONCLUSION

Furniture industry can be characterized by a wide range of product portfolio. In the concept of making calculations, the methodological procedure of surcharge calculation is used to a large extent in the conditions of Slovak enterprises. This costing based on direct and overhead costing requires applying the right allocation bases for overhead costing. Therefore, this calculation has its inaccuracies. The issues of calculations in the furniture industry were addressed in the studies Foltínová and Budinský (2008), Potkány (2006) and Wenker, Richter and Rüter (2017).

In this work, we have presented the use of the machine hour rates calculation, which shows a relatively efficient and more accurate way of allocating overhead cost for specific products, taking into account the cost of the machines involved in product creation. The practical application was to redistribute overhead costs at production facilities, CNC machining center HOMAG (rate 50.89 € / Sh) and CNC machining center GREDA (rate 62.00 € / Sh) incorporating time-consuming production of dining wood table STORN. Despite the fact that the price of the table increased by 311 € without VAT during the innovative method of calculation, there is still space for maneuver to reduce the profit margin, which is calculated at the same level of 20%. However, this decision would require a more comprehensive analysis and comparison of the prices of other products. We certainly state that the method applied by us calculates more accurately the cost of products, provides more relevant information for decision making and comparison. However, a successful application of the calculation of the use of machine hour rates requires very precise information on the detailed classification of production overhead costs, the time-consuming nature of the company's technological equipment and its time-consuming production and use.

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ASSESSMENT OF THE INNOVATION ACTIVITY OF THE WOOD PROCESSING INDUSTRY

Erika Loučanová, Miriam Olšiaková, Mikuláš Šupín

Abstract: The paper deals with the assessment of the innovation activity of the wood processing industry in Slovakia. The situation is evaluated in terms of innovation activity overview consisting of three areas: wood and cork (not furniture), manufacture of pulp, paper and manufacture of furniture. The primary raw material of the wood processing industry is wood, which is considered to be an environmental material. Therefore, it is convenient to identify the innovation activity and performance of wood-processing industry of Slovakia and its favorable and critical areas through the analysis. 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

Activities in the area of innovations are the elementary prerequisite for the company´s success for sustainable development within the market economy. These activities are an important dynamic factor of each company and at the same time they create an important link between the present and future of each company. Schumpeter defines innovation (Shumpeter, 1939) as creating a new production function representing new ideas application into the production process. According to some authors (OECD and Kotsemir, Abroskin, 2017) innovations is one of the factors influencing economic changes. Radical innovations create significant changes in the world; sequential innovations present the change process.

Innovations could be understood 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 it should use all supporting factors influencing its innovation processes.

Innovation process is strongly linked to 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 main prognosis´ aims in innovation process are usually market changes estimates, customers' needs and requirements, market capacity development, competition development, as well as estimates of technology 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 lies in the lack of own financial resources for innovations. It mainly concerns small and medium-sized wood processing companies. Consequently this economic unstable situation causes problems in innovation preparation and implementation that would lead to the raised competitiveness. It results in various difficulties of most of domestic wood processing companies trying 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) indicate that the comparative advantages are changing with the level of wood products processing. In particular, they decline with the increasing value added products. The level of wood processing also influences the trade specialisation. Slovakia is inter-industry specialised on the raw material level and the level of semi-finished mechanical wood products with low added value (e. g. sawnwood). With the increasing added value of the products Slovak trade changes in specialisation with the industry (Loučanová et al. 2017; Šupín 2009; Parobek et al. 2014; 2015).

There were not signified significant 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 considerations (Paluš et al., 2014; Paluš et al. 2011). Thus they identify the specific product characteristics regarding the customer requirements.

The specification of mentioned elements presents an important impulse in order to identify trends and to determine consecutive procedures, improvements and innovations for chosen products (Loučanová et al., 2014) in applying the quality management systems with the objective to ensure a higher efficiency in the whole sector (Gejdoš, 2016).

Kaputa et al. (2016) realized the study which results validate that foreign competition is considered to be the most significant obstacle for the Slovak exporters of wood products. It is followed by the necessity to invest in promotional activities and limited access to capital.

Another problem rests in an absence of the strategic development of the whole forest sector that would provide more effective solving of problems resulting from the transformation of the industry structure 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.

According to Klenk and Wyatt the strategy in the forest sector should fixate on knowledge mobilisation. It leads to innovations, which rather 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 in this sector for all types of wood.

The aim of the paper is the assessment of the innovation activity of the wood processing industry in the Slovakia.

2. METHODOLOGY

The principal approach to process the issue of the innovation activity of the wood processing industry assessment is an analytical-synthetic method. Through the researched features and processes analysis, in the paper we analyze the issue within the individual parts of the wood processing industry. The findings 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 activity are those that have launched new or significantly improved products or have introduced new or significantly improved processes in the company, or have introduced organizational or marketing innovations. There are also those companies that have had unfinished or suspended innovation activities.

In the Slovak Republic, 28.7 % of enterprises were active in innovations in the period under review. 30.7 % comes from industry and selected services (except construction). Enterprises from the industry sector had higher innovation ability (32.7 %) than in the service sector (28.4 %).

Compared to the previous survey realized in 2014, the share of innovatively active enterprises in the industry increased by 0.2 percentage point.

In individual sectors of economic activity, the share of enterprises with innovation activity varied and ranged from 16.7 % to 66.7 %. On average, it reached 32.7 % in industry and 28.4 % in services (*Štatistický úrad Slovenskej republiky, 2018)*.

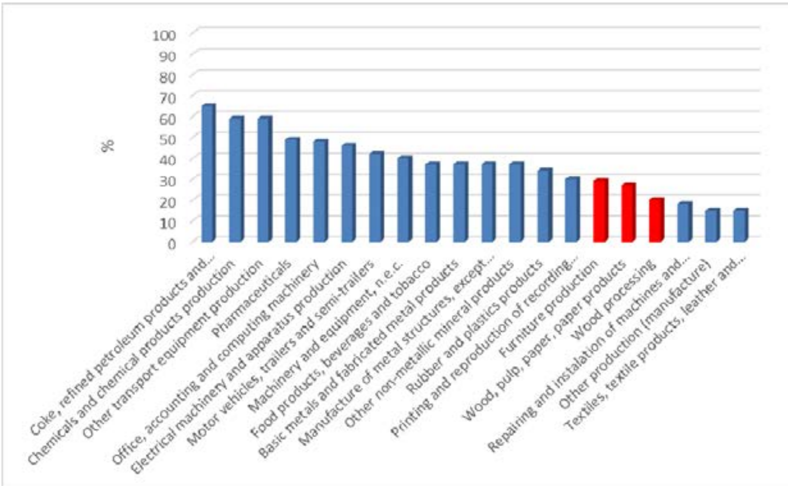

Figure 1. The share od enterprises with innovation activity from the total number of enterprises in industry
Source: Štatistický úrad Slovenskej republiky (2018)

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 %. On average, innovation activity for 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 say that it is below average.

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) (*Štatistický úrad Slovenskej republiky, 2018)*.

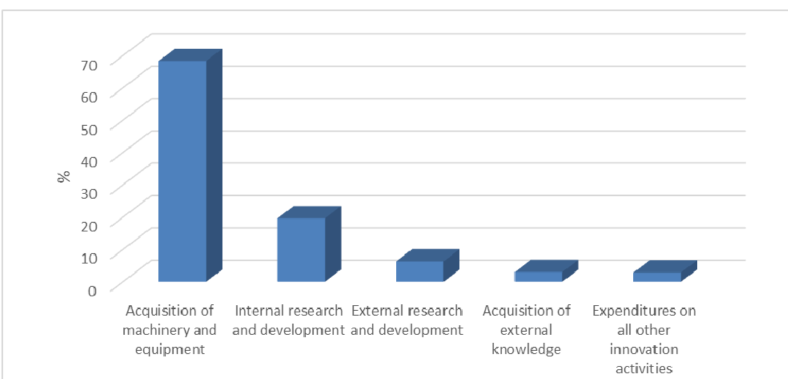

Figure 2. The structure of expenditures on innovation in industry
Source: Štatistický úrad Slovenskej republiky (2018)

Below-average innovation activity in the wood processing industry is mainly caused by a lack of own financial resources for innovation, especially for small and medium-sized processing enterprises, and therefore this economically unstable situation causes complications in the preparation and implementation of innovations that would lead to increased 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.

4. 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. 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.

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THE APPLICATION OF MODERN METHODS OF CHANGE MANAGEMENT TO OPTIMIZE PROCESSES IN WOOD PROCESSING INDUSTRY

Lubica Simanová

Abstract: The aim of this paper is to present the theoretical basis of domestic and foreign sources focusing on process management and use of selected concepts and approaches of process management. On the theoretical knowledge of the field of follow-up analysis of the results of research that illustrate the use of selected concepts and approaches of process management in all enterprises in manufacturing enterprises and enterprises in wood processing industry (WPI). We focus on the relationship between the use of selected concepts and methods for process improvement in all companies surveyed and ROE indicator height. Classical methods of research work such as analysis, synthesis, comparison, descriptive statistics, graphical representation, and pivot table were used during processing. The impact of using new concepts and methods of process improvement on the level of process optimization in enterprises of the wood processing industry in Slovakia.
Key words: process, improvement, optimization, wood processing industry

1. INTRODUCTION

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. Production process optimization is currently one of the most common optimization tasks in manufacturing. The complexity and difficulty of the market environment forces enterprises, including the enterprises in wood processing industry, to pay particular attention to improving operating conditions. The manufacturing enterprises must function in such a way that the transformation of inputs into outputs takes place at optimal consumption of production inputs, optimal choice of production processes and utilization of production capacity. The issues of prosperity, successful business development, optimization of production and non-production processes, increased product and process performance and quality, the efficient use of human and financial resources are constantly at the forefront. The use of new concepts and methods of process improvement has an impact on increasing process optimization, then on process performance and increasing efficiency. By successfully implementing economic goals, supported by the implementation of new concepts and methods for improving and optimizing processes, the company will secure market positioning and consolidation.

2. MATERIAL AND METHOD

2.1. Process Management, Change Management and Process Optimization

According to authors Slack et al. (2004), Krajčiová (2014), Luděk (2005), Šmída (2007), Gejdoš (2006) coincide in the definition of the process as a set of interrelated activities with one or more types of inputs and form an output which has a certain value for the customer and represents a characteristic variable of process control. Of these theoretical results it shows that the authors have a similar idea on that basis we will not further distinguish these concepts, as in the professional community are understood identically and without significant differences.

Process management is focused on the causes of arising discrepancies, not on the final outputs.

This type of management control is based on the idea that the cause of company's bad results is inefficient running of company processes where it is necessary to make them rationale and more effective, which will result in higher added value for the customer (Marcineková and Sujová (2015).

According to Džubaková (2010), the application of the system of processes within the organization together with process identification and their interaction, as well as their management, can be understood as a procedural approach. Authors Grasseová et al. (2008), Šmída (2007), Tuček and Zámečník (2007) agree that process management is defined as a methodology for evaluating, analysing and improving key business processes, based on the needs and requirements of external and internal customers.

In order to change management, optimization and improvement of production processes, increasing organizational performance, achieve high productivity and efficiency in terms of process management is important in the selection of appropriate methods, tools and techniques. Business Process Management – BPM can be defined as a strategic approach to business management, in which using appropriate methods, techniques and tools of management processes for the purpose of achieving maximum business performance (Ciencala, 2011).

The process approach focuses on process goals and outcomes, regardless of the organizational departments of the process. Organizational units have a supplier-customer relationship, process owners provide services within the enterprise. The process approach makes it possible to identify critical points in customer value creation faster than in case of functional management (Závadský and Kovaľová (2011).

Change management in the enterprise by Majtán (2002) can be seen as a project for which it is necessary to observe the following steps: defining targets and milestones, identify the person, their roles and responsibilities, determine the form and extent of communication, establishing a timetable.

Successful change requires adaptation of methods, techniques, strategies and implementation tactics to specific history, culture, and people in the organization. The change process is very complex, but there are models to make the change (Rosenau, 2000).

According to the authors Krnáčová et al. (2011), Rosová (2012), Malindžák et al. (2007), Krauszová (2010, the production process is a complex mechanism of subsystems, elements, factors and linkages that need to be constantly monitored and analysed. The result of this process is then learning about the dependencies and consequences of possible changes on any subsystem. Process optimization is always based on the type and nature of production in the enterprise. Nowadays, various modern means, approaches and methods are being used, in which the necessary information is obtained and possible ways of optimizing the production process are then proposed.

Methods of optimization, redesign and process reengineering are aimed at improving processes in an organization. Basically, they are divided into reengineering, business process reengineering (BPR), improvement, redesign, and continuous improvement methods based on quality management. Currently, the following improvement methods are used: Process Reengineering, Participatory Process Prototyping, and generally, it can be used to continuously improve the quality management methodology processes such as TQM (Total Quality Management), Deming PDCA, DMAIC, Six Sigma. The most used methods and approaches in process management of production, change management and in logistics by the authors Sujová and Čierna (2018), Dupaľ and Richnák (2017), XU (2013), Gregor et al. (2000), Košturiak and Frolík (2006), Rašner and Rajnoha (2006), Feylizadeh and Bagherpour, (2011) are as follows: Kanban, Just-In-Time, Optimized Production Technology – OPT, Kanban, Method 5S, Lean Production, Kaizen, Computer integrated production (CIM), JIT, Systems ERP, and other.

2.2. Methods

This article is part of the research project VEGA 1/0286/16 – Management of Changes Based on a Process Approach. Relevant data and information on industrial enterprises in the Slovak Republic were obtained through an on-line research questionnaire and direct controlled interview with managers of randomly selected enterprises. 2 525 enterprises in selected industrial branches of Slovakia were addressed, a research sample of 524 enterprises was researched. The sample was relevant, had sufficient explanatory power, which was also verified by selected mathematical-statistical methods. According to the calculation of the minimum statistical research sample, this was a representative sample at 99% confidence level and 4% standard deviation. Methods of analysis, synthesis, pivot tables and graphical methods were used to evaluate the data obtained.

3. RESULTS

The study of the application of modern change management methods to the optimization of processes in the woodworking industry had to be started by identifying the representation of the individual woodworking enterprises in the sample of 524 enterprises.

As regards the business sector, it was found that 35.88% of the total of 524 enterprises were services, 15.65% were enterprises WPI and trade, and the construction industry was 14.12%. The engineering, electrical, automotive and other industries have reached 8.02%. In terms of sectors of manufacturing enterprises, 37.57% consisted of the enterprises of the wood-processing industry in the pulp and paper industry, the timber industry and the furniture industry, which can be seen in Figure 1.

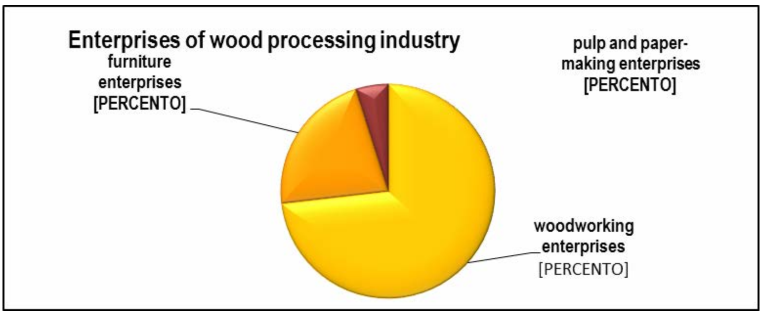

Figure 1. Enterprises of wood processing industry

The analysis of research results in determining the implementation of selected approaches in production management and process optimization is shown in Table 1 by enterprise category – all enterprises, manufacturing enterprises and WPI enterprises in absolute and relative frequencies.

Table 1. Analysis of implemented approaches in managing and optimizing processes

Implemented approaches	All enterprises		Manufacturing enterprises		Enterprises WPI	
	n	%	n	%	n	%
Kanban	25	4,77	14	7,41	3	3,66
Just in time	155	29,58	56	29,63	23	28,05
Optimized Production Technology (OPT)	33	6,30	16	8,47	4	4,88
Lean Production (LP)	25	4,77	14	7,41	2	2,44
Method 5S	65	12,40	29	15,34	10	12,20
Computer integrated manufacturing (CIM)	66	12,60	37	19,58	16	19,51
Enterprise resource planning (ERP)	51	9,73	20	10,58	4	4,88
Other	162	30,92	23	12,17	22	28,05

From the analysis of research results regarding the implementation of approaches in production management and process optimization, we can see that approximately the same percentages from 28.05% to 29.63% were shared by all monitored enterprise categories in Just in time implementation. At a level of 12.20% to 19.58%, all enterprise categories have implemented approaches such as method 5S or CIM – Computer integrated manufacturing in production management and process optimization. ERP systems have been implemented in more than 10% only in manufacturing enterprises, all enterprises implemented the methods at 9.73% and enterprises WPI at 4.88%. Kanban approaches, Optimized Production Technology (OPT), and Lean Production (LP) have been implemented in all enterprises under review ranging from 2.44% to 8.47%. In production management and process optimization using other methods of 30.92% of all enterprises, 28,05% of enterprises WPI and 12.17% of manufacturing enterprises. Different levels of optimization have been investigated in the enterprises WPI to track the level of optimization.

The first level was to identify the possibility of optimization, whether there are places in the enterprises WPI where there is room for improvement.

The second level of process optimization was to find out if the enterprises WPI had a mathematical model for quantifying the total costs up to the delivery of the goods.

The third level monitored the equipment of employees with modern technology to create efficient business processes.

The fourth level explored whether business standards and processes are linked to identified business success factors and customer requirements.

Fifth level was focused on the use of change management program that ensures the loyalty of employees.

The sixth level contains answers in which enterprises have not provided any preceding the options of optimization.

Table 2. Analysis of implemented approaches in managing and optimizing processes in enterprises WPI

New concepts and methods*	Process optimization level							
	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	SUM	Relative frequency
BSC	*5 %*	*0 0.00%*	*0 0.00%*	*0 0.00%*	*0 0.00%*	*0 0.00%*	*4*	*4.04%*
Six Sigma	*1 2.22%*	*0 0.00%*	*0 0.00%*	*1 11.11%*	*1 11.11%*	*0 0.00%*	*3*	*3.03%*
PC	*11 24.44%*	*0 0.00%*	*0 0.00%*	*2 22.22%*	*3 33.33%*	*0 0.00%*	*16*	*16.16%*
TQM	*4 8.89%*	*0 0.00%*	*1 12.50%*	*3 33.33%*	*1 11.11%*	*0 0.00%*	*9*	*9.09%*
Kaizen	*7 15.55%*	*0 0.00%*	*1 12.50%*	*1 11.11%*	*1 11.11%*	*0 0.00%*	*10*	*10.10%*
B	*3 6.67%*	*1 100.00%*	*1 12.50%*	*3 33.33%*	*1 11.11%*	*0 0.00%*	*9*	*9.09%*
No	*20 37.78%*	*0 0.00%*	*9 100.00%*	*7 77.78%*	*1 11.11%*	*10 100.00%*	*47*	*47.47%*

**BSC – Balanced Scorecard, PC – Process controlling, TQM – Total Quality Management, B – Benchmarking, No – we do not use any of these methods and concepts*

Table 2 analyses the relationship between the level of optimization and the use of new process optimization concepts. It can be seen from the data that most of the enterprises WPI analysed do not use any of these concepts at the individual process optimization levels. The overall response rate to this question was 47.47%. The most frequent response to the enterprises WPI that implement new concepts and methods was the use of process control, 16.16%. On the other hand, the least used new concept was Six Sigma and BSC, whose frequency for enterprises WPI was below 4.1%. From the point of view of categorization according to the process optimization level, it is interesting to find out that enterprises WPI belonging to a group with zero optimization in 100% do not use any of the new concepts and methods. These results indicate that different levels of process optimization require the use of specific tools. On the other hand, it should be noted that, regardless of the categorization of Slovak enterprises, enterprises WPI still do not use any new concepts at various levels of process optimization in most cases. This is also evidenced by the relative response rate of 47.47% of the 98 responses of the participating enterprises WPI.

CONCLUSION

In the context of process optimization, it is important for an enterprise to monitor and measure the use of its production factors using appropriate criteria, evaluate the relationship between the results it produces and the inputs it consumes, thereby achieving high process performance as well as business performance as a whole. The importance of monitoring and managing change in enhancing the competitiveness of enterprises results from the characteristics of the theoretical change management aspects and the identified effects of a successful change. We can conclude that the change management of enterprise based process approach is a way to increase competitiveness. The benefit of the analysis of the partial research results was the finding that the use of new concepts and methods in the enterprises WPI is low, depending on the degree of process optimization. Only by increasing the level of optimization, using new concepts and methods in managing and optimizing processes, increasing process performance and achieving a synergistic effect that are strategic for enterprises in the future will bring the desired effect.

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PERCEPTION OF WOOD-BASED PACKAGING INNOVATION APPLYING SMART SOLUTIONS

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Abstract: The paper deals with the perception of innovative approaches to packaging from wood based materials focused on smart and features of packaging. Wood is still perceived as environmental most friendly packaging material and therefore wood-based materials with specific properties have potential to be widely use as packaging material in innovative and environmental way. According to analysis of survey, we evaluated the customer perception of the innovative packaging functions. The customers perceive the above mention issue as new and unknown, that is why, the results discover the low interest of using individual smart packaging innovation among them.
Keywords: innovation, smart packaging, functions of packaging, wood-based packaging.

1. INTRODUCTION

The packaging is still one of the most important parts forming the product. Its character as size, material, design and font significantly influence the consumers decision-making process and thereby affect the marketability of the product itself (Kotler, 2001). Packaging inform consumers of all the properties of the product and simultaneously it is a tool to protect the products from a potential damage. It allows better handling, facilitates the marketing and consumption of products. The package moves through various stages of marketing and consumption. The way is divided into three stages, which are – transport, sales and consumer package. The transport package has the protective and rationalizing function during handling, storage and transport process (Zeman, 2005).

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

The packages are used to:

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

To create product innovations, it is necessary to think about the product at different levels whereas each level increases its value to the customer. The purchasing habits and demands of consumers are continuously changing (Kaputa et al., 2018). Innovative packaging is the result of creative, unconventional thinking outside the usual framework of thought. The result of an innovative approach to packaging is the creation of packaging with interactive features. Actually two groups of such packaging systems are distinguished: intelligent and active packaging. They focus to improve packaging functions to meet current consumer demands, increased regulatory requirements, as well as increased interest in security. Active packaging represents shift in the perception of functions namely, the protection function of packaging has been shifted from passive to active (Yam et al. 2005). Active packaging allows actively changes the condition of the package to extend shelf life or improve food safety, while maintaining the quality of the food (Kačeňák, 2011). Intelligent packaging is a packaging system that is capable of carrying out intelligent functions (such as detecting, sensing, recording, tracing, communicating, and applying scientific logic) to facilitate decision making to extend shelf life, enhance safety, improve quality, provide information, and warn about possible problems (Yam et al., 2005; Kačenák, 2011; Sosnovcová, 2008). Loučanová et al. (2016) applied Kano model to evaluate the perception of packaging innovations in terms of their functions. The results indicate that consumers interested by the new innovative packaging are mostly in age between 41 to 60 years.

Choosing the adequate packaging material is important task from many point of views. It ensures full functionality of packaging and fulfils specific packaging tasks. At the present time, wood base materials are very required. Wood as renewable and ecology material has a lot of advantages. It is necessary to prefer it as material also in the packaging industry. In general, wood is used at all levels of transportation of many different products. The key benefits of wooden packaging are a lifelong natural product with great design variety. We have to mention that wood has individual character, underlining quality awareness. It is a renewable, resource-friendly, raw material that behaves completely CO_2-neutrally. Wood crates are one of the best materials for packaging. They are self-supporting structures that are the ideal choice for shipping various products, especially lightweight or breakable items. The advantages of wooden crates are the possibility to repair them locally. Wood is relatively resistant to different weather conditions and is often used on more than one journey (Mujtaba, 2015). Wood-based packaging can save resources themselves, as well as, nature. Therefore, the paper deals with the perception of innovative approaches to packaging from wood based materials focused on smart and features of packaging in Slovakia.

2. METHODOLOGY

We applied marketing survey as the elementary approach of the research. The survey was conducted online during February and March 2019 and focused on individual smart package areas, such as:

- smart packaging suitability and aesthetics,
- increasing awareness for purchasing decisions,
- innovation and ability to distinguish product,
- improving information about product,
- increasing good will and ethical values of brand as fair trade, CSR, etc.,
- customer preferences for smart packaging with absorbent component,
- customer preferences for smart packaging with antioxidant properties or antimicrobial agents,
- enhancement of product packaging through smart packaging,
- acceptance of product price increase with a smart package up to 10%.

The perception for above mentioned issues were evaluated by a Likert scale in the range of 1 to 7, where 1 was insignificant (unimportant for the respondent) and 7 was considered as very significant (important). The survey sample consisted of 100 respondents. The obtained research data were processed and analysed. Within the statistical analyses, the interdependencies between variables (income and education) and attitudes to the individual areas of smart packaging were examined. The impact on individual answers of these categorical variables as education and income were analysed by the Chi square test. The test aims at determining the statistical significant effect between two variables. Through the Chi square test, the null hypothesis is verified. This hypothesis says, that the expected answers are independent of the variables such income and education. The rejection of the null hypothesis ($p < 0.05$) represents that the differences between the actual and expected frequencies are significant. It is mean, there is a statistical significant relationship between the independent variables and answers. (Rimarčík, 2007).

3. RESULT AND DISCUSSION

The results show the preferred functions of smart wood packaging in the Slovak Republic (Figure 1). According to data, the most important functions of packaging for Slovak customers are the economic and ecological functions. For them the least important function is a promotional function, nor it is negligible for their decision-making, whereas the value is higher than average (3.9).

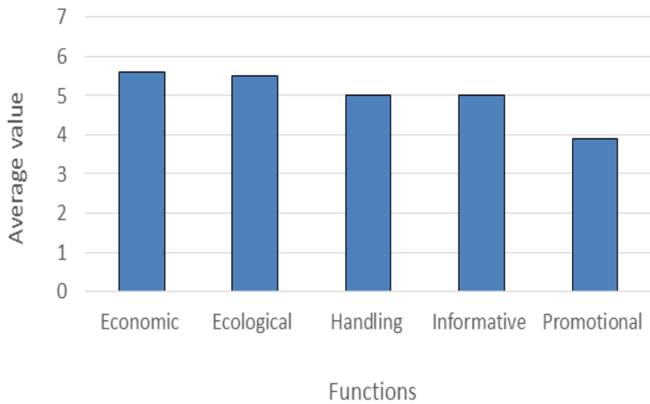

Figure 1. Average value of understanding of different wood packaging functions
Source: authors' computation

The Table 1 describes the results based on the statistical analysis of the interdependence between variables (income and education) and the individual attitudes. Income as independent categorical variable represents parameter with less statistical significance compare with education. The statistical significant influence of education is in attitudes to utilise of paper packaging or antioxidant or antimicrobial films ($p = 0.009$). Furthermore, the issue of packaging functions in relation to product advertising (namely whether they are appropriate and aesthetic for a given product type) is also statistical significant ($p = 0.047$). For the other attitudes the Chi square test confirmed independency between answers and income or education ($p > 0.05$) with 95% of probability.

From the perspective of education, the results confirm that income and education have a statistical significant impact on perception of suitability and aesthetics of smart wood packaging as well as on information on purchasing decisions ($p = 0.015$ and $p = 0.013$). Moreover, education have significant role on understanding of advertising-related packaging functions ($p = 0.016$), which contain information influenced selection of a product at the market place (p value of 0.013). In addition, Chi square test confirmed statistical significant relationship on information-related issues which reported the content ($p = 0.043$), as well as, the preferences of traditional wood packaging ($p = 0.039$) and packaging contained pads that absorb liquid waste and improve protection of product ($p = 0.037$). The Chi square test considers the other attitudes as statistically insignificant.

The results focused on the individual functions of the wood based packaging, namely the information and promotion function. Although, the ecological function for Slovak customers is on the second place, the attitudes are similar for different income groups as well as for different groups by education. This may be due to the fact that wood based packaging is already perceived by customers as ecological. The customers do not consider the improvement of wood base packaging from the material point of view because they perceived wood as one of the best environmentally friendly packaging material. Loučanová et al. (2016) concluded that requirements for new approach in terms of all elementary packaging functions (handling, preservative, informative, economic, environmental, promotional and ecological) were identified. The main target group for the new packaging innovations are consumers of age categories from 41 to 60 years, because they had the highest requirements for packaging innovation. The results confirmed similar attitudes of consumers to the ecological function as previous study, when all age categories respondents required ecological innovation packaging and the older generation requires mainly innovation of the handling function of packaging, which has a low innovation status but has a very big influence on their purchasing decision with a clear effect.

Table 1. Chi square test of perception of smart wood packaging issues regard to education and income

Research area	p value	
	education	income
Smart packaging suitability and aesthetics	0.015	0.047
Improve information for buying decision	0.013	>0.05
Innovation and ability to distinguish product	0.016	>0.05
Improve information about product	0.043	>0.05
Increases good will and ethical values of brand as fair trade, CSR, etc.	0.037	>0.05
Customer prefer traditional wood base packaging	0.039	>0.05
Customer preferences for smart wood packaging with absorbent component	0.037	>0.05
Customer preferences for smart wood packaging with antioxidant properties or antimicrobial agents	>0.05	0.009
Enhancement of product packaging through smart packaging	>0.05	>0.05
Acceptance of product price increase with a smart package up to 10%	0.048	>0.05
Acceptance of product price increase with a smart package from 10% up to 50%	0.032	>0.05

Source: authors' computation

CONCLUSION

Currently, packaging has a significant potential to contribute to sustainable development through the functions. It is necessary to ensure how packaging features are accepted by consumers and affect sustainable development. According to the survey, we are able to identify main advantages of packaging functions for the better understanding and better communication in the decision-making processes. Based on the respondents' individual statements the data confirm that the most important packaging functions are protective, ecological, information and economic. For consumers the least important function was the promotion (advertising) function. However, respondents are minimal willing to accept a price increase for individual products because of the innovation of packaging.

The customers perceive the above mention issue as new and unknown, that is why, the results discover the low interest of using individual smart packaging innovation among them. On the other side, the lack of experience, information and knowledge of using innovative wood base packaging reflects the unwillingness of the final customers to accept the higher price increase.

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ASSESSING THE FIREWOOD CONSUMPTION EFFICIENCY IN SERBIAN HOUSEHOLDS BY APPLYING THE METHODS OF ECONOMETRIC MODELING: CASE STUDY-GORNJI MILANOVAC

Branko Glavonjić, Aleksandra Lazarević, Miljan Kalem

Abstract: This paper presents the research results of the efficiency of firewood consumption in the households in Gornji Milanovac. Gornji Milanovac was selected for the research due to the fact that it is one of the most forested municipalities in Serbia and almost 95% of its households use firewood for heating purposes. The appropriate methodological concept with scientific research methods and techniques was defined for the purposes of the research. The main research technique was field survey for the purpose of which the appropriate sample of urban and rural households was defined. After the survey had been conducted, a logical check of the collected data was performed. The next step in the selected methodological concept was the econometric modelling of the effects of the heated surface area on firewood consumption using `STATISTICA` V.7.0 software package.
The results of the study showed that the average consumption of firewood per square meter of heated surface area in the heating season of 2017/2018 was 0.120 m^3 in the households that used wet wood, 0.110 m^3 in the households that used air dried wood and 0.097 m^3 in the households that used dry wood. Compared to the reference value taken as relatively satisfactory by the criteria of energy efficiency, the consumption of wood in all three categories of households was on average 2.2 times higher. Such high consumption of wood energy is, among other things, due to the unsatisfactory condition of the buildings regarding their age, high percentage of buildings without thermal insulation and the dominant participation of heating devices older than 10 years.
Keywords: efficiency, firewood, consumption, households, energy

1. INTRODUCTION

Improving energy efficiency and rational use of energy have become one of the important priorities of the Government of the Republic of Serbia. Because of such commitment and support measures, numerous activities are currently underway to improve the energy efficiency of public facilities. When it comes to households, they are still not in the focus to the extent that the public facilities currently are. According to the official energy balance of Serbia, the share of households in total final energy consumption for energy needs in 2017 was 33.3% [2]. It is an extremely high participation that shows that households are large energy consumers and that in this segment there is a need for implementation of measures and activities for improving energy efficiency. This is confirmed by the results of the conducted research in the past six years. According to Glavonjić 2011, the total consumption of firewood for households heating in Serbia amounts to about 6.4 million m^3 per year or 7.3 m^3 / household. Compared to other countries in the Western Balkan region, Serbia is the leader for the average consumption of firewood per household [4]. The high value of the average consumption of firewood has imposed the need to obtain an answer to the question of the efficiency of firewood utilization in households in Serbia? In order to obtain answers to this question, this paper presents the results of research on the efficiency of firewood utilization in households in one of the numerous municipalities in Serbia where firewood is the main fuel for households heating. Although it is only a single municipality, the basic approach in this paper was the necessity to continue with the testing one methodological concept that was defined and tested for the first time in the paper Glavonjić 2011.

When it comes to the efficiency of firewood utilization, there is a small number of authors dealing with this issue. For instance, Dzian M. et al.2018, have developed econometric models for supplying

Slovakia's market with firewood for energy purposes, while Hoffmann H. et al.2015 dealt with the importance of energy efficiency.

2. SCOPE OF WORK AND OBJECTIVE

Scope of the research in this paper is firewood consumption in households in Gornji Milanovac (Serbia), where 49.5% of households use wood fuel for heating purposes. The main objective of the research is to determine the degree of efficiency of the firewood utilization and, in this regard, the impact of the most important factors on its consumption. The main factors whose impact on the efficiency was investigated in this paper are the size of the heated surface area, the age of the heating devices and the frequency of chimney cleaning.

3. METHOD OF WORK

For the purposes of the research in this paper, the method of surveys based on a pre-defined questionnaire and the appropriate sample was used as the basic method. The sample size consisted of 2% of the number of households which use solid fuels for heating in the selected municipalty. Size of the selected sample was representative enough to observe the actual situation regarding the consumption of firewood for the purpose of heating.

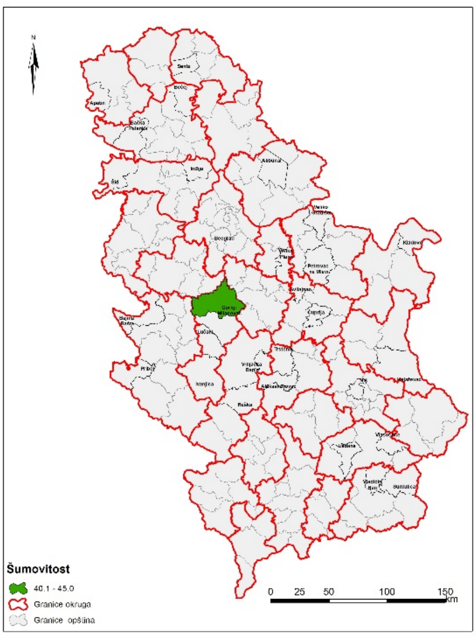

Figure 1. Position of the municipality of Gornji Milanovac on the map of Serbia

After defining the sample size, certain strata were defined regarding geographic position and number of households (in urban and rural areas) in which the survey was to be conducted. Survey was conducted in such a manner that interviewers visited households and applied the method of direct interviews (face-to-face). Using this method, appropriate data were obtained on the characteristics of the buildings, the characteristics of the firewood consumption, the participation of certain types of devices and their age, as well as the data on the frequency of chimney cleaning as an important factor for the efficiency of firewood utilization. After the conducted survey and obtained primary data, their logical control and systematization were carried out. In this way, preconditions were created to approach their processing and analysing. In this process, adequate statistical methods, including econometric modeling, were used in program packages Statistica V.7.0. and MS Office Excel 2007.

The results obtained were then interpreted and appropriate conclusions were drawn from them. The evaluation of the parameters of the obtained econometric models was made using the methodological instructions developed by Ranković, 1996 and Jovičić, 1981.

As the geographical area where the research was conducted, the area of Gornji Milanovac was selected. The selection of this area is the result of the fact that it belongs to a group of the most forested municipalities in Serbia with an area under the forests of 37.200 ha. Compared to the total area of the municipality, forests cover 41.3%. With such a high percentage of forest cover, the municipality of Gornji Milanovac is significantly above the average of the Republic of Serbia (29.2%) (National Forest Inventory RS, 2009). The wealth of the forest fund that Gornji Milanovac has also influenced the choice of the population to use mainly firewood for heating purposes.

4. RESEARCH RESULTS AND DISCUSSION

The efficiency of firewood consumption depends on many different factors. For the purposes of perceiving the degree of efficiency and causality of consumption, the size of heated surface area was chosen as the one of the most important factors affecting the consumption of firewood in households.

The relation between the size of the heated surface area and the consumption of firewood in households in the selected area is represented by its degree of the form (the highest R^2) in the econometric model. The basic parameters of the degree econometric model are:

$$y = f(x)$$

a = -0, 0,4467		b = 0,6937	
$S_{(a)}$ = 0, 216		$S_{(b)}$ = 0,0492	
$t_{(a)}$ = 2,0626		$t_{(b)}$ = 14,095	
$\mid t_a \mid > t_{005}$		$\mid t_b \mid > t_{005}$	
R = 0,75	R^2 = 0,57	R^2_{cor} = 0,56	S_e= 0,3344
$F_{(1,152)}$ = 198,67	$F_{test(0,05)}$: +	D = 1,837	DW -test(0,05) : -

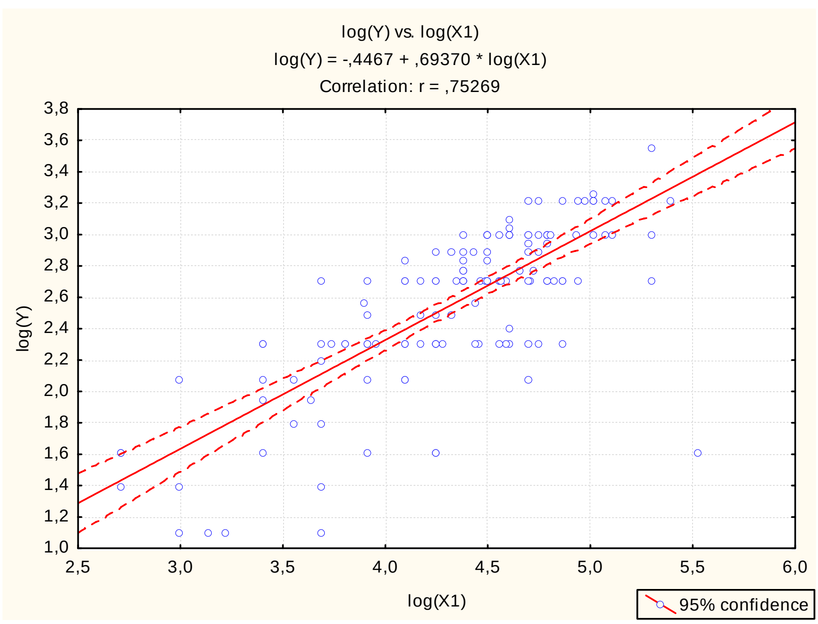

Figure 2. Influence of the size of the heated surface area on the consumption of firewood in households in Gornji Milanovac

The correlation between the size of the heated surface area and the consumption of firewood in households using firewood for heating purposes is shown by the following logarithmic linear equation:

$$\ln y = \ln a + b \ln x$$

$$\ln y = -0{,}4467 + 0{,}6937 \ln x_1$$

or in a transformed form:

$$y = 0{,}6397\, x^{0{,}6937}$$

Considering the high value of the correlation coefficient, the significance of the parameters of the model and the fact that 57% of the variation in firewood consumption is explained by this model, it can be concluded that there is enough strong connection between the consumption of firewood and the size of the heated surface area, comparing to the results of other regression models. In the selected case, with each increase of the size of the heated surface area by 1% it can be expected an increase in the consumption of firewood by 0.69%.

The results of the research showed that the average consumption of firewood per square meter of the heated surface area in the heating season of 2017/2018 was 0.120 m^3 in the households that used wet wood, 0.110 m^3 in the households that used air dried wood and 0.097 m^3 in the households that used dry wood. Converted to energy values, wood energy consumption per square meter of heated surface area ranged from 258.5 kWh in households using dry wood up to 297.6 kWh in households using wet wood.

Compared to the reference value of 138 kWh/m^2, which is considered to be relatively satisfactory from the point of view of energy efficiency, the consumption of wood energy in households using dry wood was 1.87 times higher, and in households that used wet wood 2.16 times. Both values are higher than the maximum allowed annual energy consumption for the last level of the energy passport for residential buildings.

Compared to the average consumption of firewood per square meter of the heated surface area in households using wet wood, the average consumption for households using dry wood was 13.1% lower. This confirms the well-known fact that for heating it is always better to use dry than wet wood because it generates more energy and consumes less wood. Consequently, heating costs are lower if used dry instead of the wet wood.

The general estimation of wood energy consumption per square meter of the heated surface area in the selected households is that average consumption is extremely high. This situation is result of the impact of the following factors: lack of thermal insulation on buildings, high average age of the heating devices and frequency of chimney cleaning.

When it comes to thermal insulation on buildings, the survey results show that 89% of the households do not have any type of thermal insulation on their buildings, while only 11% have thermal insulation (fig.3). This is the first factor that negatively affects the high consumption of firewood and wood energy.

Regarding the age of heating devices, the situation in households is also unfavorable for this indicator. Namely, only 17% of households have heating devices whose age ranges from 1 to 5 years and fall into the category of new and relatively efficient devices. The rest of 83% own heating devices over 5 years old, (16% of total households use devices with age exceeding even 20 years). Such devices are very inefficient which leads to exceptionally high wood consumption (fig.4).

