Trnava 2022

WoodEMA

CRISIS MANAGEMENT AND SAFETY FORESIGHT IN FOREST-BASED SECTOR AND SMEs OPERATING IN THE GLOBAL ENVIRONMENT

WoodEMA i.a. International Association for Economics, Management, Marketing, Quality and Human Resources in Forestry and Forest Based Industry

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Slovak Association for Quality in Trnava, Slovakia

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Proceedings

International Scientific Conference
Trnava, Slovakia

Jun 8th – 10th 2022

Trnava, Slovakia 2022

Publisher

International Association for Economics, Management, Marketing, Quality and Huma Resources in Forestry and Forest Based Industry – WoodEMA, i.a.
Slovak Association for Quality, n.o.

Editor-in-chief
Assoc. prof. Renata Nováková, PhD.

Technical editor
Ing. Andrea Vadkertiová, PhD.
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ISBN 978-953-8446-00-9

Publisher:
International Association for Economics, Management, Marketing, Quality and Human Resources in Forestry and Forest Based Industry – WoodEMA, i.a.
Slovak Association for Quality, n.o. Trnava, Slovakia

This international scientific collection is published with the financial support of the KEGA project no. 012UCM-4/2020 – System applications of foresight processes in the new study programme Safety Engineering.

Print:
KON-PRESS,
Pekárska 29, Trnava, Slovakia
eko@kon-press.sk

Edition: 100 copies

ISBN 978-953-8446-00-9

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Preface

Dear colleagues, experts and friends of the WoodEMA association,
the 15th edition of the international scientific conference WoodEMA 2022 took place in Trnava, a city also called Little Rome. Trnava had the honor of organizing such an important conference for the second time. The name of the conference „Crisis management and safety foresight in forest-based sector and SMEs operating in the global environment“ was not determined by chance, but reflects the situation and problems of today.

In the last two years, humanity had to deal with a pandemic crisis that turned into an economic crisis. As usual, the crisis affects all areas, including the forestry and timber industry. That is why the traditional topics of the international scientific conference include, for example: economics and management, product management, renewable energy from wooden biomass, innovations, crisis management, circular economy, etc. in the context of a pandemic situation. Traditionally, a large number of experts and research teams from more than 10 countries have registered for the conference. All topics correspond to each other and create a holistic picture of the post-pandemic situation in individual countries, especially the economic impact on the forestry and wood industry.

We are pleased that many contributions include not only analyzes of the current state, but also suggestions for improvements, suggestions and updates within the framework of new quality standards and the use of alternative products. The proceedings of the WoodEMA 2022 conference present a summary of starting points for new ideas and innovative approaches in the subject area. It can serve the scientific, professional and lay public as a set of information and views on the situation in several EU countries.

Thank you to everyone who contributed to the creation, editing and distribution of this exceptional scientific work.

Assoc. Prof. Renata Nováková, PhD.
The WoodEMA 2022 conference organiser

Trnava 2022

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CONTENTS

DIGITALIZATION OF THE CORPORATE REPORTING IN EUROPE - EVIDENCE FROM BULGARIAN WOOD BASED INDUSTRY

Atanas Atanasov

Abstract: In the conditions of digital transformation, change of business models and more requirements to the transparency and accuracy of disclosed information, the corporate reporting - financial and non-financial - still adheres to the paper format. The introduced requirement for European public companies to use the European Single Electronic Financial Reporting Format (ESEF) aims to increase the analytical qualities of the disclosed information. The main thesis we share is that the introduction of ESEF will allow a wide range of users to use the reports, extracting from them the information they need, and the digitalization of reporting can enable managers to focus on specific risks that determine the value of the business. Arguments regarding the digitalization of non-financial reporting in the context of the lack of a uniform framework and standards for disclosure are also considered. Bulgarian public enterprises from wood based industry - public and non-public, were studied, and the results of the study significantly support our thesis.
Keywords: digital reporting, ESEF, Bulgarian wood based companies

1. INTRODUCTION

The digitalization of business processes in the economy in the last few years is developing at a very high speed. As a result of the digital revolution, the way many companies and even entire industries operate has changed. The specialized literature talks about the change of traditional business models and the emergence of the so-called. digital business models. A WEF report states that in this new world, analogue companies - large, successful companies before the digital revolution - may feel like they are being "hunted" by all parties. (World Economic Forum, 2016) In the context of this economic reality, the need for adequate, timely, clear and verifiable corporate information is becoming increasingly acute. In the conditions of digital transformation, change of business models and more requirements to the transparency and accuracy of the disclosed information, corporate reporting - financial and non-financial - continues to adhere to the paper format. In response to these challenges, a requirement has been introduced for European public companies to use the European Electronic Financial Reporting Format (ESEF), which is based on improving the analytical quality of the information reported.

The purpose of this study is to perform a critical analysis of the conditions for implementation and regulation of the European Single Electronic Financial Reporting Format (ESEF), as well as to examine the experience of Bulgarian wood based companies in applying the introduced regulatory requirements and on this basis to formulate substantiated conclusions and recommendations. The scope of the study includes the four largest companies in the industry in question, one of which is a public company and has implemented ESEF. The financial statements of these companies for 2020 and 2021 have been analyzed and the reports of non-public companies will be considered only as a benchmark to highlight the differences between the traditional paper financial statements and the European Single Electronic Financial Reporting Format.

2. OVERVIEW OF THE EXISTING REQUIREMENTS

The idea of using the European Single Electronic Format dates back 16 years. This idea was first introduced in accordance with the requirements of Article 4 (7) of Directive 2004/109 / EC of 15 December 2004. Its purpose is to harmonize transparency requirements with regard to information provided by companies whose securities are trade on a regulated market (also known as the Transparency Directive). In 2013, the Transparency Directive was amended, stating that a harmonized electronic reporting format would be very useful for publishers, investors and competent authorities, as it would facilitate reporting and contribute to the accessibility, analysis and comparability of financial statements. Thus, in practice, Directive 2013/50 / EU stipulates that all annual financial statements of issuers whose securities are admitted to trading on regulated markets in the European Union must be prepared in a single electronic reporting format as of 1 January. 2020 (EU, 2013, p. Par.26) In connection with these amendments, Commission Delegated Regulation (EU) 2018/815, known as the European Single Electronic Format Regulation, was issued, introducing general rules on format of the annual financial statements, as well as specific rules concerning the marking of the financial statements included in them.

In the Bulgarian legal framework, these requirements are applicable to companies whose securities are traded on the Bulgarian Stock Exchange and have been transposed through amendments to the Public Offering of Securities Act, according to which after January 1, 2021 issuers must prepare their annual financial statements for the activity in a single electronic reporting format. According to the requirements of the Directive and Delegated Regulation 2018/815, all public companies that prepare separate financial statements must submit it to the Financial Supervision Commission in XHTML format. The "single statement" presented in this new format should include both the financial statement and the activity report, the corporate governance statement, the non-financial statement, the government payment statement, the remuneration policy implementation report and other legally required documents.

The introduced ESEF is a new format that all issuers of securities in the EU must use in preparing their annual financial statements. In purely technical terms, this means that individual ESEF financial statements must be prepared using the eXtensible HyperText Markup Language (XHTML), and consolidated IFRS financial statements must be marked with XBRL tags. In fact, XHTML is an extensible hypertext markup language that is part of the XML markup language family. (ESMA, 2019)

EXtensible Business Reporting Language (XBRL) was proposed by Charles Hoffman in 1998 (Financial Reporting Council, 2017) and has been increasingly used in the last decade in the disclosure of readable financial information. According to a study by Accountancy Europe, the main advantage of the new format is the freely available XBRL data, which has the potential to increase transparency and accessibility while reducing the cost of accessing the data. (Accountancy Europe, 2019) XBRL and its growing use for publishing financial information do not change the basics of the financial accounting concept, but only the ways in which the information is disclosed and the degree of disclosure. (Marinova & Atanasov, 2012) The following main characteristics can be pointed out in relation to the published individual reports, the reports in the ESEF, which in our opinion can also be considered as advantages of this format:

- ✔ The report should be easy to read, view and organize and be able to open with standard Internet browsers such as Chrome, Firefox, Edge, etc .;
- ✔ The submitted report should allow for free search by text, keyword or parts of it;
- ✔ The ESEF report must make it possible to copy parts of it, including photographs if necessary.

In addition to the requirements for presentation in XHTML format, all companies that prepare consolidated financial statements must submit it to the Financial Supervision Commission and tagged with iXBRL tags in accordance with the ESEF taxonomy. XBRL is a machine-readable extensible language, and its use involves the application of taxonomy to convert human-readable text to machine-readable format. The taxonomy provided under IFRS is an approved taxonomy developed for the marking of disclosed IFRS data. Companies whose securities are traded on the BSE and prepare consolidated financial statements as of 31.12.2021 must also comply with the requirement that both the four main parts of the financial statements are subject to marking with iXBRL tags (Statement of financial position, Statement of comprehensive income, Statement of Equity and Statement of Cash Flows) and other, mainly informational parts of the financial statements.

According to Troshani and Rowbottom, digital corporate reporting describes the process by which corporate reports on paper are transformed and presented in machine-readable digital format. They point out that digital corporate reporting can be distinguished from 'electronic reporting', which presents traditional corporate paper reports in electronic formats (eg PDF, HTML) (Troshani & Rowbottom, 2021). Therefore, they believe that in "true" digital corporate reporting, information is assigned or "tagged" with contextual meaning to enable computers to have some "understanding" of what is being reported. This allows users to easily retrieve whatever reporting information they want, in any layout and for different companies.

Another study states that digital corporate reports can be visually presented in human-readable formats that depict traditional corporate corporate reports. This capability can be achieved by using iXBRL (Inline XBRL), which structures internal digital corporate reports using XBRL tags, but also facilitates the presentation of digital reports in ways that seek to replicate paper report formats (for example in HTML). (Troshani, et al., 2015)

One of the main criticisms of the digitalization of financial statements is found in the publication of Rowbottom et al. Their study of the IFRS digitization project highlights how digitalisation has disrupted corporate reporting and details the effects of requiring a taxonomy that allocates contextual metadata to all corporate disclosures. (Rowbottom, et al., 2021) They analyze how IFRS-based reporting will be affected by the development of a taxonomy that seeks to refine all accounting disclosures. It is important to note that the results of the study by Rowbottom et al. describe in detail how standard-setters seek to reduce the impact of digitalisation by modeling the taxonomy only on disclosures explicitly required by accounting standards. This in turn means that certain disclosures will not be part of the ESEF if they are not part of the established IFRS taxonomy.

We should also point out that the single European electronic format must also be applied to the non-financial information disclosed by companies. There are different opinions in the literature on the issue of its effectiveness in this case. According to Bertolacci et al. the advantages of using XBRL are the same as in financial reporting: the ability to develop rigorous sustainability indicators that increase comparability and reduce costs; more accurate and reliable data management and real-time reporting to internal and external stakeholders. (Bartolacci, et al., 2021) La Torre et al. consider that in addition to the advantages of using XBRL in integrated reporting, the need to codify sector-specific information should be taken into account so that efforts can be made to develop specific extensions of the taxonomy in the development of XBRL taxonomy for integrated reporting. (La Torre, et al., 2018) This statement corresponds to our understanding that the application of ESEF to the non-financial statement prepared by companies at this stage, when there is no requirement for a uniform format for reporting non-financial information raises a number of questions about what data companies will choose to mark in their non-financial statements and how comparable the information will be between companies.

According to a study by Deloitte, among 613 financial managers, 48% of their time is spent preparing and updating reports and only 18% in communicating information with business and stakeholders. (Morganti, et al., 2018) Our view is that despite these shortcomings, ESEF is a step towards reversing these percentages in favor of communicating financial information, which is crucial for the business success of companies.

3. ESEF - THE EXPERIENCE OF BULGARIAN WOOD BASED ENTERPRISES

We analyzed the annual financial statements of the four largest companies in the wood based industry in Bulgaria - Fazerles, Kronospan Bulgaria, Kastamonu Bulgaria and Welde Bulgaria. Only one of these companies is a public company whose shares are traded on the Bulgarian Stock Exchange and this company has an obligation to prepare its financial statements under the new ESEF. The scope of the companies in question is determined on the basis of the principle that "big players reveal more", as their stakeholders are more, with a different profile and seek more information.

Popova and Georgieva point out that good practices related to the use of digital technologies have been implemented in the Bulgarian wood based and forest industry (Popova & Georgieva, 2019). This suggests that the introduction of the new electronic reporting format (ESEF) should not be problem for companies in this sector, given the advantages that this electronic format provides companies in communicating financial and non-financial information with stakeholders. Marinova-Kostova & Kostov share a similar view, pointing out that the modern industrial enterprise must take advantage of all technological innovations that can increase its efficiency (Marinova-Kostova & Kostov, 2021). Our results showed that despite the fact that ESEF is not expensive to implement none of the non-public companies have voluntarily accepted the ESEF in its practice.

Table 1. ESEF characteristics based on Annual Financial Reports of Bulgarian Wood Based Enterprises

Enterprise	Freely readable, clear and tidy and can be opened with standard internet browsers	Allow for free search by text, keyword or parts of it	Allow copying parts of ESEF, including photographs if necessary
Enterprise 1	Yes	Yes	Yes

(public)			
Enterprise 2 (non-public)	No	No	No
Enterprise 3 (non-public)	No	No	No
Enterprise 4 (non-public)	No	No	No

Source: 2020 and 2021 Annual Financial Statements of the surveyed companies

As a result of the study, the following summaries and conclusions can be made:

- ✔ Only one company has submitted its annual financial statements in a readable format with the ability to copy, search and open via a standard Internet browser. This company is public and has used the ESEF format;
- ✔ The reports of non-public companies are published as „scanned copies“, which does not allow users to freely search, copy and save text or part of the report;
- ✔ Although some companies are non-public and do not have to use the ESEF format, they can present their financial statements in the so-called readable PDF, which will also allow searching for text and copying it, but with different formatting. They did not use this opportunity;
- ✔ The only public company that used ESEF for 2021 has also published its reports in previous years in „scanned copy“ format without the ability to search, copy, mark, etc., which leads to the conclusion that a single access point to the financial statements of companies.

CONCLUSION

The results of our study show that companies in the wood-based industry in Bulgaria publish all required financial information according to applicable law, but in a format that makes it difficult to use and analyze by stakeholders as only public companies use the ESEF format.

The ever-increasing demands on the information that corporate reporting produces today also determine the key characteristics that corporate reporting must possess in order to meet the growing demands of consumers: to be integrated - including financial and related non-financial information, related to business; to have a high degree of interactivity and to be as close as possible to real time in order to offer adequate and timely information about the business. All these requirements could be realized through the digitalization of corporate reporting for all industries (incl. wood based), but in a way that does not violate the basic principles of financial disclosure set out in IFRS.

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POTENTIAL USE OF INORGANIC BONDED LIGNOCELLULOSIC COMPOSITES IN ARCHITECTURE

Nadir Ayrilmis, Manja Kitek Kuzman

Abstract: This study focused on the recent applications of inorganic bonded composites in architecture applications. In different inorganic binders such as gypsum, cement, and magnesia are used to bond the lignocellulosic materials such as wood particles, wood fibers, wood residues, and wood wool. These composites have outstanding properties with respect to their resistance to fire, durability, sound insulation and stiffness, which make them excellent material for building applications such as sheathing and siding, exterior and partition walls, ceiling, acoustic and thermal insulation, decoration, and the cladding of prefabricated house units. The utilization of inorganic bonded lignocellulosic composites is highly dependent on building codes, safety and fire regulations, construction techniques and aesthetics. Recent applications of inorganic bonded composites in contemporary architecture will be studied and presented as case studies.
Keywords: inorganic bonded composites, architecture, arbolite, wood, heraklith, construction

1. INORGANIC BONDED COMPOSITES (IBC)

Inorganic bonded composites (IBC) are boards or other types of constructional elements produced from wood wool, particles or flakes, or other types of fibre of vegetable biomass blended with cement, magnesite ($MgCO_3$) or gypsum. It does not contain formaldehyde resin, polystyrene or other substances that can serve as source of emission of volatile toxic compounds. Thanks to mineralising additives, wooden particles are decay-resistant, which also contributes to maintaining of heathy atmosphere within premises.

The most expedient binder giving strength, durability and acoustic insulation properties is however Portland cement. In this process, heat is not required. The wood-cement boards are used for specialised structural applications. They have outstanding properties with respect to their resistance to fire, durability, sound insulation and stiffness, and this means that the product is most suitable for internal wall constructions in public places, the lining of lift shafts, the construction of cabling ducts, soffits, motorway acoustic fencing and the cladding of prefabricated house units. The cement-bonded board is harder and more resistant than its components alone, with a lower cost and lower density than concrete. Many manufacturers use additives like mica (silicate/phyllosilicate minerals), aluminium stearate and cenospheres (a lightweight, inert, hollow sphere made largely of silica and alumina, and filled with air or inert gas) in order to achieve certain board qualities [1]. A typical cement fibreboard is made of 40-60 weight-% cement, 20 30% fillers, 8 10% cellulose, 10 15% mica. Additives such aluminium stearate and polyvinyl alcohol (PVA) are normally used in quantities less than 1%. Cenospheres are used only in low-density boards with quantities between 10 and 15% (Fig. 1).

Figure 1. Inorganic bonded composites.

Inorganic-bonded lignocellulosic composites have some advantages in comparison with resin-bonded composites: fire and biological resistance, high durability, good dimensional stability and low production cost. Besides, mineral composites generally use solid wood waste or other lignocellulosic material, including agricultural wastes. For this reason, these panels occupy a special place in the new eco-friendly economy as they provide for energy saving, conservation of natural resources and reduction in environmental pollution.

Application areas of inorganic bonded lignocellulosic composites are given below [2].

Interior

Internal walls

- Floor / Raised floor
- Mezzanine floor
- Indoor ceilings
- Wet spaces
- Elevator shaft walls

Exterior

External walls (*)

- Roofs
- Outdoor ceilings (*)
- Soffit an fascia (*)
- Fences and boundary walls

(*) for only prefabricated and light steel buildings.

1.1. Application Cement bonded lignocellulosic wood composites in building industry

Inorganic-bonded lignocellulosic composites are used for constructive frameworks, bearing purpose, fire protection and other compliments for walls and floors. What they all have in common are their strong fire-, mould-, and vermin resistances because of the cement and acidities. They also have good thermal and acoustic properties and they are competitive with reinforced concrete because of their relatively low density. The low-density cement-bonded boards (excelsior) could be used for high-performance applications and improved acoustic and damping properties such as; fire-resistant, sound-absorbing walls, ceilings, and thermal insulation panels [3]. A comparative use ability of mineral bonded composites is given in Table 1. The use of Jelovica wooden house production is given in Figure 2.

Table 1. General uses of mineral bonded composites (+: low level; ++: medium level; +++: high level [3].

Place of use	Gypsum bonded composites	Cement bonded composites	Magnesia bonded composites
Exterior and partition walls	+	+++	+
Coating of the Wall	+++	+++	++
Acoustic and thermal insulation	+++	++	++
Decoration	+++	++	++
Flooring	+	+++	++
Large size prefabricated elements	+	+++	++
Roofing, shingles and shade	++	++	++
Ceilings and architraves	++	++	++
Fire resistant construction	+++	+++	+++

Figure 2. Jelovica wooden houses production, Preddvor, Slovenia, 2018 [1].

Cement bonded particleboard is very much suitable for frame construction. This technology implies sheet sheathing, which, in turn, ensures high technological effectiveness as well as time saving. It is sound insulating material which reduces acoustic communication between rooms separated by a partition. In general the boards (up to 20 mm thick) are used for frame sheathing (Fig. 3). The panels can be also used for the flooring applications (Fig. 4).

A.

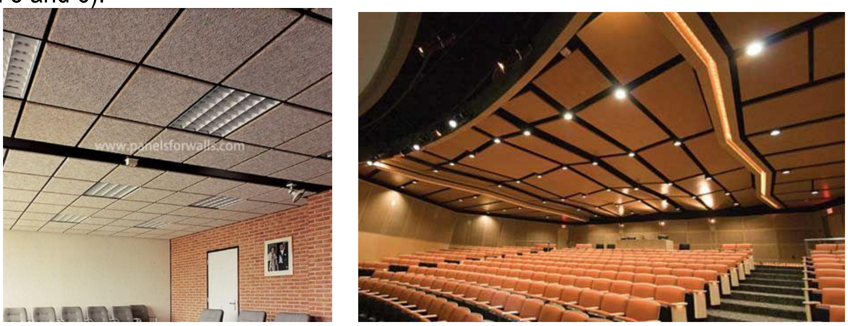
B.

Figure 3. A. Cement bonded particleboard for Sheathing of walls and partitions.

B. Laminate overlaid cement bonded particleboard

Figure 4. Flooring application of cement bonded particleboard.

Heraklith™ (acoustic) panel: It is a panel produced from cement with a special wood shavings (wool) shavings. Wood-wool acoustic panel is made of wood fiber, cement and minerals under high pressure. There are countless pores inside of the panel, which can absorb noise. It is not only has great acoustic and decoration effect, but also environmental friendly (Figs. 5 and 6).



A. B.

Figure 5. A. Heraklit ceiling. B. Heraklit ceiling in Theatre.

Figure 6. The application of heraklith panel with stone wool core.

Public halls, music venues, and theatres all need excellent acoustic to give audiences the kind of the experience they expect. Heraklith wood wool panels are an a good solution for their excellent sound-absorption properties (Fig. 7 A.). The Wood Hotel is a 20-story hotel built entirely of wood one of the world's tallest wooden buildings located in central Skellefteå, Sweden (Fig. 7B). The ceiling of the hotel was made from the heraklith due to its advantages such as sound absorption.

1. B.

Figure 7. A.The ceiling application of heraklith panel; B. Wood Hotel, Skelleftea, Sweden 2022.