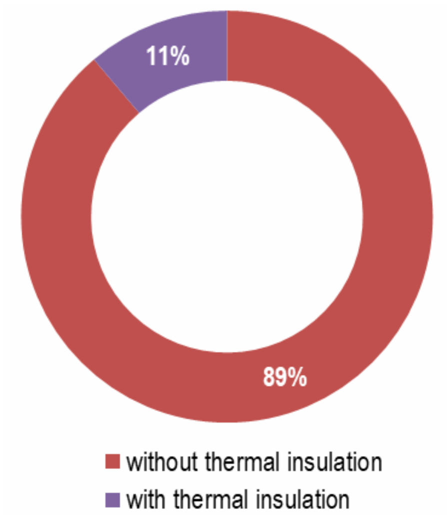

Figure 3: Thermal insulation (walls&roofs) of residential buildings in Gornji Milanovac

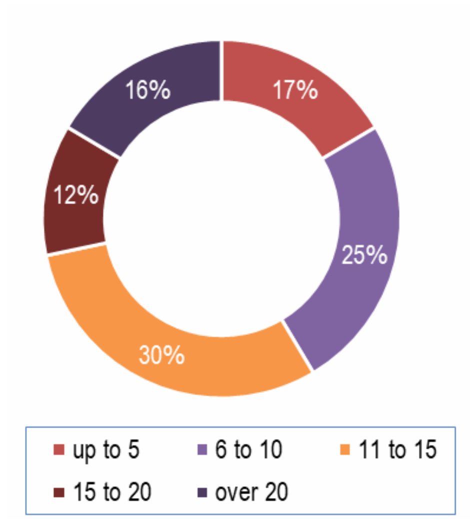

Figure 4. Age of heating devices used in households in Gornji Milanovac

When it comes to the frequency of chimney sweeping situation in the households is satisfactory as there are only 7% of households that reportedly never clean their chimneys. 93% of households in this municipality have their chimneys cleaned at least once a year or more (fig.5). Poor chimney maintenance not only poses a safety risk, it can also impact the efficiency of combustion negatively.

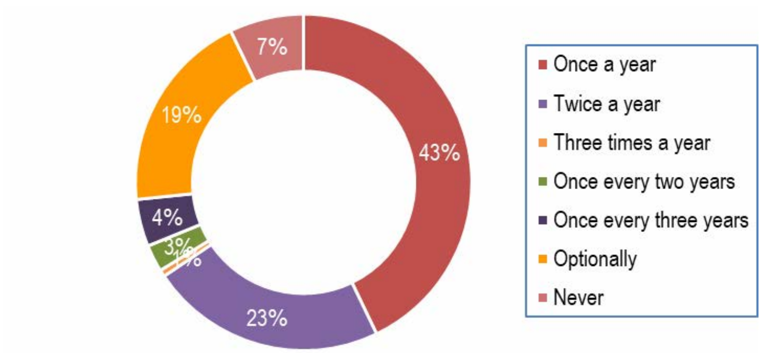

Figure 5: Frequency of chimney cleaning in households in Gornji Milanovac

5. CONCLUSIONS

On the basis of the conducted research and parameters of the obtained econometric model, it can be concluded that the efficiency of firewood utilization in households in the selected municipality in Serbia is extremely low, i.e. that firewood is used inefficiently. Depending on whether the households used dry or wet firewood, the consumption of wood energy expressed in kWh/m^2 of the heated surface area was higher than 1.87 (for dry wood) i.e. 2.16 times (for wet wood) compared to the reference value considered to be relatively satisfactory from the point of view of energy efficiency.This shows that households are relatively neglected category of consumers and should be given adequate attention in terms of creating measures to support their energy efficiency improvements. As two of the most important measures that need to be implemented in the shortest time are: subsidies for procurement of modern and efficient heating devices and awareness building and education campaign of households across the country how to use firewood efficiently.

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A CASE STUDY OF THE POTENTIAL OF THE FURNITURE INDUSTRY IN POLAND BASED ON ITS SPATIAL DIVERSITY

Leszek Wanat, Elżbieta Mikołajczak, Łukasz Sarniak

Abstract: The paper discusses the problems of spatial diversity of the furniture industry in Poland. An attempt was made to identify the potential of furniture making as an important sector of the economy. The main question was asked about divergence trends in this sector. The analysis used linear ordering methods, statistical verification and comparative analysis. Based on the indications of the proposed synthetic measure, the regional variation of the measurements of the furniture industry potential in Poland was verified. The recommendations were also formulated, in particular for furniture industry.
Keywords: furniture industry, regional development potential, Poland,

1. INTRODUCTION

The Polish furniture industry is one of the leaders in the global furniture trade, and at the same time an important sector of the Polish economy. In the last decade it has occupied a permanent place in the top five of the world's furniture exporters. This sector shows a positive balance in foreign trade, balancing the deficit of other sectors. This proves the high competitiveness of Polish furniture. At the same time, the furniture industry is characterised by a high level of fragmentation. This is confirmed by the dominating share of microenterprises in the structure of economic entities producing furniture. However, the strong competitive potential of the industry in Europe and in the world, including the regional potential, consists primarily of the participation of medium and large companies, for which small and microenterprises are often partners in cooperation (Grzegorzewska, 2019; GUS, 2018a).

In the value chain created by the wood-based sector, the furniture industry is the strongest link, which impact on the economy results primarily from the leading share in the market of wood products with a high degree of processing, and often final products, such as finished functional furniture (Chudobiecki et al., 2016; Paluš et al. 2018, Wanat et al. 2018a). The indicated arguments speak in favour of the legitimacy of identification of the regional furniture industry potential in Poland. Appropriate identification of regional specialisation for the furniture industry, as a leading branch of the Polish economy, is an opportunity for effective management of streams of EU cohesion funds (Rachwał, 2018; Wanat et al., 2018b). On this basis, it can be said that the integral development of regions can be effectively programmed, taking into account the specific nature of each of them.

2. SCENARIO OF THE RESEARCH AND TEST METHODS

The aim of the study was to investigate the regional diversification of the potential of the furniture industry in Poland according to the administrative structure of voivodships (corresponding to the classification of regions). A hypothesis was adopted for verification, in which it was assumed that the regional potential of the furniture industry is strongly differentiated regionally. The scope of the research includes enterprises classified in the Polish Classification of Activities (PKD 2007), in section 31 "Manufacture of furniture". All companies grouped in subclasses are included:

31 – production of furniture – 149 companies;
- 31.01 – production of office and shop furniture – 221 companies;
- 31.02 – production of kitchen furniture – 84 companies;
- 31.03 – production of mattresses (lounge and bedroom furniture) – 26 companies;
- 31.09 – production of other furniture – 425 companies.

The population (and sample) selected for analysis was 905 economic entities (as of 30.06.2019).

A targeted selection of companies was made: first according to the substantive criterion (furniture production) and then according to the amount of annual sales revenues (at least one million EURO per year). The regional development potential of furniture industry enterprises was examined in the scope of the subject matter, based on the administrative division of Poland into 16 voivodships. The temporal scope of the research covered 2018 (in terms of data on sawmill industry enterprises) and additionally 2017 (in terms of general industry data of Polish public statistics (GUS 2018, 2018a)).

The development of the research scenario was based on both a qualitative analysis (according to substantive criteria), followed by a quantitative approach and a method (Hwang and Yoon, 1981) of variable standardization (zero unitarization). To measure the potential of the sawmill industry in Poland, the method of linear TOPSIS was used (Technique for Order Preference by Similarity to an Ideal Solution). It is based on the determination of the Euclidean distances between individual objects, and a predetermined pattern and anti-pattern. The research (research scenario of quantitative analyses) was carried out in the following steps:

1. on the basis of substantive and statistical analysis, the features describing the studied phenomenon were selected
2. the values of the features were normalized using the zero uniformization method (formula 1):

a. For the stymulant: $z_{ij}=\frac{x_{ij}-\min_i\{x_{ij}\}}{\max_i\{x_{ij}\}-\min_i\{x_{ij}\}}$ (1a)

b. For the destimulant: $z_{ij}=\frac{\max_i\{x_{ij}\}-x_{ij}}{\max_i\{x_{ij}\}-\min_i\{x_{ij}\}}$ (1b)

Description:
z_{ij} – normalized value of the j-th characteristic for the i-th object;
x_{ij} – value of the j-th attribute for the i-th object.

3. Determination of pattern and anti-pattern:

a. For the stimulant: $A^{+}=(1,\ldots 1,)$

b. For the destimulant: $A^{-}=(0,\ldots\ 0)$

4. Calculation of the Euclidean distances from the standard pattern and anti pattern (formula 2):

a. For the stimulant: $d_i^{+}=\sqrt{\sum_{j=1}^{m}(z_{ij}-A^{+})^2}$ (2a)

b. For the destimulant: $d_i^{-}=\sqrt{\sum_{j=1}^{m}(z_{ij}-A^{-})^2}$ (2b)

Description:
d_i^{+} – euclidean distance – from the standard pattern; d_i^{-} – euclidean distance – from the anti-pattern;
z_{ij} – value of the k-th characteristic – for the i-th object.

1. Application of the value of the synthetic characteristic (formula 3):

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

Description:
d_i^{+} – euclidean distance – from the standard pattern;
d_i^{-} – euclidean distance – from the anti-pattern.

In this way, a synthetic measure determining[1] the potential of individual voivodeships can be determined (Wysocki, 2010, Juczak, 2016, Potkacski and Wanat, 2017).

3. RESULTS

In order to identify the regional potential of the furniture industry in Poland, factors (measures) describing the industry from the mesoeconomic perspective were selected (wood harvesting in the regions, value of investment outlays in the forest-wood sector, consumption of wood-based panels: chipboards and fibreboards in the production process) and microeconomic perspective (sales revenues per company and profit per one employee). The potential of the furniture industry, aggregating data by region for enterprises located in particular voivodships of Poland, was determined on the basis of 6 deliberately selected factors (F1, …, F6) – quantitative measures:

F1: Average annual sales in the sector (value of sales per company) [in thousands of EUROS];
F2: Average annual profit in the sector (profit per employee) [in thousands of EUROS];
F3: Total investment in the forest-and wood based sector [in thousands of EUROS];
F4: Logging (per year) in m^3 per 100 ha of forest area in 2017;
F5: Annual consumption of fibreboard in million m^2 (consumption) in 2017;
F6: Annual consumption of particle board in thousands m^3 (consumption) in 2017.

Table 1. Selected aggregated measures of the furniture industry potential in Poland (2017-2018)

Voivodship (Region)	Average sales value (sales / number of companies) [in thousands of EUROS]	Average profit value (profit / 1 employee) [thousands of EUROS]	Total investment outlays in forestry [thousands of EUROS]	Logging [m^3/100 ha]	Fibreboard consumption [mln. m^2]	Particle board consumption [thousand. m^3]
Dolnośląskie	15 562	2,64	17 490	558	2,69	238,73
Kujawsko-Pomorskie	11 719	2,82	7 607	601	1,32	136,72
Lubelskie	21 786	0,42	9 013	329	11,23	190,61
Lubelskie	25 689	0,45	14 180	504	43,06	643,72
Łódzkie	7 723	2,57	9 177	336	1,96	172,84
Małopolskie	5 511	4,57	8 060	310	1,15	100,58
Mazowieckie	8 390	4,13	14 416	288	13,51	410,10
Opolskie	6 566	2,81	3 737	561	3,77	88,61
Podkarpackie	11 472	2,66	12 525	381	3,64	393,10
Podlaskie	7 553	5,18	8 681	352	4,99	103,08
Pomorskie	8 739	1,45	16 854	726	4,48	287,98
Śląskie	7319	2,67	8 718	472	6,76	191,27
Świętokrzyskie	3090	5,75	7 651	404	0,25	51,86
Warmińsko-Mazurskie	15 531	4,24	9 475	495	7,63	941,79
Wielkopolskie	17 436	5,14	15 068	492	16,78	1 092,01
Zachodniopomorskie	55 172	2,55	17 131	565	25,11	1 319,63

Source: Own elaboration based on financial data of furniture industry enterprises in Poland (financial reports, Court Monitor B, GUS 2018, 2018a).

[1] For the purposes of this analysis, the values of the synthetic indicator were grouped into 4 classes: 1) high development level: $S_i \geq \bar{S} + SD$. 2) upper-medium development level: $\bar{S} \leq S_i < \bar{S} + SD$ 3) lower-medium development level: $\bar{S} - SD \leq S_i < \bar{S}$ and 4) low development level: $S_i < \bar{S} - SD$. S_i designates the value of the synthetic characteristic for object i; $\bar{S}$ is the mean value of the synthetic characteristic; SD is the standard deviation of the synthetic characteristic (Wysocki, 2010).

The selection of factors was of a substantive nature. The characteristics representing various economic categories with potentially weak correlation were selected. All characteristics tested are stimulants. Their values[2] are presented in Table 1.

The correctness of variable selection was statistically verified by determining Pearson's correlation coefficients. In most cases a strong correlation did not occur. A different trend was shown only in the case of linking the index of consumption of basic materials for furniture production: particle boards and fibreboards with the sales volume index and the index of investment level (relatively strong or average correlation). However, this link is justified on the merits. These factors, despite the relationship, inform about the potential of the furniture industry in different ways from the supply perspective: resources (production) – a measure of consumption of wood-based panels and from the demand perspective, investments – a measure of development capacity. For these reasons, the proposed components of the synthetic indicator were accepted.

In order to examine the potential of the furniture sector, normalization of variables was carried out using the zero uniformization method. In the next step the following values were determined: euclidean distances and synthetic meter values. Then the ranking positions, corresponding to the strength of the development potential of the furniture industry for particular regions of Poland, were verified. The results are presented in Table 2.

Table 2. Euclidean distances, the value of synthetic measure in the furniture industry ranking

Voivodeship (Region)	d_i^+	d_i^-	S_i	Ranking position	Class division
Dolnośląskie	1,64	1,28	0,44	6	II
Kujawsko-Pomorskie	1,85	0,91	0,33	10	III
Lubelskie	1,99	0,60	0,23	15	IV
Lubuskie	1,38	1,49	0,52	3	I
Łódzkie	2,02	0,59	0,23	16	IV
Małopolskie	2,05	0,84	0,29	12	III
Mazowieckie	1,71	1,13	0,40	7	II
Opolskie	2,03	0,78	0,28	14	III
Podkarpackie	1,78	0,86	0,32	11	III
Podlaskie	1,92	0,98	0,34	9	III
Pomorskie	1,71	1,42	0,45	5	II
Śląskie	1,85	0,73	0,28	13	III
Świętokrzyskie	2,01	1,07	0,35	8	III
Warmińsko-Mazurskie	1,43	1,22	0,46	4	II
Wielkopolskie	1,12	1,61	0,59	2	I
Zachodniopomorskie	0,82	1,96	0,71	1	I

Source: Own calculations based on the formula 2 and 3.

The calculated values of the arithmetic mean and standard deviation were grouped into classes. Each of the four classes corresponds to a category of furniture development potential in the regions. The limit values were respectively as follows:

- Class I: high development level: $1 \geq S_i > 0{,}52$.
- Class II: upper-medium development level: $0{,}52 \geq S_i > 0{,}39$.
- Class III: lower-medium development level: $0{,}39 \geq S_i > 0{,}26$
- Class IV: low development level: $0{,}26 \geq S_i > 0$

The regional differentiation of the main potential classes of the furniture industry is illustrated in the figure below. 1.

[2] The analyses included figures in Polish zloty, converted into euro according to the average exchange rate of 1 EURO=3.40 PLN as of 31.12.2018 of the National Bank of Poland.

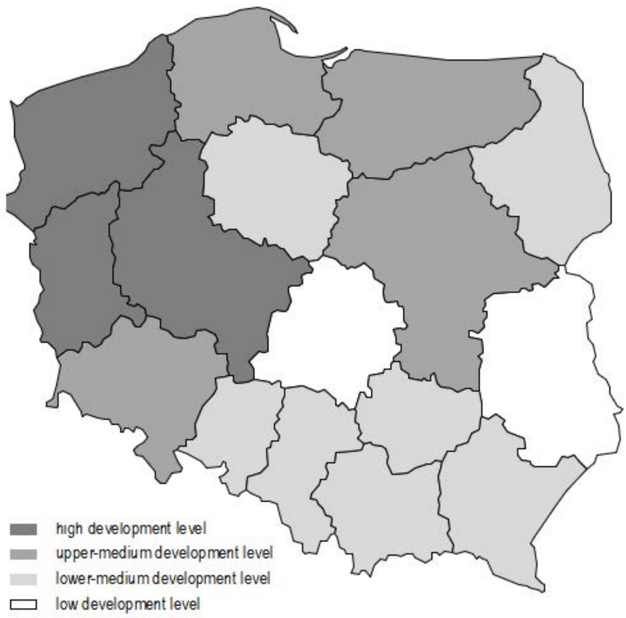

Figure 1. The regional differentiation of the main potential classes of the furniture industry in Poland
Source: Own elaboration based on the Statistica.

4. CONCLUSIONS

Based on the analysis of the results, the following conclusions were drawn:

1) The largest potential of the furniture industry in Poland was identified in north-western voivodships (strong regions). The regional competitive potential in these cases is based on the strong competitiveness of the furniture industry in terms of resources.

2) The difference in indications of synthetic measurement between the leader of the ranking (Zachodniopomorskie region) and outsiders (Jydzkie and Lubelskie regions) proves that there is a regional variation in the potential of furniture production. This means that there are no grounds for rejecting the hypothesis assumed at the beginning. Moreover, it was noted that the degree of diversification (divergence) of regional potential is well reflected in the identified four classes. However, within the classes one can indicate tendencies to convergence and economic symbiosis.

3) The regional leader of the ranking for the furniture industry in Poland can be indicated. Zachodniopomorskie Voivodeship is the leader. At the same time, the leader is accompanied by the regions of northern and central Poland, which potential encourages the search for development opportunities through cooperation between local governments (financing development) and between sectors (development of the furniture industry, cooperation and coopetition).

4) Provided for regions with the lowest identified industry potential, another specialisation can be sought or the furniture industry can be supported through intersectoral cooperation with neighbouring regions along with strong potential.

The proposals presented may also constitute recommendations for regional development policy. Their importance increases the significance of the furniture industry for the Polish and European economy. By indicating regions with strong industry specialisation, one can influence the maintenance or growth of their development dynamics and search for interregional stimuli for the development of green economy – in this case through the production and sale of furniture based on wood.

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IMPACT OF QUALITY MANAGEMENT PRINCIPLES ON BUSINESS PERFORMANCE OF WOOD PROCESSING COMPANIES IN SLOVAKIA

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Abstract: The article deals with the impact of applying the principles, methods and tools of quality management on the performance of companies of the wood processing industry in Slovakia. It presents the results of the research carried out during 2017, which analyzes the relationship between the application of quality management principles and their impact on the overall performance of these enterprises. At the same time, we would like to point out that the use of quality management tools and methods can have a positive impact on the reduction of poor quality, reduction of unproductive costs, increasing customer satisfaction and thus on the overall performance of companies of the wood processing industry in Slovakia.
Keywords: quality management, business performance, wood processing industry

1. INTRODUCTION

Managers of business entities are forced to constantly look for new methods and concepts that bring a new approach to traditional management approaches to process management approaches. The decisive factor for competitive advantage, success, business flexibility and stability of the business entity is their focus on the process approach to management. Although this approach is not new, its advantages are now appreciated in comparison with the functional approach. In particular, it is the implementation of new concepts and methods aimed at improving, optimizing and modelling the processes the use of which is presented in the article. The expected result is new capabilities to increase process performance and thereby increase the competitiveness and quality of enterprises as a whole. Withing the implementation of quality management practices in every type of enterprise it requires from managers and also employees to adjust to new processes, methodologies and overall thinking. It is interesting that companies with a strong customer orientation are more able to implement the quality initiatives. The issues of quality, like production quality, management quality, and process quality, play an important role because constant quality improvement is one of the essential principles anchored in the ISO 9000 standard as well as in the total quality management (TQM) philosophy. 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, optimization and modelling of processes in wood processing enterprises (WPI) in Slovakia.

2. MATERIAL AND METHODS

Process improvement is a BPM (Business Process Management) category. Its active role lies in identifying, analysing and improving existing business processes in organizations to optimize and meet new quotes and quality standards, using new concepts, approaches and methods. When investigating the use of concepts and methods to improve processes, we focused on the following methods: The Six Sigma methodology (SSM) is an organized and systematic method of strategic processes based on the philosophy of statistics about a non-existent error rate of 3.4 defects per one million opportunities when considering the products and processes (Linderman et al. 2003; Pande et al. 2008). According to Töpfer (2008), Six Sigma is project management with reliable statistical foundations and effective practices for quality management, it contains systematic methodology

DMAIC (Define-Measure-Analyse-Improve-Control) and DMADV (Define-Measure-Analyse-Design-Verify), process management, and a set of processes analysis practices to solve problems, statistics, philosophy, and quality culture at a zero-defect standard.

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

Process controlling is used to ensure process management and is part of corporate controlling focused on planning, controlling, optimizing, and evaluating processes at all levels of business activities. The reasons for introducing process controlling into corporate practice are primarily to provide better insight into business activities and processes, measure unit cost of processes, and rationalize cost savings to optimize them (Ellis, 2006). Controlling of quality is one of the practices that can ensure, transform, and complete the information on economic results into a form suitable for management. The economic aspect of quality is becoming more important, and its aim is to make quality measurable, plannable, and manageable (Sasse 2000).

A continual improvement, also often called a continuous improvement process (abbreviated as CIP or CI), is an ongoing effort to improve products, services, or processes. These efforts can seek "incremental" improvement over time or "breakthrough" improvement all at once. (Marcineková, Sujová, 2015) Delivery (customer valued) processes are constantly evaluated and improved in the light of their efficiency, effectiveness and flexibility.

The PivotTable is a method of organizing and analysing data by groups, categories, or classes that allows you to compare them. It connects the distribution of the variables of two variables and represents the extension of the simple frequency table (Rimančík, 2007). However, according to some literature sources (Finkelstein, Levin, 2001), for tables larger than 2x2, it is recommended to have at least 80% of the expected abnormalities greater than 5 or the expected abundance less than 1 in more than 10% of cases.

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 was filled by 524 enterprises (82 wood processing enterprises) that have been researched, and despite the relatively low return of filled – in questionnaires stemming from unseen causes, we can say that a survey sample of enterprises is relevant, has sufficient denunciation, which is also verified by selected mathematical and statistical methods. 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 show the answer of question “Which businesses regularly monitor and improve processes”.

The highest percentages received a response to the monitoring and improvement of production processes, with 76.83%, purchasing and supply processes have reached 53.66% and logistics processes 35.37%. The lowest percentages of responses were reported in 1.22%, which do not regularly evaluate or even improve processes. The Figure 2 show the answer of question “What new concepts and methods have you used or used to improve processes”.

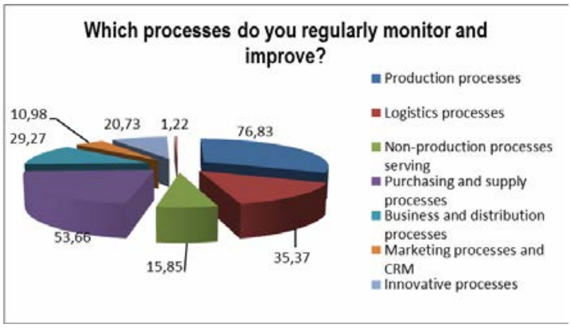

Figure 1. Monitoring and improvement of processes in wood processing enterprises in the Slovak Republic

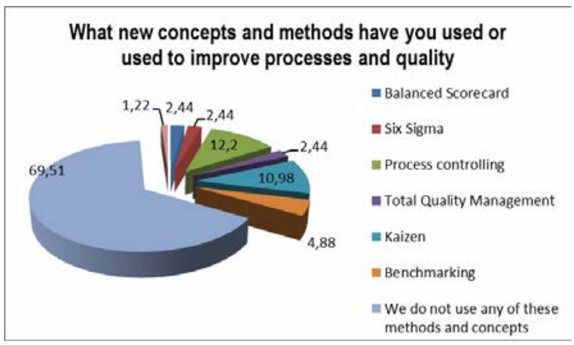

Figure 2. New concepts and methods used to improve processes in wood processing enterprises in the Slovak Republic

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. These percentages reached 69.51%. Process controlling use 12.2% of enterprises and Kaizen 10.98%.

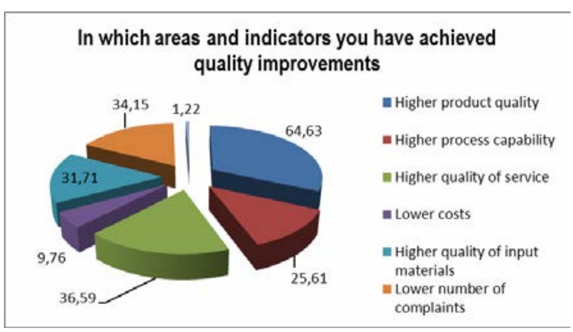

Figure 3. Areas and indicators of the quality improvement achieved in wood processing enterprises in the Slovak Republic

Figure 3 shows that most of the companies surveyed are improving quality by making changes, particularly in areas such as the higher product quality, identified by 64.63% of enterprises. The second area of improvement was the higher quality of services, which was reflected in 36.59% of enterprises. The third identified area was lower number of complaints from customers, where this improvement was recorded in 34.15% of enterprises.

Table 1. Contingency question D-14

D. What is the Return of Equity (ROE) of your company reached in 2015? 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.

Table 2. Contingency Questions 6 and 14 in wood processing enterprises in Slovakia

6. At what level do you optimize (improve) processes?								
14. What new concepts and methods have you used or used to improve processes and quality ?								
New concepts and methods of process and quality improvement	Process Optimization Level							
	Optimization options are identified	We have a mathematical model built to quantify total costs	Employees have the latest technology to create efficient business processes.	Business standards and processes are linked to identified business success factors and customer	We have created a change management program that ensures loyalty of employees	None of these options apply.	SUM	Relative frequency
Balanced Scorecard	*4* *8.89%*	*0* *0.00%*	*0* *0.00%*	*0* *0.00%*	*0* *0.00%*	*0* *0.00%*	*4*	*4.04%*
Six Sigma	*1* *2.22%*	*0* *0.00%*	*0* *0.00%*	*1* *11.11%*	*1* *11.11%*	*0* *0.00%*	*3*	*3.03%*
Process controlling	*11* *24.44%*	*0* *0.00%*	*0* *0.00%*	*2* *22.22%*	*3* *33.33%*	*0* *0.00%*	*16*	*16.16%*
Total Quality Management	*4* *8.89%*	*0* *0.00%*	*1* *12.50%*	*3* *33.33%*	*1* *11.11%*	*0* *0.00%*	*9*	*9.09%*
Kaizen	*7* *15.55%*	*0* *0.00%*	*1* *12.50%*	*1* *11.11%*	*1* *11.11%*	*0* *0.00%*	*10*	*10.10%*
Benchmarking	*3* *6.67%*	*1* *100.00%*	*1* *12.50%*	*3* *33.33%*	*1* *11.11%*	*0* *0.00%*	*9*	*9.09%*
We do not use any of these methods and concepts	*17* *37.78%*	*0* *0.00%*	*8* *100.00%*	*7* *77.78%*	*1* *11.11%*	*10* *100.00%*	*47*	*47.47%*

It can be seen from the data in Table 2 that most of the analyzed enterprises in the range of 77.8% to 100% for each of the process optimization level categories in the wood processing industry do not use any of these concepts. The next largest answer for wood processing enterprises is the use of process control with a relative frequency of 16.16%. On the other hand, the least used new concept is based on the results of Six Sigma and BSC, whose frequency for the wood processing industry reaches less than 4.1% of responses. From the point of view of categorization according to the process optimization level, it is interesting to find out that companies belonging to the group with zero level, resp. none of the above options apply in 100% do not use any of the new concepts.

Prior to analyzing the results using the Chi square test (Table 3), a null hypothesis was needed: H0: there is no relationship between the level of optimization of wood processing enterprises and the use of new concepts and methods to improve quality.

Table 3. Results of Chi-square test in wood processing enterprises in Slovakia

Results of Chi-square test			
	Chí-kvadr.	Unrestricted variable	P value
Pearsons chí-square	39.05747633	df = 5	0.016806545
Contingency coefficient	0.98545577		
Cramér. V	0.29964529		

The results of Table 3 confirmed the existence of dependence on wood-processing enterprises between process optimization levels and whether other than the proposed analyzes were carried out by the companies in this pre-change period. Based on Cramer's Relationship Measurement, it was possible to state that the strength of the relationship is 0.299 and is a slight relationship (above 0.29 and below 0.59). The correlation coefficient is 0.985, a positive dependence, and a p value of 0.0168 (which is less than 0.05) confirms the statistical significance of the question under consideration, with Cramer-V referring to a moderate link.

4. CONCLUSION

Strong globalization pressures, starting with the lack of adequate workforce in organizations, cause competitive problems in business environments, and therefore improving quality through applying quality management principles improving performance and process capabilities is considered one of the most effective ways to work in such a long-term environment, because the way of organizing processes and processes has an impact on the overall efficiency of the organization.

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.

Generally in conclusion it can be stated that quality management practices can positively influence the increasing of production quality and process performance, reducing the number of complaints with a secondary cost reduction for poor quality products.

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RISK ASSESSMENT OF TIMBER WOOD FUMIGATION BY APPLYING THE REQUIREMENTS OF ISO 9001: 2015

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Abstract: To fulfill the regulatory requirements and those of the customers, the Bulgarian timber exporting companies must manage their processes by introducing mechanisms to provide and guarantee the compliance. The purpose of the present study is to apply the risk-based thinking approach ISO 9001: 2015 to risk assessment of the process of fumigation of timber wood for export. The goal is achieved by identifying and analyzing the types of risks arising from the process, determined by the impact of the associated external and internal circumstances. In this study, the FMEA method for risk assessment of the fumigation process of timber wood was used. Various factors have been analyzed that can contribute to reliable and consistent assessments of experts participating in the study. The results of the risk assessment show that there is a significant risk of inadequate pest control measures in the fumigation process. The results confirm that the quality management system based on ISO 9001: 2015 has a practical application in risk analysis of the fumigation process of timber wood. The basis for achieving better results and preventing negative consequences for the development of the company exporting timber wood is created through the risk assessment and identification of measures to control the risks to the fumigation process.
Keywords: risk assessment, timber wood, fumigation, quality management system

1. INTRODUCTION

The worldwide quality-related topics are highly important when it comes to the customer expectations meeting what the Market has to offer (Ioannis S. Arvanitoyannis, Christos Palaiokostas &Panagiota Panagiotaki, 2009), (Conduit, J., & Mavondo, F. T., 2001). This highlight is strongly dependent on the manucaturers or traders achieving good financial performance (De Boeck E, Jacxsens L, Bollaerts M and Vlerick P, 2015). From this point of view the product quality is of primary importance to companies that produce and distribute wood material on the European and on the world markets.

We have witnessed many times, in many cases, the market letting unfair commercial and customer practices appear, which as a matter of fact is related to goods realization – ones that do not correspond with the established international practices nor with the current regulatory requirements. A huge part of the harvested timber and wood material produced in Bulgaria is subject to a number of unfair practices related to the illegal forests felling followed by illegal export (Belev & Staevska, 2018). The purpose of these practices is gaining profit without respecting rules and requirements imposed. Those facts on the other hand determine the adoption of such approaches and mechanisms in the European Union (EU) that would facilitate the achievement of more sustainable forms of consumption and production (COM(2008), 397 final, 2008). The international timber trade is currently a regulated process that is greatly dependent on the application of phytosanitary measures upon both the timber import and export. Being the EU member she is, Bulgaria has managed to harmonize her national legislation by implementing these measures.

2. RESEARCH GOAL AND METHOD

The purpose of the present study is by applying a risk-based thinking approach to the standard ISO 9001: 2015 in order to assess the risk taken in the fumigation process of otherwise unprocessed raw wood material intended for export. The accomplished by identifying and analyzing the types of risks arising from the process performance determined by the impact of reported external and internal circumstances.

The validated and standardized method FMEA (Failure Modes and Effects Analysis) has been used in the present study to assess the risk carried by the fumigation process of unprocessed raw wood material. FMEA is being used as a basis for identifying corrective actions that would reduce the risk to an acceptable level. The method of risk assessment applied uses the available quantitative (numerical) information, which makes possible achieving a quantitative final result. This method is characterized by a greater level of objectivity and accuracy of the research procedure itself and its final result, as this last one has in fact been implemented in the international standard EN 31010 (Bulgarian Institute for Standartization, 2010).

3. RESULTS AND DISCUSION

Forest plantations are a valuable natural resource for any country; they are a source of wood, a subject to internal processing and international trade. There is a number of regulatory documents that indeed regulate the import and export of wood (both processed and unprocessed material) between different countries, both within and beyond the EU. International trading is directly dependent on the application of phytosanitary measures when importing and exporting timber. Bulgaria, as an EU member, has harmonized her national legislation and is committed to controlling plants, plant-based products and all mechanisms related to the implementation of precautionary measures to prevent the entry and spread of quarantine pests.

The European legislation includes COUNCIL REGULATION (EC) No 2173/2005 of 20 December 2005 on the establishment of a FLEGT licensing scheme for imports of timber into the European Community (hereinafter referred to as the "FLEGT Regulation") as a part of the legislation implementation strategy of EU from 2003 to the forestry management and trade (FLEGT)) (COM (2003), 251 final, 2003). In 2008 the Commission has adopted 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. The FLEGT Regulation defines specific rules for the FLEGT licensing scheme implementation through the conclusion of voluntary partnership agreements with timber producing countries that include as a requirement for all wood imports into the EU originating from their FLEGT partner countries to be covered by a so called FLEGT (COM (2018), 448 final, 2018). The FLEGT licensing scheme initially started operating on 15 November 2016, precisely when the Indonesia FLEGT licensing scheme was launched as well.

The Bulgarian legislation regarding all timber exports is being determined by the operating Plant Protection Act. The law governs public relations related to the implementation of the internationally established phytosanitary measures for plant protection from the International Plant Protection Convention (IPPC), the plants and plant products protection against economically important pests and their cross-border spread, and protection of integrated plant production.

By applying the rules regarding phytosanitary control of plants and plant products and the protective precautions against the entry and spread of plant quarantine pests into the country, Bulgaria has engaged into applying all protection mechanisms defined as international requirements (COUNCIL DIRECTIVE 2000/29/EC, 2000). In order to successfully meet the regulatory requirements and also the customers requirements, for the Bulgarian timber exporters it is indispensable to manage their procedures by implementing mechanisms that would ensure compliance with all regulations. It is necessary for them to ensure suitable conditions, to implement mechanisms and to provide objective evidence proving that the quarantine pests in the timber (if any) have been eliminated and the export requirements from Bulgaria have therefore been fulfilled. This in fact could be achieved through the use of internationally recognizable instruments, such as the international standards for example. Speaking of examples of recognizable tools, we might add that the model presented in the international standard – BDS EN ISO 9001: 2015 (Bulgarian Institute for Standartization, 2015) would indeed be a good one. The Standard sets requirements for the establishment and the implementation of a Quality Management System able to manage different interrelated processes determining the activities of logging and timber trading companies.

The requirements for all timber exporters to the EU or to third countries are subject to the universal principles of the integrated pest management and involve the use of appropriate methods and tools. Such methods include science-based warning, forecasting and early diagnosis systems, as well as decision making on the type and frequency of the applied precautions for plant protection according to the established thresholds of economic harm. Upon deciding on the type of plant protection methods to be applied, the most important factors are the quarantine pest species typical for the product that is subject of economical harm, so are the specific areas of harvesting and the climatic conditions according to the given period. Depending on the type of goods exported, there are chemical, biological and physical methods of pest control which may be applied (Allen, E., Noseworthy, M., & Ormsby, M, 2017). In most cases, physical and chemical plant protection methods are applied for wood damaging pests' control, and furthermore the exact choice is being determined by the degree of risk to the crop, taking care of not letting the risk of the pest resistance to be enhanced (Wang, D. Q.; He, J.; Zhang, Q. H., 2017). The repeated plant protection product treatment aims to ensure the preservation of the product's quality. This may incavelude the use of several plant protection products with different action mechanisms. The applied plant protection products need to be selective in terms of purpose and to have minimal side effects on the human health, on the beneficial organisms and on the environment.

As a natural material the wood chippings, especially when untreated and in an appropriate environment for development of various biological hazards (microorganisms and insects). Under specific developmental conditions, those microorganisms and insects could cause many damages associated with quality decrease, and they could also cause for the wood itself to suffer from phytopathogenic diseases. The effects of such biological hazards are directed towards phytopathogenic diseases that lead to destruction of the wood structure and wood structure and composition deficiencies (their enzymes accelerate the decomposition of macromolecules on the tree, the degradation of physico-mechanical properties, they cause reduced denseness, staining and also deterioration of the external, the visible part of the wood). The damage caused from the appearance of these hazards is being measured by the realization of high costs.

Taking appropriate precautions for protection against quarantine pests requires the use of chemical methods with appropriate plant protection products. The choice of method is dictated by the pest type and by the amount of the damage made. The product choice is determined by the wood type and purpose and by the specific regulatory requirements for this very material. Nowadays when exporting wood, the main method of fighting pests is the chemical one – it consists in treating wood with different pesticides in terms of composition and action. The use of pesticides as a plant protection product is controlled by the regulatory framework and its launching on the plant protection products market is related to the regulatory authorization (European Parliament, 2009).

The process of timber fumigation for export from Bulgaria is most often carried out by an external contractor, which requires timber exporters to carry out a precise assessment and a fair contractor choice for this process. Whether the process is proprietary to the organization or outsourced, a risk assessment of these processes is required in order for the requirements to be met and a compliance to be ensured. Some authors (Jodkowski, 2015), view the risk for the various processes as an accumulation of various types of risks (e.g., economic risk, organizational risk, health risk from consumption, risk of force majeure).

Quality management is being observer as a function of all actors not only in the production process but also in all the supply chain processes. Through the development of the QMS, each company could successfully plan and control the activities to eliminate potential or actual discrepancies and their associated unforeseen consequences in the delivery of products and services. The Bulgarian standard EN ISO 9001: 2015 uses the process approach, laying down one of its fundamental principles of risk-based thinking (Bulgarian Institute for Standartization, 2015). This approach will reveal the ability of each Organization to identify the factors able to cause a deviation from the expected results from each of its processes and activities. This, on the other hand, is a prerequisite for planning the implementation of adequate and realistic precautions related to the management, the performance and control of the process in order to limit the negative consequences and to make the most of the opportunities available (Bulgarian Institute for Standartization, 2018).

Fulfilling fumigation activities in raw wood processing is inevitably linked to the possibility of a wide variety of hazards to appear, some of which have a high potential for posing risks with very serious consequences. Eliminating all risks associated with fumigation performance as well as achieving an absolute safety is impossible. The solution to this problem and to others is specifically related to the risk management of processes which have already been identified and controlled. The highlight is on managing the activities and processes that can be considered as risky or uncertain, and furthermore it is necessary to focus on implementing precautions related to (Aven & Zio, 2014):

- Usage of risk assessment and risk management to identify and implement adequate risk management precautions to minimize the risk;
- Accumulating risk data and knowledge and applying models for understanding, assessing, characterizing, communicating and managing the risk.

The risk-based way of thinking provides us with the opportunity to identify the factors that may cause a deviation from the expected outcomes of the daily fumigation processes. This in fact is a prerequisite for planning the implementation of adequate and real precautions related to the actual state of the untreated timber, the established degree of its contamination and of its damage, the direction and the destination, including the specificity of the phytosanitary measures currently undertaken in the country of destination, of the fumigation process used to reduce the negative consequences and to make the most of the offered opportunities (Bulgarian Institute for Standartization, 2018). The application of appropriate methods and tools ensures adequate assessment and management tools and that way it becomes possible to achieve positive risk-related outcome in the event of specific issues coming up.

The methodology of the International Standard BDS EN ISO 31000: 2018, risk management is determined by the following sequence – risk identification, risk analysis and risk treatment. The risk management process comprise the stages of the process itself, the information exchange and the consultation, including the identification of all elements and factors determining the likelihood of the risk being manifested, the accumulated knowledge regarding risk change, and the degree of impact of the various factors determining the probability, the issues pertaining to the risk itself, the causes of the risk, the severity of the consequences and their attitude towards the measures taken in relation to the degree of impact on the risk.

The emphasis on risk management in a particular process is on the dynamics of the risk analysis and assessment rather than on the static or traditional risk assessment, in order to meet solely the requirements defined by the normative or specifically selected documents. As in many other industries, in wood trading, companies are trying to implement approaches that can improve the reliability of their processes (either of their own or outsourced ones), in order to avoid a situation of uncertainty. On this very basis, the concept of security is being developed, with considerable attention being paid to the details, as the focus falls on the interaction between the risk and the uncertainty of its mastering (Khorsandi & Aven, 2013).

According to certain studies (Kaplan & Garrick, 2017), the risk management is to be considered as a systematic implementation of policy, procedures and practices for managing information exchange, counselling, circumstances establishment, as well as activities related to risk identification, analysis, assessment, impact, monitoring and risk audit. Performing an adequate risk assessment is a framework defining the understanding of the specific threats of a probable occurrence and the extent of the consequences of poorly performed fumigation and the detection of a live pest disease located on the untreated timber. When analysing the risk one must not neglect either of the following factors: likelihood of events occurrence and possible consequences, sort and size of the consequences; complexity and relatedness; time and change related factors; efficiency of the existing control measures; sensitivity and confidentiality levels.