Arbolite is a type of lightweight concrete, which is made from organic filler: wood chips (mainly from coniferous trees) or chopped stems of cotton, rice straw, flax and hemp fires; water; sawdust; chemical additives for the mineralization of the filler and portland cement without the use of sand and other, larger aggregates (Fig. 8). Arbolit can be used for the construction of houses with a small number of storeys (up to 3 floors). For the manufacture of wood concrete, cheap wood waste from carpentry is used, which processes the necessary fractions into wood chips or waste from enterprises that process flax, hemp, and cotton. In the sixties of the last century, more than 100 factories throughout the Soviet Union established production of wall blocks, panels, etc. from arbolit. After the introduction of panel housing, the mass production of structures from wood concrete was discontinued [4].

Figure 8. Arbolite production phases.

2. CONCLUSIONS

Cement-bonded composites are emerging as an important class of construction materials. Its unique properties such as water resistance, durable to extreme climatic conditions, resistant to fire, fungus, and termites make it excellent structural panel for construction industry. It is successfully used in interior and exterior paneling. It can be used for facades or decorative aspects, as the production process allows the flexibility of producing semi-finished boards. It is a good choice for pre-fabricated house in terms of cost-effective property.

Acknowledgements: We wish to thank Slovenian Research Agency, Program P4-0015 and P4-0059.

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HYBRID AUDIT AS AN INNOVATIVE APPROACH IN THE AUDIT PRACTICE OF FORESTRY

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Abstract: Auditing has undergone many changes in the context of globalization and digitalization. Under the influence of the COVID-19 health crisis, additional restrictions are introduced, which are related to the impossibility of physical inspections (desk cheks or on-site ones). This has a significant effect on the activities of sectors and enterprises where on-site inspections are a priority, like in forestry. In order to answer the current challenges, the Forest StewardshipCouncil introduces a new audit approach, called "hybrid audit". The main goal of the study is to analyze the benefits and risks of hybrid audits in forestry. This will be done by (1) performing a comparative analysis with other types of audit (particularly financial and IT audit) and (2) deriving the characteristics and requirements of the hybrid audit. The study is conducted based on the scientific methods of analogy, analysis and synthesis, induction, deduction, and logical approach. The results of the study outlined the need for specific, local forestry-related rules and methodology of the procedures for the hybrid audit to be developed. Additionally, there is a risk of gaps in the check and verification of the forestry documentation and resources when using the hybrid audit.
Keywords: hybrid audit, forestry, management, risks, benefits

1. INTRODUCTION

Development of the COVID-19 epidemiological situation on a global basis has negative impacts and consequences on a number of sectors, including forestry (Belova and Hristova, 2021, p 46). As a result, many enterprises are facing challenges of different kinds: financial, economic, and social. Health authorities limit restricted physical contact with accountants, lawyers, and managers of the enterprises. This is the reason why the audit community is experiencing increasing difficulties in conducting audit procedures. That negatively affects the internal control environment in the forestryauditor'sprocedures in terms of identifying gaps, and/or frauds in the forest enterprises and in documenting the tests and performed procedures. Procedures related to the licensing of forestries are characterized by specific audit procedures (preparation for certification, preliminary audit, basic audit for certification, annual audits/inspections, special audits) (WWF booklet, 2016). Due to the difficulties arising from the inability to make physical inspections and audits the Forest Stewardship Council (FSC) is introducing an innovative approach to conducting a "hybrid audit". Hybrid audit is defined as a combination of a remote desk audit and an on-site inspection.This type of audit is still new in audit practice and therefore it is not sufficiently analyzed in the scientific literature.The main objective of this paper is to make a theoretical analysis of the hybrid audit in forestry in terms of some positive and negative aspects of its application. An additional goal is a general comparative analysis of the hybrid audit and the currently applied financial and IT audits to be made. The object of research is the audit procedures in forestry, and the subject of analysis is the hybrid audit proposed by the FSC. To achieve this goal, the authors set the following research tasks:

- To outline the nature of hybrid audits by distinguishing it from the other types of applied audits, more precisely financial and IT audits.

- To identify the benefits and negative aspects of introducing the hybrid audit into forestry practice.

The used scientific methods and approaches in the current study are: logical, deductive, and comparative methods, as well as the methods of analysis and synthesis. The results of the study contribute to the literature by presenting the possibilities of using hybrid audits in forestry. As a limitation of the study, it can be pointed out the fact that it presents a theoretical basic based on collected secondary data, due to the lack of practical research as the hybrid audit is still a new method.

2. SIGNIFICANT RISKS AND GAPS IDENTIFIED IN THE FORESTRY

The audit function needs to be updated at all times concerning external and internal factors (external and an internal audit) that affect the subject matter of the audit. The audit is widely used and can have various manifestations: medical audit; human resources audit; marketing audit; audit of corporate social responsibility, social audit, and others. The use of relevant audit procedures and types of audits depends on the specific risks and activities being checked. In the specialized literature it is outlined specific risks and issues of audit in forestry (A framework for audit quality key elements that create an environment for audit quality, 2014; Auditing Forests: Guidance for Supreme Audit Institutions, 2010; Audit guideline on fraud, 2014; Nicorescu et all, 2021, p. 2). Generally among the significant risks are: the way information is received (including in-field observation); the selection of appropriate procedures, requiring the use of appropriate tools and technologies, by the specifics of the activity; the results of the performed procedures; key actions for the preparation of the financial statements and contextual factors, public opinion, factors influencing external audit fees. Studies of audit reports to the financial statements of forestries in Bulgaria (Georgieva and Bankova, 2020) are indicative of reported issues related to the disclosure of contingent assets and liabilities, the real value and impairment of assets, problems in the activities of companies, income and expense reporting, as well as the receivables and liabilities of the forestry. Georgieva and Bankova (2020) point out that it is important to pay attention to human and institutional capital as well, including management, government, consumers, and regulators. This requires further analysis of risks such as: the risk of attempted fraud (documentary, on the field checks, or interviews); intervention by forestry management staff; risks associated with incorrect accounting and valuation of biological assets (as required by International Accounting Standards (IAS 41), changes in the size of the land, etc., risk of lack of information, risk of lack of long-term financial strategy. In this respect, it is necessary to pay more attention to the methodological problems that arise. It is necessary for each country that certifies its forestry to have updated standards according to which the licensing is related to the emerging risks that take place.

3. OPPORTUNITIES FOR APPLYING FINANCIAL, IT, AND HYBRID AUDITS IN FORESTRY IN THE CONTEXT OF COVID-19

To prevent the previously outlined risks, a fundamental type of audit is the financial audit, which is introduced in many countries after the Great Depression of 1929 (Veysel, 2017). It has wide application and implementation due to changes in the structure and contents of the financial statements and the possibilities of financial crimes. For managerial use, a financial audit is an insufficient form of control and prevention of abuse and fraud. The reason is related to the weaknesses in the control environment (a common weakness is documentary fraud) and the development of digitalization, leading to new risks and types of fraud, including cybercrime. Cybercrime is causing significant losses, especially during the pandemic situation with COVID-19. This requires additional investment in the prevention of cybercrime in each sector (Bankova, 2020). To meet the challenges of globalization and digitalization, the so-called "IT audit" and "hybrid audit" are emerging, which have an important role in the management of digital processes in forestry. IT audit helps enterprises to better protect their assets by identifying gaps and vulnerabilities in these systems, which lead to inconsistencies with generally accepted information, security guidelines, and good practices. The IT audit provides an objective assessment of the effectiveness of the currently applied controls (the strategic and operational decisions and mechanisms for data protection adopted by the organization) against existing and emerging threats. Information security analysis examines the protection of assets and data, administration and levels of access, information security policies, as well as ensuring business continuity assurance and contingency planning, disasters, and emergency planning. Except for the quality assurance standards (ISO 9001:2015-Quality Management System and ISO 19011:2018 Guidelines for auditing management systems), additional audit oversight of forestries is necessary. The FSC, which is the official international licensing authority for forestry, is taking into account the emerging risk related to coronavirus in the forest sector. New approaches are being sought for the exercise of the licensing and auditing function in the forestry sector, based on the following weaknesses identified by INTOSAI (2020) for unsustainable forest management - Biodiversity and Ecosystem Loss, Forest fires, Illegal Logging, Illegal use of land, Disasters, Conflict, Revenue loss, Livelihood loss, Social problems, Decreased carbon storage, Reduced water quality, Shortage of raw materials for industry. Because of that on November 20, 2020, a new united audit method was approved called "hybrid audit". It is an innovation for forestries and their managers, related to receiving license certification by certification auditors. This type of audit is described in COVID-19 Policy Responses as a united approach to conducting remote work (online meetings, interviews, and on-site inspections). The reason is to minimize the risk to public health, as well as to limit travel and physical contact with other people.

Procedures of the hybrid audit are performed by a qualified person. It is necessary primarily for an auditing plan (audit program) to be developed. This process, as required, must describe which part will be performed on the field and which one online - from distance. It is also necessary to make a risk assessment of the hybrid process, by determining the degree of risk ("high", "medium", "low") for the procedures performed by the auditor (FSC, COVID-19 Policy Responses, p. 11-12). Depending on the identified risk, an audit approach is chosen (one-stage and two-stage). According to item 6 of the COVID-19 Policy Responses (p. 14.), the hybrid audit must include a „qualified audit team leader managing the audit remotely; technical expert(s) and/or qualified auditor(s) on-site to obtain audit evidence; virtual video meetings between the remote audit team leader and the organization/on-site team member(s); interviews with relevant managers, employees, contractors and other stakeholders (remotely and/or on-site; review of relevant documents and records (remotely and/or on-site); conducting the opening and closing meeting of the hybrid audit with physical/virtual presence of the full audit team (auditors and local experts) together with relevant staff of the organization, and other available information”. Supervision after the procedures of certification of forestries should also not be underestimated. For this reason, the FSC unifies and digitizes audit reports in different languages (German, English, Spanish, French, Japanese Portuguese, Russian, Ukrainian, and Chinese), and the certification body facilitates access to information. With the use of the new option (the hybrid audit), the licensing authorities apply procedures that are a compilation of external audits. It is carried out based on a remote form, as well as for specific components on-site inspections that are performed at the discretion of the audit team. Nicorescu et all (2021, p.10) state that “the higher the number of auditing days, the higher the use of online and hybrid approaches”.Without claiming to be an in-depth comprehensive analysis, Table 1 presents the author's view on the possible benefits and negative aspects of the implementation of financial, IT, and hybrid audits in forestry. The analyzes are done based on some specifics of the forestry sector activities outlined in the scientific literature (Chobanova et all, 2018; Jelačić, et all, 2010; Gejdoš and Potkány, 2015; Popova, 2018).

Table 1. Types of audits in forestry

Type of audit	Audit objectives	Benefits of using the approach	Negative aspects of using the approach
Financial audit	Review of financial statements and accounting policy, accounts, disclosures, and business processes.	- Inspection from an independent certified public accountant ; -Review of accounting documents and policy.	Lack of mandatory audit companies rotation.
IT audit	Inspection of IT controls.	- Ability to detect mistakes in electronic platforms.	There is a lack of standards for IT audits in forestry.
Hybrid audit	Hybrid inspections with desk checks or on-site.	- Developed COVID-19 Policy Responses (2020). Collection of derogations, interpretations, and frequently asked questions, FSC International Canter; - Possibility to work from distance (Teleworking); - Prevention of infection with COVID-19, etc.	- Requirement to develop local rules and methodology for hybrid audit; - Probability of failure to review documentation on-site; - Review of assets, inventories, etc.

From Table 1, it can be stated that each of the analyzed types of audits has weaknesses for further improvement. In the financial audit, it is necessary to implement rotation about the auditor performing a financial audit of the specific industries like forestry. This method will minimize the risk of neglecting audit procedures. About the reflected finding for the IT audit of forestry - it is difficult to unify the needed framework. The reason is that each forestry has an individual management structure. However, it is necessary to have minimum criteria and requirements for IT controls in forestry. The hybrid audit is a way to unite financial audit and IT audit. The aim is for audit procedures under the licensing regime to be easier to implement. It is important a check on the IT systems and the possible weaknesses that will arise due to the lack of standardization of digital processes to be done. However, the use of the hybrid audit requires additional IT knowledge related to the used software not only by the auditors but by the relevant stakeholders involved in the different audit procedures. This leads to the need for additional skills and resources. The lack of relevant local rules and methodology will lead to a significant time to be developed and implement the reliable and unitized procedures. We should not neglect the fact that there are many people in the field (from the management, staff, control institutions, etc.) who can refuse the new approach, as it is part of the overall psychology of people when implementing something innovative. Another issue could come in terms of gaining companies' trust when implementing the hybrid audit. In this respect, this type of audit is still not mature enough, so it could reflect a lack of understanding by the managerial staff of the companies.

4. CONCLUSIONS

In a conclusion, it can be stated that the digitalization of inspections and checks through hybrid audits facilitates the process of certification of forestry. This approach can preserve the health of employees, which is fundamental in the conditions of COVID-19 or other health crises, but also in other conditions that prevent the possibility of physical documentary and field inspections. Despite the outlined positive aspects, there are indications that a hybrid audit leads to a risk of introducing asymmetric information. This requires additional technical knowledge from auditors who will apply the hybrid approach to forestry inspections. Additionally, financial resources need to be provided to ensure cyber protection of key information from forestry activities. Subsequent research on the issue should be aimed at a more detailed analysis of the benefits and weaknesses of conducting a hybrid audit, based on primary and secondary data collected and analyzed by the implementation of the necessary hybrid audit procedures.

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RECYCLING AND WOOD SHAPING THROUGH THE CIRCULAR ECONOMY

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Abstract: Recycling and the circular economy are being discussed on a daily basis as the goal of preserving a better future. Therefore, this scientific paper will attempt to show the connection between recycling and the circular economy through creative designs of recycled wood. The circular economy, as a circular model, advocates the return to nature and the reuse of materials as a sustainable process. The goal of the circular economy is to increase the transformation and recycling of existing or already used materials and wood products giving them new purposes. Wood is one of the most recyclable materials. The recycling of wood has several advantages and in addition, it is one of the simplest recycling processes carried out. It is a physical process that does not require the introduction of chemical materials which would imply environmental contamination. Each recycling process has both environmental and economic benefits. In addition, in most cases, the recycling process is cheaper than the production of raw materials. Wood from construction waste which is cleaned, recycled, creatively designed, and placed in public spaces, results in its circulation in nature, the preservation and protection of the environment, consequently having an impact on climate change reduction. Examples of designing recycled wooden beams into sculptures present a circular model through a very simple way of production; without consuming additional energy, through creative recycling methods while working with children and youth.
Keywords: circular economy, sustainable development, wood, recycling, shaping

1. CIRCULAR ECONOMY THROUGH SUSTAINABLE DEVELOPMENT BY RECYCLING AND SHAPING

The concept of the circular economy implies the use of renewable and regenerative materials and products, in order to maintain their useful and utilitarian value at the highest level (Ellen MacArthur Foundation, 2015). Therefore, the optimization of the circular economy potential is associated with more sustainable production and value increase of technological and natural cycles that raw materials go through in a circular strategy, such as reuse, reduction, processing, and recycling (so-called 4R principle) of products, materials and their components (Hieminga, 2015). Interestingly, many experts come to the same conclusions and often repeat themselves. According to Vrbek (2020), the circular economy system is based on the utilization of already used materials, which can be renewed and reused in different ways, which at the same time ensures the reduction of the use of natural resources. However, there is a lot of talk about this issue while little is applied in practice and everyday life.

Although the Republic of Croatia is a member of the European Union and has the task of following and respecting all guidelines introduced by the European Commission, it came closest to the attempt of trying to meet the requirements of circularity when it adopted the Sustainable Waste Management Act 2014 (OG 84/21). As part of the Act, the Waste Management Plan of the Republic of Croatia was adopted. This plan "determines and directs waste management based on the analysis of the current situation and waste management objectives. The plan determines measures for the improvement of procedures for preparation for reuse, recycling and other procedures for the use and disposal of waste on land and sea under the sovereignty of the Republic of Croatia". Desire and aspiration are present, but concrete progress is minor to previous expectations. There are various ways to protect the environment and reduce the impact of climate change. Therefore, eco-design which is also called green design or environmental design is involved in activities aimed at reducing the impact of products on the environment throughout their life cycle. The activity begins with the supply of resources and materials, continues with production, and ends with the storage of products that have completed their life cycle to the end (Trošić, 2020).

The modern way of product design implies knowledge of the effects of products on the environment, therefore we strive to produce sustainable products based on the assessment and selection of designs that are "environmentally friendly" (Jambrešić, 2019). Jambrešić (2019) believes that at the same time eco-design supports the reuse, processing, and recycling of products.

As such, unlike traditional design, it includes the entire product life cycle. It is a process from "cradle to reproduction" (Sun and Zhang, 2019) that serves to improve the impact of the product on the environment by improving its characteristics through design alteration (Jambrešić, 2019). "It is important to advocate for materials with the ability to be recycled and for renewable energy sources" (Trošić, 2020).

Everything can be reused or broken down into substances that can become part of the life cycle. The significance is in diversity, modularity, and adaptability, while all energy should come from renewable sources. (Lovrenčić Butković, Mihaljević, 2021)

Sustainable development, as a part that fits into the theory of the circular economy, raises the question of promoting sustainable development; actor-interest approach in sustainable development consideration; social forces "for" and "against" sustainability/consideration; social forces "for" and "against" sustainability. (Lay, 2007)

By taking resources from nature we can produce everything we need, and then we need to give back to nature what we have taken in its acceptable form. If not out of concern for the environment, then at least for selfish reasons, so that we can re-exploit that same nature. Because if we pollute everything with our carelessness, there will be nothing left to exploit for future generations. Recycling can bring many new benefits, all with a minimal burden on the environment in which we live and which we try to protect and reduce the negative impact of climate change that can lead to unwanted events. The goal of the circular model in practice is to increase the transformation and recycling of existing or already used materials and products to develop new businesses and create new jobs.
Wood is one of the most recyclable materials. Wood recycling has several advantages, and in addition, it is one of the simplest recycling procedures carried out, as it is a physical process in which it is not necessary to introduce chemical materials that would imply environmental contamination.

Recycling is based on a circular economy and sustainable development and therefore it gives everyone dealing with creation, design, and engineering the opportunity to evolve to reduce their negative impact on the environment by choosing environmentally friendly materials, processes, and technologies. Due to the growing environmental problem that is increasing every day, changes and the introduction of environmental approaches at the global level are necessary. However, it is important to develop awareness and show that even at lower levels the development of preservation and protection of the environment can be influenced. By raising awareness of environmental protection and health, the demand for organic products is growing.
Wood is an increasingly sought-after renewable resource and an important raw material for construction and materials. In addition, new consumer habits lead to the production of increasing amounts of waste wood, which as a raw materials can be mobilized for the cascading production of new materials. (Besserer at all, 2021).

2. EXAMPLE OF CIRCULAR ECONOMY, RECYCLING AND DESIGN ON THE EXAMPLE OF PUBLIC SCULPTURE - UNIDUran

Working with wood enriches, relaxes, and creates a feeling of satisfaction and happiness, due to the warmth of the material, aesthetic properties, texture, color, fragrance, fineness, and ease of processing. But wood is not just found in woods, sawmills, factories, and stores; it is all around us. Let's ask a simple question:

“What is happening with old furniture, old building joinery, old roof beams, old wooden floors in the Republic of Croatia?"

The answer to this question is impossible to get in some acceptable form when we talk about sustainability and the circular economy. But we must strive to resolve this issue if we are to engage in this business, trying to improve wood technology and properly manage forests that mean life.
Cabinets, chests of drawers, shelves, tables, chairs, armchairs, beds, doors, windows, where does it all end up? In addition to the old furniture and construction carpentry discarded by citizens, hotels are a large source of this waste, by changing the entire interior during their renovations.

In the worst-case scenario, old furniture ends up as a wild dump in the woods. In the "better" version, old furniture is collected as part of occasional or previously agreed actions for the removal of bulky waste by utility companies or citizens themselves, bringing it to recycling yards. In the "best" case scenario, citizens hand over old furniture that is still in usable condition to entrepreneurs or non-profit organizations who, with or without minor repairs and alterations, return it to the market as second-hand products. However, the problem is with old furniture which is no longer interesting to be repaired, reused, and which needs to be “disposed of” in another adequate way. It's not just about the furniture; there is a lot of discarded carpentry, wooden windows, doors, roof beams and wooden floors.

These wood items in Croatia usually end up in landfills. To begin with, the state should “raise awareness" of the problem of managing waste furniture and other solid wood products, collect data on the quantities and the way in which it is currently "disposed of" in the Republic of Croatia.

Such an analysis would certainly lead to the conclusion that this is waste that should be declared a special category of waste and for which a regulatory framework should be adopted aimed at an organized system of recovery of old furniture.

However, until solid wood disposal is regulated, individuals and associations are trying to draw attention to the importance of recycling in a variety of ways. Below will show an example of making a public sculpture out of wood collected from a bulky landfill.

The sculpture was made on the occasion of the "Days of Cultural and Creative Industries" in Dubrovnik, which was organized by the development agency "DURA".

Old pine roof beams, construction carpentry doors, and windows made of quality types of wood - larch, cypress load-bearing beams, and solid beech bed frames, cried out for reuse. Although some were in poor condition as they were attacked by woodworms, they were treated and prepared for disinsection. After a certain time, they were processed, cleaned, and prepared for further processing. The procedures were done with small hand tools and woodworking machines, so that minimal sources of electricity were used, as the overall aim was to preserve the environment. (Figure 1. 2. 3.)

Figure 1. 2. 3. Wooden beams, windows and doors, bed frames from bulky waste

Wood found in various landfills should be prepared for recycling. The most important procedure is a thorough cleaning because only when all the dirt and layers from standing and weather influence are removed, an insight into the condition of the wood is obtained. Some roof beams required disinsection because they were attacked by insects. The wood was sanded and then sawn into smaller pieces suitable for shaping according to a previously prepared sketch of the sculpture. The construction of wooden slats was placed in the position that the sculpture would have been after being placed on a stone bench in the park. All joints were protected with putty, due to the possible penetration of water into the interior of the sculpture, which would prevent "lying" of water on the horizontal wooden parts. The putty was made of sawdust and glue. (Figure 4.5.6).