In this way, one could prioritize and define which risks it would be possible to impact and possibly manage to master to a tolerable level, as for this purpose exactly it is important to determine the most adequate measures to ensure the performance of the fumigation process, also to determine the most appropriate products to impact according to the disease type and degree, or to reject the actions that have been applied so far as a risk impact measure. The risk treatment may cause new risks or changes in the already existing risk. The risk treatment related to the negative consequences is sometimes called "risk mitigation", "risk elimination", "risk prevention" and "risk minimization" (Bulgarian Institute for Standartisation, 2011).

This study uses the FMEA (Failure Modes and Effects Analysis) method for assessment of the identified risk (Bulgarian Institute for Standardization, 2010). The failure and failure effects analysis is an approach for determining, identifying and classifying possible types of failures, the likelihood of their occurrence, and assessment of their criticality (Ostasz, G.; Pacana, A.; & Olejarz, T., 2017). Through the FMEA, it is possible to analyze the efficiency of the measures implemented in the process of fumigation and the measure planning in the process management when there are many deviations. One mut note that the final quantitative results could be influenced by the validity, representativeness and accuracy of the incoming information. Therefore, the quantitative results obtained should not be considered as precise final values (point estimates of the indicator under consideration) but rather as a quantitative evaluation with possible variations depending on the quality of the input data. The application of this method highlights the possibility of reaching a conclusion offering a much wider range of information than the initial facts, a.k.a. the reliability of the conclusion varies and depends on the impact of future events only. The characteristic part of this method is the fact that it enables the severity identification and assessment, as well as quantitative risk evaluation of the fumigation process.

Upon the implemantation of the FMEA method, priority risk numbers (RPNs) for each of the studied factors have been determined by the following formula:

$$RPN = S \times O \times D \quad (1)$$

***S** (severity)* – the inportance of the consequences from a potential failure
***O** (occurence)* – the likelihood of the potential failure to occure as a result from its importance
***D** (discovery)* – the possibility of establishing an efficient control in order for the negative impact of the factor to be prevented or found before it has affected the processes in the management system

The determined numerical value for the severity, the probability and risk establishment for each factor would take values from 1 to 10. The risk class is determined for each of the numerical values obtained. Numerical values for each of the components of RPN that were classified into four groups according to Table 1 were determined. The numerical value for gravity, probability and risk identification for each factor is set to values from 1 to 10. The risk class is determined for each of the numerical values for RPN obrained, ranging from 1 for the lowest risk to 1000 for the highest priority risk class as presented in Table 1.

Table 1. Determination of risk class

Risk class, RPN value	(S) Severity	(O) Occurence	(D) Discovery
RPN up to 1000 and above?	**8 – 10 = High signicicance.** Minor factor changes make significant changes in the shipping and delivery related processes.	8 – 10 = Very high probability of occurrence	7-10 = The possibility for establishment is less than 10%
RPN above 800 Very high risk score	**5 – 7 = Average signicicance.** Only a significant factor change exerts influence on the shipping and delivery related processes.	5 – 7 = Moderate probability of occurrence	4-6 = Low possibility for establishment up to 35%
RPN above 340 High risk score	**2-4 = Little significance.** The factor changes exert little influence on the shipping and delivery related processes.	2-4 = Unlikely to occur.	2-3 = Average possibility for establishment up to 80%
RPN up to 340 Moderate risk score	**1 = Minor significance.** The factor changes could only cause minor changes in the shipping and delivery related processes.	1 = Minor probability of occurrence. (Impossible)	1 = High possibility for establishment up to 100%

Based on the calculations made with formula 1, the numerical values of PRN have been determined. These values were systematized and presented in Table 2. For risks with a final PRN score equal to or above the threshold, the management decides whether to reject the entity because of its risk or to accept the risks after having developed a risk reduction plan. The risk assessment for the processes of shipment and delivery to the customer of finished products is presented in Table 2 "Register of risks related to expedition and delivery of goods", as real risk mitigation measures have been developed with a risk factor, greater than 340.

Table 2. Register of risks associated with fumigation of raw timber

Risk	O	S	D	RPN
Insufficient qualification and education of the staff performing the fumigation.	6	6	6	216
Lack of license by authorized state authorities for legaly performing fumigation services.	8	8	8	512
Unclear rating criteria for contractors performing fumigation services.	6	4	10	240
Unsuccessful fumigation due to unfavorable environmental circumstances (negative temperatures during the loading for export)	4	4	2	32
Lack of PEST Products availability of importers and traders to allow the fumigation process to be performed.	6	4	4	96
Increase of all activity expences related to changes in the price parameters for plant protection products against pests	8	6	2	96
Insufficient active substance concentration according to the degree the untreated wood material is contaminated	4	6	2	48
Unfulfilled export and fumigation schedules in accordance with the territory exit regulations	6	4	2	48
Lack of ensured airtightness upon fumigation condution at the object of treatment	8	6	2	96
Overdue terms of exposure	6	6	6	216
Short international transit destinations and inadequate exposure times	8	4	4	128
Not authenticating fumigation by control authorities	4	6	4	96
Lack of substitute preparations for specific processing methods or inappropriate weather conditions (environmental temperatures affect the pests viability)	6	8	8	384
Use of unauthorized and unapproved plant protection products that are not registered on the territory of the country	4	6	2	48
Lack of identification of the observation and measurement resources	6	6	2	72
Non-compliance with statutory requirements	6	4	4	96
Customer's claim on wood upon delivery	8	4	2	64
Increase of materials and fumigation costs	8	6	4	192
Lack of financial and material resources for new equipment	4	8	4	128
Acceptance of customer orders that can not be fulfilled	2	4	2	16
Incorrect performance of the accuracy of attached supporting documents	8	4	4	128
Lack of adequate communication rules between control authorities and contractors for fumigation services	6	4	6	144
Unfulfillment of the expedition and delivery due dates	6	4	4	96
Unfulfillment of the transportation conditions	4	6	4	96
Infringement of traffic regulations by drivers of vehicles on the road	8	6	8	384
Incorrectly announced subsequent requirements changes	8	6	2	96
Sanctions and penalties imposed by the customer for non-compliance	8	6	2	96
Incomplete and inaccurate expression of the customer requirements	6	6	6	216
Vehicle related orce majeure circumstances	2	4	2	16
Changes in the regulation requirements	8	6	2	96
Early contract termination due to impossibility of execution	4	4	6	96
Unclearly defined and non-delegated responsibilities and rights	4	4	4	64
Likelihood of military action development in the customer's country	4	6	4	96
Lack of information regarding weather changes	6	4	4	96
Profit reduction (loss) due to unfulfilled oreds for wood material	8	4	4	128
Targeting markets with restrictive requirements	6	4	4	96
Loss of loyal customers related to delivery due dates	4	4	2	32

4. CONCLUSION

Through the performed risk assessment and identification of measures to control the fumigation process risks, the basis for achieving better results and preventing negative consequences for the timber exporting company development has been created.

By implementing risk-mitigation measures, the basis for enhancing the QMS efficiency, achieving better results and preventing negative consequences, and also the basis for prioritizing through the company's development, has been created. The obtained results from the risk assessment can serve as a basis for making adequate management decisions related to goals achievement, ensuring the fulfillment of a consistent quality, preserving the consumer's trust and implementing measures for continuous improvement.

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ANALYSIS AND PREDICTION ABOUT THE DEVELOPMENT IN THE SPRUCE RAW MATERIAL BASIS IN THE CONTEXT OF THE DEVELOPMENTS IN THE BARK BEETLE DISASTER IN THE CZECH REPUBLIC

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Abstract: In the context of the extremely dynamic developments in the bark beetle disaster in the Norway spruce stands, of the wilting of coniferous forests in 2018, and of the continued pace of unplanned logging, enterprises engaged in the timber industries are concerned about the decline in the raw material basis in the years to come. For the decennium of 2017 – 2026, the overall Czech growing stock of spruces of all age classes amounted to 399.6 million m^3 of timber to the top of 7 cm under bark. Building on the exploitation percent, the theoretical outlook for the spruce logging potential for the next decade (2017 – 2027) is 112.63 million m^3 of timber to the top of 7 cm under bark. Should the pace of the bark beetle disaster continue with the same intensity and supposing that the overall annual felling with permanent restrictions on planned felling reaches 20 million m^3, the complete spruce growing stock from the 5th age class on could be felled within approximately the next 18 years. This article brings an analysis and prediction of the development in the spruce raw material basis for the period up to the year 2027.
Keywords: bark beetle disaster, Norway spruce, unplanned logging, timber industries, spruce raw material basis

1. INTRODUCTION

The extremely dynamic development of bark beetle disaster in the Norway spruce forest stands together with the wilting of coniferous forests in 2018 make any prediction of the development in raw material basis of forest biomass for energy purposes in later years very difficult.

In 2018, there was a dramatic deterioration of the production conditions in forests and forest management. The year 2018 was adverse due to extreme weather conditions, unevenly distributed preciptionation and extreme temperature events, which led to further progression of bark beetle disasters and consequent economic problems in the whole primary production sector of forest management and in the compex of downstream sectors. By the beginning of 2018, the overall logging of raw timber in the Czech Republic was still expected to amount to 17.5 – 18.0 mil. m^3. By the end of 2018, the total logging was expected to amount to roughly 20 million m^3 with all available domestic capacities included and with modest reinforcement from abroad. According to latgest estimates, the total volume of wood infested by bark beetles logged in 2018 amounts to ca 12 million m^3, which is double the volume of wood infested by bark beetles logged in 2017 and which exceeds a current year volume of such wood roughly twenty times. The estimate of the total volume of wood infested by bark beetles for 2019 amounts to 18 million m^3 (Ministry of Agriculture's 2019 Strategy for Dealing with Disasters in Forests).

Currently, seven regions are most hit by the bark beetle disaster (Moravian-Silesian, Olomouc, Zlín and South-Moravian Region, Vysočina, South-Bohemian Region, and Plzeň Region), but infestations occur throughout the Czech territory. Moreover, pine stands are also affected by drought and secondary underbark pests. The maximum annual performance of logging capacities which are currently available in the Czech Republic is esimated at 20 – 25 million m^3, which is the average monthly performance of 1.6 – 2 million m^3. During extreme summer months, the montly need of processing of logged wood infested by bark beetles can even exceed 3 million m^3 in some regions (Ministry of Agriculture's 2019 Strategy for Dealing with Disasters in Forests).

The total spruce growing stock of all age classes for the decennium of 2017 – 2026 is 399.6 million m^3 of timber to the top of 7 cm under bark. The theoretical outlook for deccenial spruce logging possibilities (2017 – 2027) deduced from the logging percentage amounts to 112.63 million m^3 of timber to the top of 7 cm under bark. (Basic characterstics of forests in the Czech territory including their longterm development trends, ÚHÚL, 2019).

1.1. Hypothesis

Should the pace of the bark beetle disaster continue with the same intensity and the overall annual logging reach 20 million m^3 with permanent restrictions on planned logging, the total spruce reserve of the 5th age class and older might be logged out within approximately 18 years.

This hypothesis can be confirmed, rejected or modified using a logging model with the current increment.

2. MATERIALS AND METHOD

Having examined the materials assessing the current state of the addressed issue, the authors set up the following method:

2.1. External materials

Status Report on Forest and Forest Management in the Czech Republic for the period of 2015 – 2017

- Considering its extremey dry summer, the year 2015 can be seen as the year of initiation of the bark beetle disaster.
- The Green Report 2017 is essential to establish the 3-year timeline for the subsequent modelling of development in total and unplanned logging.

Modelling the general overview of logging possibilities regarding forests in the Czech Republic

A calculation of the theoretical outlook for decennial logging possibilities for outputs according to individual regions and basic assortment structure.

- The theoretical outlook for decennial logging possibilities regarding forests in the Czech Republic for the period of 2017-2057. The outlook has been prepared for the Czech Republic, by individual regions, by regeneration and tending felling, cumulatively for all woody species, and for the main groups of woody species (spruces, pines, other coniferous woody species, oaks, beeches, and other broadleaf woody species).
- The theoretical outlook for the species composition (spruces, pines, other coniferous woody species, oaks, beeches, and other broadleaf woody species) in the Czech territory and in the individual regions, by deccenia within the period of 2017-2057.
- The basic assortment structure (quality classes of saw log, pulp wood, and fuel wood) in the Czech territory and in the individual regions, by deccenia within the period of 2017-2057 for the groups of woody species of spruces, pines, other coniferous woody species, oaks, beeches, and other broadleaf woody species.

2.2. Internal materials

The internal materials used for the analysis and prediction included the partial outputs of the National Institute for Agricultural Research project NAZV 2018 – 2020 “Potential of Structural Changes in Forestry and Wood Processing”. The project has been conducted by the employees of the Department of Forest and Wood Products Economics and Policy of the Faculty of Forestry and Wood Technology of Mendel University in Brno. Some usable outputs of the project included the calculations of material and value flow of raw wood material in the forest-timber complex.

2.3. Methodological framework

An analysis of the input data about timber logging in the Czech Republic till 2017 divided into groups of coniferous and braodleaf woody species. An analysis of the impact of salvage logging on the timber market in the Czech Republic including a determination of the correlation between logging indicators and implementation of main trading assortments. An overview of logging possibilities in the Czech Republic and modelling of the development in overall logging. A narrative prediction of the development in logging possibilities and in the raw material basis with the inclusion of standardized needs of wood processing industry, pulp and paper industry, and the expected increase in dendromass left behind in stands to decompose.

3. OVERVIEW OF LOGGING POTENTIAL OF CZECH FORESTS

Table 1.1.: Perspective of the future development of the areal representation of the individual age clasess of SPRUCE (in ha) in the individual deccenia of the period of 2017-2057

Decennium / Age class	1st dec.	2nd dec.	3rd dec.	4th dec.
1	102,825	179,737	128,831	114,584
2	102,908	102,825	179,737	128,831
3	116,500	102,906	102,823	179,734
4	91,217	116,483	102,887	102,811
5	100,764	91,184	116,379	102,800
6	86,710	100,706	91,096	116,145
7	75,610	86,346	100,458	90,854
8	109,424	74,965	85,735	99,855
9	117,011	106,157	72,976	83,632
10	91,872	102,160	92,651	64,437
11	91,622	64,093	73,467	66,256
12	66,800	46,429	35,656	41,921
13	34,292	21,075	17,632	14,573
14	17,861	9,372	7,205	6,210
15	8,438	7,439	4,381	3,242
16	3,823	4,525	3,761	1,567
17+	2,690	3,964	4,693	2,913
Total	1,220,367	1,220,367	1,220,367	1,220,367

Source: ÚHUL

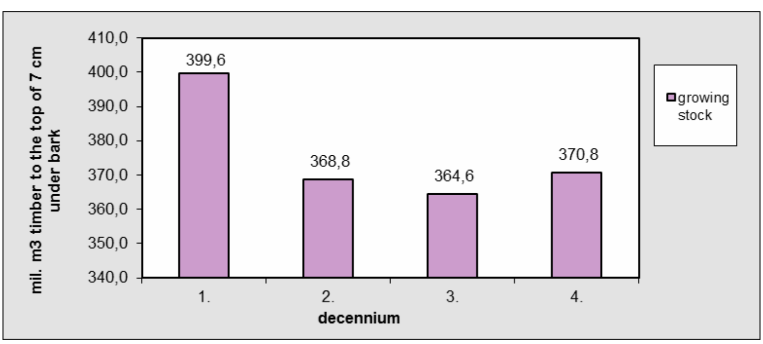

Figure 3.1: Perspective of the development of the growing stock of the SPRUCE woody species

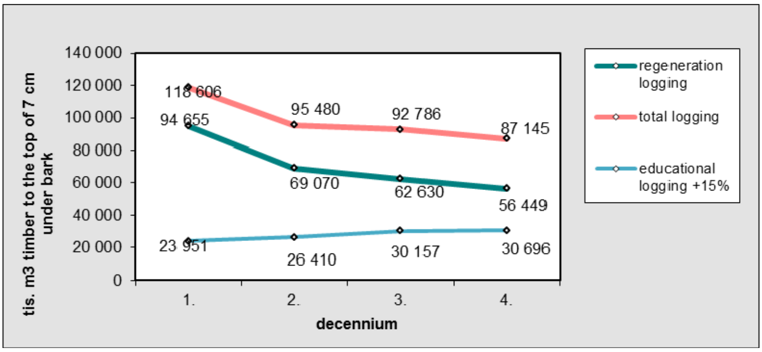

Figure 3.2: Theoretical outlook for decennial logging possibilities (of logginng percentage) for the SPRUCE woody species

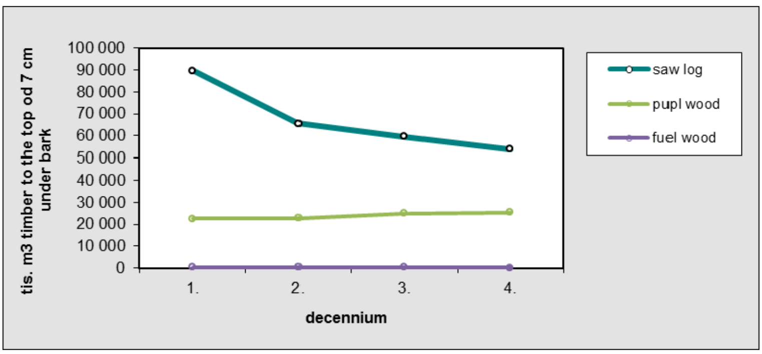

Figure 3.3: Theoretical outlook for assortment possibilities for the SPRUCE woody species

4. PREDICTION OF DEVELOPMENT IN LOGGING

The following conclusions can be drawn on the basis of the CONDUCTED analyses and of the findings:

Should the pace of the bark beetle disaster continue with the same intensity and the overall annual logging reach 20 – 25 million m^3 with permanent restrictions on planned loggging, the total spruce reserve of the 5th age class and older will be logged out within 18 years – the hypothesis has been confirmed.

The analysis of the information provided in the Status Reports on Forest and Forest Management for the reference period of 2000 – 2017 showed a clear trend of increase in unplanned logging, where the value of 61% of the annual percentage for the whole Czech Republic can be regarded as the minimum ratio for the period of 2019 – 2028. This can be documented with the established high correlation between the development of unplanned logging and of overall logging. Notable differences will occur in individual regions based on the progress of unplanned logging of wood infested by insects. If the year 2017 with its annual logging of 19.39 million m^3 and the 85% ratio of spruce is taken as the basis for the prediction, a constant or increasing trend of this ratios can be assumed. If the annual volume of logging in the period of 2019 – 2028 amounts to 22 – 25 million m^3, which equals the current maximum of logging capacities available in the Czech Republic, then the annual part of spruce in the logging will be at least 20 million m^3 to the exclusion of other mainly boradleaf woody species.

Since 2016, there has been a decline in the production of saw log assortment for sawmill processing due to the increase in unplanned logging of wood infested by insects and an increase in the production of pulp and fuel wood assortment. At the same time, a medium correlation was identified between the increase in export of saw log assortment and the increase in the volume of unplanned logging and a low correlation between the increase in pulp wood assortment and fuel wood and the increase in the volume of unplanned logging. This can be explained by the higher transfer earnings related with saw log assortment than those related with pulp wood and fuel wood. Consequently, an increase in the reserve of less easily marketable assortments in the Czech Republic in the period of 2019 – 2028 can be predicted.

Taking account of the results of the analyses of logging possibilities and timber flows, a sharper decrease in logging possibilities can be predicted based on the previous development in unplanned logging and on the drop in the increment and logging percentage starting in 2027 and with the minimum decennial total volume of 42.4 million m^3, which represents an annual depletion by 4.3 million m^3. In the 2nd decennium (2027 -2036), there will be an increase in the representation of the 1st age class (0 – years) by approximately 80% and a drop in the total growing stock below 600 million m^3 of timber to the top of 7 cm under bark. There will be important differences in the individual regions according to NUTS and to the progress in pest infested wood procesing. The Moravian-Silesian, Olomouc, South-Moravian Region, (Southern) Vysočina, and South-Bohemian regions seem to be most affected. A sharp drop in the production of coniferous saw log for sawmill processing can be expected since the middle of the 2nd decennium (since about 2030), in the above-mentioned regions in particular.

4.1. Rough balance of consumption and export of raw timber to the top of 7 cm under bark in million m3 till 2019

Total annual logging	20 – 22
Domestic consumption including the above-mentioned increased capacities of LabeWood and Mondi Štětí	13 – 14
Intra-union trade and export with the increse included except for UNECE	8 – 9
Space for additional import of some assortment and woody species (mainly pines)	1 – 2

Assortment structure

Saw log	8.8 – 9
Pulp wood	4.5 – 5
Fuel wood	6 – 7

The current consumption of fuel wood to the top of 7 cm under bark amounts to approx. 2.5 million m^3. This consumtion can be increased by 3.5 – 4.5 mil m^3 of timber to the top of 7 cm under bark.

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SYNTHETIC MEASURES AS A TOOL FOR IDENTITYING THE POTENTIAL OF THE WOOD-BASED INDUSTRY SELECTED SECTORS

Elżbieta Mikołajczak, Łukasz Sarniak, Leszek Wanat

Abstract: The search for adequate synthetic measures that allow to identify the potential of economic sectors is an important and active challenge of research. The authors made such an attempt on the example of the analysis of the potential of the sector based on wood in Poland. In this paper, the method of linear ordering (TOPSIS), statistical verification and comparative analysis were used. Based on the indications of the proposed synthetic measure, the regional differentiation of the development potential of the sawmill industry in Poland was verified. Conclusions and recommendations were also formulated, in particular for sawmill enterprises.
Keywords: sawmill industry, regional development potential, Poland,

1. INTRODUCTION

The importance of the forest and wood sector in the national economy of Poland is much greater than the average in the European Union. However, the social awareness of this fact is relatively small. The sector based on wood occupies the first place in Poland in terms of the registered number of economic entities, the second place in terms of the number of employees and the third place in terms of the value of sold production. At the same time, Poland is one of the leading European exporters of wood products (fourth place). This sector shows a positive balance of trade in wood products, alleviating the deficit of other sectors in foreign trade. It is advantageous that the majority of exports goes to the demanding EU markets (GUS, 2018). This proves a relatively high competitiveness of Polish wood products.

In the value chain created by the wood processing industry, the sawmill industry plays the role of the initiator of development (of course based on forest resources). In Poland it is strongly territorially dispersed. It is also difficult to determine the number of actually operating companies, especially small and very small ones. These are often family companies, of a service nature, sometimes operating only periodically. According to the REGON [Business ID] system, there are about 9,000 economic entities operating in the sawmill industry. In relation to the entities operating in the Polish industry in general, sawmill companies account for 2.5%. Not all of them are exclusively sawmills. Apart from sawn timber, these companies produce construction elements, flooring materials, panelling, wood packaging, pallets and others. More than 90% of sawmill companies employ less than 10 people. Such a size structure influences the specific approach to management in this industry. At the same time, however, the sold production of the sawmill industry constitutes 0.7% of the volume generated by the processing industries and 9.7% of the sold production of the woodworking industry together with the furniture industry. After a period of economic downturn in 2008-2012, the situation in the sawmill industry was improving and the industry was developing dynamically. According to data from the Central Statistical Office (GUS, 2018), in 2017 the sawmill industry achieved a high growth rate of sold production, one of the highest among all woodworking industries.

Polish sawmill industry, although it belongs to industries with significant potential, unfortunately it is characterized by relatively low work efficiency. It is both an effect of the specificity of production processes in this industry and low added value (reflected in prices of sawmill products), as well as insufficient mechanisation of works. One of the priorities for the development of the Polish sawmill industry is therefore the systematic improvement of low labour productivity (Aniszewska et al., 2018; Czemko et al., 2017). Only these arguments speak in favour of identifying the development potential of the sawmill sector in Poland on a regional basis. One of the priorities of the Polish development policy, including regional policy, is to identify the specialisation of the regions (Chudobiecki et al., 2016; Paluš et al., 2018; Wanat et al., 2018b). This enables accurate and effective management of streams of funds supporting entrepreneurship and European Union funds in order to ensure integral development of regions, taking into account the specificity of each of them.

2. PURPOSE OF THE RESEARCH, MATERIAL AND METHODS

The aim of the study was to investigate the regional differentiation of the development potential of sawmill industry in Poland according to the administrative structure of voivodships (corresponding to the classification of regions). A controversial hypothesis was adopted for verification, which assumes that the regional development potential of the sawmill industry in Poland is relatively similar, and that there are small disproportions between regions in this respect.

Within the scope of the survey, enterprises classified in the Polish Classification of Activities (PKD 2007), section 16: "Manufacture of wood and cork products, except furniture; manufacture of products from straw and plaiting materials" are included. As of 30 June 2019, the population (and sample) selected for analysis comprised 331 economic entities. Targeted selection of companies was made: first according to the substantive criterion (predominance of sawmill production), and then according to the amount of annual sales revenues (at least EURO 20,000 per year). In terms of subject matter, the regional development potential of sawmill industry enterprises was examined, referring in spatial terms to the structure of 16 Polish voivodships. The temporal scope of the research covered the year 2018 (in terms of data on sawmill industry companies) and additionally 2017 (in terms of general industry data of Polish public statistics (GUS 2018)). The research scenario was based on both qualitative analysis (according to substantive criteria), followed by a quantitative approach and a method of variable standardisation (unitarization).

To measure the potential of the sawmill industry in Poland, the method of linear TOPSIS was used (Technique for Order Preference by Similarity to an Ideal Solution) (Hwang and Yoon, 1981). It is based on the calculation of Euclidean distances between individual objects and a predetermined pattern and anti-pattern. In this way, a synthetic measure determining the potential of individual voivodeships can be determined (Wysocki 2010, Łuczak 2016). The research (research scenario of quantitative analyses) was carried out in the following steps:

1. on the basis of substantive and statistical analysis, the features describing the studied phenomenon were selected
2. the values of the features were normalized using the zero uniformization method (formula 1):
   a. For the stymulant: $z_{ij}=\frac{x_{ij}-\min_i\{x_{ij}\}}{\max_i\{x_{ij}\}-\min_i\{x_{ij}\}}$ (1a)
   b. For the destimulant: $z_{ij}=\frac{\max_i\{x_{ij}\}-x_{ij}}{\max_i\{x_{ij}\}-\min_i\{x_{ij}\}}$ (1b)

Description:
z_{ij} – normalized value of the j-th characteristic for the i-th object;
x_{ij} – value of the j-th attribute for the i-th object.

3. Determination of pattern and anti-pattern:
   a. For the stimulant: $A^{+}=(1,\dots 1,)$
   b. For the destimulant: $A^{-}=(0,\dots\ 0)$
4. Calculation of the Euclidean distances from the standard pattern and anti pattern (formula 2):
   a. For the stimulant: $d_i^{+}=\sqrt{\sum_{j=1}^{m}(z_{ij}-A^{+})^2}$ (2a)
   b. For the destimulant: $d_i^{-}=\sqrt{\sum_{j=1}^{m}(z_{ij}-A^{-})^2}$ (2b)

Description:
d_i^+ – euclidean distance from the standard pattern
d_i^- – euclidean distance from the anti-pattern
z_{ij} – value of the k-th characteristic for the i-th object

5. Application of the value of the synthetic characteristic (formula 3): $S_i = \frac{d_i^-}{d_i^+ + d_i^-}$. (3)

Description:
d_i^+ – euclidean distance from the standard pattern
d_i^- – euclidean distance from the anti-pattern

For the purposes of this analysis, the values of the synthetic indicator were grouped into 4 classes: 1) high development level: $S_i \geq \bar{S} + SD$ (class I); 2) upper-medium development level (class II): $\bar{S} \leq S_i < \bar{S}$ +SD; 3) lower-medium development level: $\bar{S} - SD \leq S_i < \bar{S}$ (class III) and 4) low development level: $S_i < \bar{S}$-SD. S_i (class IV) designates the value of the synthetic characteristic for object i; $\bar{S}$ is the mean value of the synthetic characteristic and SD is the standard deviation.

3. RESULTS

In order to identify the development potential of the sawmill industry in Poland in a regional perspective, the factors (measures) characterising the industry were selected from a macroeconomic perspective (use of forests in the economy), mesoeconomic perspective (participation of enterprises in the industry and use of sawn timber in the production process) and microeconomic perspective (sales revenues of the surveyed enterprises and profit per one employee) (Wanat et al. 2018a, 2018b).

The potential of sawmill industry, aggregating data for enterprises located in particular voivodships of Poland, was determined on the basis of 6 purposefully selected quantitative measures (M1, …, M6):

M1: Annual sales revenues in enterprises (in thousands of EUROS);
M2: Annual profit per employee in the company (in thousands of EUROS);
M3: Number of companies in the industry (% rate of change [increase or decrease] over a decade, in absolute numbers, 2008-2018);
M4: Total investment outlays in the sector (forest- and wood based sector) in thousands EUROS (2017));
M5: Harvesting of timber (per year) per 100 ha of forest area in m^3 in 2017;
M6: Sawnwood consumption (per year) in dam^3- cubic decameters in 2017.

The selection of factors was of a substantive nature. The characteristics representing various economic categories with potentially weak correlation were selected. The analyses included figures in Polish zloty, converted into euro according to the average exchange rate of 1 EURO=3.40 PLN as of 31.12.2018 of the National Bank of Poland. All characteristics tested are stimulants. Their values are presented in Table 1. In order to perform statistical verification of the correctness of the selection of variables, their correlation coefficients were determined. The results are presented in Table 2.

In general, most of the variables did not turn out to be strongly correlated, which confirms the overall correctness of the selection of variables. The exception is a relatively high correlation between sales revenues (in thousands of EUROS) and the consumption of sawn timber. This correlation is well founded, but both values, despite the correlation, inform about the potential of the industry in different ways: from the production and resource (supply) perspective – the measure of sawn timber consumption and from the demand perspective, and from the consumers' perspective – the measure of sales. Therefore, despite one case of statistically unfavourable correlation, the proposed factors were left as components of the synthetic measure.In order to examine the potential of the sawmill sector, normalization of variables was carried out using the zero uniformization method.

Table 1. Selected aggregated measures of the sawmill industry potential in Poland (2017-2018)

Voivodship (Region)	Revenues from sales [in thousands of EUROS]	Profit per employee [in thousands of EUROS]	Number of companies in the sawmill industry during the last 10 years [% rate of change in absolute numbers]	Investment outlays overall in forestry [in thousands of EUROS]	Logging per 100 ha of forest area [m^3]	Sawnwood consumption [dam^3]
Dolnośląskie	34 234	5	0,78	17484,0	558,1	282,0
Kujawsko-Pomorskie	143 686	7	0,25	7607,2	600,5	341,3
Lubelskie	60 337	10	1,00	9012,6	329,1	186,7
Lubelskie	44 035	1	0,17	14180,2	503,9	616,0
Łódzkie	70 500	4	0,27	9177,0	335,8	190,4
Małopolskie	100 812	6	0,47	8060,5	309,5	882,7
Mazowieckie	151 148	4	0,59	14415,6	287,8	415,2
Opolskie	28 349	8	0,20	3737,0	561,1	99,0
Podkarpackie	86 136	5	0,40	12524,7	381,2	312,4
Podlaskie	74 084	10	0,08	8680,5	351,5	285,7
Pomorskie	218 032	4	0,40	16853,7	726,2	432,3
Śląskie	137 146	6	0,31	8718,4	471,8	346,3
Świętokrzyskie	54 158	5	0,33	7650,9	404,1	270,4
Warmińsko-Mazurskie	84 400	13	0,13	9474,9	494,8	651,6
Wielkopolskie	437 277	6	0,53	15068,4	491,9	1427,6
Zachodniopomorskie	271 304	7	0,31	17131,2	564,7	1071,7

Source: Own elaboration based on financial data of sawmill industry enterprises in Poland (financial reports, Court Monitor B, Central Statistical Office).

Table 2. Correlation coefficients for selected features characterizing the potential of the sawmill industry in Poland

Correlation coefficients	M1	M2	M3	M4	M5	M6
M1	1,00					
M2	-0,10	1,00				
M3	0,08	-0,07	1,00			
M4	0,48	-0,43	0,31	1,00		
M5	0,28	-0,11	-0,22	0,32	1,00	
M6	0,80	-0,02	-0,02	0,45	0,12	1,00

Source: Own calculations using Statistica

Then the following were determined: Euclidean distances and synthetic measure values, corresponding to the ranking position of the region according to the strength of the development potential of the sawmill industry in individual voivodships in Poland (Table 3).

Table 3. Euclidean distances, the value of synthetic measure in the ranking

Voivodeship (Region)	d_i^+	d_i^-	S_i	Ranking position	Class division
Dolnośląskie	1,53	1,58	0,51	4	II
Kujawsko-Pomorskie	1,63	0,98	0,38	7	III
Lubelskie	1,83	0,94	0,34	11	III
Lubuskie	1,84	0,99	0,35	9	III
Łódzkie	1,98	0,57	0,22	16	IV
Małopolskie	1,65	0,99	0,38	8	III
Mazowieckie	1,68	1,15	0,41	6	II
Opolskie	2,00	0,86	0,30	14	III
Podkarpackie	1,72	0,90	0,34	10	III
Podlaskie	1,93	0,87	0,31	13	III
Pomorskie	1,34	1,56	0,54	3	I
Śląskie	1,66	0,82	0,33	12	III
Świętokrzyskie	1,90	0,61	0,24	15	IV
Warmińsko-Mazurskie	1,61	1,26	0,44	5	II
Wielkopolskie	0,91	1,86	0,67	1	I
Zachodniopomorskie	1,05	1,61	0,61	2	I

Source: Own calculations based on the formula 2(a, b) and 3.

On the basis of the arithmetic mean value and standard deviation, classes were determined, corresponding to four categories of development capacity of the examined industry in the region. The limit ranges were determined accordingly:

- high development level: $1 \geq S_i > 0{,}52$; (class I);
- upper-medium development level: $0{,}52 \geq S_i > 0{,}40$; (class II);
- lower-medium development level: $0{,}40 \geq S_i > 0{,}28$ (class III);
- low development level: $0{,}28 \geq S_i > 0$; (class IV).

4. CONCLUSIONS

The following conclusions have been drawn from the qualitative verification of the development factors selected by the industry, the use of the quantitative method and the TOPSIS synthetic measure, and the comparative and descriptive analysis:

1) The largest development potential of the sawmill industry in Poland was identified in north-western voivodships (strong regions).

2) The difference in synthetic measure between the leader of the ranking (Wielkopolska region) and outside (Jydzkie region) was 0.45 (0.67-0.22). This proves that the development potential of the sawmill industry in Poland is regionally diversified. This conclusion is the basis for rejecting the main hypothesis assumed at the outset. However, it is not possible to conclude on this basis on the regional degree of diversification of development potential.

3) It was found that there is no clear leader in the ranking for the sawmill industry. The leader is a group of regions, the best of which achieved a synthetic measure of 0.67, in the range from 0 to 1.

4) It was noted that the synthetic measure of development indicators for two regions are outliers: Њwiкtokrzyskie (0.24) and Jydzkie (0.22).

In conclusion, the correlations shown may constitute recommendations for regional development policy in the forest and wood sector in Poland, indicating regions with strong industry specialisation, which support may result in maintaining the dynamics of economic growth. At the same time, it allows to search for directions of specialisation of the wood processing industry in regions where the competitive potential of the sawmill industry is weaker. When programming the development of the industry it is worth to refer not so much to the principle of sustainable development in the regions, but rather to the concept of integral development, taking into account economic, social and specialisation diversity in the territorial dimension.

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ASSESSMENT OF TECHNOLOGY, TECHNOLOGICAL RESOURCES AND QUALITY IN THE MANUFACTURING OF TIMBER PRODUCTS

Krzysztof Knop, Robert Ulewicz

Abstract: The article presents the results in the field of assessment of technologies and technological resource used in the production of wooden products in analysed sawmill industry enterprise to improve quality of the products. A matrix of strategic technology areas – STO matrix was used to evaluate the technologies used. ABC technology method and 5 grade Parker scales were used to assess critical machine for the production process – four-side planer. It has been shown that the technologies used in the production of the tested product – pine wood coffin – can be assessed on an average level – rating "2" on a scale of 0-3 according to the STO matrix, while machine critical for the production process that was assessed as made of the use of mostly the well-known technology, requiring, however, having the appropriate technical knowledge – a rating of "3" on a scale of 1-5 according to the 5 grade Parker scales. The high impact of technologies and technological resources used on the quality of manufactured products was pointed out. Actions to be taken in the context of technology and technological resources have been identified to increase the quality of manufactured products. Utilitarian value of the research are recommendations for executives pointing the way to improve products quality by the area of "technology" and "plant and machinery".
Keywords: technology, technological resources, STO matrix, ABC technology method, improvement

1. INTRODUCTION

Products often require the use of a number of technologies to manufacture them. Proper selection of technologies for the production of the product and their proper use has a huge impact on the product's properties and its final quality [8]. Technology is a set of elements of practical and theoretical knowledge, the ability to apply it (know-how), methods, procedures and physical devices that use this knowledge. A large set of elements creates technology [10]. Technology is identified with the knowledge necessary to produce a specific product, with the method of preparing and conducting the process of production or processing of some good or information, with a specific process (e.g. adhesive technology), with the process of processing, with a sequence of production activities for the production of a given product, with equipment, apparatus, with a collection of installations, machines, tools, methods, able to realize production tasks in a specific time [10,11, 12, 13].

Skillful use of the available technologies by the enterprise (both inside and outside) affects the achievement of competitive advantage [4]. The attractiveness of a given technology for an enterprise can be considered, among others from the point of view of reducing costs, increasing productivity, flexibility, quality, creating unique product features. The attractiveness of technology is one of the elements taken into account in the assessment (audit) of technology. The purpose of the technology assessment is first of all to describe and verify the technologies used, identify their strengths and weaknesses, determine how to increase the competitive advantage of the company through better use, including the indication of available technologies that the company could incorporate into improving its products and processes together with determining the effects of introducing these technologies, including their impact on added value [1]. Such an assessment can significantly help to reveal technological opportunities within or outside the company [4]. Based on the results of the evaluation technology company can make different decisions, e.g. to invest in technologies implemented with a medium or high mastery and eliminate the technology used, which are the "bottleneck" in the process [14].

Technological resources are a term associated with technology. Technological resources are all material means (including machinery and equipment) and intangible assets (including knowledge and information) collected by the company in order to implement the production process and its service. They are a key component of the production system, which mainly determine the production capabilities and the competitiveness of the company on the market. The quality of the offered products depends on the available technological resources of the company and the way they are used [6]. Available technological resources determine the type of production in the company and create its level of development. On the other hand, the type of production planned in the enterprise forces investments in specific technological resources [2, 3].

The aim of the article is to present the results in the assessment of technologies and technological resources used in the production of wooden products – pine wood coffins in the sawmill industry and suggestions for improvement in these areas based on the results obtained.

2. RESEARCH METHODOLOGY

The studied enterprise is the Wood Production Department, which is a part of a transport company providing logistics services in Poland and throughout Europe. This plant produces coffins of various designs and sizes. The main recipient of the plant's products is Germany. The company offers about 40 patterns of pine coffins in its offer, it also makes models at the recipient's request. The company's clients are production plants dealing in the production of coffins (finishing) and funeral plants. This department is a dynamically and dynamically developing company with 18 years of experience on the market.

The matrix of strategic areas of technology – the STO matrix – was used to evaluate the applied technologies in the studied company. Technology assessment according to this method consisted of two stages: in the first one the technologies (technological processes and others) used in the company in the production of the tested product were reviewed, in the second one the technologies were compared with those used by the market leader. The level of applied technologies was evaluated using a 4-point scale, where: 0 – unused technology, 1 – delayed technology, 2 – average technology, 3 – leading technology [5, 7]. Technology assessments using the STO matrix were made for the product – a wooden coffin made of pine wood.

In order to assess technological resources, the technology ABC method was used [7]. It is a method that allows to assess the level of modernity of parts and subassemblies of machines and devices. Its essence consists in the categorization of individual elements of a given machine [16]. Parts and subassemblies are divided into three categories: A – basic parts/subassemblies (fundamental parts and subassemblies of the machine guaranteeing the product special attributes), B – support parts/subassemblies (of a general nature), C – side parts/subassemblies (they are not subject to the user's innovative activity, they are not significant during purchasing new one machines). The evaluation of levels of modernity is carried out with the help of the five-point Parker scale, where [2, 3, 7]: level 1 – means simple components; they can be made by means of craft techniques, e.g. machine foundations; level 2 – means components that have been manufactured using technologies known and unchanged for many years, e.g. standard engine cooling system; level 3 – means components made using a controlled technology that requires, however, having technical knowledge, e.g. a standard electric motor; level 4 – means components manufactured using modern market technologies, e.g. displaying the diagnosis on the computer of the control panel; level 5 – means components that are the result of the most modern technologies, patented and occurring only in a given machine. As a result of applying such categorization, the modernity of the examined machine can be ranked in terms of purposefulness of development and investment [15]. The analysis also allows you to decide which parts and subassemblies should be upgraded, replaced and which are not [16].

The Weinig UNIMAT 22N planer from 1980 was chosen for the ABC method assessment due to the fact that it is a machine that is particularly important for the proper functioning of the technological process and for the quality of the final product tested – a wooden coffin made of pine wood. Four-side planer is a machine designed for planing boards, logs, strips simultaneously from 4 sides. The machine aims to give the elements the exact dimensions of the cross-section.

3. RESULTS

3.1. Results of the evaluation of technologies used – STO matrix

The analysis and evaluation of the technology used by the company being researched in the production of the product was made in confrontation with the same product and technologies, but the market leader in the production of coffins – a competitive company. In a competitive company, the traditions of working with wood reach back to the 1940s. As the Wood Industry Plant has been operating since 1991. For over 20 years, it has grown into the largest producer of coffins in Poland and one of the largest in Europe. The company has the most modern machinery park in Europe; is a reference company for world leaders in machine manufacturers such as: Weinig, Wood-Mizer, Homag or MBM. Machine manufacturers improve and modernize their technologies here. Many machine park elements are prototype devices that have been designed specifically for the reference company. The result of these activities is a product that is almost perfect.

Applied technologies (technological and control processes) in relation to the tested product, which have been evaluated (in the order of their occurrence): 1. Cutting blocks with the help of a power saw, 2. Cutting with saw blades, 3. Cutting with sawmills, 4. Drying wood in a steam dryer, 5. Selective control of dried pine wood with a hygrometer, 6. Humidity control in computer controlled dryers, 7. Treatment of pine wood (boards) on multi-plywoods, 8. Processing the edges of the boards on the planer, 9. Transport of elements (automatic), 10. Gluing table tops on a windmill press, 11. Gluing tops on the gluing line, 12. Removing knots from worktops with a single-spindle knotter, 13. Removal of knots on multi-spindle devices, 14. Milling, 15. Gluing the slats together with the bottom top (ground floor of the coffin) – by hand, 16. Automatic assembly of slats, 17. Cutting on a format saw for longitudinal and transverse cuts, 18. Cutting out from the length of the tops on a miter pile, 19. Assembly, stitching of the made boards forming the lid by corrugated nails – manual assembly, 20. Manual assembly of the ground floor of the coffin using corrugated nails by the use of connectors of joint type, 21. Assembly press for coffins, 22. Lapping the manufactured product with an oscillating grinder (manual), 23. Execution of the finishing strip on the transverse saw, 24. Folding the frame on the assembly table – manually, 25. Automatic mounting of the frame on the assembly line, 26. Installation of the finishing strip after putting the lid on the ground floor of the coffin (manually), 27. Painting the product using pistols.

The graphs depicting the degree of technological advancement in the production of a pine casket in the 0-3 scale for the examined Wood Production Department (Fig. 1) and a competitive company that is a leader in the production of coffins are presented (Fig. 2).

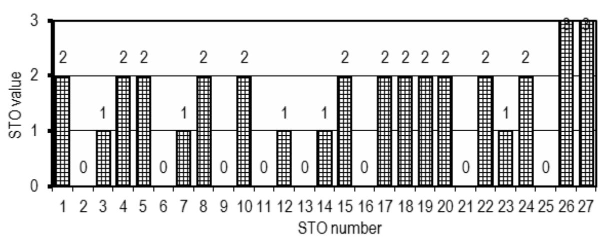

Figure 1. Graph of strategic technology areas for the Wood Production Department

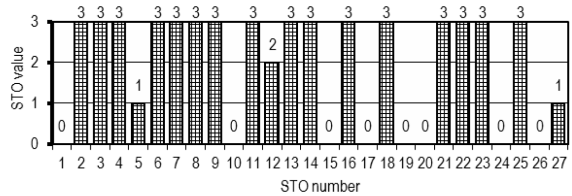

Figure 2. Graph of strategic technology areas for the competitive company

Analyzing the assessments contained in Figures 1 and 2, it should be stated that a competitive company is characterized by a much higher level of technological advancement than the surveyed Wood Production Department, as evidenced by its 3 grades (leading technology). Many of the advanced solutions used in the reference company do not take place in the Wood Production Department. These are, among others: dryers in which the humidity of the wood is assessed by computer, automatic transport (on feeders), gluing on lines for gluing, automatic assembly lines of decorative strips, assembly lines of coffin bodies, automatic assembly of the frame on the assembly line. There are also technologies that are used by the Wood Production Department and not by the reference company, but these are mostly backward technologies, in place of which the reference company uses more advanced technologies, as well as the assembly of bodies and finishing strips, which operations in the Wood Production Department are not automated.

The general level of technology of the Wood Production Department can be assessed at level 2. This means that the portfolio of technologies used in the studied department is on an average level. The company also uses technologies that are considered to be delayed, as evidenced by the assessment 1.

3.2. The results of the assessment of the technological resources used – the ABC method of technology

Table 1 presents the results of the assessment of the level of modernity of an important machine for the production process of the wooden coffin – four-side planer Weinig UNIMAT 22N.

Table 1. Evaluation of the level of modernity of a parts/ sub-assemblies of the four-side planing machine

Category	No	Parts / sub-assemblies of the machine	The level of modernity
A	A1	Feed mechanism	3
	A2	Upper and lower horizontal spindles	3
	A3	Vertical pressure device (pneumatic)	2
	A4	Horizontal pressure device (pneumatic)	3
	A5	Universal spindle	3
	A6	Spindle motor	3
B	B1	Bed (table)	3
	B2	4-knife head	3
	B3	Front guide bar	3
	B4	Rear guide bar	2
	B5	Brake	3
	B6	Sledges of feed rollers	2
C	C1	Nuts for regulating the pressure force of the feed rollers	3
	C2	Spring of the pressure bar	2
	C3	Knobs regulating the spacing of feed rollers	3
	C4	Spindle pull screws	3
	C5	Lubrication system	3
	C6	Housing cover	2

The assessment of the modernity level of the tested machine is mostly at level 3 (13 out of 18 analyzed parts), secondly on level 2 (5 parts). The share of machine parts in individual categories A, B and C is as follows:

- category A: 83.33% of the part is at level 3, 16.67% at level 2,
- category B: 66.67% of the part is at level 3, 33.33% at level 2,
- category C: 66.67% of the part is at level 3, 33.33% at level 2.

All 18 parts of the four-side planing machine are on level 2 or 3. 13 parts are on level 3, so 72.22% of the total, while 5 parts are on level 2, so 27.78% of the total. Evaluation of parts in individual categories, but above all, a high share of 3 and 2 grades for parts in category "A", i.e. in the basic category, testifies to its low level of modernity of the machine. The tested machine should be classified as level 3. This means that it has been made using a mastered technology but requiring the possession of appropriate technical knowledge.

4. CONCLUSIONS

A very important aspect in the production of wood products is the appropriate selection of technologies, and their proper use and maintenance, which in addition to the employee's qualifications and involvement in the production process is an important factor determining the quality of the manufactured product and affecting the competitive position of the company on the market.

The surveyed entity was a sawmill industry company – the Wood Production Department. The subject of the research were technologies and technological resources used in the production of the product – pine coffins. The aim of the research was to evaluate the above mentioned elements for the purpose of improving quality of the process and product.

The evaluation of technology with the use of STO matrix showed that the majority of technologies used in the Wood Production Department in comparison with the competition and market trends are at the average level. The examined Wood Production Department should modernize its machinery so that the production process runs more efficiently and the products do not differ quality from those produced by competitive companies. In order to assess technological resources, the ABC technology method was used, which allowed to evaluate the parts and subassemblies of one of the critical machines for the production process and to classify this machine to one of the five levels of modernity. The machine under research – a four-sided planer has been classified on the 3rd level of modernity, which means that it was made with the use of a mastered technology requiring, however, appropriate technical knowledge. Condition, age of the machine and the level of modernity affect the quality of its work, which leaves much to be desired.

Due to the fact that planing technology used by the Department is average and the technological resource utilized – a four-sided planer is not modern, the enterprise should seriously think about buying a new machine, more modern, guaranteeing higher product quality in particular higher aesthetic values of the product. The purchase of a new planer will also increase production efficiency, which in turn will increase the speed of order fulfillment. An important aspect that the company should not be overlooked is caring for the proper technical condition of the machines, including new ones, which is the responsibility of the maintenance services and is (should also be) part of the responsibility of production workers – operators. A machine that is properly maintained, lubricated, inspected and cleaned should work without failure for a long time and should pay for itself with the quality and culture of its work.

Level of technology and modernity of machine parts and sub-assemblies has a significant impact on the properties and quality of the products obtained as well as the parameters of the process itself (e.g. efficiency). It should be remembered, however, that a modern machine does not guarantee the highest quality of the product at once. Modern technologies only properly maintained (see: TPM – total productive maintenance [9]) contribute to the improvement of the quality of manufactured products.

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THE PRODUCTION POTENTIAL OF THE PULP AND PAPER INDUSTRY – THE CASE OF POLAND

Emilia Grzegorzewska, Renata Stasiak-Betlejewska

Abstract: A wood is an important raw material used for the production of the Polish industry, in particular: the wood, the pulp and paper and the furniture industry. The paper shows the comparative analyses related to the production potential of the pulp and paper industry and manufacturing in Poland. The time range of the studies was adopted for the years 2006-2016. Primary source of the research material includes reports published by the Central Statistical Office in Poland (Statistical Yearbook of Industry, Production of major industrial products, Structural changes of groups of the national economy entities in the REGON register). In order to explore the production potential of the pulp and paper industry some economic production indicators have been selected such as: the production output, the gross value added, the number of entities, the average level of employment or the productivity growth measured by the production output per 1 employee. The production potential of the Polish pulp and paper industry is determined also by available assets. Therefore trends in gross value of fixed assets have been shown in the paper. Moreover, the manuscript presents development of the production volume of the pulp and paper industry major products.
Keywords: production potential, economic indicators, pulp and paper industry

1. INTRODUCTION

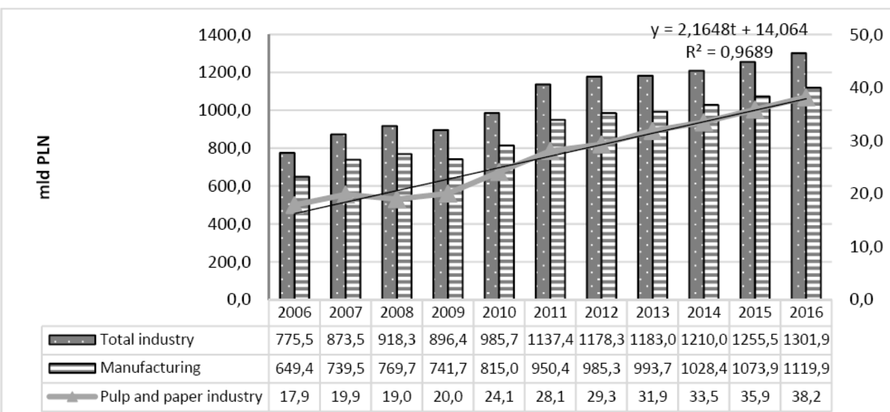
As compared to other European countries, Poland has relatively large timber resources, and the country's forest coverage amounts to 30.8% [Forestry 2017]. Thus, it is an autonomous country in terms of resources of this raw material to a great extent [Ratajczak et. al. 2018]. Nevertheless, the good economic condition of the country and specific branches of the timber sector along with the competition for timber raw material in the past years from the energy sector led to a shortage of wood [Grzegorzewska, Stasiak-Betlejewska 2018]. Since wood constitutes the rudimentary production raw material for three industries: timber, furniture, and pulp and paper. Consistent with the statistical data, in 2016 paper usage per capita was at the level of 134.3 kg. Poland, approaching the European average in this area, managed to overtake many countries (among others, the Czech Republic, France, Spain, Great Britain) [Szymczyk 2018]. The upward demand for the pulp and paper industry products, both in relation to the domestic consumers and foreign buyers, means that companies in this industry have to face challenges relating to the development of production potential.

2. RESEARCH METODOLOGY

The determination of the potential of productive development of the pulp and paper industry was the main objective of the research. A comparative analysis of this industry was implemented in relation to the manufacturing industry and industry in general. According to the methodology of the Central Statistical Office (CSO), the "General industry" was differentiated within the PKD 2007, which in addition to Section C (Production – sections 10-33), which includes the pulp and paper industry, consists of: section B (Mining and extraction – sections 05-09), section D (Production and electricity, gas, steam, supply of hot water and air conditioning – chapter 35) and section E (water supply, sewage and waste management, and remediation activities – sections 36- 39). The time range of the research covered the years 2006-2016, because the comprehensive and reliable statistical data has been obtained for this time period. The main source of the research material covers reports published by the Central Statistical Office in Poland (Statistical Yearbook of Industry, Production of major industrial products, Structural variations of groups of the national economy entities in the REGON register). The research analysis used the following indicators: sold production, average annual employment level, productivity growth measured by the value of production per 1 employee. Due to the fact that a machine park is one of the resources of the production process, the analysis also included the gross value of fixed assets along with dynamic changes. What is more, the article illustrates tendencies of changes in the production volume of the most vital products of the pulp and paper industry.

3. RESULTS

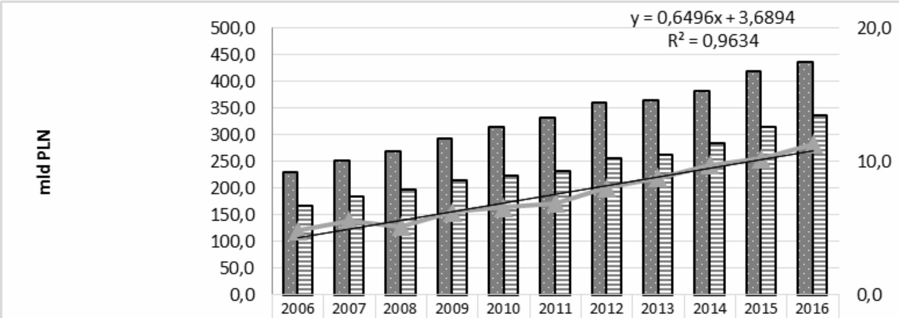
In accordance to research performed by the Central Statistical Office, it can be seen that the sold production of pulp and paper industry amounted to PLN 17.9 billion in 2006, zwhich constituted approx. 2.3% of sold industrial production in total and approx. 2.8% of industrial processing (Figure 1). Sold production of the manufacturing industry grew every year in the analysed period (except for 2009). In 2016, it amounted to PLN 1119.9 billion and was 72.5% higher than 10 years earlier. In contrast, the sold production of the pulp and paper industry augmented more than twice in the analysed period and in 2016 it reached the level of PLN 38.2 billion. Still, it should be noted that there was a decrease in the value of sold production by 4.5% in 2008. In turn, the highest growth rate in this area was observed in 2010 and it amounted to 20.2%. The value of sold production of industrial enterprises was higher by 67% in 2016 compared to the base year and reached the level of PLN 1301.9 billion. The analyses presented above exemplify that the growth rate of sold production of the pulp and paper industry was evidently higher than in the case of industrial processing and industry in general.



	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Total industry	775,5	873,5	918,3	896,4	985,7	1137,4	1178,3	1183,0	1210,0	1255,5	1301,9
Manufacturing	649,4	739,5	769,7	741,7	815,0	950,4	985,3	993,7	1028,4	1073,9	1119,9
Pulp and paper industry	17,9	19,9	19,0	20,0	24,1	28,1	29,3	31,9	33,5	35,9	38,2

Figure 1. Sold production of the pulp and paper industry in terms of industrial processing and industry in general in 2006-2016 [PLN billion]
Source: own study based on the Statistical Industry Yearbook for 2007-2017, CSO.

The analysis of gross added value also provided significant information about the manufacturing potential, which is part of the global production generated in the industry, that is left after the deduction of intermediate consumption. The gross added value achieved by industrial enterprises in the studied period improved by 90.4% from the level of PLN 229.4 to 436.8 billion (Figure 2). In terms of the processing industry, the growth was somewhat higher (100.1%). However, enterprises dealing in the production and paper and paper products improved the ability to generate gross added value to the greatest extent. Its level increased from PLN 4.8 to 11.3 billion in the studied period.



	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Total industry	229,4	251,1	268,6	293,7	316,2	332,5	361,3	366,1	381,5	419,6	436,8
Manufacturing	167,9	185,5	197,3	215,1	224,8	233,6	257,1	263,5	284,0	314,2	336,0
Pulp and paper industry	4,8	5,6	5,2	6,2	6,6	6,9	8,0	8,8	9,8	10,2	11,3

Figure 2. Gross added value of the pulp and paper industry in the years 2006-2016 [PLN billion]
Source: own study based on the Statistical Industry Yearbook for the years 2007-2017, CSO.

The number of enterprises conducting production activity, as well as the number of employees also prove the production potential of enterprises. In 2006-2016, the average employment level in the industry enlarged by 3.9% from 2673.6 to 2777.9 thousand people (table 1). The main growth took place in 2007 and amounted to 4.7%, respectively. In contrast, in the pulp and paper industry, an average of 45.2 thousand people were employed, which accounted for 2.0% of people employed in manufacturing and 1.7% employees in industrial enterprises in general. In 2006-2016, the average employment in the pulp and paper industry improved by nearly 25% and reached the level of 56.1 thousand people, which led to the increase of the percentage of employees in this industry to 2.3 and 2.0%, respectively, in relation to industrial processing and industry in general.Labour productivity is another factor that has been analysed in the evaluation process of the development of the manufacturing timbre industry. This indicator is measured by sold production per 1 employee in the studies performed by the CSO. The dynamics of labour productivity in the pulp and paper industry was positive in 2006-2016, except for 2008 (table 1). The key growth in labour productivity in this industry was observed in 2011 and it amounted to 14.7%, respectively. In turn, a positive dynamics of labour productivity was recorded in the manufacturing industry and industry in general every year, as measured with the sold production value per 1 employee. The best result was achieved by industrial processing companies in 2006 and 2010. The dynamics of production efficiency per employee amounted to 110.0% and 111.4%, respectively. Industrial enterprises in general typically exhibited somewhat lesser efficiency. Again, the main value of this indicator has been observed in these periods (respectively, 109.2% and 110.1%). However, it should be noted that enterprises that produce paper and paper products have achieved higher dynamics of labour productivity calculated as the ratio of sold production value to the number of employees since 2012. It is worth emphasizing that a noteworthy rise in the average employment level was related with a substantial increase in the number of enterprises that manufacture paper and paper products. The number of business entities in the pulp and paper industry improved by more than half in the period covered by the study, whereas the number of industrial enterprises grew by 14%. There were over 5.7 thousand enterprises of the pulp and paper industry registered in REGON in 2016.

Table 1. Number of enterprises, average employment and dynamics of labour productivity in the pulp and paper industry in terms of the industrial processing and industry in total in 2006-2016 [PLN billion]

Itemisation	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
The number of entities [thousand]											
Total	3613.6	3685.6	3757.1	3742.7	3909.8	3869.9	3975.3	4070.3	4119.7	4184.4	4144.6
Manufacturing	3748.8	3750.2	3719.3	3436.2	3600.9	3540.5	3614.9	3670.1	3717.6	3752.7	3731.1
Pulp and paper industry	3.7	3.7	3.7	4.3	5.1	5.2	5.4	5.6	5.7	5.6	5.7
The average employment [thousand]											
Industry	2673.6	2798.3	2890.7	2725.4	2696.1	2714.2	2674.2	2627.2	2676.5	2705.6	2777.9
Manufacturing	2225.0	2350.8	2431.0	2261.7	2229.8	2251.2	2217.7	2186.6	2248.4	2294.9	2377.8
Pulp and paper industry	45.2	47.6	48.9	49.5	51.0	52.9	52.1	53.0	54.3	54.9	56.1
The dynamics of the labour productivity measured by output per 1 employee [%]											
Industry	109.2	106.2	100.3	101.3	110.1	106.9	101.9	103.8	101.9	104.8	100.9
Manufacturing	110.0	106.9	100.5	103.3	111.4	107.8	102.1	103.4	102.6	104.8	100.4
Pulp and paper industry	103.4	104.6	93.5	104.4	114.7	102.5	104.7	106.3	102.2	105.1	101.7

Source: own study based on Statistical Yearbook of the Industry for the years 2006-2015, the Central Statistical Office of Poland.

The availability of fixed assets, which are necessary for the implementation of production activities, also demonstrates the production potential of enterprises. The fixed assets in enterprises consist of buildings and structures, machines, equipment and means of transport. In general, the higher value of fixed assets contributes to a fairly high manufacturing capacity of a given enterprise.

In accordance with the CSO research, the value of these fixed assets in the industry amounted to PLN 572.1 billion in 2006 (Figure 3). At the end of the studied period, this indicator was more than twice as high and amounted to PLN 1190.9 billion. It was also possible to observe positive tendencies in this area in the processing industry. The gross value of fixed assets improved by 109.3% from PLN 313.7 to PLN 656.6 billion. An even greater increase in these fixed assets was noted in the pulp and paper industry – in 2016, their value was higher by 131.6% and amounted to PLN 31.5 billion.

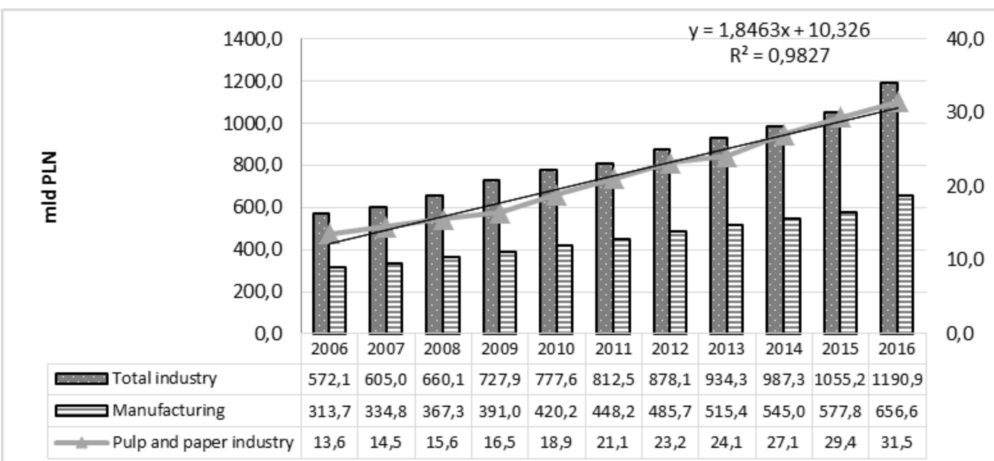


Figure 3. Value of the fixed assets of the pulp and paper industry in the years 2006-2016 [PLN billion]
Source: own study based on Statistical Yearbook of the Industry for the years 2006-2015, the Central Statistical Office of Poland.

The scale of production, i.e. the volume of manufactured products of the pulp and paper industry, also proves the development of the production potential. Table 2 demonstrates tendencies in changes in the manufacture of the key products of this industry. A double upsurge in the production scale was observed for cardboard, cartons and boxes as well as corrugated board in 2006-2016. At the end of the analysed period, 2039.5 and 2516.1 thousands of tons of these products were manufactured. A clear growth dynamics (162.5%) was also distinguished for paper and cardboard. The production volume of wooden soda or sulphate pulp, as well as the wooden mechanical and semi-chemical pulp, was unquestionably slower.

Table 2. Production of the pulp and paper industry major products in the period 2006-2016 [thousand tons]

Specification	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Soda or sulphate chemical woodpulp other than for dissolving grades	824.6	813.8	819.9	826.3	881.0	894.3	847.6	881.3	880.7	873.3	877.4
Mechanical wood pulp; semichemical wood pulp	345.2	352.5	331.1	318.9	298.8	307.4	303.9	305.8	301.1	286.4	303.2
Paper and paperboard	2857.1	3004.8	3055.4	3275.0	3699.8	3755.6	3821.8	4105.5	4278.4	4399.3	4643.7
Corrugated paperboard	1053.7	1158.3	1209.5	1248.7	1324.1	1527.6	1587.6	1702.5	1811.0	1933.4	2039.5
Cartons, boxes and cases of paper and corrugated paperboard	1192.8	1416.6	1400.3	1521.9	1666.4	1746.6	1863.6	2010.3	2185.8	2407.9	2516.1

Source: own study based on the Central Statistical Office of Poland reports: "Production of major industrial products 2016".

CONCLUSIONS

The research shows that a significant, more than twofold growth in the value of sold production of the pulp and paper industry occurred in 2006-2016, and at the same time the growth dynamics was visibly higher than for industrial processing and industry in general. %). Simultaneously, enterprises involved in the production of paper and paper products have enhanced the ability to generate gross added value to the greatest extent. Its level increased from PLN 4.8 to 11.3 billion in the studied period. Furthermore, the average employment in the pulp and paper industry improved by approximately 25% and reached the level of 56.1 thousand people, which resulted in the increase of the ratio of employees in this industry to 2.3 and 2.0%, respectively, in relation to industrial processing and industry in general. Consequently, the analyses in recent years have included companies that produce paper and paper products that attained the highest labour productivity dynamics calculated as the ratio of the sold production value to the number of employees. These entities observed a clear increase in this category of fixed assets – in 2016, their value was higher by 131.6% than a decade earlier and amounted to PLN 31.5 billion. The illustrated statistical data analysis confirmed a clear increase in the production potential of the pulp and paper industry in terms of industrial processing and industry in general, which constituted a response to the market demand.

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EXAMINATION OF THE INFLUENCE OF THE SELECTED DIMENSIONS AND CLASSES OF PARQUET QUALITY ON THE PRODUCTIVITY BY APPLICATION OF THE METHOD OF STATISTICAL ANALYSIS: CASE STUDY OF THE SELECTED PRODUCER IN SERBIA

Miljan Kalem, Aleksandra Lazarević, Branko Glavonjić, Slobodanka Mitrović

Abstract: This paper presents the influence analysis of different dimensions and parquet class quality on the production productivity in the selected company. The need of determination which parquet dimension and quality class present in the selected company has the largest influence on productivity initiated this kind of research. The research was conducted using the correlation and regression analysis, as the main statistical tools. The results of the correlation analysis point out that the largest degree of correlation between productivity, parquet quality class and dimension registered the R (rustic) quality class and the dimension of parquet 400 x 62 mm. Based on the results obtained by the correlation analysis, regression analysis was performed to observe the influence of R class of parquet quality and dimension 400 x 62 mm on total productivity in the selected company.
Key words: parquet, productivity, analysis, class of quality, dimension

1. INTRODUCTION

Wood-based floor production represents one of the key branches in Serbian wood industry, which besides chair production aspires to become Serbian trademark. To be competitive with the EU companies, productivity and economy must be comparable to those of the companies from the EU. The companies exposed to a foreign competition have no other choice but to become more productive or close down (Bacchetta et al., 2011). Wood industry is dynamically changing and imposing the need for more flexible and efficient production process, which would satisfy the demand for different products and the market requirements (Oliveira, 2016). Productivity represents companies' ability to produce a certain amount of products in a unit of time with a condition to consume a minimal amount of the working force during the production process and that the products satisfy a certain standard of quality (Kalem et al., 2019). More productivity means that more outputs can be produced using the same or less number of inputs (Zhang, 2006). A large number of factors, which can be split into two groups, subjective and objective, influence the productivity (Lazarević et al., 2018). Economy represents a more complex indicator than productivity that besides the rational use of working force comprises the efficiency of using capital assets and the product (Glavonjić, 2010). One of the main factors in every company, which influences the productivity and economy is the product with its characteristics whose influence on productivity is analyzed in this paper.

2. AIM AND METHODOLOGY

The main goal of the paper is the need to determine the influence of parquet class quality and dimension on the productivity in the selected company. For this purpose a unique statistical tool was used, which is consisted of the correlation and regression analysis. Using by the method of correlation analysis, a degree of productivity dependence from certain parquet classes and dimensions was determined and by the method of regression analysis the functional shape of this dependence. In addition, it is needed to say that the research on this paper is connected to the research published in the paper of Kalem et. al. 2019[1].

[1] Kalem, M.; Mitrović, S.; Lazarević, A. (2019). *Analysis and measurement of productivity in the parquet production by the methods of statistical modeling on the example of selected production system in Serbia,* Glasnik Šumarskog fakulteta, No. 120

3. RESEARCH RESULTS AND DISCUSSION

The research of the influence of the parquet quality class and dimension on the productivity was conducted on the sample of 12.752,42 m^2 of parquet which consisted of the three quality class (standard, rustic and out of standard). After determination which quality class has the largest degree of correlation with the productivity, parquet slat of this quality class was taken into consideration.

The results of the correlation analysis, the correlation of different parquet classes and the productivity are shown in the Table 1.

Table 1. The results of the correlation analysis of different parquet quality class and productivity

Correlations		S_class	R_class	VS_class	Total_ productivity
S_class	Pearson Correlation	1	.212	-.283	.540*
	Sig. (2-tailed)		.448	.307	.038
	N	15	15	15	15
R_class	Pearson Correlation	.212	1	.165	.700**
	Sig. (2-tailed)	.448		.556	.004
	N	15	15	15	15
VS_class	Pearson Correlation	-.283	.165	1	-.216
	Sig. (2-tailed)	.307	.556		.439
	N	15	15	15	15
Total_productivity	Pearson Correlation	.540*	.700**	-.216	1
	Sig. (2-tailed)	.038	.004	.439	
	N	15	15	15	15

**. Correlation is significant at the 0.05 level (2-tailed).*
***. Correlation is significant at the 0.01 level (2-tailed).*

From the Table 1. it can be noticed that the largest degree of correlation with the production productivity has the R quality class with coefficient of correlation amounting to 0.700 (Pearson Correlation 0.700). This can be considered a high coefficient of correlation. Statistical significance is also large, and it amounts to Sig. 0.004[2].

After determining that the rustic quality class has the largest degree of correlation with the productivity, dimensions of parquet elements from this quality class, processed in the production system of the selected producers, were taken into consideration. The results of modeling the degree of correlation between the dimension of parquet elements and productivity are shown in the Table 2.

Research results presented in the Table 2. show that the highest degree of correlation and parquet productivity has the parquet element dimension 400x62 mm. Correlation coefficient of this dimension and parquet quality class with productivity is 0.527 (Pearson Correlation 0.527), which can be considered as a strong correlation. Statistical significance of this correlation is also strong and amounts to Sig. 0.044.

After the conducted correlation analysis, the regression analysis was done with the aim of determining the form of functional dependence between the rustic parquet quality class and dimensions of the elements 400x62 mm with the productivity. The results of regression analysis are shown in the Table 3.

[2] Statistical significnce is high if value closer 0

Table 2. The results of analyzing the correlation of different dimensions of R quality class to the productivity

Correlations		R_300x42	R_350x42	R_350x62	R_400x42	R_400x62	Total_ productivity
R_300x42	Pearson Correlation	1	.139	.314	-.055	.167	.057
	Sig. (2-tailed)		.621	.254	.845	.552	.839
	N	15	15	15	15	15	15
R_350x42	Pearson Correlation	.139	1	-.362	-.026	.512	.288
	Sig. (2-tailed)	.621		.185	.926	.051	.297
	N	15	15	15	15	15	15
R_350x62	Pearson Correlation	.314	-.362	1	.102	-.220	.492
	Sig. (2-tailed)	.254	.185		.717	.430	.063
	N	15	15	15	15	15	15
R_400x42	Pearson Correlation	-.055	-.026	.102	1	.308	.235
	Sig. (2-tailed)	.845	.926	.717		.264	.400
	N	15	15	15	15	15	15
R_400x62	Pearson Correlation	.167	.512	-.220	.308	1	.527*
	Sig. (2-tailed)	.552	.051	.430	.264		.044
	N	15	15	15	15	15	15
Total_ productivity	Pearson Correlation	.057	.288	.492	.235	.527*	1
	Sig. (2-tailed)	.839	.297	.063	.400	.044	
	N	15	15	15	15	15	15

**. Correlation is significant at the 0.05 level (2-tailed).*

Table 3. The results of regression analysis of functional dependence of the productivity from the parquet R quality class and parquet dimension 400x62 mm

Descriptive Statistics			
	Mean	Std. Deviation	N
Total_productivity	850.1427	50.02154	15
R_400x62	101.2495	24.01180	15

The results of descriptive statistics on the sample base from the fifteen-parquet elements of R quality class and dimension 400x62 mm, as well as fifteen sample elements of total productivity are presented in the Table 3. *Descriptive Statistics*. The number of sample parquet elements of the R quality class and dimension 400x62mm was obtained based on the number of working orders for this class and dimension of parquet. The number of elements of total productivity was obtained based on the sum of productivity for all parquet quality classes and dimension for fifteen working orders.

Correlations		Total_ productivity	R_400x62
Pearson Correlation	Total_productivity	1.000	.527
	R_400x62	.527	1.000
Sig. (1-tailed)	Total_productivity	.	.022
	R_400x62	.022	.
N	Total_productivity	15	15
	R_400x62	15	15

The results of correlation between the parquet of R quality class with the dimension 400 x 62 mm and the total productivity are presented in the table *Correlations*. The results presented in this table point out a strong correlation between the parquet of R quality class, the dimension 400x62 mm and the total productivity. The coefficient of correlation amounts to 0.527 (Pearson Correlation 0.527). Statistical significance of the correlation coefficient is also high and amounts to Sig. 0.022.

Model Summary[b]				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.527[a]	.277	.222	44.12687

a. Predictors: (Constant), R_400x62
b. Dependent Variable: Total_productivity

The value of the coefficient of determination amounts to 0.277 and it is presented in the table *Model Summary*[b] in the column *R Square*. The coefficient of determination shows which part of the variance of the dependent variable explains the value of this model. When this value is multiplied by 100, the value in percentage is obtained, which tells us that 27.7% of the variance of the dependent variable (productivity) is explained by the independent variable (parquet R quality class and the dimension 400 x 62 mm), while the residual percentage is dissipated to other factors which influence the total productivity of parquet production.

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	9716.808	1	9716.808	4.990	.044[b]
	Residual	25313.351	13	1947.181		
	Total	35030.159	14			

a. Dependent Variable: Total_productivity
b. Predictors: (Constant), R_400x62

In the table ANOVA[a] statistical significance of linear regression is given amounting to Sig. 0.044, which can be considered statistically significant at the level of confidence of 95%. This value shows that based on this model it makes sense to explain the state in the productivity.

Coefficients[a]													
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0%Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	739.055	51.017		14.486	.000	628.839	849.271					
	R_400x62	1.097	.491	.527	2.234	.044	.036	2.158	.527	.527	.527	1.000	1.000

a. Dependent Variable: Total_productivity

In the table *Coefficients*[a] and the column *Standardized Coefficients* the value of the parameter *Beta* is given and amounts to 0.527 which shows how much the independent variable contributes to the prediction of the dependent variable. This value can be considered statistically significant (Sig. 0.044).

One-simple model of the influence of the dimension in the rustic quality class on total parquet productivity in the selected production system is showed with the following linear equation:

$$y = 739.055 + 1.097x$$

Interpretation of the parameters' values shows the following:

- Parquet slats of rustic quality class, dimension 400x62 mm have a positive influence to the total productivity and this influence is statistically significant (Sig. 0.044).
- By increasing the production of the rustic quality class and the dimension 400x62 mm for 1m^2 per shift, it can be expected an increase of productivity for 1.097 m^2 per shift.

4. CONCLUSIONS

Based on the research results it can be concluded that the total productivity of parquet production in the selected company is strongly dependent on the participation of R quality class and the elements' dimension 400x62 mm. The coefficient of correlation between the parquet of R quality class, the dimension 400x62 mm and the total productivity amounts to 0.527 (Pearson Correlation 0.527), the statistical significance is Sig. 0.022. This shows that these two factors have significant influence to the productivity in the selected company. The coefficient of determination, which amounts to 0.277 shows that 27.7% of the total productivity can be explained by the influence of R quality class, the dimension 400x62 mm, which can be considered a significant percentage. All mentioned is confirmed by a high value of the Beta parameter as well as its statistical significance.

Basic recommendation which can be made to the selected production system is related to the need of purchasing better quality processed wood with a larger capacity to produce a large amount of parquet R quality class, dimension 400x62 mm. The advantages of the parquet production in this quality class are mirrored in the high productivity and high sales price in the market.

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THE PROCESS OF INDEXING WORKING COMFORT FACTORS IN ORGANIZATIONS OF WOOD PROCESSING INDUSTRY

Renata Nováková, Alena Pauliková, Natália Canet

Abstract: The aim of the paper is to define the process of indexing working comfort factors in organizations of wood processing industry. The basic prerequisite is the assessment of the interdependencies of individual factors effects on the body of the exposed employee during his work. The Job Comfort Index is designed to allow the setting of individual workload and work environment for employees in selected specific conditions of wood processing industry.
Keywords: Comfort factors, wood industry, job comfort index, employees

Introduction

More than 48,000 employees work in the Slovak Republic's wood processing industry, on average about 7.2% of total employment in wood processing industry. Over the past period, the sectoral structure in the industry has changed. Currently, is given above-average emphasis on the automotive industry. However, from a historical or better-said from a regional point of view, the wood processing industry has a very important role in the creation of the gross national product. We found the following facts from the FINSTAT database (6):

The average return on assets of the industry in the Slovak Republic for 2013 was in the area:
Agriculture and Forestry - 0,2 %
Wood and Paper - 1,8 %

The average return on capital of the industry in the Slovak Republic for 2013 was in the area:
Agriculture and Forestry - 0,4 %
Wood and Paper - 4,1 %

The average gross margin of the industry in the Slovak Republic for 2013 was in the area:
Agriculture and Forestry 18,9 %
Wood and Paper 18,4 %

As we can see, the financial-economic analysis shows below average values in given sectors. The reason can be a macroeconomic environment that companies can hardly influence, but the reason may be also unsatisfactory conditions within the microeconomic environment. The subject of our interest will be to analyze the working environment in the wood processing industry and to point out the risk factors that may affect the quality and efficiency of employees' work performance. The quality of working conditions in terms of worker health is very important in the current and projected development of working length of life. Every entrepreneur should realize that excessive fluctuation, resp. omitting the work process due to health problems can seriously jeopardize the economic operation of the whole company. Wood processing production is a relatively exposed area in terms of health risks. Currently, the Decree of the Ministry of Health of the Slovak Republic no. 448/2007 concerning details of labor and work environment factors in relation to the categorization of works in terms of health risks and requisites of the proposal to include works in categories is in force. It is known that various factors affect the worker in the work process, such as physical, chemical, biological, physiological, psychosocial, and others. The employer is obliged to ensure the assessment of the health risk from exposure to the factors of work and the working environment and, on the basis of this assessment, to provide a written risk assessment report with the categorization of work in terms of health risk. This should be done in cooperation with the work health service. Employer is also required to manage and keep records of staff that perform work in second, third or fourth category, for exposure to work and work environment factors such as noise, vibration, ionizing radiation, electromagnetic fields, ultraviolet radiation, infrared radiation, laser radiation, heat burden, cold burden, chemical factors, carcinogenic and mutagenic factors, biological factors, physical workload, etc.

1. PRESENT STATE OF WORK COMFORT INDEX METHODOLOGY IN THE SLOVAK REPUBLIC

The study is based on years of experience of the Institute of Industrial Engineering and Management at Faculty of Materials Science and Technology faculty STU in Trnava in the field of ergonomics and industrial management. The results of the research in this area were pointed out in the VEGA project Transformation of the ergonomic program into the company management structure through the integration and utilization of QMS, EMS, HSMS, APVV, transformation of industry in Slovakia with participatory ergonomics, bilateral SR-USA project to the need for a comprehensive assessment of ergonomic indicators in industrial plants.

The workloads of employees in industrial facilities are currently still being evaluated as independently and mutually independent effects of all the operating factors on the worker's body during his / her work.

The most frequently evaluated factors include noise, vibration, lighting and light comfort, dust, humidity, temperature, air quality, air flow, overall working environment and ergonomic characteristics of the working environment. In connection with an increasingly higher degree of automation and robotization, other factors resulting from human-machine interaction, such as measuring the cognitive load of operators and their ability to make decisions in critical situations, are also coming to the fore.

According to the results of the NCZI publications "Occupational or Occupational Disease Disorders in the SR 2014", the most newly registered disease permits by economic activity were in industrial production up to 53.9% in 2014. According to professions, they were qualified workers and craftsmen. The diseases were the most represented by limb diseases from long-term, excessive, unilateral loading and disease of the bones, joints, muscles, vessels and limbs of extremities caused by working with vibrating instruments and devices. Statistics also pointed to significant differences between the sexes, the age categories and the regions.

Despite attempts to express the synergic effect of physical and ergonomic factors using mathematical and statistical methods, there is still no model for combining and recombination with regard to the individual needs of employees, especially in industrial enterprises. The UK Commission for Employment and Skills Study – British Commission for Employment and Skills pointed out that population aging will create four-generation operations (4G operations) where 70- and 80-year-old employees will work next to their 20-year-old colleagues. By 2030, the expected growth of 65-year and more-year-old economically active employees is one-third.

Looking at the future, "Industry 4.0" will allow the organization of work in a way that takes account of demographic change and social factors. In view of the threat of a poorly qualified workforce, "Industry 4.0" will enable older employees to extend their working lives and remain productive for a longer period of time. Flexible work organization will enable employees to combine work, private life and professional development more efficiently. It will promote better work-life balance.

2. THE NATIONAL HEALTH PROMOTION PROGRAMME IN SLOVAK REPUBLIC

In November 1999, the Government of the Slovak Republic approved the National Health Promotion Programme (14) and its second update, based on the WHO programme „Health for all in the 21st Century“, which is based on Health 21 – Health in 21st Century for the European Region. This is a continuation of priorities and programmes of the updated National Health Promotion Programme from 1995. The "Health 21" policy for the WHO European Region can be characterized by these main elements:

One long-term goal

Achieve complete health potential for all.

Two main directions

Support and protect human health through the whole life.

Reduce the occurrence of new cases of serious illnesses and damages and to avoid the suffering they cause to people.

The three fundamental values that form the ethical base of HEALTH 21

1. Health as a basic human right.
2. Equality in health and solidarity among and inside of all countries (among their inhabitants through implementing health improvement measures).
3. Participation and accountability of individuals, groups, institutions and communities for constitutional health development.

Four main strategies using scientific, economic, social and political tools to ensure the sustainability for the implementation of HEALTH 21.