Figure 4.5.6. Sawdust and glue putty, joining beams, small beams and slats, various sizes and types of wood

The construction was made in stages; while the joints were dried, parts were cut for other positions on the sculpture. It should have been borne in mind that the massive parts of the larch and pine wooden beams were very heavy in relation to the "skeleton" itself, which was made of slats. The parts that shaped the imaginary sculpture were carefully matched, keeping in mind the ratio of sizes and composition.
(Figure 7. 8.9.)



Figure 7. 8. 9. Making a structure of wooden slats, shaping of roof beams and bed frames Sculpture shaped with recycled pine, larch and beech wood

Shaping is very creative and gives countless possibilities when it comes to recycled wood. Objects made of recycled wood, as in this example of a sculpture, are shaped from pieces that are available at the time. Due to the different types of wood, different sizes and thicknesses of wooden pieces evoke the playfulness and maneuverability of wood. (Fig. 9.)

Figure 11. 12. Sculpture protected with white paint and glue coating

After finishing the design of the sculpture, all joints were additionally protected with sawdust and glue, and the surface of the wooden forms was thus prepared for a protective coating of white water-based paint and PVA glue. Since the sculpture was intended to be constantly outside, this kind of coating completely protected the wood from weather influences. (Figure 11. 12.) After drying, the sculpture was painted with water-based paints.

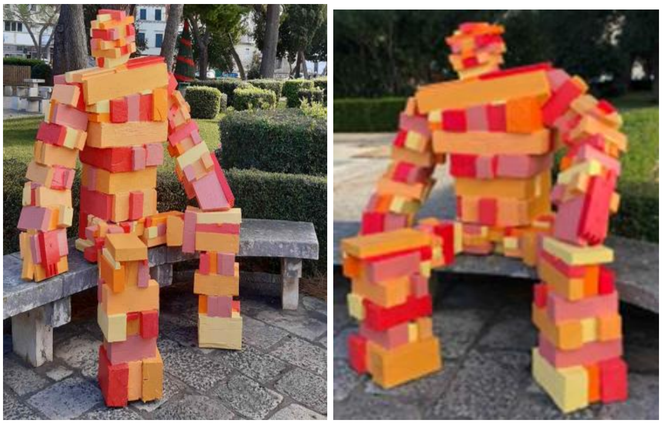

Figure 13. 14. UNIDUran set up in a park in the port of Gruž

The sculpture made of recycled wood is set in a beautiful park, near the main market in the port of Gruž, which is an ideal place to show the importance of creative creation from wood waste, where recycling has become an example of sustainability, and in this case interdisciplinarity of science and art in the circular economy.

3. CONCLUSION

The circular economy, sustainable development, recycling, and shaping of wood from waste, which actually is never waste, are connected and as a whole have resulted in the creation of an outdoor sculpture in an attractive space. Making and placing public sculptures in parks and places where there is a large concentration of locals and tourists, encourages thinking about the importance of preserving materials, wood and forests. Through the concept and understanding of the circular economy, it is necessary to expand it to all areas of application in everyday life. In this example of wood as a material, emphasizing that recycling wood does not cause additional pollution, there is no further contamination. Cleaning up buried landfills creates a new dimension in the creative creation of all participants who want to contribute to environmental protection, reducing the impact on climate change.
Here we are talking about minimum quantities of wood for recycling, which are quite minor on

a global scale. It further made us think that the possibility of a special category of wood waste, furniture and utility items made of wood other than waste, should be created with the possibility of 3R- Recycle, Renew, Reuse.

The sculpture made of recycled wood was placed in Dubrovnik in a park with a children's playground, near the open market. The park is located in the port of Gruž where tens of thousands of tourists pass daily from cruise ships, yachts and nearby hotels, and where there is a large flow of people.

Holding workshops within the University and external workshops for citizens will contribute to raising awareness of the importance of wood disposal even after its primary use; because recycling, redesign and reuse create new items that have greater artistic and added value through sustainable development in the circular economy.

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A CASE STUDY OF A CROATIAN COMPANY'S INDEPENDENT TIMBER SOURCING

Karlo Beljan, Vedran Sredić, Krunoslav Teslak, Stjepan Posavec, Petra Palátová

Abstract: The aim of this research is the business connection model between forestry and wood-processing industry which is, as generally acknowledged, characterized by the timber supply shortage. In the case study of one privately-owned company from Croatia (Požgaj group), we investigated the modality by which the company can ensure the source of raw material that would be independent of price increments and market shortages. This approach is based on the assumption that the company could purchase a forest property large enough to result in timber quantities sufficient for the company's processing capacities. Based on the last 6-year timber consumption statistics, the company's required quantities of wood assortments are defined (51,000 m^3 annually). Private forests, which by their tree species composition and wood-processing characteristics (minimal diameters) can fulfil the required timber quantity and quality, are the private productive high forests of common beech, pedunculate oak forests and beech-fir forests. Results indicated that the optimal size of the forest property should be about 18,000 ha, but only a part of that could be found on the domestic property market. Also, we encounter a misbalance between the capacity of the wood-processing company and the production potential of natural forest resources for what several solutions are presented and discussed.
Keywords: added value chain, forest property, forest management, market, optimisation, wood-processing

1. INTRODUCTION

The wood-processing industry is one of the important economic branches in Croatia (Posavec and Beljan, 2013). As many other processing businesses, it needs input resources which in most cases are not the subject of the company's core business. So, the dependence on the raw material is present and can be crucial in the circumstances of supply shortage (Pirc et al., 2010) and/or price incensement. In Croatia, where the state-owned company Hrvatske šume Ltd. manages the majority of all forests, which are of higher quality in comparison to the privately-owned forests (Čavlović, 2010), the wood-processing industry is mostly dependent on that specific source of raw material (Beljan et al., 2021b, 2021a). The so-called "distribution" of the timber produced in the state-owned forest refers to multi-year contracts between the Government and some wood-processing companies. The problem matter, which is the focus of this paper, are the companies which are in an unenviable position due to the impossibility of making multi-year contracts. Those companies are being forced to buy timber on the domestic and international free market at higher price.

By 2050, global industrial roundwood use is expected to increase by 1.1 percent per year, reaching 2.9 billion m^3 (now at around 2.0 billion m^3) (FAO, 2000). The same can be said for other forest-related goods. According to Cubbage et al. (2020), the global population increase and available land decrease due to climate change leads to land prices appreciating quicker than inflation. Furthermore, in the last few decades, the global trade of roundwood as a percentage of production has remained relatively constant, but a significant increase in the trade of sawnwood has been recorded (Chudy and Hagler, 2020). All of this indicates the possible timber price increase and supply shortages in the future.

To fulfil the independent approach in the wood-processing business, the company should own/lease a forest which can annually generate adequate quantities of timber. On the world scale, there are 48 companies that have already accomplished that goal, they own/lease about 31 million hectares and are listed on stock exchanges (Beljan et al., 2021c). All of them do sawmilling while 36% of them produce furniture, 19% paper, and 29% produce both furniture and paper. Here it is important to note that those companies which extended the added-value-chain the most are achieving the highest profits (Beljan et al., 2022). Based on these insights, a question arises; can a wood-processing company from Croatia ensure for itself a forest property by which the input timber would be quantitatively and price independent?

The aim of this paper is to investigate the modality by which a wood-processing company in Croatia can ensure an independent timber source. Due to the fact that only private forest land can be purchased by individuals or companies in Croatia (OG, 2020), it will be considered a potential pool. In other words, we will define the characteristics of a private forest property whose management can result in enough timber to fulfil one company's needs.

2. MATERIAL AND METHODS

2.1. Wood processing company Požgaj

The "Požgaj Group" is a wood industry company in Croatia. At the moment, there are about 400 employees, who are deployed in 3 locations. The company is engaged in the production of furniture, glued panels, parquet, timber and wooden houses. About 95% of its products are exported to twenty-five countries around the world. Egypt, Germany and China are some of the most important markets in which the company is present. The timber purchase (raw material) happens predominantly in the domestic market (about 95%). In the past, the Požgaj company was buying the timber from the state-owned company Hrvatske šume Ltd., but since 2021 the timber has been purchased on the free market. This change of the source procurement reflected the company's input costs since the timber from the free market is more expensive. After the timber is purchased, it is transported to one of the company's processing plants using the company's (20-25%) and contractors' trucks.

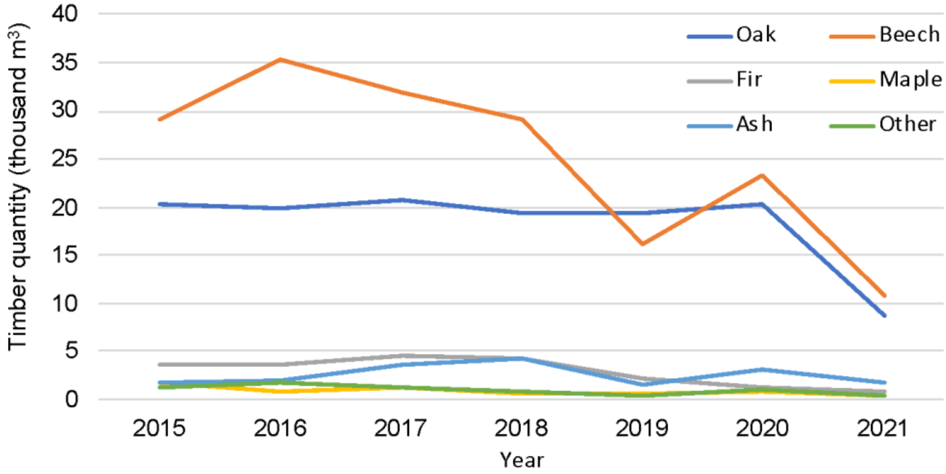

Figure 1. Company's total timber consumption per tree species

The consumption of timber is changing on an annual basis (Figure 1), mostly depending on the timber quantity which can be found in the market. In the last seven-year, on average, the predominant tree species are common beech (49%) and oak with 36% (sessile (43%) and pedunculate oak (57%)), while other species are represented in much smaller shares (Figure 1). The highest timber consumption was present in the year 2016 (63,000 m^3) while in 2021 the company used only 22,400 m^3, which was the minimum in the observed period.

2.2. Potentially available forest resources

Particular private forests, which by its tree species composition and wood-processing characteristics (minimal diameters) can fulfil the requirement timber quantity and quality, are private productive high forests of common beech (6,650 ha), pedunculate oak forests (3,716 ha) and beech-fir forests (7,377 ha) (MoA, 2016). The data source MoA (2016) contains age-class distribution, volume stock, increment and tree species characteristics, which will be used for the calculation of the optimal forest area (property size).

2.3. Research methods

Based on the company's past timber consumption (Figure 1), the year in which the highest timber volume was reached is taken as a referent one. For each forest type (sessile oak, pedunculate oak and beech-fir forest), the theoretical forest management plan has been created for the next 20 years. The idea behind that plan is to perform a regular management (using the area control method) with natural regeneration and to direct the forest towards achieving the theoretical balanced structure in the long run i.e. normal forest. The rotation periods are used as defined by the MoA (2018); common beech (100 years), pedunculate oak (140 years) while the 10-year thinning dynamics is carried out using the traditional Matić (1989).

On the other hand, for the beech-fir forests, the same normal forest postulates were applied but by performing selection management with 10-year cut dynamics and using the Klepac's (1997) cutting model.

The outcome of the forest management is the timber quantity per particular year, tree species and wood assortment following these steps: 1) after the total yearly timber quantity defined for cut is calculated, 2) it is divided per tree species, 3) since the age, apropos the tree dimensions are known, the Assortment tables are used to calculate exact quantity of wood assortment (veneer, peeled veneer, sawlogs 1st-3rd class).

3. RESULTS

The year in which the Požgaj company consumed the most timber is 2016 (Figure 1). So, that specific year was used as a starting point for defining the required timber quantities (51,540 m^3), which should be the outcome when managing a theoretical forest property. Table 1 shows those values regarding each wood-processing assortment. Most of the timber volume refers to common beech and pedunculate oak and when it comes to the wood assortments, it can be observed that the first and the second class of sawlogs represent most of the share.

The quantity of timber which is consumed per year (Table 1) predefines the size of a theoretical forest property (consisting of three forest types). Simulating the forest management and its size were the most important criteria. In order to investigate the possible options, two scenarios were applied. Scenario A, whose primary goal is to maintain enough timber in its total quantity, and scenario B, which investigates the option in which each timber assortment will be available in a sufficient quantity (

Table 2).

Table 1. Referent annual quantity of timber consumed by the company

Species	Volume* of timber assortments in m^3						
	Veneer 1st	Veneer 2st	Peeled veneer	Sawlogs 1st class	Sawlogs 2st class	Sawlogs 3st class	Total (m^3)
Common Beech	2,690	-	4,140	6,970	6,800	5,610	26,310
Pedunculate Oak	1,530	1,970	-	2,940	2,500	3,080	11,980
Sessile Oak	670	1,290	-	2,200	1,660	1,770	7,790
Ash	220	-	-	390	370	610	1,910
Silver Fir	20	-	-	270	670	280	1,250
Fruit trees	30	-	50	60	60	90	290
OBS**	230	-	350	410	390	640	2,010
Total (m^3)	5,390	3,260	4,540	13,240	12,450	12,080	51,540

***all other broadleaved species*

Table 2. Forest property size (upper part) and differences between company's needs and outcome of forest management (lower part)

<table>
<tr><th colspan="2" rowspan="2">Forest property and timber assortments</th><th colspan="4">Scenario</th></tr>
<tr><th colspan="2">A</th><th colspan="2">B</th></tr>
<tr><td rowspan="3">Property size</td><td>Pedunculate Oak forest</td><td>6,400 ha</td><td rowspan="3">© 18,600 ha</td><td>6,250 ha</td><td rowspan="3">© 22,550 h a</td></tr>
<tr><td>Common Beech forest</td><td>10,700 ha</td><td>14,800 ha</td></tr>
<tr><td>Common Beech-Silver fir forest</td><td>15,00 ha</td><td>1,500 ha</td></tr>
<tr><td rowspan="7">Timber assortme nts quantity difference s</td><td>Common Beech</td><td colspan="2">-7,090</td><td colspan="2">-210</td></tr>
<tr><td>Pedunculate Oak</td><td colspan="2">50</td><td colspan="2">-230</td></tr>
<tr><td>Sessile Oak</td><td colspan="2">700</td><td colspan="2">3,840</td></tr>
<tr><td>Ash</td><td colspan="2">2,910</td><td colspan="2">3,810</td></tr>
<tr><td>Silver Fir</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td>Fruit trees</td><td colspan="2">-30</td><td colspan="2">70</td></tr>
<tr><td>OBS**</td><td colspan="2">3,420</td><td colspan="2">3,300</td></tr>
<tr><td colspan="2">Total difference (m³)</td><td colspan="2">-40</td><td colspan="2">10,570</td></tr>
</table>

Results indicate that quite a large forest property should be in the Požgaj company's possession to fulfil its timber requirements (

Table 2). When looking in total (scenario A), the 18,600 hectares of forest property would be enough and just 40 m^3 would be lacking. However, it would result in a shortage of common beech timber (-7,090 m^3) while the surplus can be expected for ash timber (2,910 m^3). Scenario B would imply possession of an even bigger forest property, whose size would be about 22,550 hectares (

Table 2). In that case, all timber species and their assortment would be on disposal, but with a certain surplus. That surplus would result in about 10,000 m^3, which is 19% more than the company's annual consumption (Table 1 and

Table 2).

4. DISCUSSION AND CONCLUSION

The presented modality is related to a forest resource which is privately-owned and which had been mostly negatively influenced by the past management concerning its management potentials (Teslak et al., 2018). Since the growing stock is relatively low (322 $m^3 ha^{-1}$ pedunculate oak forests, 310 $m^3 ha^{-1}$ common beech forests, 252 $m^3 ha^{-1}$ beech-fir forests) and the case-study company processes only wood assortments, which imply usage of timber with large diameters, it is not surprising that the size of the forest property should be at least 18,000 hectares. Based on the previous findings concerning the asking price of private forests (Beljan et al., 2021a), here we can approximately say that the total investment cost would be around 118 million euros.

However, it is important to note that in Croatia there is not enough private forests of the investigated three forest types (MoA, 2016), which could meet this company's requirements (

Table 2), and are certainly not advertised for sale on such a large scale (Beljan et al., 2021a). The pedunculate oak forest (3,716 ha) can meet about 60% of the company's needs, common beech forests (6,650 ha) about 62%, while common beech-silver fir forests (7,377 ha) can meet all required quantities.

The total sum of timber, which could be the outcome of this theoretical forest management, includes production of thin roundwood and firewood, which is not in the company's focus but could insure a solid profit. Based on that, we can conclude that by using just one part of the forest management outcome (timber just for wood-processing), the company would be at a disadvantage. Furthermore, in the actual case when the company buys all the input raw material, it is to the greatest extend dependent on doing business with the state-owned company Hrvatske šume Ltd. or purchasing timber on both domestic and international free market.

The results point to a misbalance between the capacity of the wood-processing company and the production potential of forest resources. The fact is that the processing technology is fast developing, meaning that timber quantity which can be utilized in a certain unit of time rises and results in greater timber demand on the market. On the other hand, the forests, especially natural forests, are developing according to their natural potential of radial and high growth and cannot follow the growing market needs. Since the forest increment is generally constant and is related to the annual cut, which is also more or less constant, the forest's timber production capacity will always be lower than the needs of the wood-processing industry. So, one of the possible options for overcoming this supply shortage would be higher utilization level and development of an added-value-chain within the processing industry. Another possibility is to let the free market and the Smith's invisible hand solve the issue. That would definitely result in timber (raw material) price increment to the level at which an average wood-processing company would not be able to buy unrealistically huge quantities of timber, and that is currently the case.

This research included theoretical modality regardless of an actual forest location and its spatial interaction with the company's plant locations. In the future, steps by which the whole production chain can be better evaluated, such as the forest property prices, transport costs and usage of firewood should be taken into account.

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VIRTUAL REALITY TRAINING OF EMPLOYEES IN FOREST-BASED SMEs AS A PART OF A CRISIS MANAGEMENT

Dimitar Blagoev

Abstract: Science and manufacturing have always been a generator and conduit of innovations in every field of human life. The innovations are of both fundamental and purely applied nature. The first environment for testing these innovations is the internal firm's educational system. In this regard, the last two years circumstances around the pandemic of COVID-19 served as a catalyst for the training in companies to adopt contemporary, interactive and attractive methods of training processes. Of course, some of these methods have been used in the pre-pandemic environment, but they have not been widespread. This confirms the rule related to a crisis management, namely that any crisis must be seen not only as a threat, but also as an opportunity to master new approaches and to show their effectiveness in practice. The aim of this paper is to focus on the possibilities of using virtual reality in training employees in forest-based SMEs such as specific manufacturing procedures, healthy work condition, organization of manufacturing etc. A number of research methods will be used. These will include: literature research, retrospective analysis, method of comparison etc.
Keywords: virtual reality, training, employees, SMEs

1. INTRODUCTION

The invasion of modern technologies in people's daily lives implies their use in such traditional areas as the work training process. A number of studies show that mobile devices themselves - phones, tablets, laptops, etc. - have similar applications for tracking the time spent by the users. The people (especially younger ones) spend significant part of the day in the cyberspace. This "digital evolution" suggests a shift in the focus of training from traditional methods (such as the classical lecturing and exercising) to such that combine the advantages, attractiveness and opportunities provided by information and communication technologies. These technologies include digitalization of teaching materials, interactive teaching methods in the form of games or using simulations and coming to the use of virtual reality and artificial intelligence. In order to achieve the main goal of the investigation, several main tasks are defined: (1) To make a review on the application of the virtual reality in the educational process, with emphasis on operations management. (2) To describe the essence and the importance of the training programs for the Forest-Based SMEs. (3) To reveal the potential and the applicability of the virtual reality training on employees.

A number of research methods will be used to solve the above-formulated tasks. These will include literature research, retrospective analysis, method of comparison, etc.

2. BASIC CONCEPTS OF VIRTUAL REALITY TRAINING

The ideas underlying virtual reality systems are not new. The "father" of computer graphics, Ivan Sutherland, first postulated the use of stereographic head-mounted displays in the 1960s. (Earnshaw, Gigante & Jones, 1993)

Veronica Pantelidis (1993) says that virtual reality has been defined as a highly interactive, computer-based, multimedia environment in which the user become a participant with the computer in a "virtually real" world. In a virtual environment, the user no longer looks at a computer screen but becomes part of the action on the screen, giving the sensation of participation.

There is a practice to use interchangeably "virtual reality" and "artificial reality". Based on Helsel (1991) and Michel Spring's definition for artificial reality": an interactive environment that encompass unencumbered, full-body multisensory participation in computer events.

In the paper (Guttentag, 2010), VR is defined as the use of a computer-generated 3D environment – called a 'virtual environment' (VE) – that one can navigate and possibly interact with, resulting in real-time simulation of one or more of the user's five senses. 'Navigate' refers to the ability to move around and explore the VE, and 'interact' refers to the ability to select and move objects within the VE (Gutierrez et al., 2008; Vince, 2004). Summarizing, we can say that virtual reality uses 3D-generated images to immerse a user into a simulated environment so that he/she feels like he/she is actually there.

There are a lot of academic studies on training, and a number of meta-analyses — for example comparing virtual reality training to other traditional educational techniques. Findings generally present the advantages of VR training compared with face-to-face training, and these advantages are the lower cost of VR, the decreased amount of time needed to train with VR compared to traditional techniques, and possibilities for larger applications of VR. (Bailenson 2020).

Virtual Reality training in organization of enterprise production processes is the digital simulation of lifelike scenarios for training purposes of the employees. Employees enter a 360°, active learning environment based on video clip, experiencing sights and sounds that dissolve the barrier between virtual and actual reality. Using the headset and glasses for VR, employees look, speak, and move about freely in a 3D virtual environment, interacting with simulated real-enterprise tools, machinery, other trainees or teachers.