1. Interdepartmental cooperation in improving health determinants (physical and social environment, economy, culture, social situation including women's status in society) and assessing the impact of any health measures.
2. Programmes and investing in the development of health and health care managed by the results achieved in the physiological functions of the organism.
3. Integrated primary health care oriented on family and community supported by a flexible and sensible responsive hospital system.
4. The health development process associated with the participation of all relevant partners (in the family, school, workplace, at local community and country level), which promotes joint decision-making, implementation and performance deduction (14)

The Labor Code of the Slovak Republic adresses, in its part of Protection of Work, protection of health at work, which is defined as the status of working conditions, excluding or minimizing the influence of dangerous and harmful factors of the working process and the working environment on the health of the employee. It further states the care for workers' safety, health at work and the improvement of working conditions, as essential components of labor protection, are an equal and integral part of the planning and fulfilling of work tasks. The employer is obliged, within the scope of its competence, to systematically assure the safety and health protection of employees at work and for that purpose to take the necessary measures, including prevention of necessary means and an appropriate system to manage work protection. The employer is obliged to improve the level of labour protection in all activities and to adapt the level of work protection to changing facts.

Risk work means work associated with an increased health risk where exists a risk of an occupational disease formation or other work-related illness; it is a work that is classified under the legislation in the third and fourth category. However, it is also important to mention that the legislation not only categorizes the work but also creates the preconditions for effective prevention at workplaces, by obliging to carry out a risk assessment report for individual risk factors and in relation to this review to take measures to limit their effect, with a focus on technical and organizational measures.

Risk works mean:

a) For employees – increased risk of health damage at work

b) For employers – implementation of preventive measures, assuring medical preventive check up in relation to job (1)

Only out of curiosity we are adding the following information:

Over the past period, the number of employees who carried out hazardous work in the territory of the Slovak Republic in the area of agriculture, forestry and fishing is 2395 and in the industrial production area 66191. At present, this number may be even higher.

3. EVALUATION AND ASSESSMENT OF QUALITY FOR WORKING ENVIRONMENT

The working environment is one of the environmental subsystems and is intended and used to carry out work. The working environment consists of workplace and factors occurring at the workplace or related to the work performed and which may affect the health and well-being of the employees or their actions. The working environment has a significant impact on the efficiency and employability of the worker and on the use of production resources. (2)

Examples of working environments in the area of wood processing industry:

Figure n.1 wood processing

Figure n.2 wood processing

Figure n.3 wood processing – assembly of a wooden house

Figure n.4 wood processing industry

Figure n.5 wood processing industry

Figure n.6 wood processing industry

Figure n.7 paper industry

Figure n.8 furniture production

Figure n.9 furniture production

Depending on the nature of the work, the employee gets under the influence of chemical, physical, biological and psychological factors of work, the manifestations of which differ, as well as the activity is different of man in the work process. Each of these factors may under certain circumstances pose a health risk.

Nowadays, the impact of environmental factors is most often assessed by comparing the actual value with the determining value (acceptable or recommended). The values of the working environment factors can be determined by calculation, measurement, or expert estimation. The optimal values of the working environment are stated in STN (standards), legislation, hygiene regulations, or professional literature. The permissible (maximum and minimum) values of the working environment factors are usually determined by calculating (using correction coefficients) from the basic (optimal) values.

At present, there exist entities and laboratories authorized to carry out certified measurements of working environment factors, especially of noise, vibration, lighting, dust and electromagnetic radiation. For supervision of these entities is responsible the Public Health Office of the Slovak Republic, which falls under the Ministry of Health. In terms of measurement techniques, the National Metrology Institute is in charge of the surveillance.

The impact of work and the environment on a person can be assessed gradually (factor after factor). Using this assessment method, there arises a risk to omit the simultaneous influence of factors. Despite, being individually below the critical value their combination may cause adverse effects.

Assessment of the quality level for the working environment can be of three kinds:

a) Subjective (sensory) assessment

b) Objective assessment (according to physical laws)

c) Regulatory assessment (determined by legislation and standards) – it rises from the generalization of objective or subjective assessments and is embedded in legislation or otherwise binding decree. This kind of assessment is fundamental in all environmental elements and therefore the assessment of the factor level is performed by comparing actual values with acceptable values. If parameter exceeds or does not attain a permissible value then the influence of such is considered to be adverse or harmful. The standard intervals of optimal values are often limited by the highest permissible values.

Principles, criteria and parameters, embedded in legislation and norms, are the basis for analysis and assessment of working environment factors. As part of a subjective and objective assessment, we can still focus on basic approaches such as:

1. Subjective assessment of non-measurable or very difficult to measure factors of job comfort – it is sufficient only an informative finding of the state of the environment based on which an improvement measure can be adopted

2. Objective assessment of measurable factors of working comfort using current measurement methods and techniques – in this case, there is the need to ensure accurate data by measuring and monitoring.

In practice, we know several possibilities and methods of assessing the factors of work comfort. These include for instance:

a) Isolated assessment of work comfort factors – it is not possible to compare the quality of several environments with different parameters. It is harder to assess whether an environment with high noise or a lack of light is worse. Therefore, this assessment needs to be complemented by a comprehensive assessment that can generally point to environmental discomfort and define the impact of multiple critical factors.

b) Partial assessment methods of the working environment – these are based on the assessment of the effects of individual factors of the working environment on the basis of partial measurement and examination. The data should be reliable, but it cannot be said that they provide a picture of the overall working environment level.

c) Assessment method of the working environment by the system of coefficients – its principle is that to each level of the working environment factor is assigned a specific proportional quantity Fi according to specified criteria. The Fi coefficient is a numerical representation of the factor level of the studied working environment and is determined by comparing the actual followed level of factor Pi to its optimal value Oi. The value of the coefficients is in the interval <0.1>, whereas the value 0 means the unacceptable level of the evaluated factor and the value 1 corresponds to the optimal level of the evaluated parameter. (2)

3. CONCLUSIONS

In the Slovak Republic there is the accent put on automotive industry sphere. However, almost 50 thousands people work in the Slovak Republic's wood processing industry, on average about 7.2% of total employment in wood processing industry. The working environment of wood processing industry is very difficult to be reviewed because it covers interior and external environmental subsystems and is intended and used to carry out work.

The working environment consists of workplace and factors occurring at the workplace or related to the work performed and which may affect the health and comfort of the employees or their working actions. In working environment, in the area of wood processing industry, are most significant these factors: vibration, ultraviolet radiation, infrared radiation, heat burden, cold burden, chemical factors, biological factors and very difficult physical workload.

The optimal values of the working environment are stated in ISO EN standards, properly set legislation, hygiene regulations and professional journals and books. The permissible values of the working environment factors are usually determined using correction coefficients from the optimal values but in Slovakia employers very often do not monitor valid regulations which are necessary to be noticed.

It is possibility to reinforce auditing body's authorities to protect health and safety in wood processing industry in so much that lawbreaking activities will be ineffective and very expensive.

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PROPLEMS OF CONTROLING RENEWABLE FOREST RESOURCES IN FOREST BASED SECTOR

Plamena Nedyalkova

Abstract: The forest based sector is very important for the development of renewable forest resources. The main problem in Bulgaria is that the forestry sector is not used properly and as intended. There is a very big problem with the ways of preserving and developing the forest massif, which also has an impact on the environment. There are various control institutions in Bulgaria that are engaged in forestry control and control of renewable forest resources. The purpose of this report is to address the problems of the forestry sector and to propose different mechanisms and solutions to improve the control of the forestry sector and the control of renewable forest resources. The control of renewable resources is important in view of the fact that the world should not be conquered by concrete and iron structures, technology should help humanity, but the natural nature should be preserved and people should live in one ecological environment.
Keywords: Control, forest based sector, renewable forest resources

1. CONTROLING INSTITUTIONS IN BULGARIA ON FORESTS AND RENEWABLE FOREST

Natural resources are an important source for ensuring the development and existence of our planet. By nature, natural resources are grouped into renewable and non-renewable (exhaustible). Non-renewable sources include coal, oil, natural gas, precious stones, and others. Renewable sources occupy a significant part of the planet's territory and they include forests, water sources, heat from the Earth's core, and others. The main environmental problem of the Earth is that there is a great deal of soil and water pollution, which leads to disturbance of natural laws and natural conditions. The human species is also one of the major factors that negatively impact on renewable resources, interfering with the development of ecosystems. The unregulated timber extraction, the illicit cutting down of forests and unregulated timber exports lead to disturbance of the forests and their natural reproduction. In this regard, in recent years, the United Nations has launched an active policy and campaign for the sustainable development of all countries and reducing the trend towards extreme poverty of the population by directing its objectives and resources to protect the natural resources of the planet, and to the protection of the forestry sector.

The Republic of Bulgaria, as a member of the European Union, strives to improve the quality and condition of the forestry sector. In 2011, a new Forestry Act was passed, through which the law separates the controlling functions from the economic ones of the Forests Management. For the first time, this law distinguishes the two concepts of "control" and "management". Direct control is carried out by the Forestry Executive Agency, which is directly subordinated to the Minister of Agriculture and Food. The Executive Forestry Agency has limited control functions and they are aimed only at monitoring the regulatory compliance and enforcement of the forestry legislation. This control function is explicitly prescribed and regulated in Art. 196, para. 1 of the Forestry Act, namely, "the Forestry Executive Agency and its structures shall exercise control over the implementation of the law in respect of all activities in the forest areas as well as on the preservation, transportation and processing of timber and non-timber forest products" (Forestry Act, 2017), as in Art. 196, para. 2 of the same act specifies that the Bulgarian Forestry Agency has another approved regulatory control function, namely, "the Forestry Executive Agency and its structures control the use of biomass derived from wood that is used for the production of electrical energy, produced from renewable sources within the meaning of the Renewable Energy Act" (Forestry Act, 2017).

On the other hand, we have the management of forest areas, which includes the management of state forest ownership. This management is carried out by state-owned forest holdings and state hunting farms. By region, the respective state forestry and state-owned hunting farms unite and make up the relevant Regional Directorates of Forests, which are directly subordinated to the Executive Forestry Agency.

Other institutions that are authorized to manage the forest areas are state-owned enterprises that are approved by an order of the Minister of Agriculture, Food, and Forestry. The state companies are approved according to the requirements of art. 163 of the Forestry Act, for the management of the forest territories (state property), which are not granted to the departments or legal entities. These state-owned enterprises have a two-levelled governance structure – headquarters and territorial units with relevant state-owned forest holdings and state hunting farms. The bodies of state enterprise management are the Minister of Agriculture, Food and Forestry and the Management Board.

The protection of forests and forest resources requires quality, adequate and timely control. The overall control of forests in Bulgaria is not very well structured as a technology and organization, and consequently, there come the following problems: the presence of excessive illegal cutting of trees, illegal timber harvesting, improper transportation of timber, intentional fires, illegal forest restitution, pollution of forest areas (including water and soil pollution) and excessive forestry activities.

The state power in the person of its control institutions, namely: Ministry of Agriculture, Food and Forestry, Executive Forestry Agency, incl. Regional Forestry Directorates; the municipalities with public – municipal ownership of forest territories and the state enterprises according to art. 163 of the Forestry Act have limited control functions. The assigned tasks and control powers place a limit on the scope of the control activities of these institutions.

The individuals, i.e. the society as a whole, also determine the quality of forest resources and the quality of renewable forest resources. State institutions have a certain scope, but when the respective forest areas belong to persons, legal entities or their associations, then forest plans or programs are developed, and the allowable amount of forest resources utilization and the guidelines for achieving the management objectives of forest areas for the next 10 years are determined. Despite the plans and programs developed, they are not always observed, and even if they are, too much forestry activity is sometimes seen, which changes the appearance and structure of the forest. The foresters implement different approaches in order to manage and develop the forest in a certain way in order to produce wood with certain characteristics satisfying the production needs. The foresters often remove trees that are hollow or have broken branches, and remove old, but still living trees. This interference threatens the biodiversity of forests, as well as the natural self-regulation of forests.

2. A PRESENTATION OF THE TYPES OF CONTROL PROBLEMS ON FORESTS AND RENEWABLE FOREST RESOURCES. AN EMPIRICAL TESTING AND PRESENTETION

We can divide the control problems on forests and the renewable forest resources into two main groups:

1. The first issues arise from the control bodies themselves. The problem is that, within the same institutions, they are responsible for the protection of forests but they are also involved in the organization and the legal conduct of the organization and the planning of the extraction of timber and non-timber forest products. In other words, of the institutions so represented, they should control each other, as well the implementation of the relevant contracts for the rental of forest areas or the implementation of the timber extraction plans. The only way to improve the operation of the afore-mentioned institutions is to separate the executive management of forests from the inspection activities. For the time being, the inspectors of the Executive Forestry Agency, who perform the control, perform their functions as well in the relevant Regional Directorates of Forests, and the Regional Directorates of Forests themselves should perform the functions of the Executive Forestry Agency.

According to the data of the Supreme Administrative Prosecutor's Office, in the management of forests, the municipalities have assumed governmental functions that are in conflict with the Forestry Act. Many municipalities impose unreasonable charges, determine how investors operate on forest areas, introduce an illegal ban on access to certain forest areas, and so on. By law, the restriction of access of persons to a certain forest territory is aimed at the protection and preservation of forest territories and wildlife or is in the interest of the health and safety of citizens but this limitation is in the competence of the directors of the respective regional forest directorates for all types of forest areas, and is not in the competence of the respective municipal councilors from the respective municipality (Nedyalkova, 2017).

Other frequent violations found by the Supreme Administrative Prosecution of Bulgaria in this interweaving of the powers of the other institutions are that the municipalities themselves approve internal regulations which define and resolve the traffic of goods vehicles and carts in the forest territories and the forest roads. The Forestry Act has explicitly stated that this is not the responsibility of the municipalities, but of the respective director of the respective Regional Forestry Directorate of the Forestry Executive Agency. Thus, the municipalities are seriously harming the natural development of the forests.

2. The second problems arise from the impact and influence of society, technological innovations and natural factors – some of the control institutions can influence these problems, but others cannot. M.Minev also examines the lack of quality state control over manufacturing enterprises, in particular those using renewable raw materials „at the same time 36.84% of manufacturing and 40.91% of the agricultural companies declare that they seriously question the quality of their own information about the cost of their production. This unambiguously states that there is a vast field for improvement of the government control procedures related to the cost of production“ (Minev, 2017).

Bulgaria as a single state cannot have an impact itself on these factors. A unified system of control mechanisms and properly interconnected control institutions from all EU member countries is needed. The European Union adopts the forests as "valuable ecosystems with a diverse appearance and a lot of usages." Unfortunately, the policy that the EU has so far with regard to the protection of forests and forest areas is not very adequate and of high quality. The EU continues to lead the so-called sectoral policy on forest management. For example, in September 2013, the European Commission adopted a new EU forestry strategy (COM (2013) 659), which proposes a new European reference framework for sectoral policies that have implications for forests. The main guiding principles of this strategy are the sustainable management of forests and the promotion of their multifunctional role, the efficient use of resources and the EU's responsibility for forests globally. This document also provides strategic guidance for the actions of the European Commission and the member countries. For example, the Commission has foreseen to develop criteria for sustainable forest management. In September 2015, it adopted the accompanying multiannual plan for the implementation of the EU Forest Strategy (SWD (2013) 0343). This multiannual forest plan sets out a list of actions to be taken to respond to the challenges of the European logging industry.

The European Union has a significant impact on the development of forests and forestry areas by allocating separately funds for their recovery, maintenance and development through the European Agricultural Fund for Rural Development. For the period 2014-2020, the European Agricultural Fund for Rural Development has a total budget of € 96 billion, and the Fund can provide financial support through grants " (European Agricultural Fund for Rural Development).

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VALUE-BASED MANAGEMENT OF A FURNITURE FACTORY

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Abstract: The problem of decision making and management in a small furniture factory embraces many different aspects including economic ones. In the contemporary view of system analysis, this task is considered as management of a complex system. The study aims to assess the potential of value-based decision making for modelling the management processes in such complex systems. For that purpose, a utility function that analytically represents the preferences of an expert in this field is built. Hence, the object of research is the development of a value-based model that allows defining an optimal area for flexible choice of a wide range of furniture production to achieve the best market realization and profit. The subject of the research is an examination of the customer's preferences and determination of a range of products according to market demand. The applied method is based on the utility theory and value-based decision making in management activities of planning, organizing and controlling. An aggregated utility function that includes essential system parameters is constructed. This function reflects human thinking and expectations concerning the economic efficiency of the furniture factory. The described methodology allows effective management of the enterprise according to the concepts of the manager. The built-in mathematical model is used to evaluate the manufacturing process. The presented value-based model practically supports the optimization of production. Thus, the introduced procedure subsequently leads to efficient management of a small factory.
Keywords: value-based decision-making, utility function, furniture factory, management of complex systems

1. INTRODUCTION

Recently, digitalization is pervasive in all social and economic sectors. One of the most crucial complicated tasks is the management of material and financial resources. A solution requires the implementation of advanced information and communication technologies (ICT) and mathematical modelling. Such a tool is an Enterprise Resource Planning (ERP) system that is ICT-based information system for unified resource planning – it supports management, control and analysis of all processes in an enterprise for the sake of coordination and achievement of high efficiency. Such a system enables easy planning of the resource constraints (material, human, financial) for various departments and activities, as well as it allows an ongoing control and flexible adaptation to varying external factors. Thus, the implementation of mathematical models and principles for decision-making in planning and resources allocation enable to reach the intended targets. The quantitative mathematical approach in business management is of particular importance for all enterprises, but ERP systems are too complex for small and medium enterprises (SMEs). This research presents a value-focused approach that can support decision-making in resource allocation. In particular, it is appropriate for SMEs to help them intensifying business networks [2]. Moreover, it can bring the development of sustainable cross-border cooperation between Bulgaria and Macedonia in the forestry sector, where prevail SMEs. The approach allows managers to formulate their views and preferences and thus to make decisions regarding business policies, which are quantitatively represented by mathematical relations and complicated models of control and production processes.

The system approach helps managers to understand better what techniques and methods they can implement to achieve best the goals of an enterprise in certain situations. To research these issues in a complex environment such as economics, widely employed is the *case study* where the primary purpose is the analysis of a particular case. In essence, this holistic method in a system approach requires an in-depth description of the situation and a precise definition of problems. In trying to generate a decision strategy for a particular complex system, one needs of the underlying theories, principles, and guidelines to allow generalization of knowledge acquired from particular occasions and its application to a specific situation. Generalization may be quite challenging for complex problems.

Theories of decision-making as intentional, consequential action based on knowledge of alternatives and their consequences evaluated in terms of a consistent preference ordering are known as *rational decision theories*. Rational approaches to decision-making can generally be classified in one of the following categories: descriptive, normative, or prescriptive [1]:

- Descriptive methods analyse how decisions are taken and determine optimal choices based on what is or what has been done. Descriptive techniques use an analysis of how real people make decisions influenced by their biases regarding perceiving of the situation and the choices of alternatives considering possible outcomes;
- Normative methods – known as strict mathematical theories based on the axiomatic approach. Normative techniques are based on and demand the assumption that the decision-maker (DM) is rational and abstract from cognitive bias;
- Prescriptive methods – related to normative methods in that they determine optimal choices in theory, but these choices are constrained by limitations of what can be done in reality. The prescriptive techniques generate understanding of the alternatives through the inclusion of the empiric subjective knowledge in assistance of the normative methods.

The current research presents an innovative value-based approach [4] intended at the application in management information systems in microeconomics. In particular, it concerns a mathematically grounded description of the complex problem of an expert evaluation concerning the range of furniture products regarding used raw materials in a small furniture factory. The aim of this research is to represent analytically subjective preferences as a utility function for value-based decision making. For this reason, the manager's views about the variety of office furniture that the company has to produce for a successful appearance on the market are measured.

2. DECISION MAKING, UTILITY FUNCTION AND PREFERENCES

Human activity in decision-making terms is the subject of active research performed in a complex domain from several perspectives. From a cognitive perspective, decision-making is interactions with the environment. According to the psychological viewpoint, cognitive decision-making is considered in the framework of rational and irrational human consciousness. Rational functions are thinking and feeling, while intuition and perception is the other group. In these frames, a value/utility function could be viewed as an analytic representation of empiric knowledge. The rational decision mainly coincides with the analytical approach to decision-making (measurement theory and utility theory) that is the theoretical basis for the development of decision theory. The essential aspect of decision-making is the construction of decision models, which are mathematical (normative) representations of the decision environment. In this aspect, a value/utility function is a mathematical model that is introduced to assist people faced with complex decision problems – *value-focused thinking and modelling* [4].

A utility function is an analytical representation of DM's preferences, which are expressions of DM's cognitive ability. The DM's preferences are noted as follows ($\succ$). They are expressed over a set $\boldsymbol{P}$ of finite probability distributions of final results subject of DM's solution (set $\boldsymbol{X}$, $\boldsymbol{X}\subseteq\boldsymbol{P}$). The relation for human preference $(\boldsymbol{x}\succ\boldsymbol{y})$ and its related indifference relation $((\boldsymbol{x}\approx\boldsymbol{y})\Leftrightarrow\neg(\,(x\succ y)\vee(x\prec y)\,))$ fulfil the following main postulate [3]. They are transitive:

$$((x\approx y)\wedge(y\approx t))\Rightarrow(x\approx t)\,),\quad ((x\succ y)\wedge(y\succ t))\Rightarrow(x\succ t)\,),$$
$$((x\approx y)\wedge(y\succ t))\Rightarrow(x\succ t)\,),\quad ((x\succ y)\wedge(y\approx t))\Rightarrow(x\succ t)\,);$$

It is assumed that the expressed preferences have uncertainties and errors in the choice and that this uncertainty or errors have random nature and may be represented as a random variable with mathematical expectation zero and bounded variance, different in the different practical problems. The following practically acceptable mathematical axioms of von Neumann give satisfactory conditions of a utility function existence [3, 6]:

(A.1) **P*references* relations** ($\succ$) and ($\approx$) are transitive, i.e. the binary preference relation ($\succ$) is weak order;

(A.2) ***Archimedean Axiom*:** for all $p,q,r \in P$ such that ($p \succ q \succ r$), there is an $\alpha,\beta \in (0,1)$ such that (($\alpha p + (1-\alpha)r) \succ q$) and ($q \succ (\beta p + (1-\beta)r)$);

(A.3) ***Independence Axiom*:** for all $p,q,r \in P$ and any $\alpha \in (0, 1)$, then ($p \succ q$) if and only if (($\alpha p + (1-\alpha)r) \succ (\alpha q + (1-\alpha)r)$).

Axioms (A1) and (A3) cannot give a solution. Axioms (A.1), (A.2) and (A.3) provide a solution in the interval (temperature) scale (precision up to an affine transformation). Mathematically the utility function is evaluated by the "gambling approach" [5]. This approach consists of comparisons between lotteries. A "lottery" is called every discrete probability distribution over X. The most simple lottery is denoted as $<x, y, \alpha>$: α is the probability of the appearance of the alternative x and $(1-\alpha)$ – the probability of the alternative y. Following from the "gambling approach" the presented approach to utility function (u(.)) evaluation includes stochastic pattern recognition of two sets:

$$\boldsymbol{A_u}=\{(\alpha,x,y,z) \,/\, (\alpha u(x)+(1-\alpha)u(y))>u(z)\}, \quad \boldsymbol{B_u}=\{(\alpha,x,y,z) \,/\, (\alpha u(x)+(1-\alpha)u(y))<u(z)\}.$$

The analytical polynomial approximation of the utility function is constructed by stochastic approximation recognition of the set $\boldsymbol{A_u}$**.** The proposed evaluation is probabilistic pattern recognition ($\boldsymbol{A_u} \cap \boldsymbol{B_u} \neq \emptyset$) and machine learning with noise (uncertainty) elimination [7]. In the process of utility approximation, are used B-splines. As the utility functions are approximated with precision up to an affine transformation, in the final representation, they are normed between 0 and 1.

3. METHODOLOGY

The paper presents a study about the complex problem of decision-making for the product range in a small factory in the furniture sector. The research uses principles and algorithms from many mathematical theories – Measurement theory, Utility theory, stochastic pattern recognition, and stochastic approximation. The procedure is as follows. *First*, analytical processing of qualitative, subjective information to set both the main goal and corresponding sub-goals. The empirical knowledge and individual level of experience are the basis for the determination of this goal and sub-goals. *Second*, proceed with the choice and design of specific methodology and algorithms for its implementation according to the measurement scales of the chosen criteria (sub-goals). *Third*, determination of the structure of the multi-attribute utility function and their decomposition to one-dimensional utility functions based on the utility dependence/ independence of the preferences of the manager (expert) in regards to the significant production characteristics, i.e. sub-goal. *Fourth*, preferences evaluation of the one-dimensional utility functions and the appropriate coefficients of the multi-attribute utility function. It gives the explicit form of relations between the single-attribute sub-functions [5]. The research uses a lottery comparison approach to retrieve a utility function that is represented on a "temperature" interval scale with accuracy to a linear transformation.

The utility theory is applied for planning the product range according to possible raw materials. The primary purpose is to choose optimal furniture production and so to achieve the best profit in market realization. The proposed approach to solving this complex task uses an investigation of the customer's preferences. The current research describes the application of the decision-making procedure to determine the range of produced office furniture according to the used timber. Thus the production process is optimized considering utility function based on subjective preferences of the factory manager, which reflect market demands. In practice, the basis for the decision-making is the implementation of both the utility and measurement theories, where the first one is applied through the prescriptive approach. Considering above mentioned, Fig. 1 presents a schematic structure of the complex task for optimization of the product range in a furniture factory.

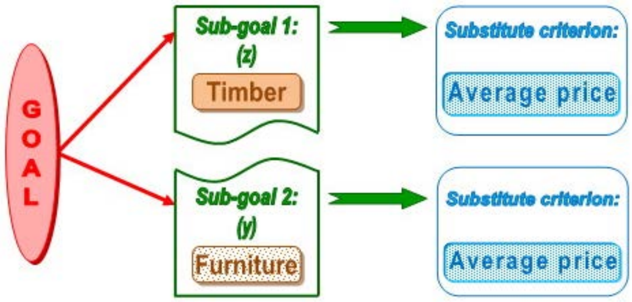

Figure 1. Goals and sub-goals in furniture factory

4. RESULTS AND DISCUSION

The presented approach is demonstrated in the context of a small furniture factory. In the considered practical application example, in particular, Table 1 gives possible timber (*z*) used for the production of the assortment of office furniture products (***y***), shown in Table 2.

Table 1. Types of raw materials for furniture

Timber/Raw material [m^3]	Chipboard	Pine	MDF	Beech	Oak	Mahogany	Cherry	Walnut
Average price [€]	260	340	470	750	1485	1965	2240	2575

Every enterprise is an economic system. Hence its primary goal is to achieve profit from production activity. The sub-objectives underlying this primary goal are focused on two aspects: 1) accounting the cost of raw materials used in the production, and 2) the assortment of products manufactured from the considered materials. Measurement/ evaluation of the manager's preferences regarding the sub-goals (factors) are 1) value/ cost of the materials and 2) value/ cost of manufactured products. Further, exploring the dependencies between these sub-goals/ factors is needed.

Table 2. Product range – office furniture

Number	Product	Average price [€]	
		Min (Chipboard)	Max (Walnut)
1	Shelf	20	170
2	Filing cabinet	25	190
3	Bookcase	30	230
4	Meeting/ conference table	36	350
5	Cupboard	40	390
6	Office Desk	50	430
7	Executive desk	80	770

The (un)dependency between the two sub-objectives in terms of the utility is analysed. Establishing independence in terms of utility between sub-goals allows decomposing the multi-factor utility function of the primary purpose to simple (single-attribute) utility functions. Generally, the independence issue concerns the achievement of the primary goal. Thus, in the considered context, the sub-goal 1 (timber or material) is not utility dependent on the sub-goal 2 (type of product).

In the presented example of office furniture manufacturing, the manager should make a decision which type of products from what kind of raw material would be the best selling. The one factor (timber) moves along the entire scale while the other one (furniture product) is fixed at a given point at the discretion of the manager within the allowable values, expressing the preferences for the different combinations. Thus, only one product is considered in many variants depending on the materials from which it can be produced (Table 1). In the next step, another product is fixed, and the procedure repeats. Thus, if the manager's preferences about the type of goods retain in one direction, so there is independence versus the changed factor (the utility of the material would not depend on the kind of product). If the manager's preferences change direction, there is a utility dependence on the modified factor (the utility of the material would depend on the product). The opposite case is also investigated – at the fixed timber, the manufactured products vary within the entire range of assortment (Table 2). These interrelations define the structure of the aggregated utility function $\boldsymbol{F}$ as follows:

$$F(y, z) = f_2(y, z_0)\,[1 - f_1(y_0, z)] + f_3(y, z_1)\,f_1(y_0, z) \qquad (1)$$

The value-focused thinking of the factory manager is explored through the abovementioned procedure. Three single one-dimensional utility functions f_1, f_2 and f_3 are constructed, where dash-dot lines are pattern recognition of DM's preferences, while solid lines are polynomial approximations of utility (Fig. 2). Function f_1 describes the choices of DM in terms of material used (Table 1) for a furniture "shelf" y_0 – the preference for this product focuses on the more affordable, but not the cheapest raw material. The minimum of utility function f_1 indicates that it is unacceptable a simple piece of furniture (shelf) to be made of expensive high-quality timber spending a large amount of money.

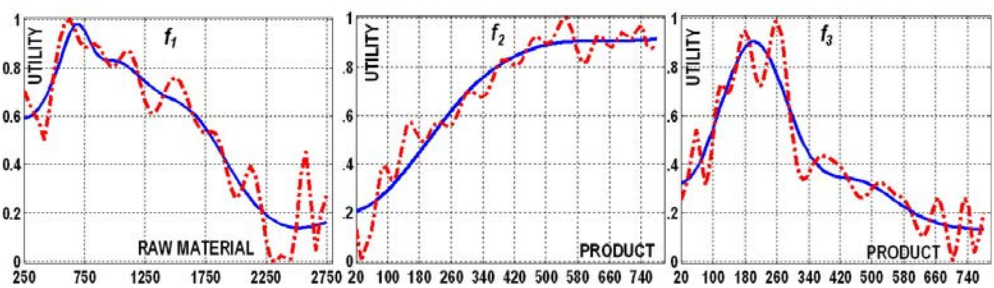

Figure 2. Single one-dimensional utility functions f_1, f_2 and f_3

The second function f_2 reflects the manager's thinking regarding the range of products for a chosen material z_0. According to DM's preferences, it is profitable to produce elaborate types of furniture when using cheaper raw materials z_0. The third function f_3 represents the manager's preference regarding a piece of furniture using a more expensive raw material z_1 (at about 700 €/m^3). The choices of DM changes significantly with the increase of raw materials price – compare the second and third graphics in Fig. 2.

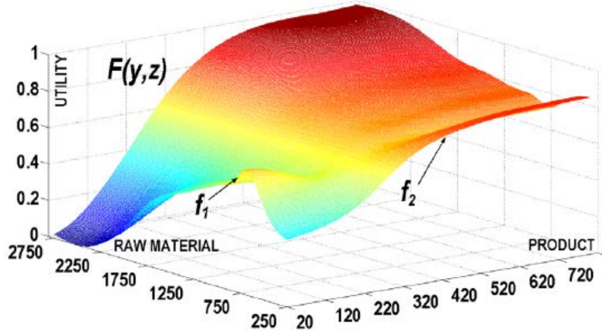

*Figure 3. Multi-attribute utility function **F***

The multi-attribute function ***F*** (Fig. 3) that quantitatively represents the DM's main goal is constructed based on the formula (1), which describes the structure of this goal (Fig. 1). Within ***F*** the scales of the single utility functions are synchronized. From the shape of aggregated utility function ***F***, some conclusions can be drawn: for the profit of the enterprise is more important not the raw material used, but the kind of furniture which customers need. Easy noticeable is the most profitable work area – the plateau of ***F***. The value-based modeling shows that working when the utility function is over 0.7 is efficient too. It is preferable to use more high-quality raw materials for more functional and long-lasting furniture. ("Expensive, but of high quality!"). According to the factory manager, office furniture made of cheaper materials is not very profitable.

5. CONCLUSION

The research presents a value-based mathematical approach to decision-making in the scope of economics, concerning the problems about the product range and resource allocation. Usually, by the conventional methods, it is difficult to find a logically sound formal decision to such complex tasks, where many factors (complexity of the problem, objectives, empirical and professional knowledge of DMs) have to be taken into account. The scientific approach is the decision-making theory and its mathematical kernel – utility theory: this is value-based modeling and decision-making, as it is discussed in the paper.

The DM's subjective preferences acquired by experience becomes of practical benefit. For every particular management task, they can be evaluated by a utility function. The applied methodology and algorithms are quite general and able to handle qualitative information. The implemented approach also allows mathematical and computer processing of conceptual data (including preferences). The research presents an innovative procedure to explicitly expose the subjective expectations to support decision-making in the management of resource allocation. The main focus is on: 1) analytical representation of subjective DM's expectations as utility; 2) mathematical evaluation of the utility function of a considered piece of furniture; 3) determination of optimal product range according to the manager's practical experience, expressed by preferences. Thus, the described approach for utility assessment of DM's preferences is an application of control theory in the management of complex systems and in particular in SMEs, as well as it is a step ahead to their digitalization.

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PERCEPTION OF BENEFITS AND NEGATIVES OF THE PRODUCTION FROM CERTIFIED RAW WOOD BY CZECH WOOD PROCESSING COMPANIES

Andrea Sujová, Jakub Michal

Abstract: The philosophy of social responsibility and ecology has been appearing in business activities and business goals of enterprising entities more often than before. The current trend in consumer thinking is towards ecologic and ethical behaviour, too. One of the important requirement of the EU is an implementation of certified systems and production of wooden products from certified wood. The paper is focused on the analysis of impacts of production from certified wood on processing companies. The aim of the paper is to analyse the reasons, benefits and negatives of the certified production from the economic point of view. The paper presents selected results of a primary research carried out in the Czech Republic, which was focused on investigating the economic impacts of wood products manufacturing from certified raw wood. Presented results show economic impacts as perceived by the wood processing companies.
Keywords: certified wood; wood processing; economic performance

1. INDTRODUCTION

The exploitation of natural resources by human society gets into conflict with sustainability and with any certainty regarding their existence for future generations. According to the WWF European Policy Report, the mankind will get into a so-called ecological debt as early as on 1st August. This information is based on the global average of the individual countries. (Joppart 2019) Demand, which increases with the development of human society, exerts pressure on our planet. Thus the term “sustainable development”, which has long been in the centre of both European and global life, becomes authoritative for both current and future society. A crucial document which addresses sustainability and which shall act as an international platform is the 2030 UN Agenda for Sustainable Development. As for the sustainability issues analysed in this article, they relate to the Goal 15 of the Programme: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss. In the European context, there is just one negative or deteriorating sub-indicator of the five ones assessed in line with the Goal 15, specifically, the “proportion of forest area under long-term forest management plans“. The other assessed sub-indicators include the “Forest area net change rate”, the “Aboveground biomass stock in forest”, the “Proportion of forest area located in legally established protected area”, and the “Forest area under independently verified forest management certification schemes”. It is the deteriorating situation in the ratio of forest areas to the overall area of the territory according to long-term forest management plans which requires attention and analyses of its consequences in relation to sustainability. This situation results from more frequent occurrences of disasters caused by abiotic agents, insects and fungi, from which central and western Europe has suffered in last years. (Kunca, et al. 2014) However, disasters and drought are not the only problems; taking account of the level of defoliation, the most affected forests in Europe are in South and South-East France, in Northern Italy, in the Czech Republic, in Slovakia, and in central Germany. Hence in the European context, the state of Czech forests remains poor despite the sharp decrease in emissions of polluting substances into the air in the 1990s. (Cenia, 2015)

The interpretation of the outputs of the research survey conducted by the authors requires an explanation of the situation in the area of sustainability in the Czech Republic. The situation of the managed forest assets in the Czech Republic is very specific: they are almost on the verge of their very existence due to the disasters and increasing drought. Sustainability plays the key role in all current problems. Obviously, it did not cause the current problems but its appropriate strategy could help solve this situation to a large extent. Looking for specific legislative measures linked with sustainability, it is only addressed in Act No. 17/1992 Coll., which mentions that "Permanently sustainable development of the society is that development which preserves for present and future generations the possibility of meeting their basic needs, and at the same time, does not reduce the diversity of nature and preserves the natural functions of ecosystems". Other documents with the nature of strategic measures include the "Strategic Framework for Sustainable Development 2010", which has been amended to the "Strategic Framework for Sustainable Development 2030" in reaction to the UN Agenda 2030. The document summarises the solutions to the situation in the area of conservation of forest ecosystems in six general principles of sustainable development and mentions resilient ecosystems in chapter "Management Summary" and in the subsequent SWOT analysis. In spite of the rather poor legislative support for this issue, formulations of environmental policies contain voluntary mechanisms and market stimuli which modify the concept of sustainability despite the uncertainties concerning their true impacts. (Cashore et. Al. 2005)

When assessing the impacts, it is important to analyse all aspects of the emergence of such mechanisms or tools and to selectively collect and evaluate information from users and stakeholders in the chain of users. At the Czech national level, the enterprises can choose between two voluntary tools which represent the interests of sustainable development, namely the FSC certification (Forest Stewardship Council) and the PEFC certification (Programme for the Endorsement of Forest Certification). A forest certification is perceived as a voluntary mechanism which arose from the worries about sustainable management of forest resources. Vlosky et. al., 2015, argue that the opinions of individual entities on certifications differ when it comes to the economic impacts of this voluntary mechanism. The study conducted by Mikulová et. al., 2015 assessed the environmental social and economic effects of certification in the Czech Republic. This article presents some outputs of a project carried out in 2018, which analysed the socioeconomic impacts in the timber product segment with the aim to assess the positive and negative effects of certified wood raw material in businesses. These outputs were analysed with respect to the specific indicators of economic efficiency of the certified businesses as well as to the facts which most discourage the non-certified businesses from accepting such tools.

2. MATERIAL AND METHODS

This article adopts a method which reflects the process of preparation of analytical studies as far as possible. During the first stage, the theoretical framework was defined using academic publications and both national and international legislation related to the issue. The findings were verified and compared with the primary and secondary data collected in the Czech Republic. In section "Results", the authors set basic hypotheses to maintain the analytical methodology. Subsequently, they tried to draw conclusions regarding rejecting or not rejecting the hypotheses using the project outputs. The data used to draw conclusions regarding the hypotheses were obtained from a questionnaire survey carried out in the Czech Republic in 2018. A complex preparation of a database of addressed respondents had preceded the creation and distribution of the questionnaire survey. It was crucial to create a database of both certified and non-certified respondent in order to maintain the informative nature of the survey. The e-mail addresses of almost all FSC- or PEFC- certified businesses of 2016 were gathered from the public databases of the certification systems (this database had been created prior to the project conducted in 2018) and they were completed with an internal database of businesses active in the wood processing industry created by the authors of this article in 2017. The two databases together comprised 723 business, i.e. addressed respondents, of which 127 filled in the questionnaire. Because of the use of the survey system method, the confidence interval of 8% had to be used to satisfy the requirements on a statistically relevant sample. Nevertheless, it did not necessarily mean a deviation from the informative value of the data thanks to the complex nature of the information gained from the enterprises. The questionnaires were mainly distributed in electronic form via a pay-platform of survio.com, which provides an umbrella for many nation-wide surveys regarding data collection using questionnaires. Several hypotheses were selected in order to identify economic effects of certification on businesses; these are provided in Table 1.

Table 1. Hypotheses which set the frame for the questionnaire survey of business entities

	Hypothesis
H_0 (1)	Does the duration of the use of certification systems have a positive effect on the economic result (profit)?
H_0 (2)	Does the duration of the use of certification systems have a negative effect on the performance result ROE (return of equity)?
H_0 (3)	The use of certification systems provably brings more positive economic impacts on enterprises than negative effects.
H_0 (4)	The costs of certification and consumers' disinterest in certified products are the main criteria for rejecting the eco philosophy in a business.

3. RESULTS

The results presented in this section were obtained from the questionnaire survey conducted in 2018. They were used to consider the validity of the interpretation of the set hypotheses. The answers to the questions "What profit or loss does your company/business make?" and "What was the level of the ROE indicator reached by your company/business?" were used in the contingency with the time aspect in the form of the duration of the businesses'/respondents' certification to either reject or not reject the H_0 (1) and H_0 (2) hypotheses. The results of the hypotheses are shown in Tables 2 and 3.

Table 2. Results of the questionnaire survey related to the H0 (1) hypothesis

Answer to question 1	**Indicators of economic efficiency (profit) in CZK**				
	Negative	Up to 50 million	51-100 million	101-250 million	More than 251 million
"less than 1 year"	1	3	0	0	0
"1-3 years"	1	3	0	1	0
"4-5 years"	0	13	0	0	1
"6-10 years"	1	16	2	2	0
"10 and more years"	2	16	0	1	1
Number of respondents	**64**	**64**	**64**	**64**	**64**

Building on the results presented in Table 2, the H_0 (1) hypothesis can be not rejected since the number of businesses with positive economic results increases with the duration of the application of the certification system. Table 3 below demonstrates the same contingency for the ROE (return on equity) indicator with respect to the confirmation of the dependency between the duration of the certification and the increase in economic efficiency. The number of respondents used in Tables 2 and 3 does not equal the number of respondents mentioned in section "Material and Methods" hereof since the questionnaire survey also aimed to determine the socioeconomic criteria of disinterest of the non-certified business. Therefore, the sample for the given questions included 64 respondents.

Table 3. Results of the questionnaire survey related to the H0 (2) hypothesis

Answer to question 1	Indicators of economic performance (ROE) in CZK					
	ROE < 0% (negative)	0% to 2%	2% to 4%	4% to 7%	7% to 10%	More than 10%
"less than 1 year"	1	2	1	0	0	0
"1-3 years"	1	1	0	2	0	1
"4-5 years"	0	6	4	2	1	1
"6-10 years"	1	8	9	2	0	1
"10 and more years"	0	9	6	2	0	3
Number of respondents	**64**	**64**	**64**	**64**	**64**	**64**

Based on Table 3, it can be concluded that the H_0 (2) hypothesis shall be rejected since, based on the data obtained from the respondents, the certification shows positive values of the ROE over the medium and long term, which means that the time aspect of the certification does not affect the ROE negatively.

The evaluation of the H_0 (3) hypothesis employed ten criteria for an assessment of the positive or negative effects of the certification experienced by the companies since the implementation of the certification. The respective values and figures are shown in Table 4.

Table 4. Results of the questionnaire survey related to the H0 (3) hypothesis

Assessed criterion	0-5%	6-10%	11-15%	16-20%	21-25%	26-30%	30-35%	36-40%	40 and more %
Increase in sales	32	12	5	2	1	0	0	0	0
Increase in profit	37	7	3	0	1	0	0	0	0
Decrease in costs	41	3	1	0	0	0	0	0	0
Increase in added-value	29	9	5	4	1	0	0	0	0
Increased return on investment	38	3	2	1	1	0	0	0	0
Increase in number of customers	27	12	5	1	3	1	0	0	2
Decrease in complaints	42	3	0	0	0	0	0	0	1
Increase in number of contracts	26	14	3	2	2	1	0	0	1
Improved market position	23	12	6	2	2	2	0	0	2
Improved competitiveness	21	16	6	2	5	0	1	0	1
Decrease in sales	35	1	1	0	0	0	0	0	1
Decrease in profit	34	0	0	0	0	0	0	0	1
Increase in costs	31	9	4	0	1	1	0	0	1
Decrease in added-value	35	1	1	0	0	0	0	0	0
Decreased return on investment	32	3	0	0	0	0	0	0	1
Decrease in number of customers	34	0	0	0	0	0	0	0	1
Increase in complaints	35	1	0	0	0	0	0	0	0
Decrease in number of contracts	33	2	0	0	1	0	0	0	0
Worse market position	36	0	0	0	0	0	0	0	0
Worse competitiveness	35	0	0	0	0	0	0	0	1
Difference in absolute values	**-24**	**74**	**30**	**14**	**14**	**3**	**1**	**0**	**1**

The assessment of the H_0 (3) hypothesis follows from the difference in the positive and negative values as well as from their frequency. The difference clearly shows that the numbers and percentages of the positive criteria prevail, which means that the H_0 (3) hypothesis cannot be rejected. The last followed criterion which demonstrates the partial outputs of the project and informs about the economic impacts of the certifications is the most frequent reasons which discourage companies from applying the eco-philosophy in their business. The most frequent answers with the largest percentages of the overall number of responses are presented in Table 5.

Table 5. Results of the questionnaire survey related to the H0 (4) hypothesis

Answers to the questions	Number of answers	Percentage
Competitive disadvantage due to higher price of products	17	**13.40%**
Increased operational costs	31	**24.40%**
Consumers' disinterest in such products	22	**17.30%**
Poor legislative support	9	**7.10%**
I do not consider this area of business important (more aspects)	17	**13.40%**
I do not know ECO labelling, therefore I do not prefer it	9	**7.10%**
Poor marketing support of the ECO labels and the consumers' lack of knowledge	14	**11%**
Poor initiative of interest groups to promote this philosophy globally	8	**6.30%**
Other reasons (please specify)	8	**6.30%**

Based on the information obtained from the responses, it can be said that the H_0 (4) hypothesis is not rejected and that the costs of certification and the consumers' disinterest in those products are the most frequent criteria for rejecting the eco-philosophy in business. These statements are also confirmed by Michal et al. (2018).

4. SUMMARY

The article is based on the outputs from the research project conducted by the team of authors in 2018. Regarding the specified areas of the given issue, it can be said that a strategic plan for sustainable development based on voluntary tools such as certifications has more pitfalls.

It cannot be proved that certifications have exclusively positive economic effects or that they ensure high levels of nature protection and conservation. Formulations of strategies and concepts of national and international policies shall focus more on stimulating real interest of the whole society in sustainability matters. However, numerous studies have shown that certifications are not the most effective option to entice such interest and that they often have rather market and marketing character. Despite the fact that in the view of the broader range of options certifications systems seem to be beneficial for companies, the actual benefits for the society as a whole is often subject of confrontations at the level of national policies as well as of broader public.

The current form of the certification systems has some drawbacks and their continuous monitoring and assessment is beneficial for all interested parties. Despite the voluntary nature of the certification as one of its fundamental principles, it has become increasingly clear that the interest in certifications is only sparked by internal and external stimuli which are neither spontaneous nor environmentally oriented. The authors will further deal with analyses and research of these facts in their future academic and publication activities.

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Part 5
GLOBAL TRENDS AND CHALLENGES: POLICIES AND GOOD PRACTICIES FOR FORESTRY AND FORESTRY BASED INDUSTRIES

GLOBAL TRENDS AFFECTING THE EU TIMBER TRADE

Michal Dzian, Hubert Paluš, Ján Parobek

Abstract: Nowadays the economy is under the strong influence of globalization trends. The set of variety economic and political decisions have impact for the whole wood market sector. Traditional trade patterns of wood products market are transforming by effects of global megatrends such as social and economic development, technological progress, demographic and climate changes. The aim of this paper is to examine the global trends which affecting the position of the EU on wood and wood products markets. Industrial wood production and consumption increase yearly in the EU. A share of the EU industrial wood and wood products trade is nearly 50% of the global trade. Therefore, the EU represents one of the world´s strongest trading blocks. The results describe the development of EU production and trade of industrial wood and selected wood products and identify the EU position from the global perspective. Following the results, the EU represents very stable and important trading partner from the global perspective. Nevertheless, the results confirm the significant differences of development of specific commodity markets.
Keywords: timber trade, EU, global factors

1. INTRODUCTION

The international wood market and wood products market is constantly evolving. Traditional business models are shaped by global megatrends such as demographic change, social and economic development, climate change and technological progress. At present, significant changes in the political, social and economic spheres are reflected in the use of domestic renewable resources. It is wood that is a significant renewable resource and is very closely linked to a number of national economy sectors (Kalamarova et al., 2014). The importance of globalization in the development of world markets has been evident in recent decades and its impact on the wood and wood products market can be also observed. There are several studies which reflect the global changes at the world industrial wood and wood products markets (e.g. Hurmekoski, 2013; Buongiorno, 2015; Zhang, 2012; Dragicevic, 2017; Knauf, 2017; Latta et al., 2016; Wear et al., 2016). New approaches oriented towards reducing construction emissions affect the growth of wood-based products in the different sectors of national economies, in an effort to replace carbon and energy-intensive concrete and steel structures (Hildebrandt et al., 2017). The EU wood and wood products market share is almost 50% of the global trade. Therefore, the EU is one of the strongest trading blocs in the world. On the other hand, rapidly growing markets in Asia and in the regions with relatively low production costs such as the South America have also influenced the trends of the industry in countries of Europe and North America.

The aim of this paper is to analyze current global trends in the wood and wood products market and to evaluate the EU market share in the global trade. The analysis focuses on the most important wood products as well as roundwood. The applied comparative indicators for trade analysis are derived from the production, export, import and consumption data of EU countries.

2. EU´S TIMBER TRADE

In the EU we have seen rapid changes in the industrial processing of roundwood and in the production of individual wood products, such as pulp, paper, or sawnwood in the last decade. These changes were more rapid than in other sectors. One of the most important global events was China's accession to the WTO, which led to the increase in imports of wood products to China. China's position on the world wood market is very important. This country has experienced rapid economic development in recent decades that led to an increase in demand for commodities and import of raw materials in the country. Apart from this development, there is also visible an increase of imports of furniture from developing countries to the EU (Khosravi et al., 2018).

2.1. Industrial roundwood market and trade in the EU

Year 2017 was the fifth consecutive year of increasing industrial roundwood production in the EU. Countries such Finland, Sweden and Poland contributed most to this increase. Industrial roundwood 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). In the same period, the development of EU´s roundwood imports has decreased by 6%. There was a significant shift in wood flows in Central Europe, namely in the Czech Republic. The exported volume of roundwood from Czechia increased by almost 43% between 2015 and 2017 and was the largest among all EU member states. The share of EU's import of roundwood at the worldwide imports has been stable over the past 5 years and reached about 40%. The share of exports was about 30%. Based on the analysis of roundwood market in the EU it can be stated that consumption and production were growing over the examined period. This development is based on the efforts to increase the use of domestic resources in the EU countries as wood supply has been constantly growing in the recent decades. One of the global factors affecting the EU´s industrial roundwood trade is the China position on the world wood market. Roundwood represents one of China's main importing commodities. Insufficient forest resources, harvesting restrictions and a growing economy together have continued to widen the gap between domestic roundwood supply and demand in China (Sun, 2014). The increasing production and consumption of wood in the EU is also linked to the development of the economic situation. The economic growth represents one of the most important factors which creates ideal conditions for the development of timber market. Following the theory of derived demand, the demand for wood depends on the demand for final wood products (Parobek et al., 2014). Therefore, the changes in the development of related industries are reflected in the wood products market.

2.2. Wood products market and trade in the EU

The following part highlights the changes caused by global developments in the global wood market. The source of the analysed data was the FAO database (FAOSTAT, 2017) and UNECE Forest Products Annual Market Review (2018).

2.2.1. Sawnwood

Demand and production grew in all global sawnwood markets in 2017. Since 2013 the EU market has increased production by 10.5%. The development trend is associated with the consumption of coniferous sawnwood, which has grown by almost 14%. Germany remains the biggest consumer with a consumption of 2 mil. m^3 in 2017 (Mutanen, 2006; UNECE, 2016). The share of EU production of coniferous sawnwood at the worldwide production is around 30%. The EU consumption of coniferous sawnwood represents 25% of worldwide consumption of coniferous sawnwood. However, this share declined by 5% in the long-term.

Coniferous sawnwood EU trade has been increases in both trading categories (export and import). A level of import has grown by 23% over the past 5 years and reached value 35 mil. m^3. Since 2013, the growing trend is also evident in the case of export, which has increased by 13.5%. In 2017 it reached almost 50 mil. m^3. The volume of exported coniferous sawnwood in the EU represents almost

40% of the global market (UNECE, 2016). Globally, the EU export share on the global exports has slightly decreased by 2%over the past 5 years. The EU export of coniferous sawnwood to China increased by 37% to 2.1 mil. m^3. Finland and Sweden were the most significant China partners. The import of coniferous sawnwood in the EU represents almost 30% of the global imports. The EU share on the global import grew by almost 2%. Overall, EU´s import grew faster than consumption.

In the case of non-coniferous sawnwood a gradual increase in both production and consumption in the EU market can be seen (Figure 1). Non-coniferous sawnwood represents one of the most important material sources for furniture industry. Following the theory of derived demand, an important factor, which largely influence the non-coniferous sawnwood market, are the customer preferences. One of the key trends was a change in oak furniture preference by a large number of end customers (UNECE, 2016). It is necessary to understand that customer behaviour is transformed under the pressure of global change. Another factor which is also affecting the consumers purchasing decisions is the fact that furniture nowadays stands for a symbol of consumer status and is most often considered a permanent investment (Kaputa et al., 2018). Production of non-coniferous sawnwood increased by 6% in the last 5 years and reached 10.5 mil. m^3 in 2017. Consumption increased by 2.5% to 11 mil. m^3 in 2017. The growth of consumption was related to the changes in the development of related industries such as the furniture industry and other industries using wood, mainly represented by the construction industry. Construction of new buildings in the EU increased by 8.8%, but a significant slowdown was expected in 2018 and 2019 (UNECE, 2016). The EU furniture market, which is another demand driver for non-coniferous wood increased slowly by 1%, however there is a stagnation in the output of the furniture industry in many Western European countries. The share of production and consumption of non-coniferous sawnwood on the global scale was around 7.5% and 8.5%, respectively.

The EU´s non-coniferous sawnwood trade has changed rapidly in the long-term. Over the latest 17 years the roles of export and import have changed. Under the influence of global changes in the wood market, the EU has become export-oriented region from formerly import-oriented part of the world. The volume of exported coniferous sawnwood has increased by 30% over the last 5 years, reaching the highest value 5.6 million m^3 in 2017. At the same time the imports grew slowly than the exports, rising by 14% over the past 5 years.

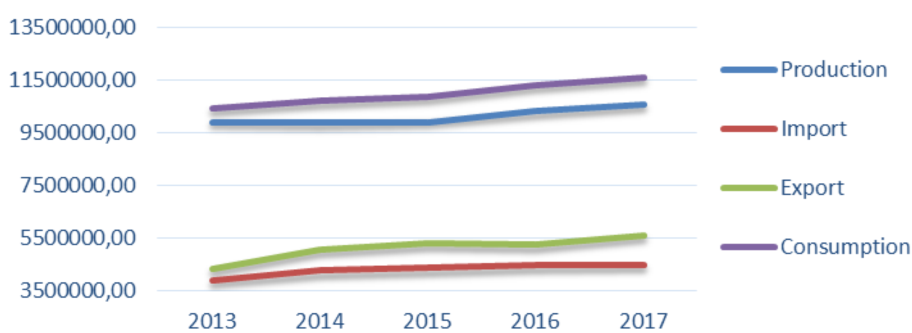

Figure 1. Development of EU´s non-coniferous sawnwood trade2.2.2 Wood based panels

The growth of the EU production and consumption of wood based panels in 2017 was slower than in the two previous years. The final consumption is still the most important factor affecting the consumption of wood based panels. The total production of wood based panels in the EU has increased by almost 11% over the last 5 years and in 2017 it was 64 mil. m^3. In the same period the consumption of wood based panels increased by 18% and reached a maximum 64 mil. m^3. The export level was higher than the import level, but the difference between them has been steadily decreasing.

There is also a change in the wood based panels trade from the worldwide perspective. In 2017, the share of EU exported wood based panels on the global exports was almost 35%, while the share of import increased by almost 3% in the latest 5 years and reached the share of 38% (figure 2).

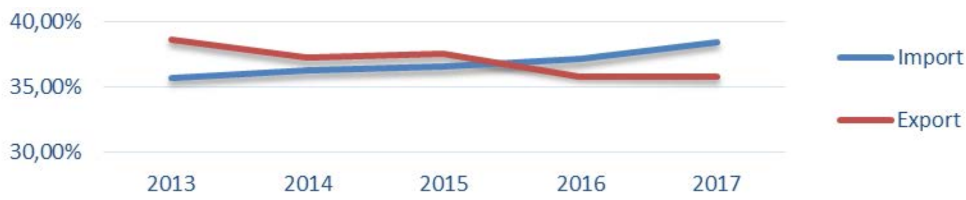

Figure 2. The share of EU export and import of wood based panels at the global trade

2.2.2. Paper and paper boards

The pulp and paper industry was characterized by overcapacity and low prices. Paper production increased by 1% in 2017 and reached 92.5 mil. ton. The paper sector is largely affecting by constant growth of electronic communications (UNECE, 2016). The share of EU on the global paper and paperboard consumption and production was about 20%. A decrease in demands for some types of paper was also characteristic for the EU markets. For packaging paper, sanitary products, and foils decreasing demand has not been shown (Toppinen et al., 2017). In the case of pulp production there was an increase in production by nearly 2.5% over the past 5 years, with the highest volume of 38 mil. t recorded in 2017. The EU pulp consumption exceeds its production by almost 5 mil. t annually. The EU paper and paper board trade is characterized by prevailing export over import. The EU export has increased by almost 5.5% over the past 5 years and reached its maximum in 2017 (64 mil. t). The level of import had a slightly increasing trend over the last 5 years (about 1%) and reached almost 20 mil. t. in 2016.

3. CONCLUSION

The paper analysed the development of timber market and trade in the EU and examined the influence of the main global factors affecting the EU´s market and trade with wood and wood products. Following the previous analyses we can observe that the EU wood and wood products market is under the strong influence of global changes. The EU market holds a dominant position on a global scale and therefore is even more affected by global development. Permanent global changes are caused by various dimensions, such as social, economic, political, cultural or ecological. These changes have a direct impact on the global wood and wood products market and consequently on Europe as one of the most significant player in this field.

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THE EU-28 MARKET OF UPHOLSTERED WOODEN CHAIRS

Slavica Petrović, Igor Džinčić

Abstract: During the period 2004-2018, the EU-28 countries increased the import value of upholstered wooden chairs for 35.1% up to €5.4 billion. Germany, France and the United Kingdom represent the biggest importers of this product in the EU-28, having reached the import value of €3.2 billion in 2018. The most important countries supplying above mentioned countries are Poland and China. Serbia, as a non EU-28 country, participates with small share in the EU market supply with upholstered wooden chairs. The most important EU-28 markets for export from Serbia are Slovenia, the Netherlands, Italy, Croatia and Germany. Except for the international trade flow, the paper also deals with the analysis of the specific requirements of certain markets referring to the quality of chairs, as well as their components.
Keywords: the EU-28 market, upholstered wooden chairs, import, quality requirements

1. INTRODUCTION

In 2012, the world's furniture production was worth €361 billion and the consumption €347 billion (Rende et al., 2014). The biggest producers by value were China, the USA, Germany, Italy, India, Japan, Poland, Canada, Brazil and France. The countries listed produced 80% of total value of the world's production that was realized in 2012 (Rende et al., 2014). The biggest producers of furniture were also the biggest exporters. In 2012, those were China, Germany, Italy, Poland, the USA, Vietnam, Canada, Malaysia, Sweden and France. The same year, the biggest importers of furniture were the USA, Germany, France, the UK, Canada, Japan, Russia, Switzerland, Belgium and Australia (Rende et al., 2014).

A quarter of the world's furniture is produced in the EU 28 (Renda et al., 2014). In 2012, Germany, Italy, Poland and France produced 13% of the world's production and almost 60% of total production in the Union (Renda et al., 2014). Wooden furniture has had significant share in the total value of furniture production. In 2016, its production was worth €39.6 billion (White 2018). The most important producers were Italy and Germany, followed by Poland, the UK, Spain, Romania and Lithuania (White 2018).

In 2016, the consumption of wooden furniture was worth €36.1 billion (White 2018). The consumption was stable in countries with the largest markets such as Germany, the UK, Italy and France, while the consumption in Spain, Poland, Sweden and the Netherlands slightly increased (White 2018). The members of the EU have been the most significant suppliers of its furniture market. In 2016, internal trade in wooden furniture in the EU 28 was worth €16.2 billion, so that the positive trend that had existed in the previous period continued (White 2018).

China has represented the most significant foreign trade partner of the Union in wooden furniture for years. In 2017, the import value to the Union from China was over €2.1 billion, or 49.5% of the total import value from the non-EU countries (White 2018). In addition to China, among the non-EU countries, Vietnam, Indonesia and Bosnia and Herzegovina have been significant suppliers to the EU market, as well. In 2017, the share of Vietnam in the total import value to the EU was 12.2%, Indonesia 5.3% and Bosnia and Herzegovina 3.3% (White 2018).

2. MATERIAL AND METHODS

The market research of upholstered wooden chairs in the EU 28 was done by using office research. The analysis of the volume of trade, of the largest suppliers of the EU market with this type of product, and the countries that represent the largest importers in the EU, was done based on the data taken from the Eurostat database. The analysis of the market of upholstered wooden chairs in Serbia, with the aim to identify the characteristics of this type of product, as well as the requirements regarding the quality of products was done based on the field research and interviewing largest producers.

The market research of upholstered wooden chairs in the EU 28 was conducted for the period 2004-2018, which represents a sufficiently long period, which allows looking at the situation and changes at the market, as well as the reasons that lead to them. European countries underwent an economic crisis in the past decade, and for that reason, the chosen period for analysis covered the years before, during and after this event.

The research whose results are represented in this paper, was performed using selected general and specific scientific methods. In the research, general scientific methods were used, including method of content analysis, structural analysis, methods of induction and deduction, method of synthesis and two of the specific methods, personal interview and benchmarking analysis. Method of content analysis was used to understand the quality requirements for durability of chairs prescribed by the national standard SRPS EN12520:2016. Structural analysis was used to determine the share of EU and non-EU countries in supplying its market with chairs, the most significant countries in supplying EU market, as well as the share of the most significant suppliers to the largest consumers of this product in the EU. The induction and deduction methods were used to draw conclusions about the current state and changes at the market of upholstered wooden chairs in the EU. Method of syntheses was used to identify the main trade flows of upholstered wooden chairs at the EU market. The technique of personal interview was used for collecting certain data for the analysis of the market of chairs in Serbia. The benchmarking analysis was used to analyze the largest exporters of upholstered wooden chairs in non-EU countries, as well as largest importers of this product in the EU.

3. RESULTS AND DISCUSION

3.1. Trade in upholstered wooden chairs at the EU28 market

In the period 2004-2018, the EU28 increased the value of trade in upholstered wooden chairs by 35.1% up to €5.4 billion (Eurostat 2019). During the whole analyzed period, internal trade was more intense than external trade, and in 2018 theirs shares in the total value trade in upholstered wooden chairs in the EU28 were 69.5%:30.5% (Figure 1). The mentioned ratio was different than 2004, when it was 80.3%:19.7%. The change of the value shares in the analyzed structure was the result of an increase in the external trade of EU28 chairs by average annual growth rate of 5.5% in the period 2004-2018. In the same period, the internal trade in chairs of EU28 increased by average annual growth rate of 1.1%.

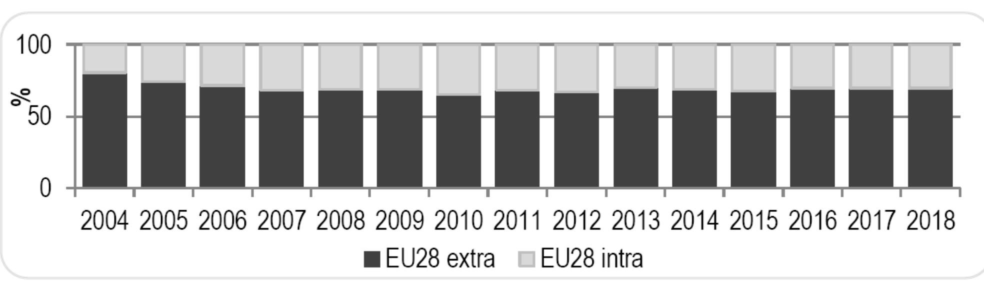

Figure 1. The structure of trade in upholstered wooden chairs in the EU28 (Eurostat 2019)

3.2. The most important suppliers of the EU 28 market with upholstered wooden chairs

The biggest suppliers of the EU market with upholstered wooden chairs are Poland, China and Italy (Figure 2). The analyzed period marked significant changes in the list of the biggest suppliers of the Union market. In 2004, Italy was the biggest supplier of the Union market, followed by Poland and China. However, in 2007 the order changed, because Italy and China changed treir positions. The mentioned change came about as a result of the decrease in import to the Union from Italy by average annual growth rate of 8.2% in the period 2004-2007. In the same period, the import to the EU from China was increasing by average annual growth rate of 37%, and from Poland by rate of 1.5%. China remained the biggest supplier of the Union market until 2010, when Poland took its place. In the period 2010-2018, the EU was continuously increasing the import from Poland, and the import from China alternately grew and fell, and the negative trend of the import from Italy continued. In 2018, the import value to the EU from abovementioned countries represented 61.2% in the total import value, and the share of Poland being 30.2%, China 21.8%, and Italy 9.2%. According to above mentioned, in the period 2004-2018, the EU increased the import value of chairs from China by 3.1 times, from Poland almost by 2 times, while the import value from Italy decreased by 2.4 times.

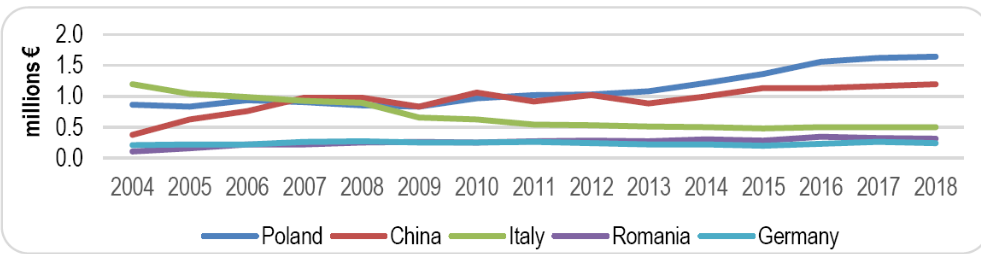

Figure 2. The most significant countries supplying of the EU 28 market with upholstered wooden chairs in the EU28 (Eurostat 2019)

Romania and Germany are less significant suppliers of the Union market then previously analyzed countries. The import value to the EU from Romania increased from €106 million in 2004, to €312 million in 2018, and from Germany it increased from €206.7 million to €239 million (Eurostat, May 2019). In the period 2006-2018, the EU 28 had a positive import trend of upholstered wooden chairs from Serbia, and its value increased from €13.5 million in 2004, to €30.8 million in 2018 (Eurostat 2019).[1] The only more significant supplier to the EU, among the non-EU members neighbouring to Serbia, is Bosnia and Herzegovina. In the period 2004-2018, the import value of upholstered wooden chairs to the EU from Bosnia and Herzegovina increased by 5.7 times to €74.6 million (Eurostat 2019).

3.3. Biggest importers of upholstered wooden chairs in the EU 28

The biggest importers of upholstered wooden chairs in the EU are Germany, France and Great Britain, while the Netherlands and Belgium are less significant. Although Germany and France had significant import oscillations during the recession, they achieved the import growth by average annual rate of 2.7%, and 3.9% in the period 2004-2018, unlike Great Britain that had drop by rate of 1.05%. In 2018, Germany had bigger import value by 45,2% than in 2004, and France by 79%, but the import

[1] Since Serbia became an independent country in 2005, the analises of external trade between the EU 28 and Serbia was done for the period 2006-2018.

Figure 3. Structure of the import of upholstered wooden chairs to Germany in 2018 (Eurostat 2019)

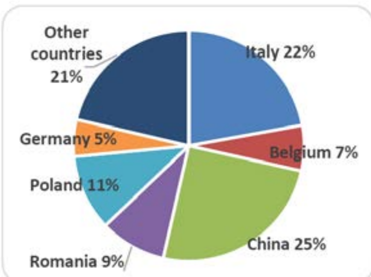

Figure 4. Structure of the import of upholstered wooden chairs to France in 2018 (Eurostat 2019)

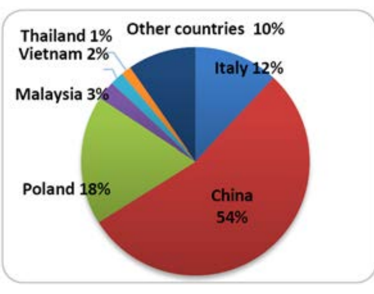

Figure 5. Structure of the import of upholstered wooden chairs to the UK in 2018 (Eurostat 2019)

value of Great Britain was 13.7% smaller. For achieving such results at the Germany`s market, the most significant was the period 2013-2018, during which the import value of chairs to Germany increased by 28.7% up to €1.47 billion (Eurostat 2019). In 2018, France imported upholstered wooden chairs worth €0.9 billion, and Great Britain €0.8 billion (Eurostat 2019). Great Britain had the biggest import in the period 2004-2007, but during the period of recession, it decreased significantly. By 2018, the import value of chairs in Great Britain did not reach the level from the beginning of the analyzed period. In 2018, the Netherlands was the fourth importer in the EU with the import value of €0,46 billion, and Belgium was the fifth with the import value of €0,24 billion (Eurostat 2019).

The Union members have been the most important suppliers to the markets in Germany and France, and the non-EU countries for Great Bretain. During the whole analyzed period, Poland was the most important foreign trade partner of Germany. China became the second, when it suppressed Italy from this position in 2007. In 2018, the share of Poland in total import value to Germany was 58% and China 8% (Figure 3). In the same year, Germany achieved record import value from China worth €120.8 million, which was 3.7 times more than in 2004 (Eurostat 2019). Other significant suppliers of the market were Hungary, Slovakia and Romania. In the analyzed period, Serbia had small importance in supplying Germany market with upholstered wooden chairs. The biggest import value to Germany from Serbia worth €4.2 million was achieved in 2010, and it decreased to €2.0 million in 2018 (Eurostat 2019). The import value of chairs to Germany from Bosnia and Herzegovina was significantly bigger than from Serbia, and it reached €28 million in 2018 (Eurostat 2019).

By 2015, Italy was the most important foreign trade partner of France, and later it became China. During 2004-2018, France increased the import value of chairs from China by 7.8 times to €227 million, while import from Italy decreased by 33% (Eurostat 2019). Poland is the third most important foreign trade partner of France, followed by Romania and Belgium. The structure of import value of upholstered wooden chairs to France in 2018 is presented in Figure 4. During the whole analized period, import from Serbia was simbolic and did not exceed €200.000, unlike import from B&H that achieved €6.2 million in 2018 (Eurostat 2019).

China, Poland and Italy are the biggest suppliers of the market in Great Britain with upholstered wooden chairs. Great Britain achieved record import from China worth 515.3 million € in 2015, and in 2018 it was at the level of 482.2 million €, that was two times higher compared to 2004 (Eurostat 2019). In 2018, a share of China in total import value of Great Britain was 54%, and the share of Poland was 18%, and Italy 12% (Figure 5). During the analyzed period, Great Britain did not have significant cooperation with Serbia, that achieved the biggest import of €0.5 million in 2017 (Eurostat 2019). A bit better cooperation was with Bosnia and Herzegovina, from which Great Britain made record import of €1.5 million in 2018 (Eurostat 2019).

3.4. The characteristics of upholstered wooden chairs produced in Serbia

Slovenia, Italy, the Netherlands, Croatia and Germany have been the most important foreign trade partners of Serbia for upholstered wooden chairs for years. According to estimates of the furniture producers, aproximately 75% of upholstered wooden chairs with a 30mm thick seat produced in Serbia are exported to the EU market (Figure 6). Althought furniture belongs to a group of products whose quality is not mandatory to be controlled, most producers decide to test theire products. In this way, the testing of chairs quality helps the producers protect themselves from unwarranted customer's complaints about the quality of the chairs. Also, the producers use the test reports of the products for theire better positioning at the EU market.

Figure 6. The upholstered wooden chair produced in Serbia most exported to the EU market (“X“ producer in Serbia)

Except in accordance with the general requirements prescribed by the national standard SRPS EN 12520:2016, the largest number of export oriented producers of furniture are determined to test chairs in accordance with additional requirements for load capacity of 120 kg (SRPS EN12520:2016; chapter 6 and 7). In 2018, almost all significant European wholesalers of the chairs announced to the producers more rigorous requirements for the durability of chairs. The warranty period for the chairs will be extened to five years, instead of two, that was the standard in the previous period. The producers of the reproductive material that follow production of sitting furniture (the producers of the sponge and upholstery material) can meet these more rigorous requirements for the quality of the chairs. Required change will cause increase in the average selling price which will have the biggest influence on the chairs of the lowest price in the first category.

According to selling price, the chairs can be devided into three categories (the first category with the lowest price of 30€, the second category with selling price up to 79€ and the third category with selling price over 79€). The second category can be devided into two subcategories, i.e. in the first with selling prices of 31÷49€ and the second with selling prices of 50÷79€. The largest number of the chairs that are exported from Serbia to the EU belongs to the first subcategory. In this category, the material participates in the selling price with about 22%, while the wooden components participate with about 30% (Serbian producers of uhpolstered wooden chairs). Somewhat higher transport costs (compared to competitors, primarily in Poland and Romania) are offset by lower labor costs, so Serbian producers are still competitive in the EU market.

Additional requirements for the durability of chairs, in addition to the quality of the sponge and upholstery material, have less impact on the wooden invisible elements of chairs – gestel of the chair. The producers can meet additional requirements for durability and stiffness of the chair in two ways: by installing a slightly larger amount of basic material (wood) and/or by increasing quality of the production (primarly the elements of joints). Due to adopted approach to structural design, as well as the obsolescence of machines, more rigorous requirements are expected to be fulfilled by installing larger amount of basic material.

4. CONCLUSION

In the period 2004-2018, the EU28 increased the value of trade in upholstered wooden chairs by 35.1% up to €5.4 billion (Eurostat 2019). During the whole analyzed period, internal trade was more intense than external trade, and in 2018 theirs shares in the total value trade in upholstered wooden chairs in the EU28 were 69.5%:30.5%. The biggest suppliers of the EU market with upholstered wooden chairs are Poland, China, Italy, Romania and Germany. In 2018, the import value to the EU from Poland, China and Italy represented 61.2% in the total import value, and the share of Poland being 30.2%, China 21.8%, and Italy 9.2%. In the period 2004-2018, the EU increased the import value of chairs from China by 3.1 times, from Poland almost by 2 times, while the import value from Italy decreased by 2.4 times. The biggest importers of upholstered wooden chairs in the EU are Germany, France and Great Britain. The Union members have been the most important suppliers to the markets in Germany and France, and the non-EU countries for Great Bretain. Slovenia, Italy, the Netherlands, Croatia and Germany have been the most important foreign trade partners of Serbia for upholstered wooden chairs for years. According to estimates of the furniture producers, aproximately 75% of upholstered wooden chairs with a 30mm thick seat produced in Serbia are exported to the EU market

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REQUIREMENTS FOR GREEN PUBLIC PROCUREMENT OF WOOD-BASED PRODUCTS IN THE EU

Hubert Paluš, Nikola Slašťanová

Abstract: Public authorities are the largest consumers in Europe, costing around 16% of the European Union's gross domestic product. They can make a significant contribution to sustainable development by choosing goods and services that contribute to improving the environment. In particular, this paper deals with the analysis of requirements for green procurement of wood and wood-based products by public institutions. Almost all wood and wood products procured by the public fall into three broad categories of paper products (printer and copier paper, envelopes, folders, notebooks, etc.), furniture (tables, chairs, wardrobes, park, street and garden furniture, etc.) and wood used in construction, renovation or maintenance (fencing, roofing, floors, window frames, doors, linings, etc.), including special use of wood, such as harbor barriers or flood barriers. One of the main goals of public procurement policies is to tackle the problem of unsustainable and illegal exploitation of forest resources through several activities. Therefore, this paper also identifies and describes various governments, corporate sponsored associations and organizations that have developed detailed standards and certification systems with technical specifications that are intended to support sustainable forest management.
Key words: wood, paper, public procurement, certification, illegal logging

1. INTRODUCTION

Green purchasing often called as well environmentally preferable purchasing is a way of buying with which public and private institutions purchase goods and services with the least possible negative impact on the environment to replace goods and services that would normally be purchased for execution same function but with a lower environmental impact (Rizza, 2008). Green products or services utilise fewer resources, are designed to last longer and minimise their impact on the environment from cradle to grave. In addition, green products and services have less of an impact on human health and may have higher safety standards (Janssen and Jager, 2002). Whilst some green products or services may have a greater upfront expense, they save money over the life of the product or service. Green purchasing increases the demand for green goods, promotes green production, and helps environmentally sound technologies to succeed in the market. At the same time, it also takes into account energy efficiency and resource efficiency, as well as waste reduction. According to a recent survey in 15 Member States (Salam, 2008), the biggest obstacle to green procurement is unpreparedness to set appropriate environmental criteria in tender specifications, budget constraints related to higher purchase price of green products and services, and legal uncertainty. In fact, global experience and examples show how environmentally preferable criteria early in the procurement process improve the organizations' environmental performance, while addressing ethics, social regeneration and economic concerns (Stefanelli, Jabbour, and Jabbour, 2014).

In addition to improved environmental performance, many'green products work as well or better than traditional products and can even save money. Overall, the implementation and integration of green purchasing concepts constitutes a system-wide process reform that collectively contributes to an organization's reduction in ecological footprint (cumulative associated ownership to global ecological damage stemming from a demand for natural resource to sustain economic and social balance) (Min and Galle, 2001).

Green procurement policies and programs can reduce expenditure and waste; increase resource efficiency; and influence production, markets, prices, available services and organisational behaviour. According to Mosgaard (2015) green procurement is not an easy task. The purchasers need specific environmental and often technical competences to perform green procurement. It involves collaboration between the actors in a supply chain, as the environmental issues considered are not as simply communicated as, e.g., the price of a product (Min and Galle, 1997).

There are also obstacles to implementing green procurement programs, e.g. lack of readily available environmentally friendly products, expensive or non-existing environmental alternatives, inaccurate studies, lack of organisational support, and inaccurate or unsupported environmental claims by manufacturers and suppliers (Srinivas, 2015).

2. GREEN PUBLIC PROCUREMENT

Europe's public authorities are major consumers. By using their purchasing power to choose environmentally friendly goods, services and works, they can make an important contribution to sustainable consumption and production – what is called Green Public Procurement (GPP) or green purchasing. GPP is a voluntary instrument, which means that states and public authorities can determine the extent to which they implement it (EC, 2019).

GPP is a process whereby public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life cycle when compared to goods, services and works with the same primary function that would otherwise be procured. GPP can affect environmental impact as follows (EC, 2008a):

- directly, through improved environmental performance of goods, services and works bought
- indirectly, through using this market leverage to encourage companies to invest in cleaner products and services.

Although GPP is a voluntary instrument, it has a key role to play in the EU's efforts to become a more resource-efficient economy. It can help stimulate a critical mass of demand for more sustainable goods and services which otherwise would be difficult to get onto the market. GPP is therefore a strong stimulus for eco-innovation.

To be effective, GPP requires the inclusion of clear and verifiable environmental criteria for products and services in the public procurement process. The European Commission and a number of European countries have developed guidance in this area, in the form of national GPP criteria. The challenge of furthering take-up by more public sector bodies so that GPP becomes common practice still remains. As does the challenge of ensuring that green purchasing requirements are somewhat compatible between Member States – thus helping create a level playing field that will accelerate and help drive the single market for environmentally sound goods and services (Carter, Kale and Grimm, 2000).

3. EUROPEAN COMMISSION APPROACH TO GPP

The objective of the Communication "*Public procurement for a better environment*" (EC, 2008e) is to provide guidance on how to reduce the environmental impact caused by public sector consumption and how to use GPP to stimulate innovation in environmental technologies, products and services. More specifically, the Communication proposes tools which should enable the main obstacles to increased take-up of GPP to be addressed. The main tasks in this area included: setting common GPP criteria; encouraging publication of information on life-cycle costing (LCC) of products; increasing certainty about legal possibilities to include environmental criteria in tender documents; establishing support for the promotion and implementation of GPP through a political target linked to indicators and monitoring. The Communication was accompanied by staff working documents. This provides useful guidelines for public authorities on the definition and verification of environmental criteria, tools for stimulating GPP and examples for a number of product groups. It also offers legal and operational guidance. Specific areas covered by the Working Document include: (i) formulating an environmental award criterion in the absence of specific GPP criteria; (ii) the specific case of wood and wood products and (iii) GPP and Life-cycle costing (EC, 2008d).

The Commission has identified ten "priority" sectors for GPP. These have been selected on the basis of the importance of the relevant sector in terms of the scope for environmental improvement; public expenditure; potential impact on the supply side; example setting for private or corporate consumers; political sensitivity; existence of relevant and easy-to-use criteria; market availability and economic efficiency. The priority sectors are (EU, 2004): (i) Construction, (ii) Food and catering services, (iii) Transport and transport services, (iv) Energy (including electricity, heating and cooling coming from renewable energy sources), (v) Office machinery and computers, (vi) Clothing, uniforms and other textiles, (vii) Paper and printing services, (viii) Furniture, Cleaning products and services (ix) Equipment used in the health sector.

The Commission intends to highlight existing legal and operational guidance on GPP and to add to it where necessary. Although this is mainly directed at contracting authorities wishing to apply a GPP policy within their organisation, Member States should include it in their national GPP policies as it will facilitate implementation. The European Commission will gradually implement GPP in its general public procurement training sessions and introduce the recommended criteria, which have been developed in the framework of the Training Toolkit on GPP, in its tendering procedures, wherever appropriate (EC, 2008c).

4. GPP CRITERIA

The EU GPP criteria are developed to facilitate the inclusion of green requirements in public tender documents. While the adopted EU GPP criteria aim to reach a good balance between environmental performance, cost considerations, market availability and ease of verification, procuring authorities may choose, according to their needs and ambition level, to include all or only certain requirements in their tender documents (Enviro portal, 2018).

The GPP approach is to propose two types of criteria for each sector covered:

- the core criteria are those suitable for use by any contracting authority across the Member States and address the key environmental impacts. They are designed to be used with minimum additional verification effort or cost increases.
- the comprehensive criteria are for those who wish to purchase the best environmental products available on the market. These may require additional verification effort or a slight increase in cost compared to other products with the same functionality.

GPP criteria are developed for several areas including e.g. cleaning products and services; computer and monitors; copying and graphic paper; electrical and electronic equipment used in the health care sector; food and catering services; furniture; gardening products and services; construction and maintenance; sanitary tapware; textiles; road transport; waste water infrastructure etc. (EC, 2008f).