Critically, with Virtual Reality, workplace scenarios that were once too expensive, difficult, and dangerous to train for (such as emergency protocols and disaster preparedness, hazardous material spills, realistic heights training, etc.), become vastly more cost-effective, practical, and safe. The teaching potential of virtual reality has been recognized by educators for many years (Jacobson, Kelley, Ellis, & Seethaller, 2005) and research already has found VR to be useful for educating employees of different ages in a variety of subjects.

One of the primary implementations of virtual reality in employees training is to create realistic role-specific scenarios. By being able to control a virtual world, teacher can formulate all types of experiences that may not have been possible otherwise. These incidents can be tailored to replicate any potential future business situations or crises so that educator can also analyze employees' stress levels and problem-solving skills. A useful aspect of this is to teach employees about operations management. If a role involves an element of danger or high levels of risk, virtual reality allows the employees to learn how to handle the situation without any potentially harmful ramifications.

Another advantage of virtual reality in training is that the trainers can receive measurable data on each employee's performance with the ability to set benchmarks and analyze the progress an individual has made over time. As a result, employees can receive immediate feedback on their performance and another targets could be set, allowing them to implement at a much faster rate what they have learnt (*** Virtual Reality in Training).

Virtual reality is perfect tool to implement one of main teaching concepts "learning by doing" and increase the quality of learning and knowledge retention by 75-90% (Figure 1).

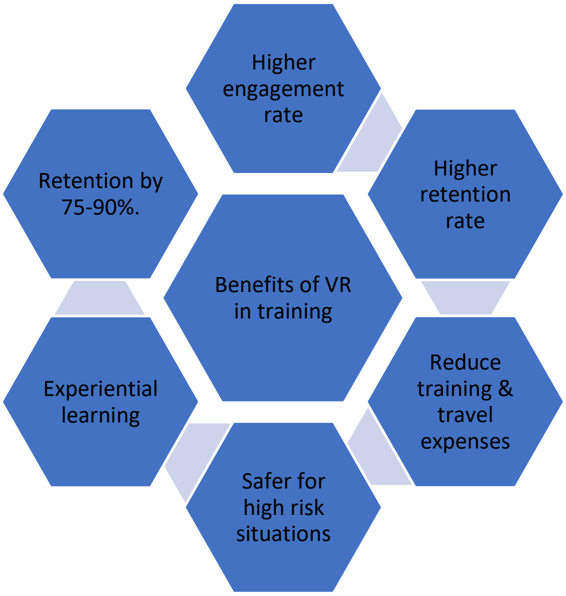

Figure 1. Benefits of VR in university training

3. OPERATION MANAGEMENT IN VIRTUAL REALITY

For decades the classical approach of an enterprise was to invest in the required resources and thus to plan and realize production process by using its own resources. This has changed dramatically during the last years. Today no single enterprise is able to provide all manufacturing resources and competencies necessary for the realization of ever-changing customer demands.

There are at least three areas in which industry anticipates change and for which it must be prepared: shrinking margins, flexibility, and technology. Operation management training based on virtual reality will help to meet these challenges.

To keep the learning experience of exploring a real factory environment, and at the same time remove the limitations of field visits, we can use the approach of virtual reality. Due to recent developments in virtual reality technologies, VR offers excellent opportunities to do so. In order to introduce a virtual factory (enterprise as a whole or only production process) environment for the employees, we need an application that consists of 360 degrees still pictures and videos from a factory, blended with virtual instructions and information. In the application, employees can visit a number of predefined areas in the factory in any order they like. Lately, they can use also integrated 360-degree videos from YouTube as virtual reality content.

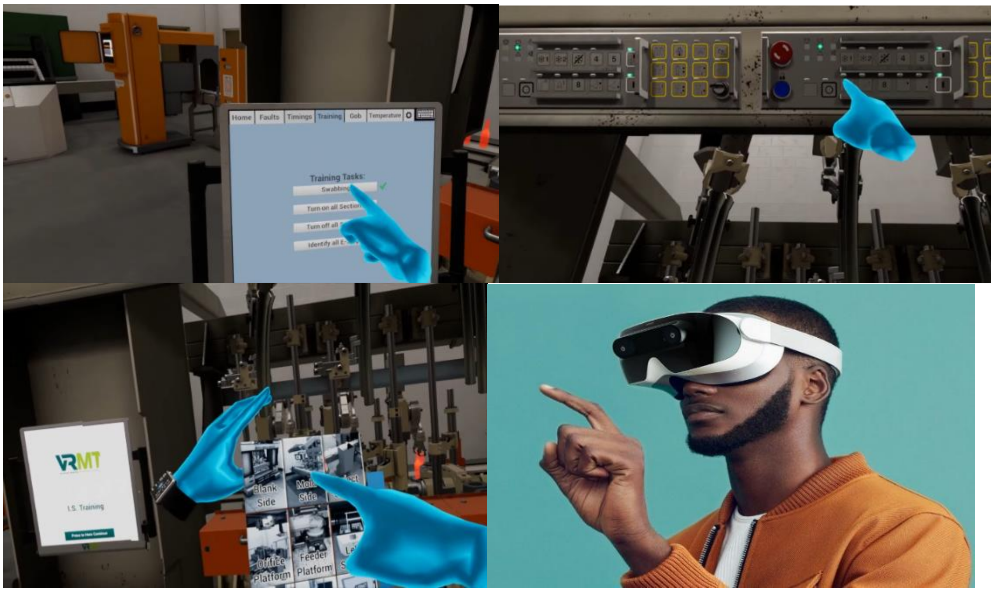

Figure 2. VR equipment and visualization

*Source: *** Beaston Clark working alongside VRMT, https://www.vrmt.co.uk/case-studies/beaston-clark-working-alongside-vrmt/*

Trainers need to work together with virtual reality experts to develop a new training system to help employees understand more details about the manufacturing process in forest-based SMEs and its organization in time and space.

The training programs recreate a lifelike 3D virtual model of the factory and allows employees to fully understand the manufacturing process and identify potential faults.

The figures above show a teaching assistant using the app with VR viewers and one of the many areas he might be exploring. By turning the viewers 360 degrees, the employees can explore the whole production hall from the spot. The pictures are a snapshot of a repeated 360-degree video that shows the production process.

Virtual reality enables full accessibility to the field immersion. Employees (especially new ones) can explore factory environments whenever and wherever they like, and at their own speed. They can revisit the virtual reality environment, for instance, to discuss content in groups. Virtual reality allows the employees to virtually visit multiple production sites in different locations and compare their differences without the need to move. They can access areas and views that might be unavailable during a field trip, such as close-up views of machinery. Furthermore, virtual reality offers the possibility to blend different types of information, such as real images and videos of factory operations with overlay digital information, to support employees' learning experience and learning outcome.

One of the biggest advantages of virtual reality is that it enables inquiry-based learning. It is more an active discovery than a passive learning experience. While the case questions guide employees to seek answers to given questions, they need to use their own curiosity and intelligence when visiting the virtual environment and seek the answers (Netland, 2020)

Table 1 provides a list of exemplar software for VR training. Of course, each SMEs should develop such personal software in accordance with the specifics of its production process.

Table 1. Examples for available VR content that can be used in operation management training.

Company	Title	Format	Access
ABB	ABB 360 VR Tour	Application	App store (Google and Apple
Noon	NOON VR 360 video player	Application	App store (Google and Apple
Zoller GmbH	ZOLLER VR	Application	App store (Google and Apple
Toyota	Toyota VR/360 Factory tour	360 video	YouTube

4. CONCLUSIONS

With VR, employees can explore different factory environments, the specifics of technological process, organization of production, etc. They can discover the factory at their own pace. Based on the virtual reality 360-degree videos and applications, employees can revisit the virtual environment for any purpose, such as discussing content in groups, do some specific tasks, etc. VR also allows employees to compare differences of multiple production sites and in different locations without changing their location, and only on the base of virtual reality, equipped with glasses and smartphone.

They can access areas and close-up views of machinery and equipment that might be restricted during a production process. Virtual reality offers a possibility to blend different types of information such as real images and videos of factory operations with overlaid digital information, to support employees' learning experiences and learning outcomes. One of the biggest advantages of VR is its active discovery of the things.

The use of a modern technology, not only virtual reality, but augmented reality as well, cloud technologies, etc., are very exciting for many employees (especially young ones). This enthusiasm can improve their learning motivation and working results. The usage of virtual reality technology will certainly boost employees' motivation and will provide for a near future perspectives.

Acknowledgements: This paper is produced as a result of a research project №NID NI-3/0222/A, Title of the Project: "Research and Development of a Conceptual Model of an "Academic Innovation-based Incubator", Funding by R&D Fund in University of National and World Economy, Sofia, Bulgaria.

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LIFE CYCLE ASSESSMENT OF COATED TERRACE FLOORBOARDS

Dominika Búryová, Pavol Sedlák

Abstract: Comparison of selected types of surface treatments for wooden terrace boards was subject of this study, performed in terms of the Life Cycle Assessment. Specifically, the aim was to find out what coating has the lowest impact on the environment. The evaluation principle of environmental parameters "cradle-to-gate with options" was used to evaluate terrace floorboards, according to the EN 15804 + A1 standard.
Keywords: terrace floorboard, coating, LCA, wooden deck board

1. INTRODUCTION

Sustainable materials are becoming an increasingly preferred building material.

Natural materials usually have less impact on the environment compared to commonly available silicate materials.

LCA is a technique for assessing the environmental aspects and potential impacts associated with a product (ISO 14040; ISO 14044, with emphasis to EN 15804+A1). According to ISO 14040/44, LCA is divided into four phases: goal definition; inventory analysis – considering pollutants, solid wastes and resources; impact assessment. The benefit of LCA is that it provides a single tool that is able to give us insights into upstream and downstream trade-offs associated with environmental pressures, human health, and the consumption of resources. Since LCA can be performed in different ways, the results are often not directly comparable. Environmental labels and declarations aim to address these issues. [2]

The evaluation methods implemented in the program Simapro are according to the international standards of the ISO 14040 with emphasis on EN 15804 + A2 (Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products). Another method for evaluation was the EPD system. These standards and EPD system are implemented in the The Ecoinvent 3 database pro-vides one of the most comprehensive sets of information, data, materials, energy require-ments and other processes related to environmental impact assessment. The mentioned methodology "cradle to gate with options" is also applied for environ-mental assessment of selected wooden facades with selected surface coatings.

There are various software available for LCA studies, including SimaPro, OpenLCA, and GaBi. [4]

Applying the maintenance coatings was beneficial to prolong a coating's service life and to repair the observed deficiencies from imperfect coating application. [1]

This article focuses on the environmental impact assessment of treated wood terraces in order to propose guidelines for the environmentally friendly design of wood terraces in the category - "cradle to gate with options" - of Life Cycle Assessment in the EPD 50-year horizon of use. For comparison, we also simulated a natural stone plate terrace. We chose natural stone plate terrace as a natural non-wooden type of terrace.

The construction industry is often accused of a significant environmental footprint. Therefore, it is important to look for design alternatives that will improve the environmental impact and retain the benefits of industry developments. From the available sources, there are not many similar studies that deal with the surface treatment of wooden terraces and their impact on the environment.

2. MATERIALS AND METHODS

2.1. The methodology adopted

The wood species selected as a construction material of the terraces was *Picea abies L.* for wooden terraces and natural sandstone plate for comparison type terrace. There was 1m^2 chosen as the functional unit for the assessment. Wood protection is necessary to apply the principles of structural protection. From the sources available to us, we chose coatings – alkyd coating a nature oil coating. Solvent borne alkyd coatings are known as excellent exterior wood primers. Linseed oil gave excellent performance on badly weathered wood. [5]

Table 3. Surface coatings for terraces applied on wood terrases (WTO and WTAP) and pressurized water maintenance for natural stone plate terrase (SPT) – frequency of use, maintenance and replacement for use stage. Shortcuts used for selected types of terraces - wood terrace with protective treatment and nature oil coating (WTO), wood terrace with paint coating (WTAP) and natural stone plate terrace (SPT).

			Wood terrases (WTO and WTAP)		Natural stone plate terrase (SPT)	
Surface methods applied during use stage B1 + B2	Protective treatment and nature oil coating	Frequency of application in years	x	App. 25x every 2 years		
	Paint coating	Frequency of application in years	x	App.10x every 5 years		
	Pressurized water maintenance	Frequency of application in years			x	App.50x every year
Replacement applied during use stage B4	Estimated area of terrace boards for replacement		x	10% after 25 years		
	Estimated area of terrace boards for replacement		x	10% after 40 years		

The entire coating system should be partially vapor permeable, protective against moisture and rain, flexible and naturally degradable.[3] Subsequently, the wooden exterior elements can be repainted after cleaning from dust.

The surface maintenance methods selected are presented in table 1. These included for wood a) protective treatment and nature oil coating and b) application of an alkyl paint. 2. For the natural stone plate maintenance methods included c) pressurized water cleaning.

The frequency of methods application was associated with LCA scenarios determination, in relation to environmental parameters derived from LCA, specifically "cradle-to-gate with options" category with options.

Replacement applied during use stage B4 is aligned with the standard life considered for wooden exterior elements. We considered an expert estimate for wood terrace replacement after 25 and 40 years in the range of up to 10%.

The modules examined A1-A3, A4-A5 and B1, B2, B4, B6 and C1 in figure 1 and the include system limit information. As we declared modules B3, B5, B7 as not relevant parts and C2-C4 as not declared parts of the module according to the international standards of the ISO 14040 series.

For the "Use stage", we have defined two methods of surface treatment of a wooden terrace (protective treatment and nature oil coating and coating with alkyd paint) and one scenario for a terrace made of natural stone without another surface method. A time horizon of 50 years was set for the "Use stage assessment", with the last surface treatment being 49. In Tab.1 for frequency and type of surface treatment for selected terraces. "End of life stage" is defined at the end of the standard life of a wooden terrace. However, the lifespan of a wooden terrace is several times longer in practice. We know 300 year old functional wooden buildings. Environmental impact simulations were processed in the SimaPro program with the Ecoinvent 3 database. SimaPro software is used to determine the value of total environmental impacts.

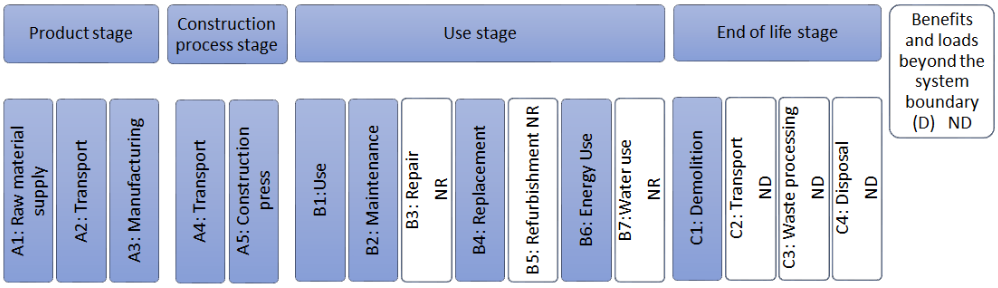

Figure 2. Scope of the LCA, system limit information.(ND – modul not declared, NR – modul not relevant)

The definition of key environmental indicators was based on the LCA analysis in the SimaPro application with the globally used Ecoinvent 3 database. Category of LCA – "cradle-to-gate with options" was used.

The LCA used in this research measures the impact of the product in key environmental indicators: Global warming potential [kg $CO_{2\ eq.}$/FU], Ozone depletion potential [kg CFC $11_{eq.}$/FU], Acidification [kg $SO_{2\ eq.}$/FU], Eutrophication [kg $PO_{4\ eq.}$/FU], Photochemical Ozone Formation [kg $C_2H_{4\ eq.}$ /FU], Abiotic depletion - elements [kg $Sb_{eq.}$ /FU], Water scarcity [m^3_{eq}/FU]. For the LC assessment the EN 15804 + A2 was used along with the EPD (2018) system. Additional indicators – the following impact categories are optional indicators and inclusion of them should be specified in the PCR. All those individual methods can be found in Simapro software.

2.2. Profile and dimension of applied wooden terrace boards and natural stone plates

Terrace construction: two types of terraces were used to compare the environmental impacts. The terrace boards for the wooden terrace (Fig.2) were made of Picea abies L. Based on the resources we have at our disposal, we have selected the following types of surface treatments - alkyd paints (water-soluble systems) and coatings with natural oils. As mentioned above, the ventilation of wooden elements is important. The ventilated cavity can easily address any adverse effects of moisture on wooden elements.Narural stone plate terrace (Fig.3) is the second type of terrace to be compared.

Terrace foundations are different for wooden terraces and natural stone plate terrace. Terrace foundations and landscaping were part of the simulation of environmental impacts in the Simapro program.

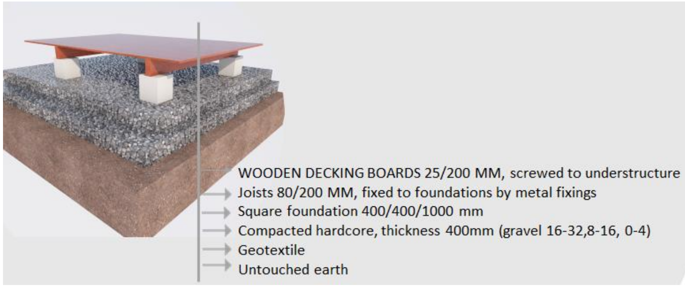

Figure 3. Structure of the wood terrace/wooden deck.

Figure 4. Structure of the natural stone plate terrace.

3. RESULTS

Table 4. Impact assessment on FU 1m2 of the floor area of the terrace - Life cycle assessment of Wood terrace with protective treatment and natural oil(WTO).

		AP	EP	GWP	POCP	ADPE	WSP	ODP
		kg SO_{2eq}	kg $(PO_4)^{3-}_{eq}$	kg CO_{2eq}	kg C_2H_{4eq}	kg Sb_{eq}	m^3_{eq}	kg CFC -11
Product stage	A1-A3	0,03	0,01	4,14	0,03	2,55E-05	1,27	3,90E-07
Construction process stage	A4-A5	167	54,48	12617	68,98	3,64	6172	8,18E-04
Use stage	B1	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	B2	5261	1671,20	670764	2936,71	17,52	197002	3,97E-02
	B4	420,94	133,68	53660	234,94	1,40	15759	3,18E-03
End of life stage	C1	426	174,73	112451	457,61	1,20	40063	5,73E-03
Overall		6276	2034	849497	3698	23,75	258997	0,049

Table 5. Impact assessment on FU 1m2 of the floor area of the terrace - Life cycle assessment of Wood terrace with paint coating (WTAP).

		AP	EP	GWP	POCP	ADPE	WSP	ODP
		kg SO2eq	kg (PO4)3-eq	kg CO 2eq	kg C2H4eq	kg Sbeq	m3eq	kg CFC - 11
Product stage	A1-A3	0,12	0,03	30,96	0,13	1,64E-04	4,20	1,99E-06
Construction process stage	A4-A5	167,92	54,48	12617	68,98	3,64	6172	8,18E-04
Use stage	B1	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	B2	2105	668,64	268563	1175	7,01	2608380	1,59E-02
	B4	420,94	133,68	53660	234	1,40	521287	3,18E-03
End of life stage	C1	426,24	174,73	112451	457,61	1,20	40063	5,73E-03
Overall		3120	1031	44732	1937	13,242	3175907	0,026

Table 6. Impact assessment on FU 1m2 of the floor area of the terrace - Life cycle assessment of natural stone plate terrace (SPT).

		AP	EP	GWP	POCP	ADPE	WSP	ODP
		kg SO2eq	kg (PO4)3-eq	kg CO 2eq	kg C2H4eq	kg Sbeq	m3eq	kg CFC - 11
Product stage	A1-A3	0,32	0,11	58,71	0,28	7,44E-05	12,15	3,50E-06
Construction process stage	A4-A5	0,07	0,02	18,64	0,08	2,23E-04	1,79	2,89E-06
Use stage	B1	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	B2	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	B4	3,29	0,82	857,20	3,35	0,01	128,79	1,31E-04
End of life stage	C1	0,06	0,02	16,70	0,06	2,19E-04	1,69	2,53E-06
Overall		3,739	0,956	951,250	3,774	0,012	144,422	1,396E-04

4. DISCUSSION AND CONCLUSION

Databases used for the assessment were part of global datasets referring to average Technology. Transport distances have been adapted to local sources because in the simulations this distance proved to be a critical value.

The Impact Assessment of the Product Stage (A1 - A3) for all terraces alternatives points to the fact that the extraction of natural raw materials puts the most strain on the environment. Interestingly, the impact of the alkyd paint production has 120% greater abiotic element exhaustion if compared to natural oil coating.

As for less environmentally friendly paints, alkyd paint coatings release heavy metals in the "Product stage", which remain bond in the soil. In this case, there was environ-mentally friendly alternative chosen, in form of water-soluble paint, whose production of heavy metals is significantly lower.

After taking surface preservation methods “Use stage” (Tab. 2, Tab. 3, Tab. 4) into account, the paint caoting wooden terrace floorboard shows greater negative effects to all casues, significantly higher values of water scarcity parameter.

“End of life stage” high values of the floorboards (Tab. 2, Tab.3) are linked to the demolition of the boards by a diesel wood chipper selected from the Simapro database, and are also influenced by the reduced recycling possibilities of treated wooden terrace floorboards.

Understanding the impact of building materials on the environment from design to implementation is key. Orienting construction as beneficial to the construction environment as possible, it is necessary to look at each stage of the life cycle in detail and assess them as a whole.LCA building structures are proving to be a useful complement to environmental assessments.

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IMPACT OF INDUSTRY 4.0 PHENOMENON ON DEVELOPMENT OF WOOD PROCESSING INDUSTRY

Andrea Čambalíková

Abstract: Development of new technologies causing improvement in the quality of life of people and the well-being of society as a whole. It is the main driving force of today's global economy. We are in the midst of a management transformation and an organization's ever-increasing focus on people's knowledge, training, competencies, flexibility, and adaptability. These changes will have a transformative impact on how organizations approach management, the role of the manager, and the methodologies and frameworks used. Managers currently face major decision-making challenges in which they are forced to respond flexibly to turbulent developments in the business environment. Industry 4.0 connects people, objects, and systems that form dynamic, optimized, self-organizing, inter-company networks that create values that affect all business processes. It can be said that Industry 4.0 unconditionally creates many new opportunities for companies, but at the same time it brings a number of challenges resulting from the ongoing automation and digitization. Based on an analysis of theoretical knowledge, this paper deals with the impact of Industry 4.0 on wood processing companies. The main aim of this paper is to provide a comprehensive picture of what management in Industry 4.0 conditions should look like so that companies operating in the wood processing industry are able to adapt to the conditions of the modern phenomenon.
Keywords: Industry 4.0, wood processing industry in Slovakia

1. INTRODUCTION

As a result of ongoing changes, the requirements for business management are constantly increasing, which leads to the development of managerial theory and practice, which are enriched with new knowledge. Approaches that have worked in the past often do not meet the conditions created by the new modern society, which conditioned the emergence of new management methods and tools. It is precisely the new methods and tools used in the implementation of individual management functions that help companies adapt to current market requirements and are a key factor in ensuring business efficiency, profitability and, last but not least, competitiveness. The changes brought by Industry 4.0 include automation, digitization, integration, robotics, artificial intelligence, big data analysis, a wide range of Internet uses, virtual reality, 3D printing, blockchain and much more. We are in the middle of management transformation, with the focus on increasing the knowledge, competencies, flexibility and adaptability of employees. These changes will have a transformational effect on the company's approach to management, the role of the manager and the management framework used.

There has been a lot of positive excitement about Industry 4.0 over the last few years, which has created awareness of the issue in many companies and made a significant contribution to rejuvenating the "good old industry" in the public consciousness. After its end, the industry leaders remain generally optimistic, but some disillusionment has crept in, as previous feelings related to the implementation of Industry 4.0 principles are mixed. On the one hand, we still see great uncertainty among manufacturers as to what the implementation of Industry 4.0 really requires of them, and many of them are still struggling to get started as soon as possible. On the other hand, most technology vendors have acted relatively quickly in adapting their portfolios to Industry 4.0 (McKinsey, 2016). Industry 4.0 is no longer just a future trend, for many companies it represents a substantial part of their strategic and research program. Already today, companies combine advanced connectivity capabilities, advanced automation, cloud computing, sensors and 3D printing, computer-controlled processes, intelligent algorithms, or the Internet of Things to transform their business (PwC, 2016).

2. INDUSTRY 4.0: THEORETICAL BACKGROUND

By "Industry 4.0" we mean the fourth industrial revolution. While "Industry 3.0" focused on the automation of individual industrial machines and processes, Industry 4.0 focuses on the final digitization of all assets and integration into value-added digital ecosystems. Industry 4.0 is characterized by a fusion of technologies that blur the boundaries between the physical, digital and biological spheres. We are currently witnessing declining productivity in Western countries and, conversely, sharp productivity growth in developing countries. Such an environment forces companies to produce faster, cheaper and provide more market-specific products. The term industry 4.0 was first used in 2011 at an exhibition in Hanover. He referred to industry recommendations to the German government by a group of experts led by H. Kagermann and S. Dais. The basic condition of the Fourth Industrial Revolution is the widely accessible Internet, which makes it very easy to connect billions of people around the world. In addition, increasing storage capacities and the ever-smaller size of carriers have a great impact. There is more information available than ever before in human history. This trend is expected to culminate over the next twenty years. Compared to the previous three industrial revolutions, there is much less time left for society to adapt and prepare for the consequences. The changes are practically "live" and the measures need to be applied immediately (CEO Forum, 2020). Industry 4.0 is characterised by the adoption of digital technology such as artificial and augmented reality, additive production, advanced analytics, Internet of Things, and other technologies (Richnák, 2021).

A Deloitte survey (2019) suggests that many managers who think they are ready may not be as ready as they really need to be. The good news, however, is that leaders seem to be gaining a much deeper understanding of Industry 4.0, becoming increasingly aware of the challenges they face and the steps required to meet them. The survey, which surveyed more than 2,000 executives from 19 countries, revealed the following findings:

- Executives seek to develop effective strategies in today's rapidly changing markets. In the face of an ever-expanding range of new technologies, leaders have recognized that they have too many options to choose from, and in some cases lack a strategic vision to help them steer their efforts. Organizational influences are also a challenge for managers who are trying to orient themselves in Industry 4.0. Many executives have stated that their companies do not follow clearly defined decision-making processes and that their current organizational structure limits their ability to develop and share knowledge.
- Managers are increasingly focusing on the use of advanced technologies as well as bold technological investments. While many of the companies that have invested in

technology see a return, it is more difficult for others to invest, even as digital technologies create more global connections and create new opportunities in new markets and local economies. Leaders recognize the ethical implications of new technology, but few companies talk about how to meet these challenges, not to mention that they are actively pursuing policies.

- The challenges of the necessary skills and competences are becoming clearer. In 2018, the majority of managers (86%) thought that their companies were taking sufficient steps to create a workforce for Industry 4.0. In 2019, only 47% believe in this effort. On the positive side, twice as many managers suggest that their companies will do everything they can to train their current employees instead of hiring new ones. And they are more optimistic than last year and say that the advent of technology in the company will expand the workforce rather than replace it.

Slovak industry is also experiencing a fourth industrial revolution. Companies are beginning to take an interest in digitizing their operations, which helps them improve workplace conditions and compete. The way in which Slovak companies are doing was revealed by a survey by the Association of Intelligent Industry Industry4UM. According to that, 40% of Slovak companies are undergoing transformation today. An increase in the innovation potential of companies and a positive shift in the availability of information can be observed. However, there was also an insufficient level of conditions for training and development of employees and the need for a change in the understanding of the roles of managers in the transformation process. Experts also talk about the lack of specialists for the digitalisation of industry and call for intensified cooperation of stakeholders on the part of industry, science, education and the state for the necessary acceleration of change. The pace of transformation is partly hampered by insufficient use of innovation potential, especially in the case of small and medium-sized companies with Slovak capital (Profit Management, 2019). Enterprises are innovating to defend their existing competitive positions as well as to seek a sustainable competitive advantage (Richnák, 2021).

One of the most serious reasons for economic development, the improvement of the Slovak economy, is the generally low efficiency of the production system caused by the lower level of technology. The success of economic reform is conditioned by the creation of capital resources, rapid technical development and the wide application of modern technologies. Industry 4.0 is increasingly being promoted as the key to increasing productivity, supporting economic growth, and ensuring business sustainability. The impact of Industry 4.0 can be seen in business processes and business areas, where it is a response to the trend towards digitalisation of industry (Richnák, 2022). Industry 4.0 is not just a technological change, but mainly a qualitative change. Increasing competitiveness is a matter for the top management of companies. Industry 4.0 primarily focuses on changing the industrial base through new technologies, but less importance is provided to the human and environmental aspects. The new strategy, Industry 5.0, aims to protect society and the environment through technological improvements that lead to economic growth and prosperity (Richnák & Fidlerová, 2022).

The digital revolution is reshaping the way individuals live and work fundamentally, and the public remains optimistic regarding the opportunities Industry 4.0 may offer for sustainability (Ghobakhloo, 2020). Enterprises should take advantage of Industry 4.0 technology adoption to improve sustainability impact but each technology needs to be carefully evaluated as specific technology will variably influence industry and sustainability dimensions. Investment in such technologies should consider appropriate priority investment and championing (Bai et al., 2020). Manufacturers emphasize developing energy-saving strategies in the wood industry and adopting recent innovations and technologies. Among them are the Internet of Things and intelligent sensors to collect data from wood and the environment such as wood moisture content, air humidity, and temperature (Haddouche & Ilinca, 2022). The integration of industry 4.0 technologies int wood processing companies can enhance the supply chain performance in terms of efficiency, collaboration, quality, and transparency (Gharaibeh, 2022).

3. RESEARCH FINDINGS AND DISCUSSION

The object of research was formed by a sufficiently large and representative sample of companies (N=30) operating in wood processing industry in the territory of the Slovak Republic. The respondents, due to the focus of the research, were mainly company executives, directors, and managers at least middle management. The research focuses on tools related to Industry 4.0 - digital transformation, and big data analytics.

Apart from material resources, labor and capital, information is undoubtedly an essential means of enabling companies to gain an edge over their competitors in the market. Big data analytics can bring a new perspective, context and thus possibilities to companies. Although it is largely dependent on rapidly evolving software and hardware, it cannot do without the human factor. The basic feature is the voluminous transfer of diverse data and the effort to convert data into knowledge and thus achieve a competitive advantage. Based on our research, 37% of companies from wood processing industry do not know method of big data analysis, 27% of companies do know this method, but they do not apply that. This method is used by 36% of companies. Breakthrough technologies continue to affect wood processing industry and change competition, change the way companies work, manage, and organize. It is the persistence and strength of the ongoing digital transformation that transforms new management and organizational concepts into operational realities as they move away from hierarchical structures and adopt new concepts and trends in management. Digital transformation is unknown for 23% of companies, 60% of them know this tool, but do not apply that. Only 17% of companies underwent digital transformation within their business.

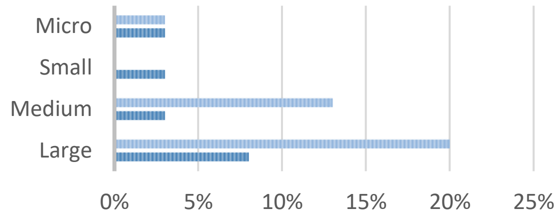
Table 1. Knowledge and usage of Industry 4.0 tools

Method	Used	Known, not used	Unknown
Big Data Analytics	36%	27%	37%
Digital Transformation	17%	60%	23%

Source: own processing

Categorization of companies was realized based on the number of employees for large (above 250 employees), medium (above 50, up to 250 employees), small (above 10, up to 50 employees) and micro (up to 10 employees). We can notice a higher rate of usage of both methods by large enterprises. Big data analytics tool was applied by 13% of medium-sized enterprises and none of small enterprises applied this tool.

Figure 1. Digital transformation and Big data analytics used by different sized enterprises



	Large	Medium	Small	Micro
Big Data Analytics	20%	13%	0%	3%
Digital Transformation	8%	3%	3%	3%

Source: own processing

Digital transformation was applied by 8 % of large companies and just 3% of other sized companies.

4. CONCLUSION

Industry 4.0 is characterized by a fusion of technologies that blur the boundaries between the physical, digital and biological spheres. We are currently witnessing declining productivity in Western countries and, conversely, sharp productivity growth in developing countries. Such an environment forces companies to produce faster, cheaper and provide more market-specific products. Slovak industry is also experiencing a fourth industrial revolution. Companies are beginning to take an interest in digitizing their operations, which helps them improve workplace conditions and compete.

The research was aimed at wood processing industry in the territory of the Slovak Republic and we were finding out knowledge and usage of tools, which are phenomenon of Industry 4.0, namely digital transformation, and big data analytics. Method of digital transformation was known to a greater extend, by 77% of companies, than big data analytics (63%). On the other hand, big data analytics were more likely used by companies than digital transformation. In terms of company size, tools were used mostly by large companies.

Acknowledgements: The paper is a partial output of VEGA No. 1/0375/20 research project titled „New dimension in the development of production management and logistics under the influence of Industry 4.0 in enterprises in Slovakia".

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INNOVATIVE WOOD-BASED PRODUCTS FOR SUSTAINABLE ECONOMY

Rastislav Čerešňa and Ján Parobek

Abstract: Cellulose and lignin are the most abundant natural polymers and common products of the kraft process where lignin is a by-product. If coniferous wood is processed, liquid rosin (tallol) is also by-produced. Despite its interesting potential that lignin has, especially as a replacement for plastics from fossil resources (petro-plastics), up to 95% of it is burned for electricity production. Therefore an innovative sustainability-thinking, delivering novel solutions in wood-based materials is needed for overcoming the petro-plastics problem. Lignin, cellulose and tallol are depicted as promising source materials for production of carbon-neutral products – they may constitute bioplastics, and so-called liquid wood, which have similar price and heat treatment options as the most common petro-plastics. In the paper there are documented several examples of sustainable solutions based on lignin, nanocellulose and tallol for new product development, introduced by Finnish research teams and companies. The paper aims to be an incentive to re-think the current use of lignin and cellulose and divert larger proportion of them to novel applications in a variety of industries, to reach higher added value and promote transition towards Sustainable Economy. The role of production companies as intended leaders of this social transition is also discussed.
Keywords: cellulose, lignin, innovations, sustainability

1. INTRODUCTION

The process of globalisation creates higher demand on the adoption of highly flexible innovative solutions (Gašová Štofková 2017). Development and application of innovative materials are together with the development of new technologies, apparently the decisive factors for European Union ability to compete on the global markets in decades to come. That is why the European efforts in economy are aiming in Knowledge Economy.

Similar situation is in the U.S. where already in 2004 The National Innovation Initiative (NII) suggests that "during the past 25 years the United States has been effective in optimizing efficiency and quality but in the next 25 years society must be optimized around innovation." (Hansen, 2010, p. 349). Further Hansen (2010) comments that product innovation can be both: new product development as well as incremental improvement of existing products. From business perspective, Nosáľová (2017) states that only those enterprises are able to bring innovations which can adequately react to changes and opportunities in the business environment, anticipate further development in the field – and that is when the innovation thinking is embedded in enterprise culture.

Now this raises the question of what kind of innovation it should be, in what direction, and what kind of knowledge that Knowledge Economy should encompass and apply. We can apply this business rule to the whole society: If we want to survive in our living environment, we must innovate. In the old days, the innovations´ goal in company was to attract new customers, increase the productivity, decrease the inputs and processing time, save the resources and thus increase the profit. Today, it is important to bring and enhance the sustainability, too. It means that not only resources and energy saving is needed, but important is what kind of material resources are used and what kind of source is the energy coming from.

Important factors determining the success and efficiency of developed economies in world business competition are their ability to decrease the amount of industrial waste and increase the use of recycled and reused materials and compounds. There are already approaches how to decrease the burden on environment from plastics. The paradigms of Circular Economy, Sustainable Economy and Bioeconomy have started to spread across the developed world, aiming to reuse and recycle once used plastic materials and not only them. This model have penetrated many industrial production sectors. The problem in plastics, however, is that the regranulated and repeatedly heated plastics prepared for further use, e.g. for injection moulding, pressure-blowing and other processing, have lower mechanical properties in comparison to virgin plastic material. This excludes the recycled plastic as a trustworthy material in high-quality-demanding products of industries such as automotive or aircraft industry. Nevertheless, this weakness does not matter so much in some other industries, e.g. consumer-goods industry, which have not so strict requirements on the material properties of the final product.

2. WOOD-BASED COMPOSITES

2.1. Wood-based products as part of solution

Starting from 1960s, there is a variety of wood composites in the world market, mostly in shape of a board, e.g. OSB, HDF, MDF, WPC and Plywood, and structuraly consisting of former waste in form of wooden or plastic particles or plies where the particles and plies are glued together with various kinds of resins – the most common is aminoplastic resin (urea-formaldehyde resin) - to reach optimal mechanical properties. All these board types are present in modern woodhouses, they are used as outer decorations, floor layers and fence boards as well. However, the open topic is their capability to be subsequently recycled in full because they contain the resin which is hardly recycleable as refers Ozaki (2000). This is why the convenient approach for the future is to substitute or reduce the resin in wood composites.

Complementary to facts mentioned, they are emerging innovation pathways in wood-based products. Thanks to still ongoing research and development in this field, novel applications of the known compounds, new processing methods and products are found. Through nanotechnology and nano-engineering the wood is not just a raw material for construction and paper industry anymore.

2.2. Cellulose and Lignin

Cellulose, the most abundant organic polymer on Earth, forms the wood in 40 – 50 %. This traditional source material for paper production has far bigger application potential in future, however. The composites based on cellulose are used in sustainable solutions in packaging, there are pioneer dental crowns made of cellulose nanocrystals combined with genetically engineered proteins, and optical fibres can be produced of methyl cellulose, a derivate from cellulose (Finnish Forest Association, 2021a). Cellulose nanocrystals can be used as lubricants, because in water they network and form viscous hydrogels which are added to drilling fluids. Also, cellulose nanocrystals can be used in filters for filtering or detection of certain compounds (Lemonick, 2018)

Lignin is the most abundant natural aromatic polymer acting as a binder of cellulose and hemicellulose in wood structure. After refining it serves as a non-toxic alternative to phenols present in resins in plywood and other veneer applications (Ratia, 2018). Originally, it is a side product of the industrial wood refining process, being produced in large quantities (Tamminen, 2017). For now, most of lignin produced in pulp mills is still being combusted for electrical energy production as part of black liquor. In chemical terms, it is a complex amorphous organic polymer, having highly branched structure consisting of three repeating monomer units: p-coumaryl alcohol, coniferyl alcohol and sinapyl alcohol. Its exact structure varies with the wood type and also fractionation process condition the properties of the lignin produced (Lehtinen, 2022).

Lignin is very promissing because of its potential to replace a big percentage of fossil-based plastics in a wide range of industrial applications. There are already injection-mouldable biocomposites with a similar possible technological processing as the most widespread petro-plastics - e.g. Burkhardt-Karrenbrock et al. (2001) report that biocomposites consisting of lignin-matrix filled with cellulose fibers are available that can be used for injection moulding after melting, and behave similarly to polyamide. This biocomposite - "liquid wood" - ARBOFORM is used for the production of consumer products. However, despite the similar price to petro-plastic raw materials, the market share of biocomposite products is still very low.

3. TRANSITION TOWARDS SUSTAINABLE ECONOMY

Sustainability awarness in the society, i.e. among producers and consumers is still developing, but this shift is too slow for now. The fault on the consumer side is just secondary, because the customers even if they know theoretically about new technologies and materials, they are not the ones to bring them on the market. Primarily, the producers should be those leaders introducing innovative products, designed in sustainability mindset and produced in sustainable way, also taking into account future full recycling of the product. If this is performed, then the consumers can make their environmentally responsible choices and decide to which products is given the “green light” and which not. For the company to be an environmentally responsible, sustainable producer of products or services, they need to possess all the below listed qualities:

a) having know-how to produce sustainable products and/or services
b) being perseverant in their sustainability direction and efforts
c) making successful marketing of their products and services to create customer basis
d) keeping producing those sustainable products and services once the customers are won

To depict this transition towards the Sustainable Economy we can use the diagram below (Diagram 1). It is a paraphrase of the original created by Frances Hill in 1999 and quoted by Laszlo (2000) to show the relation between the ISO (International Organization for Standardization) and TQM (Total Quality Management) approaches.

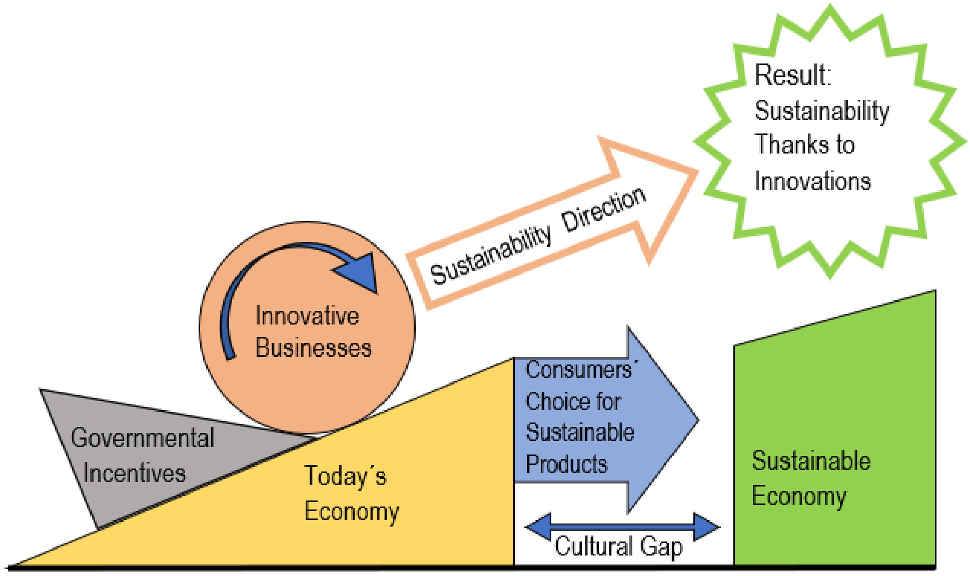

Diagram 1: Transition towards the Sustainable Economy (author, paraphr. Laszlo 2000)

Note: Innovative Businesses = environmentaly responsible companies developing and producing innovative sustainable products and services; Cultural Gap = other companies & consumers - remaining at old solutions

The onset of novel communication technologies known as electronic communication brought to downturn traditionally strong Finnish paper industry. After 100 years the growth started to slow already in late 1990s and plateaued in 2000 (Lemonick, 2018). Finnish forest industry, i.e. wood-processing companies had to react and sought the ways to diversify their production: they shifted from paper and pulp to “renewable” materials like Lignin and Micro-fibrillated Cellulose (MFC) (Janita, 2018). Today, 20 years from starting their efforts and thanks to cooperation with scientific teams of home and foreign universities, Finland is well ahead in innovations within Sustainable Economy (Bioeconomy), sustainable approaches based on wood, and to fulfilment of the goals in quoted statements of *Jarmo Rinne and* Marika Ollaranta. The most interesting recent solutions from Finland enhancing the sustainability are documented below.

3.1 Composite of wood chips and plant-based binders

The composite of wood chips are processable with injection moulding technology. They degrade by “57,6% at 462 days in the marine environment (30 °C) (ASTM D6691), 28% at 153 days when tested according to ASTM 5511 (37 °C) accelerated biodegradation in the landfill”, they biodegrade without permanent microplastics left and preferred recycling method is industrial composting (Sulapac OY, 2022).