4.1. Paper products

These recommendations cover the purchase of copying and graphic paper. This encompasses unprinted paper for writing, printing and copying purposes (up to 170g/m2) sold in sheets or reels. Finished paper products such as writing pads, drawing books, calendars, manuals, etc. have not been included. However, contracting authorities may find useful criteria for these products under the Blue Angel Eco-label scheme. The wood used for paper production can either come from tree plantations or forests with fully functioning ecosystems. Industrial logging in virgin or primary forests (in Amazonia, Indonesia, Russia, Canada etc.) and the substitution of functioning ecosystems with tree plantations leads to a loss of biodiversity and makes it increasingly difficult to guarantee that wood derives from legal forestry activities. Illegal logging takes place when timber is harvested in violation of national forestry laws (EC, 2008b). All the major sustainable forest management certification schemes allow the certification of plantations, provided they meet certain requirements. In order to reduce these impacts, there are two solutions:

a) produce/use paper from virgin fibre stemming from legally harvested woods and from sustainably managed forests. The certification of sustainable forest management (such as the FSC, PEFC, CSA, or SFI) guarantees both legality and the respect of environmental and social standards in forest exploitation, although the standards and verification systems differ between the various certification schemes. To guarantee that wood is legally harvested, the EU has also established a licensing system in the framework of its Forest Law Enforcement, Governance and Trade (FLEGT) Action Plan designed to identify the legality of the production of imported products, the FLEGT license. In order to obtain the license, Voluntary Partnership Agreements (VPAs) have to be signed between timber-producing countries and the EU (EU, 2005). Timber products, which have been legally produced in VPA partner countries, will be licensed with a FLEGT license for the legality of production by a third-party, and only licensed products from these partner countries will be allowed access to the EU. The legal origin of wood can also be demonstrated through a tracing system being in place. These voluntary systems may be 3rd party certified, often as part of ISO 9000 and/or ISO 14000 or EMAS management system.

b) produce/use paper from recovered paper. In order to produce recycled paper, paper based on virgin fibre needs to be produced. Both types of paper are part of the same production chain. In fact, it is possible to recycle high quality paper, such as graphic paper, several times for either the same, or lower quality uses, reducing the need for virgin fibre (CEPI, 2005).

4.2. Furniture

Denmark, Germany, the Netherlands and the UK are currently working together to identify the common ground of their respective timber procurement policies. At the practical level for procurers, two assessment and certification schemes have come to dominate the market for auditing of forest management practices and the chain of custody of harvested materials all the way through the supply chain to the final product. Importantly, both the FSC and PEFC schemes offer the possibility for final products to be labelled if they comply with minimum content requirements for virgin wood from sustainably managed forests and/or wood from recycled sources (EC, 2017). In order for the label to appear on the final product, all actors in the supply chain that have handled to product, semi-finished product or any wood raw materials must be covered by valid chain of custody certificates. These certificates can be checked on public databases. It should be added that for any remaining wood content, the following minimum requirements apply to both schemes: it must be legally sourced, not originate from genetically modified organisms and should not come from forests that are being converted into plantations (Rametsteiner and Simula, 2003). However, several studies aimed the consumers of furniture suggest that the origin of furniture is not the key factor influencing buying decisions (e.g. Parobek et al., 2015, Loučanová et al., 2015) or that these factors differs between regions and countries (Kaputa et al., 2017, Kaputa et al., 2018).

4.3. Construction

Designing and procuring an office building with a reduced environmental impact, whether it be new-build or a major renovation, is a complex process. Considering the complexity of the office building procurements, a guidance document has been developed to provide procurers with orientation on how to effectively integrate the GPP criteria for office buildings into the procurement process. It suggests, based on experience from different projects across the EU, how the procurement sequence could be managed in order to achieve the best results (EC, 2011).

Depending on the ambition level of the project and the experience of the contracting authority, not all of the GPP criteria included in this criteria set will be relevant. Moreover, depending on the preferred procurement sequence criteria may be best addressed at specific stages. Some activities may be let as separate contracts requiring their own criteria. The criteria are grouped into the following broad criteria areas: (i) project team competencies, (ii) Energy-related criteria, (iii) Resource efficient construction criteria, (iv) Other environmental criteria, (v) Office environmental quality criteria.

Well-recognised labels that identify lower environmental impact buildings as a whole or individual construction materials and elements are those classified according to ISO 14024 as Type I Ecolabels.

These generally take into account the environmental impacts along the entire life cycle. Recycled content is defined by ISO 14021, which is a standard for Type II self-declarations by manufacturers, as the proportion, by mass, of recycled material in a product or packaging. Environmental Product Declarations (EPD), developed according to ISO 14025 and ISO 21930, are Type III labels that can provide environmental information from LCA studies in a comparable format, based on common rules, known as Product Category Rules (PCRs) (EC, 2016).

5. CONCLUSION

GPP is an important voluntary environmental policy tool through which the EU countries seek to integrate environmental requirements when purchasing goods and services and thus reduce negative environmental impacts. This paper aimed to describe the background, legislative framework and the processes proposed for the application of green public procurement in the EU.

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SUSTAINABLE BIOENERGY POLICY FOR THE PERIOD AFTER 2020

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Abstract: Bioenergy is the form of renewable energy used most in the EU and it is expected to continue to make up a significant part of the overall energy mix in the future. Wood biomass is main source of bioenergy.
The main objective of this paper is to describe, analyze and forecast the development of the EU's bioenergy policy beyond 2020.
The development of bioenergy needs to be seen in the wider context of a number of priorities for the energy union, including the ambition for the EU to become the world leader in renewable energy, to lead the fight against global warming, to ensure security of supply and integrated and efficient energy markets, as well as broader EU objectives such as reinforcing Europe's industrial base, stimulating research and innovation and promoting competitiveness and job creation, including in rural areas.
The EU Commission stated in its 2015 Communication on the circular economy that it will promote synergies with the circular economy when examining the sustainability of bioenergy under the energy union.
The objective of improving EU sustainable bioenergy policy for the period after 2020 should be to have in harmonization EU rules that guarantee that bioenergy is sustainable in terms of biodiversity, soil and water protection, land use change limit, sustainable forest management and mainly reductions GHC emissions.
However, for this framework to be effective and successful, it must be set for forecast period after 2020, in order to provide certainty to economic operators. It must also minimize administrative burdens for operators.
Keywords: sustainability, bioeconomy, bioenergy policy, biomass, renewable resources

1. INTRODUCTION

We live in a world of limited resources. Global challenges like climate change, land and ecosystem degradation, coupled with a growing population force us to seek new ways of producing and consuming that respect the ecological boundaries of our planet. At the same time, the need to achieve sustainability, which constitutes a strong incentive to modernise industries and to reinforce Europe’s position in a highly competitive global economy. To tackle these challenges, it must improve and innovate the way we produce and consume food, products and materials within healthy ecosystems through a sustainable bio-economy. (Paluš, H., Parobek, J., Dzian, M., Šupín, M. 2018), (Parobek, J.et al. 2014).

The bioeconomy covers all sectors and systems that rely on biological resources (animals, plants, micro-organisms and derived biomass, including organic waste), their functions and principles. It includes and interlinks: land and marine ecosystems and the services they provide; all primary production sectors that use and produce biological resources (agriculture, forestry, fisheries and aquaculture); and all economic and industrial sectors that use biological resources and processes to produce food, feed, bio-based products, energy and services. To be successful, the European bioeconomy needs to have sustainability and circularity at its heart. This will drive the renewal of industries, the modernisation of our primary production systems, the protection of the environment and will enhance biodiversity. (Parobek, J. et al. 2016 c), (Loučanová, E., Kalamárová, M., Parobek, J. 2015), (EU Commision, 2011).

The global energy system depends on fossil fuels. In 2016, Coal, Oil and Natural Gas constituted 81% of the total primary energy supply of the world. Renewables accounted for only 14% and have seen an increase of 1% share since 2000.The Total Primary Energy Supply of energy sources is the highest in

Asia due to the large energy supply and use in China, India and other rapidly developing emerging economies in the region. However, in terms of the share of renewables, African continent has the highest share in their energy supply. Almost 50% of the energy supply in Africa comes from renewables – predominantly from biomass-based sources. In comparison, 10.5% of the energy supply in Europe is renewables. (Parobek, J. et al. (2016 b), (Banja M., Scarlat N., Monforti-F.F., Dallemand J.F., 2013).

Bioenergy is renewable energy made available from materials derived from biological sources. Biomass is any organic material which has stored sunlight in the form of chemical energy. Most biomass that is burnt for energy comes from trees, and more worryingly, forests. (Ecofys, 2012).

Bioenergy is the largest renewable energy source globally. In 2016, Total Primary Energy Supply of biomass resources was 70% of the share among all renewable energy sources. Hydropower share was at 18% globally. In continents, the role of biomass is very prominent. In Africa, more than 90% of the total primary energy supply of renewable energy sources is from biomass. In every other continent, biomass is the largest renewable energy source in terms of supply and accounting from between 40% (Oceania) to almost 96% in Africa. (Parobek, J. *et al*. 2016 a), (EU Commision, 2019), (Brack, D. 2018).

Biomass supply comes from a variety of feedstock – fuelwood, forestry residues, charcoal, pellets, agriculture crops and residues, municipal and industrial waste, biogas, biofuels etc. Broadly, the supply can be classified into three main sectors – forestry, agriculture and waste. In 2016, the total primary energy supply of biomass was 56.5 EJ. 87% of the supply was in the form of solid biomass – wood chips, wood pellets, fuel wood etc. 5% of the supply is from waste sources – both municipal and industrial waste. Biofuels and biogas shares are at 6% and 2%. (Parobek, J.; Paluš, H. 2008), Šupín, M. (2011).

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 wood biomass were also used in this paper.

The first section of the paper identifies major features of sustainable development's economic perspectives and presents tools to analyze and quantify the bioeconomy. The second section introduces economic research on measuring the bioeconomy and designing policies to steward it towards sustainable development objectives. The final section outlines the research for resource economics aimed at pursuing sustainable development.

3. RESULT AND DISCUSSION

Launched and adopted on 13 February 2012, Europe's Bio-economy Strategy addresses the production of renewable biological resources and their conversion into vital products and bioenergy. The objectives of the 2012 Bioeconomy Strategy remain still valid. The Bioeconomy Strategy was updated in the 2018. The purpose of this update to the 2012 Bioeconomy Strategy is to address these challenges through a set of 14 concrete actions which have launched in 2019. These actions reflect the conclusions of the 2017 review of the Strategy.

This update to the 2012 Bioeconomy Strategy will maximise the contribution of the bioeconomy to major European policy priorities. Sustainability is not only a legal obligation, it is an opportunity for all parts of Europe and underpins most EU priorities.

Bioenergy is the form of renewable energy used most in the EU and it is expected to continue to make up a significant part of the overall energy mix in the future. On the other hand, concerns have been raised about the sustainability impacts and competition for resources stemming from the increasing reliance on bioenergy production and use.

Bioenergy is unique as it can be a low cost, low carbon renewable which can store energy until it is needed, which is crucial for the power, heat and transport sectors. Very few other technologies could remove as much geologic carbon from our generation mix as quickly. Furthermore, by promoting the use of forest products which would otherwise go unused, demand for biomass is creating far more effective carbon sinks and ensuring forests cover remains.

In 2010, the Commission issued a Recommendation (COM/2010/0011 final) that included non-binding sustainability criteria for solid and gaseous biomass used for electricity, heating and cooling (applicable to installations with a capacity of over 1 MW). Sustainability schemes have also been developed in a number of Member States.

The woody bioenergy sector is characterised by many small and medium enterprises, and the biomass is supplied by hundreds of thousands of forest owners, in addition to larger forest industries and forest owners (companies and state forests). These characteristics make it essential to reach a balanced approach to develop sustainability criteria that guarantee that the increased use of biomass is met with sustainably sourced biomass while minimising new administrative burdens and not blocking the use of biomass sources.

Forests are already subject to several sets of legislation and to voluntary SFM (sustainable forest management) certification. The new EU policy should take into account this existing framework.

Biomass from forests is used for wood products (sawn wood, panels, paper etc.) and for energy purposes (advanced biofuels, heat and electricity). When managing his / her forest, the forest owner doesn't know what the individual tree or tree part will finally be used for, as this depends on the market prices, and decisions later in the supply chain. To date, wood industry (sawn wood, panels, paper etc.) do not have to comply with EU sustainability requirements. In the medium-to-long term, it may be relevant to adopt a holistic approach.

There is a great potential for waste-derived fuels to provide a significant proportion of the EU's projected energy demand. Food waste produced by industry, businesses and in households is a readily available resource that is currently undervalued and underutilised. Wastederived fuels do not require land for production and can represent significant greenhouse gas emissions savings.

One of the great misconceptions about bioenergy from biomass is that it is carbon neutral, meaning that any energy released from burning wood biomass is soon removed again by growing forests. The reality is far more complicated.

The climate emergency is on the verge of becoming a climate crisis. Years of inaction have meant that climate scientists are no longer just discussing the need to reduce emissions, they are also talking about having to remove carbon dioxide from the atmosphere. Known as negative emissions, carbon dioxide removals are now at the centre of the climate conversation.

Governments are responding by looking for technological fixes, and one of the most often discussed is Bioenergy with Carbon Capture and Storage (BECCS). But the belief that BECCS would remove emissions is based on the faulty assumption that bioenergy is carbon neutral. This is not this case. BECCS would also have massive social, environmental and economic costs. It offers the false promise of a get-out clause and must not be allowed to distract from the urgent need to stop burning fossil fuels and to protect and restore forests, soils and other ecosystems. BECCS is unworkable at scale and even in a best-case scenario it is unlikely to achieve significant carbon dioxide removals.

The answers are surprisingly simple.

Instead of burning woody biomass for energy, we can reduce the amounts of energy we use and invest in and subsidise local, real renewable energy technologies such as wind and solar.

To achieve negative emissions (the aim of BECCS) the answer is even more logical. Protecting and restoring natural forests would benefit biodiversity and also bring climate and social benefits. Unlike BECCS, restoring natural forests' climate benefits are tried and tested. Forests already store large quantities of carbon and they have been sequestering carbon for hundreds of millions of years. If protected and managed with the full inclusion of the people that live in and depend upon them, they can help us achieve the targets of Paris Agreement and the Sustainable Development Goals. But first we must reject a heavy reliance on negative emissions and rapidly reduce emissions from fossil fuels to zero, stop destroying ecosystems, and reduce the overconsumption of natural resources.

Sustainable development has since long been at the heart of the European project. The EU Treaties give recognition to its economic, social and environmental dimensions which should be addressed together. The EU is committed to development that meets the needs of the present without compromising the ability of future generations to meet their own needs. A life of dignity for all within the planet's limits that reconciles economic prosperity and efficiency, peaceful societies, social inclusion and environmental responsibility is at the essence of sustainable development. We must tackle current challenges and prepare for the future, responding to the pace and complexity of global change and the demands of an increasing global population. To preserve our natural capital, itis crucial to accelerate the transition to a low-carbon, climate resilient, resource efficient and circular economy. For these challenges to become opportunities for new businesses and new jobs, a strong engagement in research and innovation is needed. EU states have respond to this by the 2030 Agenda for Sustainable Development.

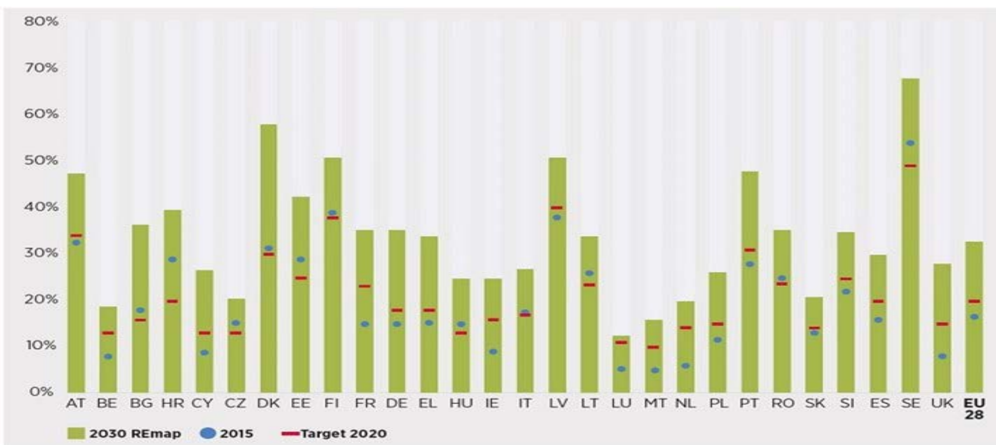

Figure 1. Renewable energy share in gross final energy consumption – 2015, 2020 target and 2030 potential with accelerated uptake of renewables.
Source: European Union & Irena (2018)

The 2030 Agenda provides an opportunity for the EU to strongly anchor its strategic orientation in the global effort to build a sustainable future, which the EU has co-shaped together with its partners. The sustainable development goals are already being pursued through many of the EU's policies and integrated in all the Commission's ten priorities. The 2030 Agenda is based on a global partnership involving all stakeholders, requires mobilisation of all means of implementation and a strong follow-up and review mechanism to ensure progress and accountability. The 17 sustainable development goals of the 2030 Agenda provide qualitative and quantitative objectives for the next years to prepare ourselves for the future. They help to steer a process of convergence, between Member States, within societies and with the rest of the world. The EU's answer to the 2030 Agenda will include two work streams. The first work stream, presented in this Communication, is to fully integrate the sustainable development goals in the European policy framework and current Commission priorities, assessing where we stand and identifying the most relevant sustainability concerns. A second track will launch reflection work on further developing longer term vision and the focus of sectoral policies after 2020, preparing for the long term implementation of the sustainable development goals. While Europe can point to good achievements and progress under all goals up to now. Strengthened implementation and further focused action in all areas will be required to implement the full 2030 Agenda by 2030. (EU Commission, 2019).

The European Commission, except for the 2030 Agenda, has set a long-term goal to develop a competitive, resource efficient and low carbon economy by 2050 and the bio-economy concept was incorporated into the general framework at different levels of EU policy.

The contribution of biomass to energy generation in the EU is important and will further increase, as result of the renewable energy targets for 2020. Bioenergy production is expected to account for about 55 – 58% of the renewable energy use in 2020, of which 45% will consist in heat and electricity production from biomass. The EU could double the renewable share in its energy mix, cost effectively, from 17% in 2015 to 34% in 2030. The European electricity sector can accommodate large shares of solar photovoltaic (PV) and wind power generation.

Biomass will remain a key renewable energy source beyond 2020 and other.

CONCLUSION

The EU has a great potential to become a knowledge and technology leader in bioeconomy, thanks to its good science basis, good R&D capacities and technological leadership in some key enabling technology areas. One of the priorities of the EU is the creation of a resilient Energy Union with a forward looking climate policy that is capable of delivering the adopted for the period after 2020. To achieve this, the EU has to decarbonize its energy supply, integrate the fragmented national energy markets into a smooth functioning and coherent European system, and set up a framework that allows the effective coordination of national states efforts. A bioeconomy has the potential to contribute significantly to the development of a green, low carbon economy due to the lower carbon footprint of bio-based products. The bio-based economy introduces a closed carbon cycle and prevents releasing more CO2 in the atmosphere through to the extraction of carbon (oil, gas or coal) from the earth, as our current fossil-based system. However, this does not automatically mean that the bio-based economy is carbon neutral. Shifting towards a bioeconomy creates new business and innovation opportunities in all European regions, but also the risks.

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INFLUENCER PERCEPTIONS OF CROSS-LAMINATED TIMBER IN THE U.S. SOUTH

Richard P. Vlosky, Rajan Parajuli, Mason T. LeBlanc, Charles B. Gale

Abstract: Mass timber products, wood-based engineered construction materials, are becoming widely prevalent in the design and construction sector. Being a cost-effective, carbon efficient, durable, and sustainable building option, mass timber construction has already had a profound impact in residential and non-residential applications in Europe. Likewise, it has been reaching new heights in Canada, and is recently gaining momentum in the United States. Envisioned as a substitute for the traditional building materials of concrete, masonry, and steel, all forestry stakeholders have reason to be excited about these new timber products. While the Pacific Northwest has been leading efforts in both production and consumption of mass timber products for the past several years, mass timber is still relatively new to the Southern U.S. The main purpose of this article is to provide a brief overview of cross-laminated timber and its market status in the U.S. and the future prospect in the U.S. South.
Keywords: cross-laminated timber, perceptions, construction influencers, United States South Region

1. CROSS-LAMINATED TIMBER (CLT)

The most widespread mass timber product is cross-laminated timber (CLT). CLT is an innovative secondary wood product which has already proven to be a remarkable alternative to traditional building materials such as concrete and steel. The CLT concept is similar to plywood, except for the use of dimensional lumber instead of veneer layers. CLT panels consist of an odd number of layers (typically three to nine) of dimensional lumber stacked perpendicular to the adjacent layers and then glued together to form structural panels (***Figure 1***). With this orthogonal configuration, adjacent layers reinforce the entire panel, adding to dimensional stability, exceptional strength, and rigidity in both directions. CLT panels consist of only two materials; lumber and adhesive. While locally produced softwood lumber is primarily used in CLT panel manufacturing, some initiatives have recently explored the possibility of using underutilized hardwoods in CLT manufacturing in the U.S.

Figure 3. Cross-laminated timber panel layup and finished panel

Over the last 30 years, CLT has been used for a wide range of applications in Europe and Australia, including single and multi-family residential buildings, schools, and office buildings. CLT panels are ready-to-use with lengths up to 60 feet and widths up to 10 feet, used in structural walls, ceilings and roofs. CLT panels are typically prefabricated with pre-cut openings for doors, windows, and stairs. As its strength is equivalent to concrete and steel to replace in multistory buildings, CLT has been used as both a standalone system in construction as well as in hybrid applications with steel and concrete.

1.1. Prospects in the U.S. South

As the United States looks for ways to reduce its carbon footprint, the commercial construction industry and architects are searching for more sustainable products that are cost effective, energy efficient, structurally sound, and environmentally friendly. A key component of an integrated campaign to replace concrete and steel with engineered wood products in modern residential and commercial buildings is to conduct baseline research to provide information on the efficacy of using wood in these applications. Previous research and development to date has focused on using Douglas-fir and other species from the Pacific Northwest region of the U.S. For this study, the Louisiana Forest Products Development Center, Louisiana State University Agricultural Center partnered with funding and non-funding entities to conduct an analysis of the awareness, understanding, perceptions, and current use of cross-laminated timber (CLT) in the U.S. South[1] which these dimensions have not been previously studied.

2. THE STUDY

This study was conducted in fall 2019/spring 2019 to better understand the dynamics of CLT production in the nation's southern wood supply from the non-residential builders, architects, and engineers (structural, civil, and architectural). Mail-based survey techniques were used to assess the current market knowledge base for CLT in the Southern U.S. Study partners helped to review and revise the study instruments, and provide general support and knowledge for the study. In addition, stakeholders, such as state and local economic development entities, were included in discussions over the the duration of the project. For the survey component, random samples were taken from the demand/influencer sectors. Pre-notification postcards, a first survey mailing with a postage-paid envelope, reminder postcards, and a second survey mailing were sent to all study recipients. After accounting for undeliverable surveys, primarily firms that had gone out of business, incomplete surveys, and non-responses, the adjusted response rates were: non-residential builders (10%, 87 useable responses), architects (14%, 116 useable responses), and engineers (12%, 228 useable responses).

3. RESULTS

In order to capture a "General Influencer" profile, these three groups were combined for this article. As a baseline, we first asked about importance of various performance factors when specifying or using structural construction materials in general (including concrete, steel and wood) (**Figure 2**). Top ranked is Structural performance followed by Durability over time. Ranked last was LEED environmental credits. We then focused on wood structural/engineered wood products that respondents actually used in the previous year (**Figure 3**). Structural plywood and Oriented strandboard were tied at the top with nearly 80% of respondents using both products. At the bottom of the list is a new product called Mass plywood panels (MPP) with only 3% of respondents using this product. Next to last is Cross-laminated panels (CLT) with 7% or respondents.

Whether or not they used CLT, 51% of respondents are Somewhat Familiar with the product and 5% are Very Familiar. The remaining 44% are Not Familiar at All with CLT. A logical follow-up question we asked was "If CLT was available in your region, how likely would you be to use CLT in one of your building projects?" Tracking with familiarity, 33% of respondents are either Somewhat Likely or Very Likely to use CLT if it was available in their region. Only 10% were either Somewhat Unlikely or Not Likely at All to use CLT. The remaining 58% are uncertain. These findings suggest that the lack of CLT awareness needs to be addressed as soon as possible for this product to gain exposure and be adopted in the U.S. South. In general for the U.S., 60% of respondents believe CLT use will either Somewhat or Significantly Increase over the next year. Obviously, if projected CLT growth does not take place in the South, other U.S. regions and species, other than Southern Yellow Pine (SYP), will be first to market. In fact, being a lead adopter is the least of respondents concerns with specifying/using SYP (**Figure 4**). Building Codes and CLT Availability are the greatest concerns.

[1] Texas, Louisiana, Mississippi, Alabama, Georgia, Florida, South Carolina, North Carolina, Tennessee, Arkansas

Scale: 1=not important at all; 3=neither unimportant nor important; 5=very important

Characteristic	Mean
Structural performance	4.9
Durability over time	4.4
Economic performance	4.4
Availability in the market	4.2
Fire performance	4.1
Aesthetics	4.0
Cost of post-construction maintenance	3.8
Environmental performance	3.5
Acoustic performance	3.0
Earthquake performance	2.9
LEED credits	2.6

Figure 2. Importance of the characteristics when specifying/using structural construction materials (n=431)

	Yes	No
Structural plywood	78%	22%
Oriented strandboard	78%	22%
Wood I-Joist	70%	30%
Glue-laminated (glulam) beams	68%	32%
Laminated veneer lumber (LVL)	68%	32%
Parallel strand lumber	29%	71%
Laminated strand lumber (LSL)	26%	74%
Structural insulated panels	23%	77%
Cross-laminated timber (CLT)	7%	93%
Mass plywood panels (MPP)	3%	97%

Figure 3. Percent of respondents that have specified/used the following STRUCTURAL wood products in the past year (n=429)

Scale: 1=not a concern at all; 3=neither insignificant nor significant; 5=very significant concern

Characteristic	Mean
Compatibility with building codes	4.1
CLT availability in the market	4.0
General knowledge about CLT	3.9
Termites	3.8
Installed cost	3.7
Initial cost	3.7
Liability	3.6
Market acceptance	3.5
Availability of techincal information	3.5
Using wood (CLT) for tall buildings (over 6 stories)	3.5
Convincing clients	3.4
Need for industry to promote CLT	3.4
Financial risk	3.3
SYP properties not known for CLT	3.3
Availability of wood feedstock	3.1
Being the lead adopter	2.9

Figure 4. Level of concern of characteristics for specifying/using CLT in the U.S. South made with Southern Yellow Pine (SYP)(n=366)

The last question for respondents that are not specifying or using CLT, specifically examines what information or activities they believe would increase their underdtanding CLT (**Figure 5**). Continuing education courses and an understanding of technical specifications are clearly the most important means and information, respectively.

(Percent of Respondents) (Multiple Responses Possible)

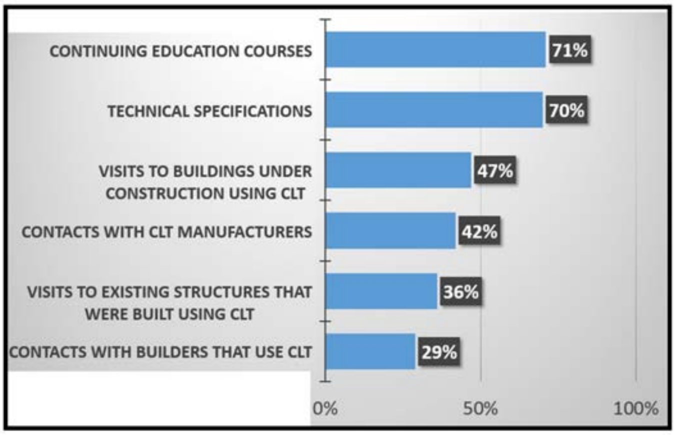

Figure 5. Information desired to improve understanding of using CLT in building construction (n=429)

For the 30 respondents that actually specified or used CLT, **Figure 6** shows the reasons that they chose CLT over steel or concrete in the instances when they did so. There is a misconception that the installed cost of CLT exceeds that of steel or concrete. Clearly, this is not the case with the respondents with 100% stating that CLT provided a lower total cost. Speed of construction has been shown to be much more rapid by using pre-cut CLT panels. In many cases, CLT buildings can be built at a rate of a story in less than a week. The other reasons listed are inherently unique to wood.

(Percent of Respondents) (Multiple Responses Possible)

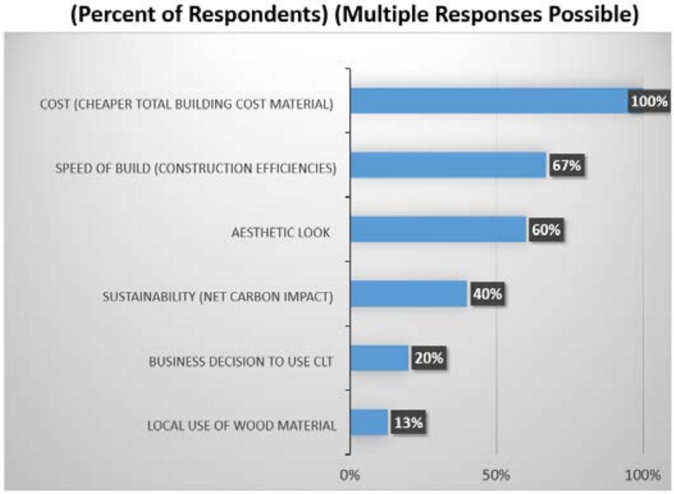

Figure 6. Reasons for choosing to use CLT vs. steel or concrete (n=30)

3. SUMMARY & COMMENTS

The U.S. South, 13 states from Virginia to Texas, has approximately 245 million acres of forestland, covering about 46% of the total land use (Oswalt et al. 2018). Of these, almost 85% is timberland (forestland capable of producing industrial wood), which produces about 60% of the nation's timber products. The region is the largest wood basket in the world supporting vibrant forest product industries, and is projected to remain the dominant region for many decades to come. Several sawmills, pulp and OSB mills, and recently pellet mills, have been consuming much of the wood and fiber resources available throughout the region. Recent data trends show that timber markets for softwood products in the South have rebounded since the 2007-2008 Great Recession, although not to pre-recession levels of demand.

Timber markets for both softwood and hardwood species are stable with significant investment in lumber manufacturing in the Southern Region. The supply is more than adequate to support a robust CLT industry. Low-value wood and small-diameter trees can also be used in mass timber production; there is a significant opportunity for the mass timber industry to grow from a perspective of raw-materials availability. To date, International Beam in Dothan, Alabama, is the only mass timber producer in the study region (using SYP), which began production this year. With the abundance of SYP, there are opportunities for CLT mills in the U.S. South to be part of the nascent but rapidly growing CLT sector. Rural towns, foresters, forest landowners and others in the CLT supply chain would benefit economically as has been shown with other types mills in the region. Aside from the economic benefits, the introduction of CLT would give architects and builders access to the material, allowing them to reduce the carbon footprint by building with wood instead of steel and concrete.

Region-wide success would be determined by architects, builders, engineers, and the public's acceptance of using timber as a substitute for conventional concrete and steel. Research, development, and successful examples will help to convince southern stakeholders and influencers as well as the general public of the soundness of using CLT. As we look to the future, perceptions can change, but it will take open minds and forward thinkers to take advantage of the resources in the U.S. South.

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THE INFORMATION SYSTEM FOR TIMBER ACCOUNTING AND ASSOCIATED TRANSACTIONS AS A TOOL TO IMPROVE PERFORMANCE OF THE FOREST SECTOR OF THE RUSSIAN FEDERATION

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Abstract. The government monitoring of the federally-owned forest resources of the Russian Federation had been insufficient till 2014. The government did not have efficient instruments to combat illegal logging and trade in illegally produced timber. Federal Law 415-FZ "On Amendments to the Forest Code of the Russian Federation and the Code of Administrative Offences of the Russian Federation" as of 28.12.2013 is aimed at combating illegal timber sales. The law puts into effect timber accounting implemented through acquisition, analysis, verification and processing of the data submitted to the Unified State Automated Information System (USAIS). Having been gradually put into operation, the system provides complete record-keeping of timber harvesting, transportation and sales; monitors the taxation of logging operators, timber producers and exporters, thus contributing to increased fiscal revenues; provides information to related supervisory authorities; improves transparency and performance of the national forest sector.
Keywords: information system, forest resources, illegal logging, forest sector, fiscal revenues

1. INTRODUCTION

The Russian forests are the common heritage of country's citizens, its strategic renewable resource, the effectiveness of which determines welfare of the state and well-being of its citizens.

According to FAO, the Russian Federation is the leader in forest area with its 20.4% of the total forest area of the world. Russia is followed by Brazil -12.3%, Canada – 8.7%, USA – 7.7% and China – 5.2%. The largest timber stocks belong to Brazil – 96.8 billion m^3, Russia – 83.4 billion m^3, Canada – 47.3 billion m^3, the United States – 40.6 billion m^3, Democratic Republic of Congo – 35.1 billion m^3 [1]. The allowable cut in Russia is 704.8 million m^3, of which 212.4 million m^3 is actually harvested (30.1% of the calculated cutting area).

After the collapse of the Soviet Union and the liquidation of the USSR Ministry of Forestry in 1991, state control in forest harvesting has stopped. Over time, illegal logging and saleshave become one of the most acute social, environmental and economic problem in the Russian forest sector. Illegal logging had caused great damage to the national economy and led to the negative image of the entire Russian forest sector. Direct damage from illegal logging in the Russian Federation is estimated at the level of 10 billion rubles annually. Finland and China are the main consumers of such illegal wood.

In recent years, certain measures have been taken to gain back control in the forest logging. On December 28, 2013, the Federal Law No. 415-ФЗ [2] made significant amendments to the Forest Code of the Russian Federation [3] to take into account all transactions in timber sales. To implement this law, the Unified State Automated Information System for Accounting for Wood and Transactions (abbreviated as “Forest” USAIS) was developed and introduced into practice.

2. FORMATION OF “FOREST” USAIS SYSTEM

There are several agencies in Russia have state unified information systems. The meaning and purpose of some of them are clear to everyone. Good example in this respect is the Unified State Automated Information System for Alcohol Turnover. The purpose of information system of forest sector is not that transparent for the outsiders. However, for the timber companies and entrepreneurs, as well as for their controlling agencies this system serves as a valuable source of data on transactions. Implementation of the “Forest” USAIS system pursues a number of goals:

1) clarification of the logging situation;

2) elimination of the illegal logging;

3) dataanalysis;

4) accuracycontrol of the information on harvested timber and forest products.

The system developers assume that implementation of the “Forest” USAIS would contribute to the increased transparency of economic activities and expose certain economic criminal activities in the forest sector.

“Forest” USAIS is developed by the "Roslesinforg", the subordinate organization of the Federal Forestry Agency (FFA). The system was implemented on the basis of PostrgeSQL DBMS database.

All subjects of the Russian Federation have introduced the new system without any exceptions.Gradual step by step introduction of consequent elements has greatly facilitated adaption of the system by the regions. The following steps were implemented to introduce and adopt the new system:

The first stage began on July 01, 2014, with the introduction of obligatory requirements to present accompanying documents for timber transportation.

The second stage has started on January 01, 2015, when responsibility was introduced for the absence of the accompanying transportation document or its inconsistency to the actual freight. Obligatory marking of especially valuable wood species were introduces for beech, oak and ash.

The third stage began on July 01, 2015, when administrative responsibility was introduced for non-compliance with the requirements for marking of valuable wood species. Mandatory declarations forwood transactions in the “Forest” USAIS have come into force as well. The declarations were to be submitted after each transaction.

The fourth stage started on January 01, 2016, when administrative responsibility for non-submission, late or false submission of the information on timber transactions was introduced. The system of fines has been fully introduced for the violation of requirements of forest legislation and wood transactions:

– non-submission or late submission of the declaration of wood transactions, as well as the presentation of deliberately false information in the declaration of timber transactions. This violation entails imposition of an administrative fine on the officials in the amount of from 5 to 20 thousand rubles. For the private entrepreneurs (non-legal entities) the fine is from 7 to 25 thousand rubles. For the legal entities, the fine reaches 100 – 2000 thousand rubles;

– transportation of wood without a legal accompanying document would entail the administrative fine of 30 to 50 thousand rubles with the confiscation of wood and (or) vehicles or without such a confiscation. For the legal entities, the fine may reach 500 to 700 thousand rubles with the confiscation of wood and (or) vehicles, or without confiscation.

The fifth stage is connected to the Order of the Government of the Russian Federation No. 911-p dated 12.05.2017 [4], which declared further changes to the “Forest” USAIS since July 01, 2017. The seller (legal entity or individual entrepreneur) has become obliged to fill out the accompanying document for the production of primary sawmilling: timber sleepers, logs, sawn timber, lumber. If the representative of the forest supervision finds violations in the design of the accompanying document, he must draw up a protocol on administrative violation and impose a penalty established by the current legislation. The continuous changes in the “Forest” USAIS 2017 are introduced due to the main goal of the information system – the prevention of unauthorized logging and trading.Table 1 shows some shortcomings of the current “Forest” USAIS.

Table 1. The most frequent shortcomings that have arisen in the implementation of the system "Forest" USAIS

Shortcomings	Description
The system did not immediately assign a transaction number	Assignment of a transaction number took from several hours to several days. The buyer had to wait for a long time for the transaction, but the buyer himself did not usually need the accompanying documents for wood
Problems with entering data in the system on the individual customers	Entrepreneurs indicated their names and taxpayer identification numbers. Regular buyers had to indicated passport details that were not always with them. It turned out that buyers may introduce zero value in the "passport data" column, but most of them did not know that. As a result, to comply with all requirements, retail stores had to postpone transportation or remain without buyers. The delay did not satisfy the byers. Therefore, they had to purchase wood from illegal vendors
Issues of integration with other information systems	The "Forest" USAIS system was not integrated in the existing business software of the enterprises. This required additional cost to cover staff salaries and purchase electronic signature to enter the system.

In 2017, the information system "Forest" USAIS took its current form, but it is evolving.

3. UNAUTHORIZED CUTTINGS AND WOOD SALES

The dynamics of timber harvesting from 2009 to 2018 in the Russian Federation, according to the Federal Forestry Agency, is presented in Figure 1.

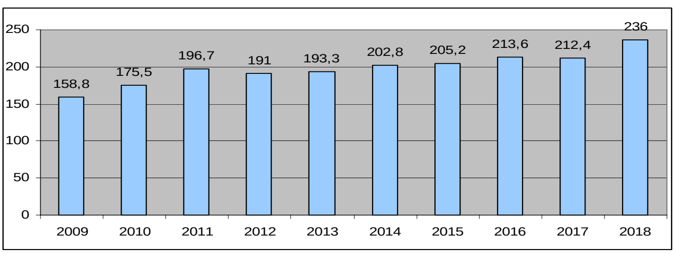

Figure 1. Dynamics of timber harvesting from 2009 to 2018 in the Russian Federation, million m3

The dynamics of illegal logging in relation to legal timber harvesting in the Russian Federation from 2009 to 2018, according to the Federal Forestry Agency, is shown in Table 2.

Table 2. Dynamics of illegal logging in the Russian Federation from 2008 to 2018

Indicators	Years									
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Illegal logging, thousand m^3	1379	1336	1179	1053	1082	1308	1208	1647	1350	1630
Illegal logging, percentage to the total wood harvesting, %	0,86	0,76	0,59	0,55	0,56	0,64	0,58	0,77	0,63	0,69

According to official data, the range of volumes of illegally harvested wood for ten years ranges from 0.5 to 0.9% of the total volumes of legally harvested wood in the Russian Federation. On average, over the recent 10 years, the annual volume of illegally harvested wood was about 1,3 million m^3 or 0.66% of the total volume of legally harvested wood in the Russian Federation.

According to unofficial data, illegal timber harvesting accounts for 10 to 35% of the total logging volume. In some Russian regions, the illegal logging, or wood of dubious origin, makes up to 50%. This problem is most acute for the border regions of Eastern Siberia and the Far Eastern Federal District (Irkutsk Region). The main consumer of the wood in these regions of Russia is China.

Illegal logging has a very negative effect on the Russian ecological situation. Barbaric illegal logging cause flora and fauna suffering, soil erosion, deforestation, forest degradation and cluttering. Illegal logging usually aims at the industrial commercial wood. Non-commercial wood remains at the spot and litters the forest. The debris provoke pollution and forest fires.

Illegal loggers often seek to cut wood in the protected areas, because the quality of wood there is higher. In these zones, valuable tree species are mainly cut: oak, beech, ash.

The most devastating are the social consequences of illegal forest exploitation. In many cases, illegal logging is accompanied by corruption and bribery of forestry and law enforcement officers. Illegal forest management is often associated with the criminal structures.

Social consequences of the illegal forest activitiesare intertwined with economic consequences. These socio-economic consequences materialize in criminal activities that undermine moral foundations of the society. Surveys show that about a third of the population of forest villages tolerantly relate to the illegal logging. Consequences are low payments to the budget, lack of social guarantees for employees of the illegal enterprises, expansion of corruption to all social strata, merge of the legal and illegal activities of foreign entrepreneurs.

Illegal logging greatly reduces the investment attractiveness of the country's forest sector. Illegally harvested wood is sold at lower prices. This adversely affects sales of the legally harvested wood. Low market price of the producers leads to unfair competition and reduced competitiveness of legitimate companies.

4. RESEARCH FINDINGS AND DISCUSSION

As it is seen from Table 2, the volume of illegal logging over the past five years, since the launch of the system, did not decrease. However, the system “Forest” USAIS has justified itself. In 2018, the amount of legally harvested wood increased in the country by 24 million m^3 (11.1%). This is a record for the growth of legal logging in recent years. Forest operators gradually emerge from the “shadow” and show their harvested wood. Harvesting increases mainly in leased forest areas. People become more disciplined. They understand that they are controlled. Forest sector is surely putting things in order, albeit slowly.