3.2 Textile fibre made of wood pulp

Finnish company Spinnova holds numerous international patents regarding their unique technology of yarn production from a wood pulp – cellulose, using just mechanical processing with no chemistry. After end-of-use the textile product can be taken back to company for upcycling to reach the cellulose micro fibrils again – of the same quality and without use of chemicals. The new textile products made of this upcycled fibres do not require adding virgin fibres to reach the original quality, yet innovative companies are making trials on how many times this fibre upcycling can be repeated. They are also trying to make their textile fibre from other materials, especially leather waste, cotton waste and agricultural waste such as wheat straw (Spinnova OYJ, 2022). According to Finnish Forest Association (2021b) there is expected the annual growth in wood-based textile fibres demand by 10 %, up to € 35 bln. by 2035, which will be caused by inability to increase the competitor fibres production (namely cotton and synthetic fibres) due to environmental issues they suffer from or cause (draught and microplastics pollution).

4. DISCUSSION AND CONCLUSION

There are no doubts that forest- and wood-processing industry will play crutial role in the transition to Sustainable Economy and future economic prosperity of European countries. From traditional timber-, through energy production, and novel materials and solutions based on wood compounds, there is much to be offered by forests (Búryová Sedlák, 2021). With shrinking fossil resources the importance of renewables will grow – so the wood. Important is also to use the by-products of wood processing effectively and seek the most profitable ways of their usage. However wood is considered a renewable resource, there are limitations in harvesting to keep it the "renewable". There are already certification systems assuring the wood and wood products originate only from sustainably managed forests (Bureau Veritas, 2022), where harvesting does not exceed the new stand planting.

The production companies are supposed to be leaders in the transition to sustainability, because primarily it is their decision and responsibility what level of sustainability their product really has and which resources it is produced from. Many companies are already having this mindset – for example, the Finnish company Sulapac Oy, although they produce from an industry-side-stream wood material, they require Declarations of Origin and Safety Data Sheets from their raw material suppliers (Sulapac Oy, 2022). There are estimates that in 2035 the global demand for wood products will be € 715 bln. compared to € 540 bln. in 2019 (Finnish Forest Association, 2021c). Open question here is how big share of this turnover will have the businesses operating in terms of sustainability.

Acknowledgements: The authors are grateful for the support of the Scientific Grant Agency of the Ministry of Education, Science, Research, and Sport of the Slovak Republic. Grant No. 1/0494/22 Comparative advantages of the wood based sector under the growing influence of the green economy principles, Grant No. 1/0495/22 Sustainability of Value Supply Chains, and its Impact on the Competitiveness of Companies in the Forest and Forest-Based Sectors.

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WHAT ARE THE IMPLICATIONS OF UKRAINE CONFLICT O EU FOREST PRODUCTS TRADE?

Michal Dzian, Hubert Paluš, Ján Parobek, Aleksandra Lazarević

Abstract: After the changes in globally traded forest products patterns and supply chains caused by the COVID 19 pandemic, currently, there is another geopolitical event that has a direct impact on a whole spectrum of markets, not least the timber market. The current situation in Ukraine resulted in many sanctions imposed by the global community and regional groups on Russia, some of them directly targeting the trade with forest products. EU is a significant global player on forest products market. In 2020 it contributed to 42% of the world total export and 32% of the world total import of forest products. As the EU member states to a large extent depends on international trade there is a need to examine what may be the implications of such sanctions on the EU wood trade patterns and consequently on the supplies for forest based industries. Therefore, the aim of the paper is to quantify the EU's dependence on timber from Russia and to indicate the possible impacts on international timber trade.
Keywords: timber trade, impact of restrictions, sanctions against Russia, timber trade analyse.

1. INTRODUCTION

Trade in wood and wood products is one of the very important elements of the EU global market. The global trade in wood products is highly regionalized with Europe, North America and Asia accounting for 55%, 25% and 11%, respectively, of the global export value of wood products (UNECE & FAO, 2021a). The COVID-19 pandemic brought great uncertainty to forest product markets in the UNECE region in 2020, and both production and consumption were subject to rapid and extreme fluctuations. By the end of the year, however, there had been only a slight overall contraction in the sector, which turned out to be an above-average performer compared with other economic segments. This good news for forest products has continued into 2021 (UNECE & FAO, 2021b). As the global market has been hit by the Covid-19 pandemic in previous years, it has also had an impact on the wood and wood products market. At a time when it was thought that the pandemic was diminishing and that the market would recover from its influence, there was a conflict between Russia and Ukraine as well as sanctions as a result, and thus this greatly affected the flows of wood and wood products, which implies the need to explore this topic a little deeper and present the current situation. Given that EU member states are highly dependent on international trade, it is important to investigate the impact of sanctions on the timber industry and timber flows. Today, the EU is requesting consultations with Russia at the World Trade Organization (WTO) concerning export restrictions placed by Russia on wood products. The export restrictions consist of significantly increased export duties on certain wood products and a drastic reduction in the number of border crossing points through which exports of wood products can take place (European Commission, 2022). According to the European Commission the Russian restrictions are highly detrimental to the EU wood processing industry, which relies on exports from Russia, and create significant uncertainty on the global wood market. Spatially, Russia has very large amounts of forests, around 815 million ha which makes it the richest forest country in the world (Gerasimov & Karjalainen, 2011; Gordeev, 2020). Therefore, based on the current situation in Europe, numerous questions arise about the impact of sanctions on the global wood market (European Commission, 2022; Gasova & Stofkova, 2017).

Both in the world and in Europe, the demand for wood and wood products has been growing in recent years. The demand for wood and wood products in Europe is always monitored by consumption. This consumption has steadily increased over last decades with shifts between commodities and ups and downs with the economic growth rates.

2. MATERIAL AND METHODS

The aim of this paper is to quantify the EU´s dependence on timber from Russia and to indicate the possible impact on international timber trade. According with the objective of the paper, statistical data analysis and consequent synthesis were performed. Different production and trade data sources such as FAOSTAT, EUROSTAT, UNECE were used. As a first step, we were interested in the value of Russia's exports and imports of forest products. In the second step, we analysed trade flows from Russia, focusing in particular on a detailed analysis of forest products flows to the EU. In the third step, we examined the relative share of Russia's exports in the European Union's imports.

3. RESULTS AND DISCUSSION

Fig. 1 shows the development of forest products exports in Russia from 2000 to 2020.

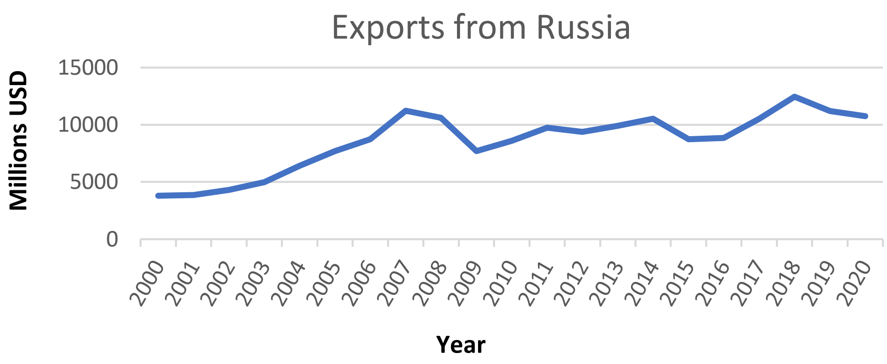

Figure 1. The value of exports from Russia

The value of exports of forest products has been increasing and increased by almost 284% in the last 20 years. After 2008 a more significant decrease in the value of exports was caused by the global economic crisis. The second drop in the value of forest products exports is observed in 2014. This decrease can be associated with the first wave of sanctions imposed on Russia in 2014 in relation to the conflict in Krym.

The following table 1 comprises the data for trade flows indicating the five most important countries in terms of Russian exports of forest products between 2015-2019.

Table 1. Value of exports from Russia to most important partner countries

2017	USD	2016	USD	2015	USD
China	4146000000	China	3376000000	China	2997000000
Japan	464000000	Egypt	473000000	Egypt	630000000
Uzbekistan	440503000	Japan	371000000	Japan	391000000
Egypt	439000000	Finland	347298000	Germany	360000000
Finland	387057000	Germany	317000000	Finland	352681000

China is Russia's most important trading partner. In 2017, exports to China represented almost 40% of Russia's total exports. Japan, the second most important country in terms of exports covers only less than 4.5% of Russia's total exports.

Figure 2. The value of Russia´s export to EU

The following analysis focused on the evaluation of Russian exports of forest products to the EU. Russian exports of forest products to the EU follow a similar trend as the overall exports. The first significant decrease in the value of exports is observed from 2007 to 2010. The value of exports decreased by almost 56% in this period. Exports to the EU represent less than 20% of Russia's total exports in 2017.

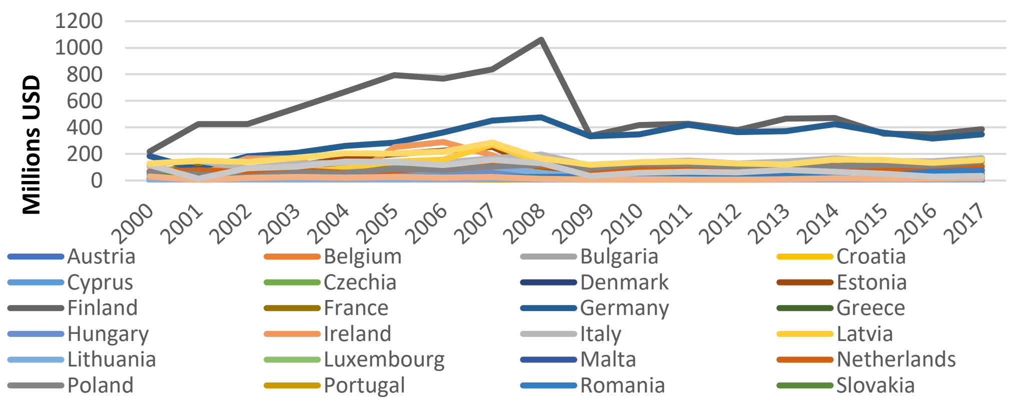

Figure 3. Value of Russian exports to EU countries

For most EU countries, exports from Russia represent a minimal share (less than 2% share). Of Russia's total exports to the EU, Finland and Germany represent almost 11%. However, the share of Russian exports to the EU has a decreasing trend. Since 2000, the share of Russian exports to the EU has decreased by almost 50%.

EU is a significant global player on forest products market. EU member states to a large extent depends on international trade. The results of our analysis show that Russia's exports of forest products to the EU has a decreasing trend. The global community and regional groups have imposed a number of sanctions on Russia, some of which directly target trade in forest products. Of course, these sanctions also trigger a response on the Russian side. On the basis of Decree of the President of the Russian Federation dated March 8, 2022 No. 100, the government of the Russian Federation has decreed a ban on exports outside the territory of the Russian Federation to foreign states and territories (Goverment of the Russian Federation, 2022). This ban was also focused on forest products. However, the decreasing trend in the share of forest product exports to the EU can be interpreted positively.

It should be noted that the consumption of wood and wood products on an annual level is about 500 million m^3. It should be also added that this amount is growing from year to year. Of course, there are ups and downs, but generally a large amount of wood and wood products are used. The important fact is that the EU largely covers its own needs. It is very important to say that over 80% of this comes from the own European forests. There is also a certain amount from North and South America, and that is some 10% and 8%. This 8% is mostly eucalyptus pulp. It should be noted that only less 0.2% is consumption is tropical hardwoods. If we look at the overall quantity and the situation in this regard, it can be concluded that with currently some 10 million m^3 of imports from Russia to the EU, this is only around 2% of the total consumption (Nabuurs, 2022). From the above, it can be said that the EU does not depend to a large extent on wood and wood products that come from Russia. What is clear now is that the situation that has befallen Europe has brought that in the future they will have to rely more on their own resources and work on increasing them.

Even before the introduction of sanctions, there were aggravating circumstances that made it more or less difficult to import / export from Russia. This primarily refers to high export duties on unprocessed round wood imposed by Russia around 2008. Since 2008, exports of unprocessed roofwood from Russia throughout the EU have declined. This had the greatest impact on imports to Sweden and Finland, given that they were the largest importers of wood from Russia. After 2008, imports were significantly hampered and accompanied, as has been said, by high export duties. A similar situation is observed in the trade of coniferous sawn timber. A number of EU countries also imported certain quantities of coniferous sawn timber. Given the rise in prices and the sanctions that have come into force, there will be a challenge to get wood and wood product, such as coniferous sawn timber, from some other suppliers.

What the EU is facing now are the challenges that lie ahead. The biggest, as it was said, is the increase in the price of import duties, from some 15% to almost 80%, which Russia does not respect its commitments under WTO law. It should also be noted that with 30 border crossings, exports have been reduced to just one (Luttya, in Finland). The new Strategy for the Development of the Forestry Complex, approved on 11 February 2021 by the Russian government, assumes that by 2030 the industry's total contribution to the Russian economy will double. This is expected to be achieved by increasing forest nurseries, increasing digitalization as well as producing products with higher added value, and reducing exports of raw materials.

4. CONCLUSION

Taking into account the size of Russia's forests and the amount of imports of wood and wood products from Russia, it can be concluded that the sanctions imposed will not significantly disrupt the EU market. And the reason for that is that the EU countries did not import large quantities of wood and wood products from Russia, but relied mostly on their own resources.

Acknowledgements: The authors are grateful for the support of the Scientific Grant Agency of the Ministry of Education, Science, Research, and Sport of the Slovak Republic, Grant No. 1/0494/22 Comparative Advantages of the Wood Based Sector under the Growing Influence of the Green Economy Principles and Grant No. 1/0495/22 Sustainability of Value Supply Chains and its Impact on the Competitiveness of Companies in the Forest and Forest-Based Sectors and Grant No. 1/0475/22 Environmental Consumer and Environmental Citizen.

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ASSESSING THE INNOVATION POTENTIAL OF THE FURNITURE INDUSTRY VALUE CHAIN IN BULGARIA

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Abstract: The dynamic changes in the global environment have a strong impact on value chains in terms of both the economic and innovation performance of individual enterprises and the growth potential of the regions in which they are located. The main goal of the report is to analyse the innovation potential of furniture manufacturing companies in Bulgaria from the perspective of their global value chain (hereinafter GVC) participation. A review of the scientific literature is presented in the first part of the paper, where information regarding the current status, challenges, and opportunities for the innovativeness of the furniture industry is studied. In addition, factors related to the innovation potential of enterprises are outlined, which could have an impact on the GVC by strengthening and expanding their effect to gain new opportunities for national and regional competitiveness. Primary data analysis from a questionnaire survey among furniture manufacturing companies in Bulgaria is presented in the second part of the paper. Emphasis is put on the possibility for adaptation of the innovation potential of furniture manufacturers to the value chains and globalization. These analyses will serve as a basis for further studies on the link between innovativeness and GVC participation in forestry.
Keywords: global value chain, furniture manufacturers, innovation potential

1. INTRODUCTION

Global value chain participation is generally seen as an important avenue for companies to access new markets and diversify exports, add value to local industries and gain a competitive advantage. It provides opportunities to access knowledge to enhance learning and innovation capability. However, many companies do not directly integrate into GVCs but rather into regional value chains (hereinafter RVCs) or local value chains (hereinafter LVCs). The aim of this paper is to examine and compare the drivers for involvement in GVC in stimulating knowledge acquisition and innovation upgrading in the context of the furniture industry. We distinguish between different types of innovation activities. We argue that value-added outcomes depend crucially on value chain governance: the power balance and interactions between the lead firms and suppliers. We draw on a survey among the companies in the furniture industry, which was conducted in Bulgaria. These novel firm-level data allowed us to study innovation drivers in value chains at the firm level. In a multivariate analysis, companies with strong GVC participation develop capabilities via interactions with their client and supplier firms. Yet, GVC participation is not the only avenue for innovation capability building; we similarly observe knowledge acquisition and innovation activities at the company level. Innovation potential is generally and strongly enhanced by trust-based governance of the client-supplier relationship. In contrast, in GVCs, control-based governance additionally promotes competitive advantage specifically in information technology-related domains.

2. INNOVATIVENESS OF THE FURNITURE INDUSTRY IN TIMES OF GLOBALIZATION

Globalisation is not a new phenomenon by which national economies, i. e. markets and production in different countries are becoming increasingly interdependent due to the dynamics of trade in goods and services and the flows of capital and technology, through sustained and open commerce (Paceskoski and Nikoloski, 2021). Globalization brings dynamism, networking, openness, cross-organizational cooperation, and free diffusion of knowledge and skills, and it requires performing processes of innovation development and implementation (Pachura, 2015). As globalization has already formed conditions for the easy transfer of knowledge, resources, products and services, organizations in specific sectors such as forestry must identify their strengths and use them to develop their innovation potential. The innovation potential, generally studied at the national level, is related to the development of economic growth and stability at the regional and country level. Fagerberg et al. (2018) emphasize that domestic capability (innovation potential) is a relevant factor, required for a broad framework of knowledge transfer and better participation in the global value chain (a particular form of openness to trade) for economic development. Moreover, Chiu (2014) suggests that a diversity of suppliers in the value chain supports businesses when searching for new products, thus enabling the use of new knowledge and technologies. In this respect, global value chains generate significant economic benefits for both participating companies and the national and regional economies where they are located. It is considered that the forestry sector is “low-tech”, mature, declining and less innovative (Weiss, 2011, p. 3; Hansen et al., 2021). The sector’s innovations are primarily incremental, with fewer investments in R&D (Pinkard and O’grady, 2016; Stefanov, 2020). In terms of forestry, essential consequences of the globalization process are primarily noticeable in countries with large forest areas (Suchomel et al., 2012). The sector is indirectly affected by the internationalization of forest-based industry and in this respect through the “globalizing” (Rametsteiner et al., 2007). Given the fact that globalization has economic, political, social and cultural dimensions of the concept, for the current study, it is considered in terms of the integration of economic activities. Four major sectors comprise the EU forest-based industries – woodworking; furniture industry; pulp and paper industry, and printing industry. Dzian et al. (2021, p. 6) argue that there is a significant relationship between the furniture trade and globalization development. Without neglecting the other industries, the main object of analysis in the current study is only the furniture industry. The global furniture market is estimated to be worth $850.4 billion by 2025. Such growth is considered due to the COVID-19 impact and rearranging the business operations (Furniture Global Market Report, 2021). Still, the furniture industry is traditionally labour-intensive SMEs predominates and has a fragmented supply chain. Many phases are often outsourced (Study on the EU furniture market situation and a possible furniture products initiative, 2014, p.17). In terms of innovations, investments by furniture manufacturers are made for augmented reality technologies (such as a virtual 3D model of furniture in a real room in real-time) that support the marketing, sales, and customers in decision-making (Furniture Global Market Report 2021). Studies in the field are indicative that companies in the furniture manufacturing spend more money on purchasing machinery and equipment rather than on R&D, changes in the design of goods or services, and purchasing of intangible assets (licenses, patents, software) (Chobanova et al., 2018, p. 193). A restriction to the innovation development in furniture enterprises is considered to be the restricted access of the company to the market including a lack of cooperation with the main supplier (Biolcheva, 2017, p. 126-127). Foreign customers and suppliers, as well as local ones, are among the significant sources of innovative ideas for new projects and technological innovations. However, newly purchased equipment or materials from local manufacturers are seen as sources of innovation rather than newly purchased equipment or materials from foreign manufacturers (Chobanova et al., 2018, p. 172). The focus of the scientific studies does not fully cover the symbiosis between geographical location, sectoral affiliation and innovation potential. If the analysis of the innovation potential is applied to the global value chain the effects of the previously mentioned factors could support the development of new opportunities for the national and regional competitiveness.

3. RELATION BETWEEN INNOVATION POTENTIAL OF BULGARIAN FURNITURE MANUFACTURERS TO THE VALUE CHAINS AND GLOBALIZATION

3.1. Data collection and methodology

In our empirical analysis of the furniture industry, we examine to what extent different types of innovation and learning drivers within the value chain are associated with trust-based and/or control-based modes of governance in supplier-client relationships. We distinguish domains of learning and competitive advantage that have been identified as important in the sector: the transfer of professional knowledge, learning of business culture and practice, IT learning, and more general information exchange. Subsequently, we examine if these associations differ for firms in GVCs compared to firms in LVCs and RVCs. We identified 3980 firms operating in Bulgaria with the subject of activity according to the NCEA-2008 code 31 – Furniture manufacturing. They were identified based on available data from the Bulgarian business register and information gained from a questionnaire survey. Of all those 3980 firms 330 were selected for the representative study. Due to missing information on some variables used in this study or the company has stopped working the number of firms included in the analysis is further reduced to 85 firms. We verified that non-response was not likely to bias findings, as the proportion of respondents was not quite different under firms engaged in the domestic market and firms engaged in international markets. Self-selection bias is unavoidable in this kind of survey, yet being involved in sample results could be assigned to stimuli for active participation, and interpreted in the context of intentions of companies (CEO and managers) to be active participants in GVC integration. In this context, it is most likely to be a mark of strong organizational culture and good management practices aligned in this venue. The survey was made based on questionnaires distributed on the spot during the months March-April 2022. Our focal dependent variable is innovation capability in value chains. We identified specific innovation domains that the literature pointed out as critical to capability building in the furniture sector. We tested these domains in a preparatory phase of the study using expert interviews to ensure that the domains were clearly understood, and the terminology widely shared across the actors in the industry.

3.2. Results and discussions

A key indicator to measure GVC upgrading potential or capability is the innovation activity of companies in terms of product and process innovation with particular attention to the collaborative innovation projects. Regarding product innovations, out of 85 companies, 80 (94.1%) have developed new products during the last year. Out of them, 66 (83.5%) of the companies have developed new products with their own company resources, and the rest, 13 (16.5%) – are in collaboration with external companies. As for the process innovations, 53 (62.4%) of the companies have introduced new improved production methods and technologies. Out of them, 41 (77.4%) have implemented new process practices with their own resources, and the rest, 12 (22.6%) – are in collaboration with external companies. In the field of sales and marketing innovations, 34% of the companies have developed either new product packages or new sales and distribution practices. Most of the innovations have originated out of customers, traders, and suppliers' requirements (about 56% for product innovations and 51% for process innovations, equally in partnerships and company dimensions). Most of them are related to media/Internet/exhibitions and similar information channels (for product innovations 38% in partnerships and 50% in the company; for process innovations – 41% in partnerships and 51% in the company). The next most important sources for learning and knowledge transfers are customers and suppliers (for product innovations 36% in partnerships and 28% in the company; for process innovations 30% in partnerships and 30% in the company). Innovation drivers related to competitive advantage factors reveal a greater variability both for product and process innovations, both in partnerships and company dimensions. In the partnership dimension, and not surprisingly, the leading part is played by the quality of products (for product innovations 38% in partnerships and 2% in the company; for process innovations – 26% in partnerships and 22% in the company). Next most important are trained labour force, design/ergonomics of products, company image, and competitive price. Included in the analysis is a sample of 63 companies. Assuming that this was a random sample, the following hypotheses can be tested:

H1: GVC participation of a company is positively related to its size.
H2: GVC participation of a company is positively related to its age.
H3: GVC participation of a company is positively related to its revenue.

The null hypothesis, in this case, would be that GVC participation of a company is not related to the size or age or revenue of the company. In addition to the above, it is possible to test for the interaction effect of age and size on the GVC participation of a company. One of the interaction hypotheses is given below:

H4: The size of a company interacts with its age in determining GVC participation such that the effect of size on GVC participation of a company increases with the age of the company. In other words, bigger and older companies have better GVC participation than bigger but newer companies.

When testing for interaction effects, it is advisable to build models such that we enter all the main effects in one model first and then enter interaction effects in another model. Thus, the hierarchy of variables in our example will be to enter the main effects of size and age in Model 1 and enter the interaction effect of size and age in Model 2. The classification table summarizes the results of our prediction about company GVC participation based on the size, age, and revenue of a company. Our model can correctly predict 98.1% of the company's participation in product innovations. Overall, our model predicts 81% of the companies correctly. This gives the percent of cases for which the dependent variable was correctly predicted given the model. In this part of the output, this is the null model (51 out of 63). Values of the coefficients in the logistic regression equation for predicting the dependent variable from the independent variables are in log-odds units. The prediction equation is

$$\log(p/1\text{-}p) = -1.858 + 0.006*\text{Size} + 0.025*\text{Age} + 0.000*\text{Rev},$$

where p is the probability of being in GVC participation. These estimates show the relationship between the independent variables and the dependent variable, where the dependent variable is on the logit scale. These estimates tell the amount of increase (in our case) in the predicted log odds of the outcome being a case (GVC participation) that would be predicted by a one-unit increase in the predictor, holding all other predictors constant. The Beta coefficients in logistic regression are to be interpreted as follows. Positive Beta coefficients for size and age mean that with increasing size and age of a company, its chances of having a GVC participation improve. In our case, a value of 1.025 for Age indicates that for a one-year increase in the age of the company, the odds of a company having a GVC participation increases by a factor of 1.025. The beta coefficient for the number of employees is 1.006, and indicates that for a unit increase in the Size of the company, the odds of a company having a GVC participation increases by a factor of 1.006. The beta coefficient for operating revenue has a value of 1, indicating no influence on the dependent variable. Beta coefficients are the odds ratios for the predictors. Odds are defined as the ratio of the predicted probability of being a case (GVC participation) to the predicted probability of not being a case. They are the exponentiation of the coefficients. For probabilities greater than 0.5, the logit is positive and the odds greater than one. The overall goodness of model fit is estimated by Cox & Snell Index (0.022) and Nagelkerke Index (0.037). The calculated deviance measure of model fit, expressed in standard notation (−2 log-likelihood) is equal to 56.938. The logistic regression model is suited to the properties and error structure of binary outcome data in our study of company GVC participation.

4. CONCLUSIONS

Our study finds that GVC participation is not the only avenue for innovation capability building, as we also observe innovation potential at company and local level. We find that learning and knowledge transfer is significantly enhanced in all value chain configurations if the partners' interactions are on trust. When producers are integrated in GVCs and supply more sophisticated markets, client control becomes more important and can facilitate adherence to international standards, which has been argued to be one of the main channels of GVC interaction. Value chain learning also has important consequences in terms of an increased probability that companies are able to develop new technology and process innovations. Availability of skilled and trained manpower is integral to building professional knowledge and innovation potential. Applied technology, like the adopted ERP, CRM, CAD/CAM, 3D, and product development software, digital applications and platform, are found to affect the quality, cost and associated risks of the delivery of the product and facilitate innovative solutions. These findings contribute new insights to the expanding literature on the importance of (global) value chain involvement for small and medium sized companies from various industry sectors, and suggest a number of policy implications.

Acknowledgements: The paper presents primary data from Project „Development and implementation of a model for assessing the innovation potential of global value chains as a basis for increasing regional competitiveness" financed by the National Science Fund, contract No КП-06-Н55/8 from 16.11.2021.

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THE IMPACT OF GLOBAL CRISIS ACCIDENTS ON THE PRICES DEVELOPMENT OF SELECTED RAW-WOOD ASSORTMENTS IN THE MIDDLE EUROPE REGION

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Abstract: The period of the last 5 years is marked by an extremely dynamic development of the timber market and wood products. The impact of the pandemic period and the war conflict was marked by extraordinary turbulence in the pricing and trading of raw wood assortments. The aim of the paper is to analyze the period in which the above-mentioned crisis accidents occurred, which had at least a regional to global impact on the timber market and trade with wood. The prices development of spruce, fir and beech sawlogs in selected federal states of Austria, Slovakia and the Czech Republic were evaluated. Data on wood prices were obtained from available information sources of professional literature or statistical reports. They were intentionally not statistically balanced to demonstrate the impact of a particular period. The results showed a significant impact of the crisis events, especially on the assortments of coniferous sawlogs. In beech sawlogs, prices in the observed period increased continuously only in Slovakia. This trend is partly influenced by processing and consumer sentiments, especially in the construction segment. However, a significant impact is also shown on the lower quality classes of coniferous and deciduous assortments, which occur mainly as a result of the energy crisis.

Keywords: raw-wood assortments, trade with timber, prices, incidental fellings, global pandemic

1. INTRODUCTION

Over the last five years, the market with timber and timber products has undergone extremely turbulent development. Global climate change and increasing weather extremes are adversely affecting the stability of forest ecosystems and causing a high rate of incidental fellings. This is associated with a relatively large volume of timber supplies at the time of the incidental felling. Another negative factor that negatively affected the stability of the timber market was the arrival of the global pandemic and its consequences on the implementation of forestry activities in the first half of 2020. The planned harvesting operations were either not implemented at all or only to a very limited extent. This caused a short-term shortage of wood in the market, which, combined with the subsequent recovery in production and a sharp rise in demand for building materials after the first wave of the pandemic, caused a sharp rise in wood prices.

The third negative event, which began to manifest itself at the turn of 2021/2022, was the instability in the energy market associated with rising fossil fuel and electricity prices. This has secondarily put renewed pressure on the prices of some raw wood assortments, which are an energy alternative to fossil fuels. The ensuing war in Ukraine has exacerbated this instability and price growth.

These negative events had a significant impact on the instability of the timber market. The prices of some assortments have reached the maximum level in the past 20 years. A basic prerequisite for successful timber trading is a thorough analysis of the market, timber prices, marketing analysis, and their statistical predictions. Several works have addressed the right approach to these areas in the past (BANAS, KOZUCH, 2019; KOZUCH, BANAS, 2020; KOZUCH, ANKUDO-JANKOWSKA, 2021). The aim of the paper is to analyze the period in which the above-mentioned crisis accidents occurred, which had at least a regional to global impact on the timber market and trade with wood products. The analysis of this period should provide basic information for the future management and preparation of the forestry and timber complex for the coming period, which is likely to be characterized by a shortage of raw materials and rising prices.

2. METHODOLOGY OF DATA COLLECTION AND EVALUATION

The analyzed period represented the time range from 2017 to March 2022. The prices of assortments of spruce, fir, and beech sawlogs in selected federal states of Austria, Slovakia, and the Czech Republic were evaluated.

Timber price data were obtained from available information sources and statistics. For selected Austrian federal states, price data were obtained from the HOLZKURIER magazine (2017-2022). Data on prices from Slovakia were obtained from the BULLETIN OF THE NATIONAL FOREST CENTER (2017-2022), which provides data on average prices of individual assortments at the trade parity of the supplier's wood storage depot in € per 1 m^3 without value-added tax. The newsletter in electronic form is regularly published on the forestportal.sk web platform. Price data in the Czech Republic are regularly published by the CZECH STATISTICAL OFFICE (2017-2022) in Forest Price Indexes. Wood prices are stated in Czech crowns, so for comparison purposes, they had to be converted into Euros at the average exchange rate of the CZECH NATIONAL BANK (2017-2022). In addition, average prices for beech sawlogs do not show since 2020, but only price indexes with a 100% base as of 2006. Therefore, average prices of beech sawlogs have been recalculated based on percentage conversion to base prices, as shown in these price indexes.

For the complete methodological correctness of the price comparison, it is necessary to state that the individual quality subclasses of the assortment of sawlogs do not have the same technical requirements in individual countries within the technical conditions for the evaluation of the permitted range of negative quality features. Also in Austria, the trade takes place mainly at the forest road trade parity, while in Slovakia it is mainly the supplier's wood storage depot, so for a completely accurate comparison it would be necessary to add transport costs from the transport point to the wood storage depot. However, for the purposes of the analysis of the impact of a specific period on the realization prices of raw wood assortments, a comparative analysis of technical conditions and recalculation of trade parities is not necessary.

3. RESULTS

The development of prices of selected raw-wood assortments was evaluated to point out the impact of a specific period, therefore they were not intentionally statistically smoothed.

3.1. Prices development for spruce and fir sawlogs

Figure 1 shows the development of the prices of spruce and fir sawlogs in selected federal states of Austria, Slovakia, and the Czech Republic.

After the global economic crisis in 2009, the market for timber and timber products stagnated. At the end of 2014, the first signs of recovery came due to the intensification of construction activity in the USA and Japan. In 2016, the price levels of coniferous logs reached the highest levels since 2000. After 2016, there was a partial stabilization of the market and wood prices. The prices of these assortments did not change significantly until 2019. The only exception was the Czech Republic, where the situation on the market with these assortments was fundamentally affected by the gradation of the calamity caused by bark beetles and its subsequent processing.

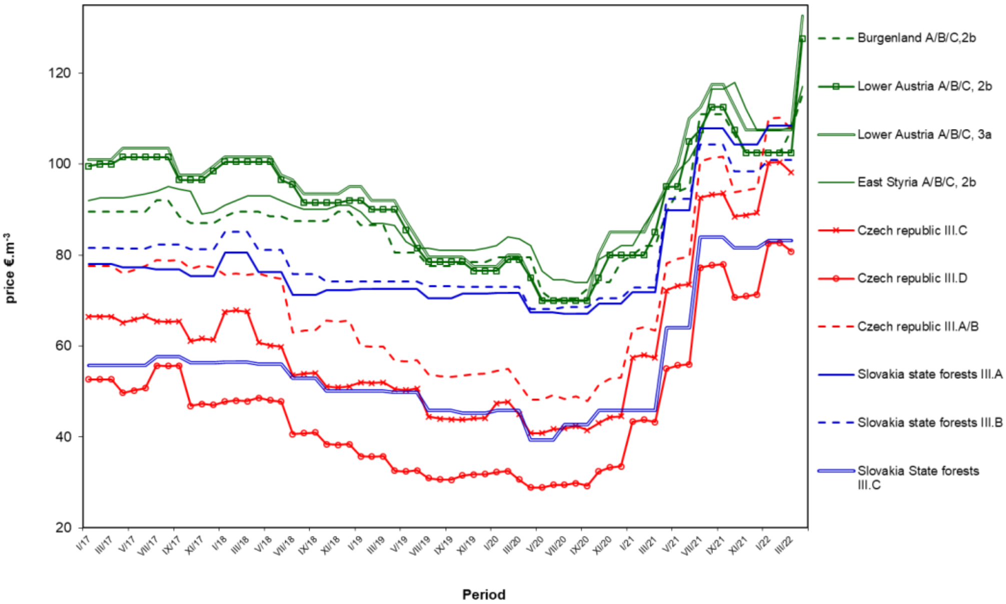

Figure 1. Development of spruce and fir sawlogs prices from selected countries in €.m^{-3}

At the beginning of 2020, the onset of a global pandemic. After the introduction of anti-epidemic actions, forestry and harvesting activities were reduced to the minimum necessary, which resulted in the non-processing of larger volumes of wood in forest stands that were damaged by harmful factors. Although the processing enterprises still had a relatively high level of stocks of coniferous sawlogs during this period, they also partially reduced production. Subsequently, in the summer months of 2020, there was a gradual easing of pandemic actions and a significant recovery in construction activity, which sharply increased the demand for construction timber almost worldwide. From the above facts, which affected the production of timber in the first half of 2020, it is clear that there was a significant shortage on the market, which sharply increased its price, as well as the price of raw materials. Approximately the same scenario occurred again at the end of 2020 and the beginning of 2021. The prices of coniferous pillar logs thus continued to rise in 2021. In the second half of this year, however, there was a partial stabilization. At the beginning of 2022, however, there was a sharp rise in energy and fossil fuel prices, caused by the crisis in Ukraine and the subsequent outbreak of military conflict. This has also put pressure on wood prices as a renewable raw material as an alternative to fossil fuels. In the first quarter, there was another significant increase in wood prices. Compared to the price levels of this range at the end of 2020, in a year and a half prices increased by 35-40% per 1 m^3. Compared to the price levels in 2017, this was an increase of 25-30% per 1 m^3 of coniferous logs.

3.2. Prices development for beech sawlogs

Figure 2 shows the development of prices of beech sawlogs in selected federal states of Austria, the Czech Republic, and Slovakia.

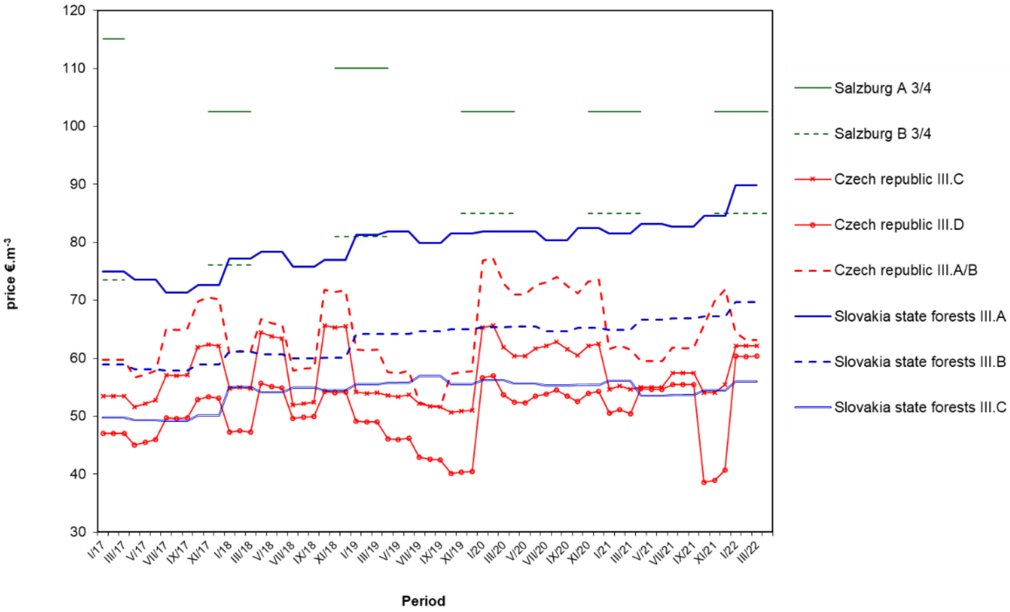

Figure 2. Development of beech sawlogs prices from selected countries in €.m^{-3}

Beech saw logs have a completely different position in the global and European market than coniferous sawlogs. Its use in the construction industry, especially for the production of wooden houses, is influenced by the tradition and technologies of processors, as well as the mechanical properties of wood. The capacity to process non-coniferous logs is significantly less. That is why the non-coniferous log market has been stagnant for several years. The above-mentioned crisis events did not contribute as much to the influence of prices in the past period as they did in the case of coniferous sawlogs. In Austria, the prices of this range have not even fluctuated significantly for several years. Paradoxically, the prices of pulpwood and wood for energy use have risen by up to 40% on some Lands. However, the beech logs did not experience such an increase even during crises. The continuous growth of the price of this assortment is recorded especially in Slovakia in all quality subclasses. From the beginning of 2017 until the end of the first quarter of 2022, prices increased by approximately 17 to 20%. In the Czech Republic, beech sawdust prices rose mainly in the first wave of the pandemic at the beginning of 2020. After partial stabilization at the end of 2021, they began to rise again to the levels reached in the first half of 2020 (with the best subclass of mixed sawmill III). A / B).

4. CONCLUSION

The current turbulent period is marked by extraordinary fluctuations in the energy and fuel markets. There has been no similar situation in the last few decades. Consequently, this development also has a major impact on the trade with timber and timber products. Not only as an alternative to fossil fuels but also as a basic building material, wood has been an extremely popular commodity on the market over the last two years. In some assortments, which are key for these ways of its use, this is subsequently relevant in its price. Assortments that have lower long-term usability (including beech pillar logs) have not yet seen turbulent changes in price levels. However, as the correlation with the lower quality classes is obvious, the price of beech pillar logs can be expected to rise more significantly soon. Just because of its substitutability for less valuable processing purposes.

Further developments in the timber market will be affected by the expected further construction development and the crisis in the energy market due to the war in Ukraine. If the current unfavorable situation does not escalate, a gradual, slowing of the market can be expected. However, a significant decline in the prices of raw wood assortments cannot be expected. Rather, a more modest increase can be expected this year and next year.

Acknowledgements: We wish to thank the Slovak Research and Development Agency (grant number APVV-20-0004 The effect of an increase in the anthropometric measurements of the Slovak population on the functional properties of furniture and the business processes); and Scientific grant agency from Ministry of Education, Science, Research and Sport of the Slovak republic (grant number VEGA 1/0655/20 The concept of bioeconomics in the conditions of the Forestry and Wood processing sector in Slovakia).

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THE IMPACT OF QUALITY MANAGEMENT TOOLS AND METHODS ON THE PERFORMANCE OF COMPANIES IN THE CONDITIONS OF THE WOOD PROCESSING INDUSTRY IN SLOVAKIA

Pavol Gejdoš, Katarína Rentková

Abstract: The article deals about the influence of the use of methods and tools of quality management on the performance of companies in the conditions of the wood processing industry in Slovakia. The aim of the paper is to point out the main reasons for the implementation of quality management systems in this industry, to analyse the benefits of implementing quality management systems and their impact on business performance.
Keywords: quality management system, performance, wood processing industry

1. INTRODUCTION

In the area of organizational management, there has been a clear shift in terms of quality management: the quality of a product or service is a necessary condition for success and increased performance (Seaver, 2003). The present in the field of quality management is characterized by a situation where more and more organizations already have or will have an implemented quality management system in the near future. It is not uncommon for the implementation of a quality management system not to meet expectations, so organizations strive to improve systems by other means and forms. Modern organizations will focus on the full use of principles, tools, techniques, methods that support the continuous development of society and continuous improvement. These conditions are basically the same everywhere globally, and the wood processing industry in Slovakia is no exception. The aim of this paper is to analyse and evaluate the current situation of implementation of quality management systems (QMS) in the conditions of the wood processing industry in Slovakia.

2. MATERIAL AND METHODS

The assurance and improvement of the processes can be achieved by various methods and techniques such as e.g. ISO standards Total Quality Management TQM, EFQM excellence model, PDCA cycle, DMAIC, Six Sigma conception. NENADAL et al. (2018) says that we can identify certain benefits of QMS implementation that have implications for business performance. These are in particular:

- increasing the credibility of the company,
- increasing the level of management and implementation processes,
- reducing the number of disagreements, customer and employee complaints, thus reducing overall costs,
- responsibilities and powers for the various levels of management in the company are clearly defined,
- increasing competitiveness,

• increasing the quality and efficiency of the products provided.

Samad (2009) confirmed that QMS has a significant impact on improving the quality of the final products, but even more significantly affects the overall performance of the company. On the other hand, Gejdoš and Potkány (2016) says that there are also objective obstacles that stand in the way of effective implementation of quality management systems. These are in particular:

• limited financial and other resources,

• for small businesses in particular, a more difficult understanding of the language and meaning of ISO 9000 standards for most employees of the company,

• insufficient level of knowledge about the basic principles of top management, especially in small companies,

• negative references to similar efforts from other companies without a deeper understanding of the reasons for the failure of these efforts,

• formality in the implementation of these systems in order to obtain a certificate and not create a functional quality management system.

Results of many studies (Nguyen *et al*. 2018; Alharbi *et al*. 2017; Rebelo *et al*. 2016;) indicate that implementation quality management system contribute positively to achieving sustainable development and higher performance. Quality is mainly economic category and factor which has a great influence on long-term business results and if profit or loss are reached. From this point of view, it is important that activities connected with quality assurance won´t be evaluated only from the view of effectiveness of these activities.

3. RESULTS AND DISCUSION

The data were obtained through an on - line research questionnaire. The questionnaire survey was conducted during the year 2021 through the platform docs.google.form. The questionnaire that have been researched, we can say that a survey sample of enterprises is relevant, has sufficient denunciation, which is also verified by selected mathematical and statistical methods.

The Figure 1 shows the answer of question " What methods, tools and concepts do you use to improve quality in the company." 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 use 7 basic quality tools, second answer was that enterprises do not use any of the methods and concepts and the same percentager answer was that enterprises use ISO 9000.