Interest touse the system is constantly growing. By the end of 2015, 23 thousand system users were registered. By the end of 2018 there were already more than 100 thousand users in the system. Interested organizations and departments continue to apply for the access to the system.

To date, the system already contains more than 7.4 million reporting documents, about 2.2 million declarations of wood transactions, information about 2.6 million units of marked oak, beech and ash logs.

According to the system, in 2018 forest users have harvested 236 million m^3 of timber and presentedfull information for more than 922 thousand sales. Exporting organizations exported more than 17 million m^3 of round timber and 28.3 million m^3 of sawn timber from Russia. The system contains information on the export of 274,259 units of marked oak, beech wood, including species, assortments and volumes.

In 2018, the “Forest” USAIS system was supplemented according to the plan of improving control over wood origin. The system added new reporting forms, expanded opportunities for the forms adjustments, improved possibilities for entering and analyzing the information, added information on the finished products and residues, simplified the procedure for the transportation of raw materials, etc.

As a result, in 2019 forest management authorities officially filed 4,086 administrative cases, including 3,920 cases in the federal districts. Fines for the violations grew up to 36.785 thousand rubles.

The “Forest” USAIS will be further developed based on its practical experience. The system is to improve certain functions, eliminate errors, and ensure simplicity and accessibility for the users. Adoption of the related information resources is an important direction for the system development in the future. One of these resources is the earth surface remote sensing. The “Forest” USAIS can be supplemented with an array of cartographic information. It requires uncomplicated and inexpensive binding of harvested timber to the cartographic data. This will allow for visualization of the information about wood harvesting and will add up analytical functions to the “Forest” USAIS.

5. CONCLUSION

Before the launch of “Forest” USAIS, nobody knew who, where and how much timber is cut and sold. If harvesting is unknown, then the state income is unknown as well. The launch of the system expands the state’s ability to regulate round wood market. A large part of this market was "gray." Reduction of the "gray" segment of the timber market is one of the great merits of the system, despite its shortcomings.

The “Forest” EGAIS contains a complete database of permits for the harvesting of wood. It also records all wood and lumber deals. In addition, the system contains export information about the labeling of valuable species of oak, beech and ash trees.

Most of the data in the system is available to users, including information on entrepreneurs, lease agreements, and so on. The system entered deals on large and small tenants. Since January 2019 “Forest” USAIS automatically provides related regulatory authorities with the information for effective control over the origin of wood in the Russian Federation. Information from the “Forest” USAIS is now available in the System of interdepartmental electronic interaction. Now interested federal agencies may expand the possibilities for combating the illegal wood trade. Adjacent controlling agencies (the Federal Customs Service, the Ministry of Internal Affairs of Russia, the Federal Tax Service, Rosfinmonitoring, and others) now have technical ability to receive the information automatically. If necessary, they are able to include in the system their departmental information resources and systems.

Law enforcement agencies and system developers should understand that illegal forest users "are not asleep." They are constantly finding new ways toavoid responsibility for their violations. It is necessary to understand that the system “Forest” USAIS cannot solve all the problems with the illegal loggers. It is not a panacea, but it a way to combat illegal logging. Other effective methods are to increase funding for the protection of forests from unauthorized felling, to increase the number of forest guard, to use modern technical means of monitoring the situation in the forest. Unfortunately, the budgets of many regions today do not allow using these mechanisms in full capacity.

Taking into account the volume of illegal logging, the authors of the publication propose, that it necessary to toughen the responsibility of loggers for illegal logging. Gradually, all these measures will help bring order to the wood trade at all stages, from submitting an application for timber harvesting to selling wood to customers.

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PROBLEMS OF INDUSTRIAL PROPERTY MANAGEMENT AND BUILDING A COMPETITIVE ADVANTAGE ON THE FURNITURE MARKET

Renata Stasiak – Betlejewska, Emilia Grzegorzewska

Abstract: In the furniture industry, the issue of protecting industrial design is particularly important. It has a huge impact not only on the reputation and increase the enterprise value, but it is mainly used to build a competitive advantage over other market. The investments and marketing activities are aimed at building the company's position and reputation on the market. Such expenditures tend to seek protection against attempts at copying and unauthorized imitation of furniture by competitors. The paper discuss the forms of intellectual property rights most often used to protect the appearance of a product in the context of selected enterprises in the furniture industry.
Keywords: industrial property management, competitive advantage, furniture market

1. INTRODUCTION

The protection of intellectual property is an extremely important subject for the furniture industry. The incidents of appropriation of other people's property confirm the importance of this issue in the process of developing furniture making and are the subject of discussion. In order to fully understand its complexity, one should look at this issue on a macroeconomic scale. The Polish furniture industry is in the strict group of global furniture export and production leaders. The Polish furniture industry is ranked 4th and 10th in the commodity exchange rankings and the value of sold production of furniture.

The awareness of the importance of care for the proper protection of intellectual property is opposed to the objective difficulties that entrepreneurs face. Short product life compared to the duration of implementation procedures, a large number of products and markets on which distribution takes place, the necessary outlays for registration and then protection of rights, and finally problems with defining what is really meant by intellectual property are problem of many companies. Intellectual property, intangible good, the scope of which includes: copyright and related rights; utility models and patents can be a source of the competitive advantage.

In Porter opinion, competition is at the core of the success or failure of firms. Competition determines the appropriateness of a firm's activities that can contribute to its performance, such as innovations, a cohesive culture, or good implementation. Competitive strategy is the search for a favourable competitive position in an industry, the fundamental arena in which competition occurs. Competitive strategy aims to establish a profitable and sustainable position against the forces that determine industry competition [14].

Competitive advantage is associated mostly with delivering the same benefits as competitors but at a lower cost (what is related to the cost advantage) or delivering with benefits competing products [22]. Competitive advantage is necessary for satisfied customers who will receive higher value in delivered products for higher income what the owners request from management and such requirements can be fulfilled with organization of production, higher application and as low as possible production costs [15].

Barney (1991) suggested that the resources that are scarce and valuable at the same time can create competitive advantage, and if these resources are also difficult to duplicate, substitute and hard to deliver, they can sustain the advantage. Competitive advantage occurs when an organization acquires or develops an attribute or combination of attributes that allows it to outperform its competitors. These attributes can include access to natural resources, such as high grade ores or inexpensive power, or access to highly trained and skilled personnel human resources.

Analysing the issue of the competitive advantage as the ability to stay ahead of present or potential competition in the market, it is important to provide the understanding that resources held by the enterprise and its business strategy have an impact on generating competitive advantage. Enterprises using a differentiation strategy are able to achieve a competitive advantage over its rivals because of its ability to create entry barriers to potential entrants by building customer and brand loyalty through quality offerings, advertising and marketing techniques [11]. Differentiation strategy is based mostly on innovations within products and used technologies that are able to create a competitive advantage for an enterprise. Most companies develop technologies in order to improve their competitiveness in the market and patent them around the world to protect their intellectual property [13].

Enterprise are interested in the industrial property protection strategy as the way that allows them to maximize returns on their investments in R&D aimed at developing new technologies and innovative products, processes and services, and to protect and possibly improve their competitiveness [8]. Bos, Broekhuizen, and Faria (2015) suggest that companies can achieve competitive advantages only by effectively appropriating value from protecting their innovation activities from use by competitors.

The main of the paper is to present and analyse forms of intellectual property rights most often used to protect the appearance of a product in the context of selected enterprises in the furniture industry.

2. INDUSTRIAL PROPERTY MANAGEMENT AND FURNITURE INDUSTRY

Industrial property management and issues of the competitiveness have been connected in the literature since the 1970s [12]. Currently, industrial property protection, more than being used by companies as a tool to attract investment has been recognized as a source of competitive advantage [6, 20, 18]. IPR protection prevents firm innovations from being exposed without any kind of protection and explored by competitors since they are legally protected from potential violations [17]. Industrial property management help enterprises in creating and sustaining competitive advantage by protecting strong brands, establishing a standard in the market, and protecting key components, thus increasing switching costs [16]. Owing to patents there is possible a technological lead and shaping industry structure and trademarks and geographical indications help with developing products and services with its brands related to promotion of the company and its products. Activities within industrial property protection encourage companies to invest in R&D to develop new, innovative products and services, in the expectation of full returns thereof, if the company is granted an appropriate, stricter protection regime of its innovations, with severe legal sanctions for those who attempt to copy or imitate them [10]. Patents and trademarks have been widely used throughout industrial history to obtain competitive advantage, as well as business method patents [18, 21]. Patents and trademarks, as well as industrial design and copyrights, seem to be very useful especially in small businesses [3].

In the furniture industry, the most common form of industrial property protection is the industrial design, that is, a new and individual character of the product or a part of it, given in particular by the features of lines, contours, colours, structure or material of the product and its ornamentation. When talking about a utility model, then it is a new and useful solution of a technical nature, concerning the shape, construction or combination of the object with a permanent form. The design is considered to be a useful solution if it allows achieving an objective having practical significance in the manufacture or use of products. In the case of the furniture industry, the industrial design can be identified with the shape, colour, ornamentation of the new furniture. Utility model is a new functionality of a piece of furniture, and a trademark is a company logo or a given collection. The protection can cover not only the functions of the furniture, but also technological solutions in the production. Every day new products and designs appear in the furniture industry, which should be submitted to the Patent Office and placed in the appropriate databases. The medium-sized company has at its disposal at least a few collections of furniture and on average twice a year introduces new products to the offer. It can be estimated that several thousand new furniture designs are being launched every year. In practice, only those companies that want to promote products under their own brand, allow themselves to create constantly operating, professional project teams. In the case of smaller companies, the designer is usually the owner of the company or the main technologist. Companies regularly reporting industrial designs for protection include: Black Red White, Forte, Kler, Vox, Mebelplast, MSP Oak and other major companies in the country. Design teams, work on product development, marketing research are very high costs, so unfortunately unfair companies also appear, copying furniture of their competitors, without incurring expenditures and efforts to prepare their own original solutions. There are even cases of placing full arrangements of a competitor in their catalogs and suggesting them as their own offer. Furniture often needs to be protected as soon as the company intends to present it for the first time at the fair. Even then, they can become the subject of copying. The issue of taking photographs during furniture fairs lasted several years ago, the agreements of European furniture chambers, trade fair organizers and the press regarding the ban on photographing exhibits [23].

3. FURNITURE MARKETS PRACTICES ON THE INDUSTRIAL PROPERTY MANAGEMENT

Furniture design and production generates intellectual property in many different forms: the visual appeal of individual products (for example tables, chairs, cabinets and 2D patterns/surface decoration) is protectable by unregistered and registered designs; the look of your websites, brochures and new software are protectable by copyright; and the technical innovations (for example new fixtures and fittings, or methods of assembly) required to make items function are protectable by patents, or may be retained as secret know-how. Copyright arises automatically through the creation of a work, and protects the expression of your ideas, rather than the ideas themselves. Importantly for the furniture trade, there is also provision for works of artistic craftsmanship. For furniture quality protection, designs must be new and have individual character – giving a different overall impression to previously disclosed designs. Registered designs last up to 25 years from registration, providing a monopoly right for use of the design [9].

The design of products in the furniture industry is very large. The appearance of the furniture decides not only about its success on the market, about the profits from its sale, but also about the shaping of the image of its producer and seller. Intellectual property law allows the enterprise to protect results of the design process of the furniture, its introduction to the market, promotion, which should not be subject to copying by competitors. The appearance of the furniture in Poland is protected against unauthorized imitation on the basis of three regulations – industrial property law, combating unfair competition and copyright. The protection resulting from the first of these regulations is only granted to those who register the design of their furniture in the office. In Poland, the rights arising from registration at the Patent Office of the Republic of Poland in Warsaw and at the Office of the European Union for Intellectual Property in Alicante application. On the other hand, the protection resulting from the regulations concerning the fight against unfair competition and copyright is independent of any registration of the image of the furniture. The relatively easiest to enforce method of protection in the furniture industry is protection based on the rights from registration of industrial or community designs. Currently, there are tens of thousands of such rights to furniture designs in Poland – both Polish and EU laws. They protect the design for 5 years with the possibility of extending a total of up to 25 years. The rights from registration of designs allow for prohibiting competitors from producing, selling and even storing a product in which a registered design is included. A number of exceptions have been provided for the protection resulting from the registration of the design. For example, the design right does not include product features that are solely due to its technical function and that must be reproduced in exact form and dimensions to enable it to be combined or interact with another product. It should be remembered, however, that if a piece of furniture illegally imitating someone else's pattern is produced by someone else and producers sell it, producers are also responsible for the infringement.

In turn, the Law on Unfair Competition protects against committing illegal activities or morality, affecting the interests of competitors or customers. The act of unfair competition is, for example, loading the finished product, whereby the external form of the product is copied using technical means of reproduction, if it can mislead customers as to the identity of the producer or product.

Finally, the appearance of the furniture is very often also protected by copyright. In contrast to industrial designs, this protection arises when the work is determined, regardless of any formalities. Nevertheless, enforcement of rights under the Copyright Act is more complicated due to the need to show a number of evidence and circumstances. Hence, an interesting topic in the furniture industry seems to be about creating pieces inspired by other works. In such cases, however, caution is recommended. Depending on the nature and scope of borrowings from other works, they may in fact enter into the legal and copyright monopoly of the creator of the original work, if they become a mere adaptation, adaptation and are not of an intrinsic character.

Designers, manufacturers and retailers of furniture in the United States often are targets of second comers that copy their furniture designs for sale to the same consumers. While there is no “one-size-fits-all” solution, traditional concepts of trademark, copyright and design patent protection, along with advanced planning before a product enters the market, can be useful in designing an overall protection strategy. Ideally, a strategy should be put in place when the furniture is initially designed, with decisions made regarding whether to seek a utility or design patent, whether to file copyright registrations on the designs and/or catalogs depicting the designs, whether and when to seek trademark protection and the type and manner of advertising and promotion of the furniture [19].

The example of the patented furniture in United States was presented below on the Figure 1.

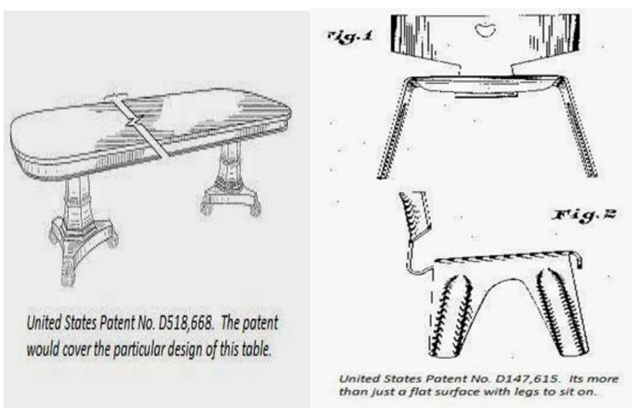

Figure 1. An example of patented furnitures in United States.

Patented furniture designs presented in Figure 1 show that the design in issue may be new and original as to form, but it is not ornamental, in a smuch as it does not please the senses or excite the emotions by its color effects, or by its proportion of form. A design that is dictated by considerations of function is not a proper subject for a design patent. Further, if the sole points of novelty over prior designs are dictated by functional improvement or alteration, a design is not patentable. The american court determined that a design need only be embodied in some article, but did not need to be a design for a complete article [5].

In European furniture market, the success of industrial property protection is associated with Mr van Hepart who is a creative and passionate furniture designer running his own successful business of manufacturing and distribution of comfortable sofas and armchairs in the centre of Brussels. He developed the idea of an innovative sofa design whose lines, contours, colour and shape contribute to conferring an appealing appearance to the piece of furniture [5].

A case which illustrates the important role of copyright in furniture design is Collezione Europa USA v. Universal Furniture International. Two of Universal's collections were accused of copyright infringement. However, the designer had modified and arranged familiar decorative elements in unique ways. Secondly, his accused design elements were separately identifiable and capable of existing independently of the furniture's utility. For these reasons, the court agreed that Universal's designs had sufficient originality according to Section 101 of the Copyright Act. Universal is an excellent example of the importance of copyright registrations for protectable matter. Casual Furniture Designs Bring Patent Infringement Claims – Pride Family Brands, a prominent outdoor furniture manufacturing company filed a complaint in the U.S. District Court for the Southern District of Florida against four defendants – Carls Patio, Inc.; Carls Patio West, Inc.; Woodard Furniture, Inc.; and Scott Coogan – alleging patent infringement and other related claims. The infringement claim is based on the similarity between both Pride's "Coco Isle" and "Cabana Bay" furniture collections and the "Jumby Bay" collection manufactured and sold by the first three named defendants. More specifically, Pride alleges that the Jumby Bay collection violates five of Pride's patents: Patent Nos. D521,263S; D519,293S; and D520,767S, all of which concern chair design, as well as Patent Nos. D519,762S and D522,778S, both of which concern furniture leg ornamentation. According to Pride's complaint, the Jumby Bay collection contains "hand-wrapped aluminium treatment" that infringes upon the ornamentation-based patents, as well as a chair that is almost identical to one within Pride's Coco Isles and Cabana Bay collections that employs Pride's patented chair designs. Though trial likely will not commence for many months if the case is not settled, Pride is making it clear that it will vigorously pursue those companies who, from Pride's perspective, are infringing upon its intellectual property rights [4].

4. CONCLUSION

Intellectual property law equips entrepreneurs with a range of instruments to counter copying the appearance of furniture. In order to be able to use them, it is necessary to properly regulate the issues related to intellectual property rights in contracts with creators, so as to guarantee full rights. Ensuring their exclusivity influences the increase in the value and reputation of the company on the market.

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MONETARY VALUATION OF FOREST DAMAGE – AN UNIFIED APPROACH

Ivailo Markoff

Abstract: Appraisal of forest damage is an essential element of many ecological decisions. It is also an instrument to regulate everyday life in agrarian countryside. E.g. in Central Europe, damage valuation is the most common task of forest valuation. Forests are rarely sold, but in the woods happen all the time things that are compensated in money.
Based on the theory of income value, a formal approach to evaluation of forest damage is proposed. The damage scope can reach from single trees to whole stands. All known kinds of forest damage are covered in a systematic way: browsing by game or cattle, bark damage by animals of forest harvest, forest fire, industrial smoke, draining, compulsory forest harvest, illegal cutting etc. Practical application is based on growth and yield tables, basic prices and inventory data. Preconditions, transparency, acceptance, and plausibility are discussed. The approach involves single tree evaluation. A derivation of a known single tree valuation formula usually considered a proxy is proposed.
Keywords: forest valuation, damage, compensation, forest value tables

1. STATE OF THE ART

The subject of this work is the valuation of damages of forest stands, ie. of the standing trees. Methods for valuating damages are usually expressed verbally and with numerical examples. In the present work, a system of formulas for valuating damages in forest stands is sought. Analytical presentation through formulas facilitates theoretical study and the development of application software.

2. DERIVATION OF FORMULAE.

2.1. Basic formulae

Basic formula set is derived for the case when the stand is even-aged, fully stocked, with one tree species only and all trees are equally affected by the damage.

Formula (3) gives the value of a damaged but still living forest, (4) – of a dead one, (5) – an intact one and (6) – of a completely destroyed one:

$$h^* = HE_w^* \qquad (3)$$

$$h^* = A_a^* \qquad (4)$$

$$h^* = HE_a \qquad (5)$$

$$h^* = 0 \qquad (6).$$

HE_w^* – normal stand value (Erwartungswert) at age w, deteriorated assortment structure

w – effective age of the stand (Wirtschaftsalter).

A_a^* – normal stand stumpage value (Abtriebswert) at age a deteriorated assortment structure
a – stand age
HE_a – normal stand value (Erwartungswert) at age a

If the damaged forest stand does not perish, the damage consists in waste and deterioration of material and increment stagnation or loss. Retention of growth is taken into account by assuming an effective age lower than the actual age. Generally, effective age is determined by the growth table as the age corresponding to the observed mean height of the estimated forest stand. In some cases, for example, when browsing a young culture is valuated, effective age can be estimated by the number of surviving annual shoots.

"Deteriorated assortment structure" can be defined in many ways. Formulae (3a) and (4a) assume that some meters of the lowermost part of the trunk (Erdstamm) are rotten and can be only sold as fuel wood. This volume is determined by the rotten length. A linear progressing of rot is assumed with a maximum length $L = 2\,\mathrm{m}$. The length actually reachrd depends on age and rotation time. Formula (3a) treats living stands:

$$h^* = d_u HE_w \quad \text{(3a)}$$

$$d_u = 1 - \frac{L}{fH_u}\frac{u-a}{u}\frac{P_T - P_W}{P_u} \quad \text{(3b)}$$

d_u – timber deterioration percentage at mature age
HE_w – normal stand value (Erwartungswert) at age w
L – maximum rotten length at rotation age
f – form factor
H_u – stand height at mature age
u – rotation age
a – actual age
P_T – stumpage price of timber (sawn wood)
P_W – stumpage price of piled wood
P_u – average stumpage price of mature stands

Formulae (4a) and (4b) treat dead stands. There, the rotten length l is an inventory data. In some cases formula (4c) might be used instead.

$$h^* = d_a A_a \quad \text{(4a)}$$

$$d_a = 1 - \frac{l}{fH_a}\frac{P_T - P_W}{P_a} \quad \text{(4b)}$$

$$h^* = A_a^W \quad \text{(4c)}$$

d_a – timber deterioration percentage at actual age

H_a – stand height at actual age

P_a – actual average stumpage price

A_a^W – normal stand stumpage value at age a when selling the whole stock as firewood.

For the deduction of the formulas (3a) and (3b), the representation of the stand expectation value by the age factor (Alterswertfaktor) in its Austrian form is used,

$$HE_a = F_a A_u \quad (7)$$

F_a – age factor

A_u – normal stand stumpage value (Abtriebswert) at age u

A_u^* – normal stand stumpage value (Abtriebswert) at age u, rotten butt log.

Thus it is obtained $d_u = A_u^* / A_u$ from the expressions

$$HE_w^* = \frac{HE_w^*}{HE_w} HE_w = \frac{F_w A_u^*}{F_w A_u} HE_w = \frac{A_u^*}{A_u} HE_w \quad (8)$$

$$A_u - A_u^* = \frac{\pi D_u^2}{4} l_u \left(P_T - P_W\right) N_u \quad (9)$$

$$A_u = \frac{\pi D_u^2}{4} f H_u \; P_u \; N_u \quad (10)$$

$$l_u = \frac{u-a}{u} L \quad (11)$$

D_u – diameter at mature age

l_u – rotten length at mature age

N_u – normal stand number at mature age

Formulas (4a) and (4b) are obtained in much the same manner as formulas (3a) and (3b).

2.2. Single-stem damage valuation

Certain types of damage are determined stem by stem – for example, brousing and bark stripping by wild animals or cattle. In such cases, sample plots are calipered and assessed.

For this purpose, the following formulas are derived: Formula (12) gives the value of a damaged but still living tree, (13) – of a dead one, (14) – an intact one and (15) – of a completely destroyed or absent one:

$$h_i^* = \frac{g_i}{G_w} d_u HE_w \quad (12)$$

$$h_i^* = \frac{g_i}{G_a} d_a A_a \quad (13)$$

$$h_i^* = \frac{g_i}{G_a} HE_a = h_i \quad (14)$$

$$h_i^* = 0 \quad (15)$$

h_i^* – the individual value of the tree (damaged)
g_i – the individual basal area of the tree
G_w – basal area (Grundfläche) of a normal forest stand of the same tree species at age w
G_a – basal area (Grundfläche) of a normal forest stand of the same tree species at age a

Suppressed and inferior trees of the lower Kraft's classes that would dieback anyway are considered Intact.

The value of a single-tree damage is determined by the formula

$$s_i = h_i - h_i^* \quad (16)$$

The value of damage to a forest stand or any part thereof is the sum of the damage to individual trees:

$$s = \sum_i s_i \quad (17)$$

In deriving the formulas of this section we use the formula for valuation of a single tree:

$$h_i = \frac{g_i}{g} h, \quad (18)$$

g_i – individual basal area of the tree.
g – basal area of the stand.

This formula is a good proxy, especially for young and mature stands (Markov et al., 2004). As a corollary of it, it is obtained that the value of a forest stand is the sum of its tree values.

$$h = \sum_i h_i \quad (19)$$

We also postulate that the value of an even-aged forest stand is the product of stocking rate and the value of a fully stocked stand of the same tree species.

$$h = b\,H\,, \quad (20)$$

as well as

$$b = \frac{g}{G} \quad (21)$$

Postulates (20) and (21) are also proxies, however, although validated by time (Mihov et al., 1999; Markoff et al.,2005).

2.3. Damage valuation by tree species

Some damages affect the entire forest stand of large parts of it and it is tiring to evaluate them tree by tree. For this purpose, planting is divided into fractions or strata of one age, one tree species only and all trees equally affected. Fortunately, there is no need for further formulas. One should establish the basal area of the fraction and apply the formulas from the previous section, assigning the fractions basal area to the variable g_i .

2.4. Special cases

1. After a surface fire, the forest usually survives, but damage occurs on the bark, which is assessed under item 3. In case of a crown fire, the forest is destroyed with significant devaluation of the timber, which has to be evaluated expertly. e.g. assuming $d_a = 0.9$
2. In the case of a browsing, the effective age of the damaged stand is determined by the number of surviving top shoots. When degradation of wood quality over time is not assumed, $d_u = 1$. Dead saplings have the value of 0.
3. In case of damage to the bark, all trees with bark damages over 50% of the diameter and half of the trees with bark damages between 25 and 50% perish. Trees with bark damages of less than 25 cm^2 are considered undamaged. For the remaining bark-damaged trees a maximum rotten length of 2 m is assumed.
4. A 20-meter strip parallel to new forest roads and aisles in closed stands must be periodically checked for Windthrow and bark damage. If later, along the road, a windthrow occurs, it is assessed as a forced use.
5. In the case of harmful emissions, the expected mortality includes trees with over 60% crown reduction. For the remaining trees a loss of increment is calculated. Effective age is determined by sample plots. If local emissions for the past period have already been compensated for age a the effective age at the end of the previous period is taken.
6. In the case of site conditions change (mainly drainage or flooding) changes site quality change is taken into account. Trees higher than the maximum height of new site conditions perish. The rest slow down their growth, which is taken into account by calculating an effective age.
7. In case of illegal logging, if the material is not captured, its damaged value is 0. If the material is captured and returned to the owner, $d_a = 0{,}8$, which takes into account improper bucking and forced use. Use is forced because the owner does not choose the time of use. Bark damage to the remaining trees is additionally valuated.

3. CONCLUSIONS

In all the most common cases stand damage is limited to measurable parameters and monetary valuation tables.

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INFLUENCE OF EMPLOYMENT TRENDS IN THE CROATIAN WOOD INDUSTRY ON THE NUMBER OF STUDENTS OF WOOD TECHNOLOGY SINCE 2010

Maja Moro

Abstract: This article presents an analysis of the current situation in the Croatian woodworking sector on the basis of established values of labour resources in Wood processing and Furniture manufacturing as well as anticipating the influence of employment trends on the number of enrolled students of Wood Technology since 2010. According to Croatian Standard Classification of Occupations (NKD 2007), for sectors Wood processing (C16) and Furniture manufacturing (C31), the data of the number and composition of persons in paid employment in legal entities are gathered from Croatian Bureau of Statistics. The data of the number of students are gathered from Information System of Higher Education Institutions (ISVU) for undergraduate and graduate students of various Wood Technology Study Programmes since introduction of the Bologna process in university teaching at the Faculty of Forestry in Zagreb. The dynamic economic analysis of time series data was performed and time series models for predicting the future trends for analyzed variables were built.
Keywords: wood processing, furniture manufacturing, employment, WT sudents, trend

1. INTRODUCTION

University education is more than the next level in the learning process; it is a critical component of human development worldwide. It provides not only the high-level skills necessary for every labor market but also the training essential for teachers, doctors, nurses, civil servants, engineers, humanists, entrepreneurs, scientists, social scientists, and a myriad of other personnel. It is these trained individuals who develop the capacity and analytical skills that drive local economies, support civil society, teach children, lead effective governments, and make important decisions which affect entire societies (EPI, 2019). All higher-education teaching personnel should have the right to fulfil their functions without discrimination of any kind and without fear of repression by the state or any other source. Higher-education teaching personnel can effectively do justice to this principle if the environment in which they operate is conducive, which requires a democratic atmosphere; hence the challenge for all of developing a democratic society (UNESCO, 1997). The European Union has committed to the principle of sustainable development as its policies and actions, based on balanced economic growth, price range of stability, strengthening the internal market, research and development, innovation, education, competitive social market economy and a high level of protection and improvement of environmental quality (Lučić, 2009).

The Trends series has been published by the European University Association and its predecessor organisation since the signing of the Bologna Declaration in 1999, and provide an institutional perspective on higher education policy and institutional developments in Europe. Over the years, the focus of Trends has been changing. Whereas previous reports analysed mainly how the Bologna reforms have been implemented at the European universities, Trends 2015 discussed, amongst other themes, also developments in learning and teaching (L&T). Trends 2018 research continues and further enhances this focus, and explores recent European policy developments and institutional strategies and practice on L&T (EUA, 2019).

In this article we presented an analysis of the current situation in the Croatian woodworking sector on the basis of number of employees in Wood processing and Furniture manufacturing as well as anticipating the influence of employment trends on the number of enrolled students of Wood Technology at the Faculty for Forestry in Zagreb since 2010.

2. MATERIAL AND METHODS

The base of these reserch are data of the number and composition of persons in paid employment in legal entities according to Croatian Standard Classification of Occupations (NKD 2007) and they are gathered from Croatian Bureau of Statistics (DSZ, different years). Database include the number of employees for period 2010-2018 in two main wood manufacturing sectors: Wood processing (C16 – official name of sector – Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials) and Furniture manufacturing (C31 – official name of sector – Manufacture of furniture). Also, database include the number of students gathered from Information System of Higher Education Institutions (ISVU, 2019) for students of one Mathematical (B1) and three Statistical courses (B2, DP, DD), in one undergraduate university study programme and two wood technology graduate programmes at the Faculty of Forestry in Zagreb since academic year 2010/2011. Abbreviations for variable names are shown in legend in Table 1., and data gathered for these analysis are shown in Table 2.

Table 1. Legend for analyzed variables

Variable	Description of Variable
WP	employees in Wood Processing (sector C16)
FM	employees in Furniture Manufacturing (sector C31)
B1	students of 1st year of Bachelor's programme Wood Technology
B2	students of 2nd year of Bachelor's programme Wood Technology
DP	students of 2nd year of Master's programme Wood Technology Processes
DD	students of 2nd year of Master's programme Design of Wood Products

Table 2. Number of employees (source DZS) and students (source ISVU)

Year	Number of employees		Number of students			
	WP	**FM**	**B1**	**B2**	**DP**	**DD**
2010	11.050	9.676	131	49	11	5
2011	10.839	9.357	131	47	15	8
2012	11.072	8.887	139	31	22	5
2013	11.072	8.447	143	35	23	6
2014	11.521	8.443	125	42	12	10
2015	12.501	8.602	118	51	20	12
2016	12.858	8.944	113	41	17	9
2017	13.379	9.216	42	32	13	7
2018	13.765	9.327	39	26	18	9

For the purpose of examing influence of employment trends in the two main wooden sectors in Croatia on the number of wood technology students, the dynamic economic analysis of time series data was performed. Data analysis for this paper, as well as tabular and graphical representations, were performed in Microsoft Excel software package.

3. RESULTS AND DISCUSSION

According the datas in Table 2., distribution of employees in the two main wooden sectors Wood Processing (WP) and Furniture manufacturing (FM) are shown in Figure 1., and distribution of number of students involved in four different wood technology courses in Bachelor's and Master's programmes are shown in Figure 2..

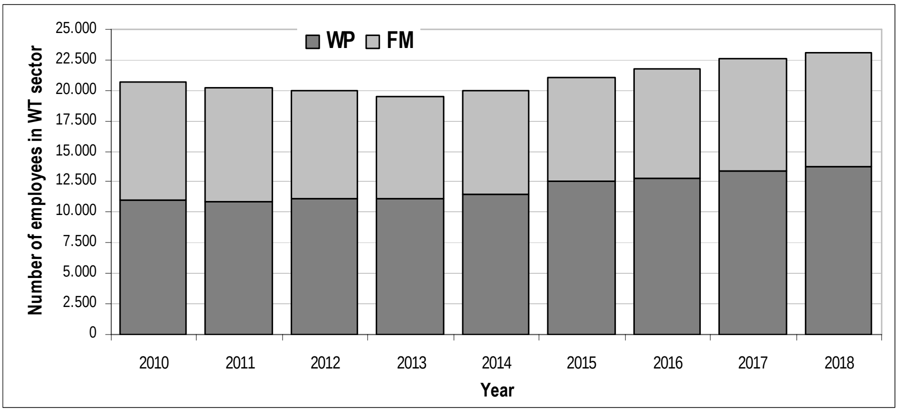

Figure 1. Number of Employees in WP and FM since 2010

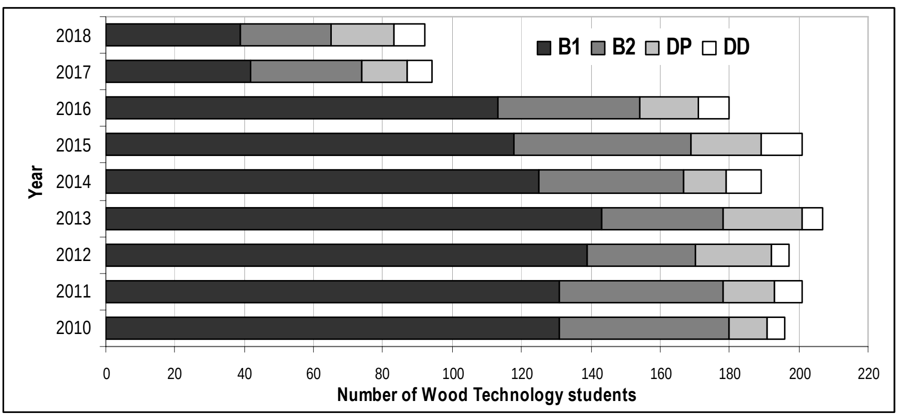

Figure 2. Number of Students since Academic year 2010/2011

Descriptive and inferential statistics were determined for the number of employees in sectors Wood Processing (WP) and Furniture manufacturing (FM), also for the number of students for all of the obligatory courses included in this analysis, from the 1st year of undergraduate Bachelor's university study programmes (B1 – Mathematics), 2nd Bachelor's year (B2 – Basic Statistics), to 2nd year of graduate Master's university programmes (Applied Statistics for programmes DP and DD). Analysis covers the last nine years, and for the number of students we used mark 2010 for academic year 2010/2011, mark 2010 for the academic year 2011/2012, etc., up to 2018 for the academic year 2018/2019. The results of thiese analysis are given in Table 3.

Table 3. Statistics for analyzed variables

Variable	Valid N	Mean	Std.Dev.	Conf.L. -95%	Conf.L. +95%	Minimum	Median	Maximum	Coef. Var.
WP	9	12.006	1.129	11.138	12.875	10.839	11.521	13.765	0,09
FM	9	8.989	437	8.653	9.325	8.443	8.944	9.676	0,05
B1	9	109	40	78	140	39	125	143	0,37
B2	9	39	9	33	46	26	41	51	0,22
DP	9	17	4	13	20	11	17	23	0,26
DD	9	8	2	6	10	5	8	12	0,30

Columns 5 and 6 in the Table 3. represents the Confidence interval (*Conf.L. -95%, Conf.L.+95%*) for the analyzed variables, and were calculated by the formula:

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

$Conf.L. \mp 95\%$ – lower and upper limit of confidence interval
n – sample size
$\overline{x}$ – mean
s – standard deviation
$t_{\alpha/2}\left(k\right)$ – critical values of Student's t-distribution
k – degrees of freedom (*k* = *n-1*)
α – level of statistical significance

The confidence interval was calculated according to 5% significance level. Specifically, for these calculation, because of sample size, we used $t_{0,025}\left(8\right) = 2,306$.

The last column in the Table 3. represents the Coefficient of Variation (*Coef.Var.)* for the analyzed period, and is calculated by the formula:

$$Coef.Var. = \frac{s}{\overline{x}} \qquad (2)$$

The most interesting thing that we can see from the table above is abnormality in distribution of the number of students in the 1st Bachelor's year of studing Wood Technology (B1). Although is average number of students in last nine academic years 109, and 95% confidence interval between 78 and 140 students, also we can see that minimum (39) is almoust equal standard deviation (40). The irregularity in distribution was caused by the surprisingly small number of enrolled students in the first Bachelor's year for the last two academic years (42 in 2017, and 39 in 2018). Numbers in all columns exept the last one in Table 3. are rounded on integer (whole) number, for example on Variable DD, mean is exactly 7,889 and standard deviation 2,369 that lead as to coefficient of variation 0,3003.

Looking for the impact of employees trends on the number of students, indices analysis was followed. The basic indices for all variables are presented with a common reference year, currently year 2014 = index 100. For period 2010 -2018 the basic and chain indices are given in folowing Table 4., then follows Figure 3. that shows the comparison of the chain indices for a number of employees in sectors Wood Processing (WP) and Furniture manufacturing (FM), and Figure 4. that shows the comparison of the chain indices for number of students according to different courses from academic year 2010/2011 to academic year 2018/2019.

Table 4. Basic and chain indices for all variables

Year	Basic indices (b=2014)						Chain indices					
	WP	FM	B1	B2	DP	DD	WP	FM	B1	B2	DP	DD
2010	95,9	114,6	104,8	116,7	91,7	50,0	-	-	-	-	-	-
2011	94,1	110,8	104,8	111,9	125,0	80,0	98,1	96,7	100,0	95,9	136,4	160,0
2012	96,1	105,3	111,2	73,8	183,3	50,0	102,1	95,0	106,1	66,0	146,7	62,5
2013	96,1	100,0	114,4	83,3	191,7	60,0	100,0	95,0	102,9	112,9	104,5	120,0
2014	100,0	100,0	100,0	100,0	100,0	100,0	104,1	100,0	87,4	120,0	52,2	166,7
2015	108,5	101,9	94,4	121,4	166,7	120,0	108,5	101,9	94,4	121,4	166,7	120,0
2016	111,6	105,9	90,4	97,6	141,7	90,0	102,9	104,0	95,8	80,4	85,0	75,0
2017	116,1	109,2	33,6	76,2	108,3	70,0	104,1	103,0	37,2	78,0	76,5	77,8
2018	119,5	110,5	31,2	61,9	150,0	90,0	102,9	101,2	92,9	81,3	138,5	128,6

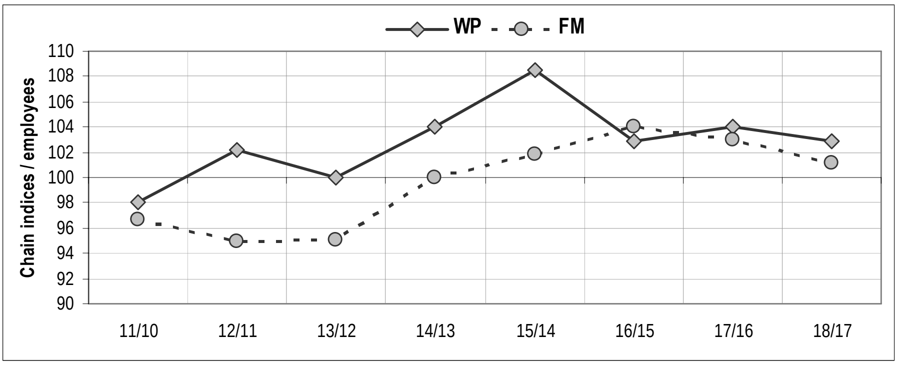

Figure 3. Comparison of the chain indices for number of employees

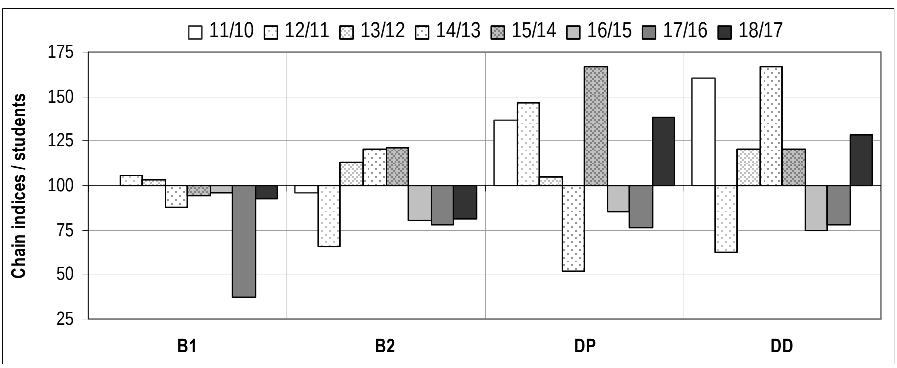

Figure 4. Comparison of chain indices for number of students

Although we recognize some trends in the number of employees in wooden sectors C16 and C31 since year 2010, and despite our expectation, it's not possible to find the influnce of those trends on the number of wood technology students enrolled in the various study programms.

4. CONCLUSION

Results of this research indicates that drop-out rates for the students of wood technology are the highest at the end of the first academic year. First-year students are particularly vulnerable to dropping out of higher education, since their expectations might be very different from what they actually encounter. Such mismatch can stem from the wrong choice of study programme, poor foreknowledge from basic subjects, as well as the feeling of helplessness and failure at the start of higher education studies. Despite the several different approaches to analyse influence of employment to number of wood technology students, it has not been shown that employment trends in sectors C16 and C31 have any impact on the number of students enrolled in the various study programs of the Department of Wood Technology at the Faculty of Forestry in Zagreb.

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