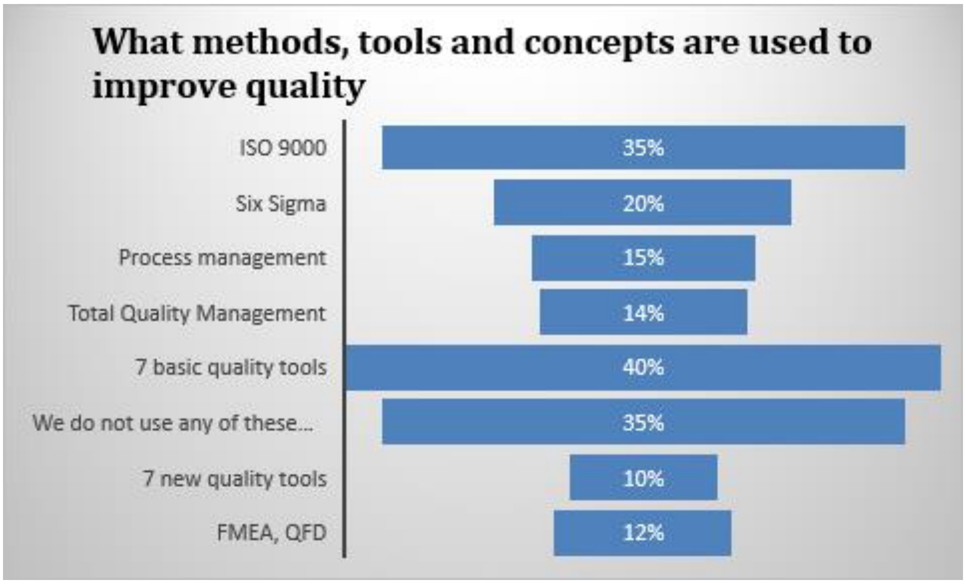

Figure 1. What methods, tools and concepts do you used to improve quality in the wood processing companies in SR

Figure 2 shows the reasons why companies in the wood processing industry have decided to implement a quality management system. The results show that almost half of the analysed companies did not implement the quality management system. The other most common reasons were to improve market position and strengthening competitiveness.

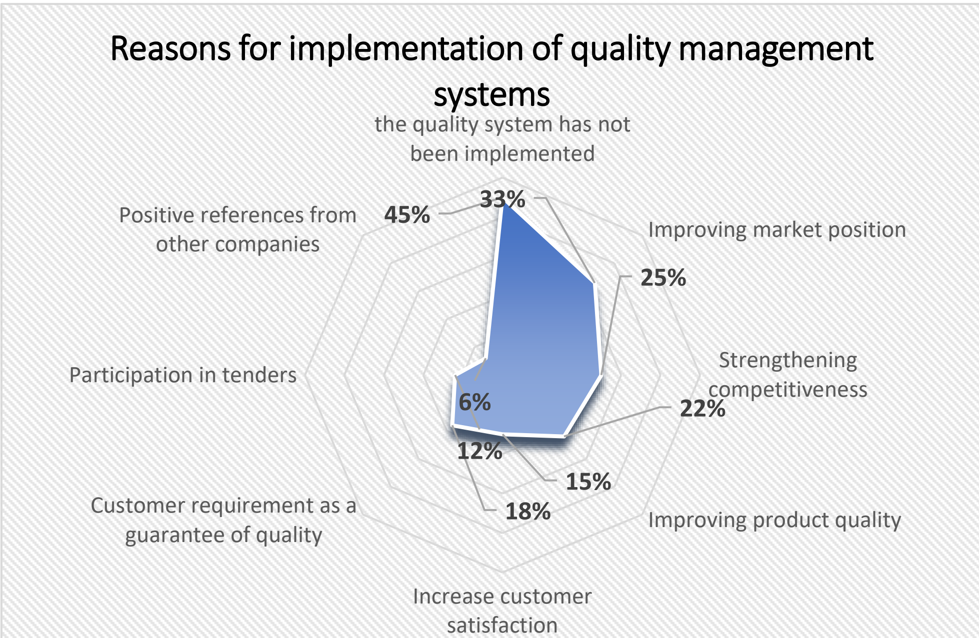

Figure 2. Reasons for implementation of quality management systems in the wood processing companies in SR

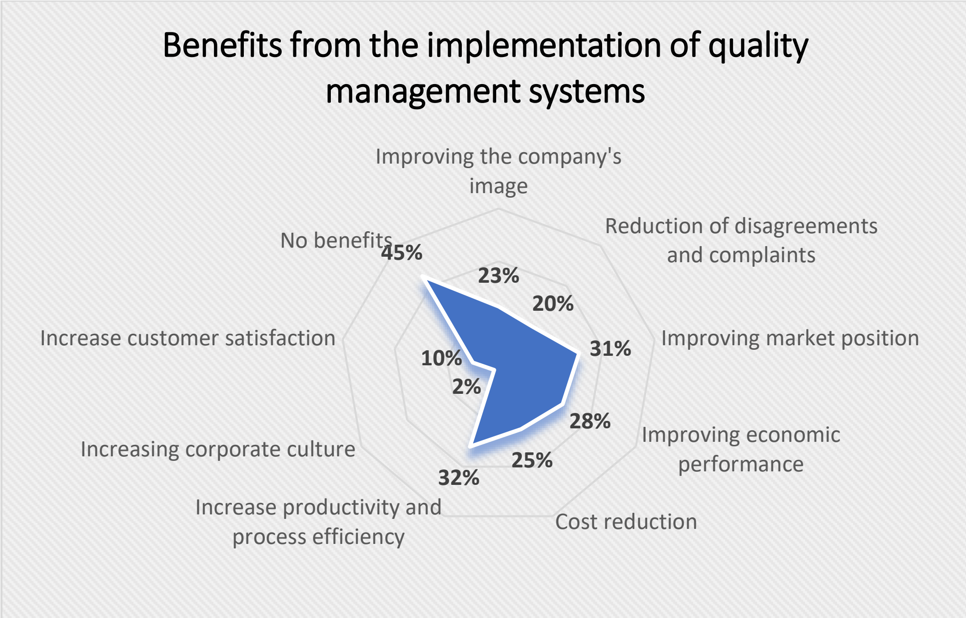

Figure 3. Benefits from implementation of quality management systems in the wood processing companies in SR

The next part of our research concerned practical use of the quality, where it was assumed that wood processing enterprises that use and implement quality management system and use wider scale of tools, methods and techniques also achieve a higher level of performance measured by Return of Sales. The contingency table (Table 1) presented sample distribution according to two variables – use of quality management tools, methods and techniques and the Return of Sales level. The Return of Sales value was chosen for the performance indicator in the scale of negative level, positive level up to 2.5%, followed by the level from 2.6% to 5% and more than 5%.

Table 1. Contingency table – relative frequencies for combinations of using quality management systems, tools, methods and techniques and Return of Sales (ROS).

QMS	Contingency table - relative frequencies				
	ROS negat.	ROS up to 2.5%	ROS (2.6% to 5%)	ROS > 5%	Total
is not used	10.32%	21.39%	4.32%	5.06%	41.09%
is used	2.40%	24.32%	19.54%	12.65%	58.91%
Total	12.72%	45.71%	23.86%	17.71%	100.00%

By using Pearson´s Chi-square test, the null hypothesis about independence was rejected at the 5% significance level. The relationship between the two examined variables was evaluated as significantly dependent (p=0.000) with the moderate strength of contingency coefficient of 0.31.

4. CONCLUSION

Based on the research results, it is clear that those companies that deal with quality, implement quality management systems with methods, tools and techniques achieve better economic results. At the same time, the results show that many companies in the wood processing industry do not focus on building and developing quality management systems. There are several reasons why this is so. This is especially true for micro and small businesses, which do not have the resources, not only financially but also in terms of personnel. Therefore, it is necessary for companies that do not pay attention to quality for various reasons to look for ways to change it, because it is demonstrable that quality management systems increase the level of products and services and thus increase customer satisfaction, which must result in increased efficiency and effectiveness organizations.

Acknowledgements: We wish to thank project KEGA 005TU Z-4/2020 „Economics, Management and Enterprising in Wood Industry Companies - University Textbooks with the Support of Visualization in Virtual Space “.

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SCIENTIFIC LITERACY ANALYSIS USING VOSVIEWER: STUDY OF DIGITAL TRANSFORMATION IN PRODUCTION SECTOR AND EDUCATION

Luka Goropečnik, Matej Jošt, Leon Oblak, Anton Zupančič, Jože Kropivšek

Abstract: Industry 4.0 is not only a technological revolution but will also significantly change the profiles of employees. Educational institutions will have to respond to this, as they will have to offer different competencies. The aim of this study is to find out how topics related to Industry 4.0 and digital transformation are addressed by researchers in the context of the production sector and education. Bibliometric methods are increasingly used to understand the structure and trends of scientific publications. The term co-occurrence analysis is a specific bibliometric analysis method that allows understanding the overall structure and thematic focus of scientific fields. The aim of this study is to find out how topics related to Industry 4.0 and digital transformation are addressed by researchers in the context of the production sector and education. The input data for the analysis was bibliometric information on peer-reviewed publications in the Web of Science and was analysed using VOSviewer, a tool for bibliometric analysis.
Keywords: digital transformation, bibliometric analysis, VOSviewer, education, competencies, production sector

1. INTRODUCTION

Due to rapid technological development and increasing digitalization, the business environment is changing rapidly, which also has a strong impact on the concept of education. The world is facing a new industrial revolution called Industry 4.0, the term of which was first introduced to the public at the Hannover Messe in 2011. This brings more flexibility and speed, better quality and higher productivity. If companies want to reap these benefits, they must systematically invest in equipment, information and communication technologies (ICT) and, above all, in employee training and development (Davies, 2015). The same is true for the wood sector. As part of the study on the digital development of the Slovenian wood industry, it was demonstrated that one of the most important digitalization activities in their strategic plans is the increase of digital competencies (Kropivšek & Grošelj, 2020). As Industry 4.0 will also significantly change the profiles of employees and their necessary skills, educational institutions will have to respond to this, as they will have to offer different competences and, above all, change the existing concepts and methods of education and support them with new technologies and services (CETEM, 2017). After setting appropriate (strategic) guidelines and goals, special attention should be devoted to the didactic and content side of the digitalization of the educational process (Damsa et al., 2015), because the digitalization of the educational process is not only a technological challenge, but above all an organisational project (Kropivšek, 2018).

Bibliometric methods are increasingly used to understand the structure and trends of scientific publications. The term co-occurrence analysis is a specific bibliometric analysis method that allows understanding the overall structure and thematic focus of scientific fields. In recent years, several software tools have been developed that can be used for a detailed analysis of the co-occurrence of terms mentioned in publications indexed in scientific databases

(Leal Filho et al., 2021). One of them is VOSviewer, which is used in the bibliometric study for cluster analysis, thematic analysis and mapping (Llanos-Herrera & Merigo, 2019).

The study aims to find out how topics related to Industry 4.0 are addressed by researchers in the context of both the education and production sector, with a focus on digital transformation. To this end, a bibliometric analysis was conducted focusing on the current literature. The analysis results of the co-occurrence of terms is a network of nodes and links, where the size of the nodes and links indicates the frequency of occurrence and the strength of the links between the nodes, respectively (van Eck & Waltman, 2021).

2. METHODS

The input data for the analysis was bibliometric information on peer-reviewed publications indexed in the Web of Science (WoS), which provides broad coverage of high-quality scientific publications. It also provides detailed bibliographic information required for analysis with VOSviewer. To gather relevant information from the WoS, a broad search string was developed that includes terms related to digital transformation, education, competences, and the wood sector: syntax = (digitalization OR "digital transformation" OR "industry 4.0" AND (((education OR training OR curricula OR curriculum) AND (universit* OR "higher education" OR "vocational education")) OR (wood OR "wood and furniture" OR production AND sector) OR (competen*))). For a schematic representation of our syntax, see Table 1. The individual terms in each row were separated by "OR", as seen in the written syntax above.

Table 7. Schematic illustration of search syntax

digitalization		education		universit*		(wood
"digital		training		"higher education"		"wood and furniture"
transformation"	AND	curricula	AND	"vocational	OR	production AND sector)
"industry 4.0"		curriculum		education"		competen*

On March 15, 2022, a search on WoS limited to title searches returned 4,824 results. In addition, the search was limited to articles only, reducing the search results to 2702, the data which were analysed in this study. The bibliographic data of these articles were downloaded and used for co-occurrence analysis of terms using VOSviewer. Terms that are closely related form clusters, which are shown in unique colours in Figure 2. The minimum number of occurrences of terms was set to 20, giving us 104 unique terms. In addition, terms that did not seem relevant to this study and errors were excluded.

3. RESULTS

Based on our syntax, which focused on relation of Industry 4.0 and digitalization to education, production sector, or competences 2702 articles were found on the Web of Science. As shown in Figure 1, the most popular research area for articles found under our search syntax in WoS is Management. The second most popular area is Business and the third most popular is Economics. There are 420 publications in Management, which is 15.54% of the total. The share of the second most popular field is 11.77%, and the other individual fields have a share of less than 7%.

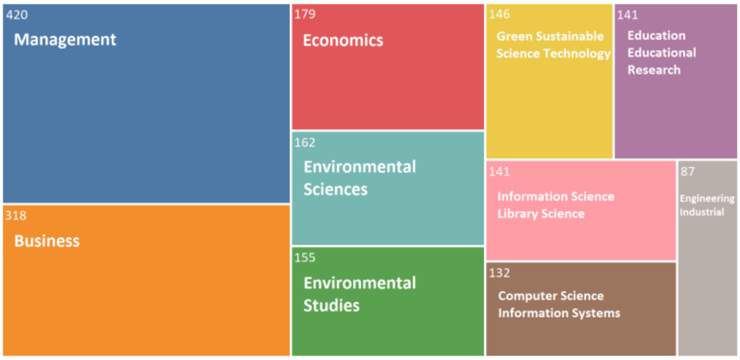

Figure 1. The top 10 research areas of the publications resulted from our syntax on WoS

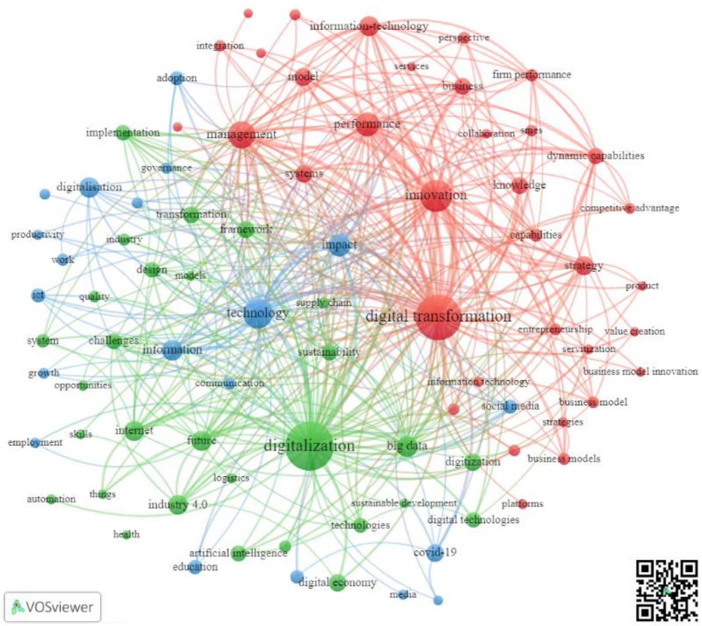

Figure 2. Co-occurrence analysis of terms (https://tinyurl.com/ycmb39z3)

Figure 2 shows the results of the analysis of the co-occurrence of terms (keywords), which in our case allows us to determine which selected topics relate to digitalization more in the literature. The results show that in addition to our search terms (digitalization, digital transformation, Industry 4.0 in the context of education, training, curricula, etc.), other terms also appear frequently (management, performance, technology, innovation, impact, etc.). The most frequently occurring terms in each cluster are: digitalization, digital transformation and technology. The clusters are represented by different colours and consist of terms that occur most frequently together. They also show the thematic focus of the existing literature. As expected, the most important keywords in the two largest clusters are digitalization (in the green cluster) and digital transformation (in the red cluster), as these were the two main terms in our search syntax. All clusters are strongly interrelated, as are individual terms that appear in multiple clusters. It is interesting to see that the synonymous terms digitalization and digital transformation appear together with different keywords. Digitalization tends to appear in connection with Industry 4.0, technologies and their implementation, while digital transformation is more associated with innovation, management and strategy. Other terms are more likely to be associated with companies and industries (with wood sector rarely mentioned, although we included it in our syntax) than with education (with curricula not mentioned at all). It is also interesting to note that the term Industry 4.0 does not appear more frequently, as it was also among our search terms.

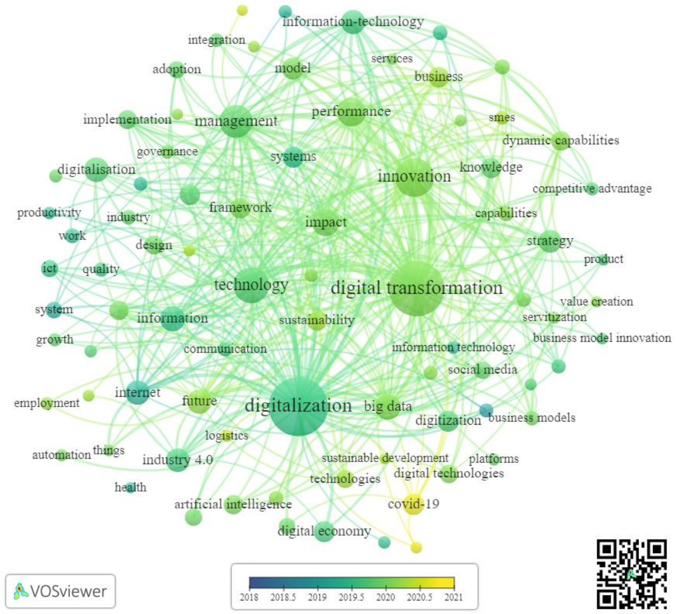

Figure 3. The most frequently used terms (colours indicate the average year of publication)

Figure 3 shows the average year of publication of an article with the use of certain keywords. Our search syntax yielded articles published between 1922 and 2022, with more than 80% of articles published in the last four years and only 8% of articles older than 10 years. Since most articles were published recently, the average is also between 2018 and 2021. The most commonly used term, digitalization, has an average of 2019.8, while the term digital transformation has an average of 2020.3. The main term of the third, smallest of the three clusters, has an average of 2020.0. Some less common and newly used terms, such as sustainability and covid-19, have appeared more recently (last quarter of 2020).

4. CONCLUSIONS

This study has provided an overview of how digitalization relates to the education and production sector in existing research articles. As technology is rapidly evolving and companies have already started to digitally transform their processes, it is necessary to ensure the right skills for current and future professionals. With bibliometric research, we can see what directions researchers are going in, what their focus is, and identify potential gaps in the field of science. Using VOSviewer software, the co-citation analysis was mapped and three clusters were defined. This method has some limitations. For example, the documents studied were collected in the Web of Science database and analysed using the VOSviewer software. Even though the WoS database is one of the most important scientific databases, it does not contain everything. Other databases such as Scopus could have been used for comparison. The search syntax should be well thought out because it is the most important variable in this type of searches. Also, the settings and parameters for analysis in the VOSviewer software are chosen by the researchers and are not standardised, so each researcher should set them carefully.

Despite these limitations, the study could be a welcome addition to the literature as it provides an overview of certain areas associated with digitalization. The results of this study highlight the importance researchers place on digitalization in the context of other targeted topics documented in the literature. It is also good to know in which research areas the articles listed under our search syntax appear most frequently, based on our target topics for this study. We can conclude that digitalization has not been discussed much in the context of education, as researchers have used the term more in relation to sector, technology, innovation, performance, and management. Digital transformation and digitalization have received much more attention than Industry 4.0, and it is interesting to see that the most common terms (digitalization and digital transformation) are used in different time periods. At the time when digital transformation is most commonly used, sustainability is also emphasised. In general, there are many articles dealing with the digitalization of production sector, which suggests that it is also relevant to the wood and furniture industry. Recent research has shown that half of the surveyed companies in the Slovenian wood industry are already implementing the concept of Industry 4.0, as a fundamental concept of digitalization of production companies, in their operations (Kropivšek & Grošelj, 2020). This means that it is also important for the training and competencies of employees. Research from 2018 shows that almost half of the population in the EU still lack basic digital skills and competencies (Kropivšek, 2018), which is a barrier to the adoption of Industry 4.0 technologies and the digitalization of business processes. It seems that this gap has also been recognised by the European Commission (2019). "A Europe fit for the digital age" is the name of one of its six policy priorities for the period 2019-2024, and to this end it is funding various projects, including educational projects related to the wood sector, e.g. FURN360, IN4WOOD, MAKING4.0, ESSENSE, etc. These projects deal with the development of learning materials and approaches for the digital age. In particular, Allview project, currently underway, aims, among other things, at an innovative approach to modernise vocational education and training in the wood sector by building a content platform and platform of 'Centres of Vocational Excellence' for the European wood and furniture industry (Allview, 2021).

For future studies, several more focused syntaxes could be developed to provide deeper insight into how digital transformation is being addressed in specific areas, such as the wood sector. In addition, a comparison could be made with other current topics such as sustainability to see how researchers approach different topics. Given the amount of projects addressing this topic, an analysis of their reports would be beneficial, as well as other sources such as conference proceedings, which are important contributors of citations, although less frequently cited themselves (Stopar, 2018).

Acknowledgements: Part of the research was conducted within the Erasmus + project Allview (621192-EPP-1-2020-1-ES-EPPKA3-VET-COVE). We would also like to acknowledge the Slovenian Research Agency for financial support within the program “Wood and lignocellulosic composites” (P4-0015).

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STRENGTH AND STIFFNESS OF T-SHAPED MORTISE AND STUB TENON JOINTS

Seid Hajdarevic, Murco Obucina, Alen Ibrisevic, Ibrahim Busuladzic

Abstract: This paper investigated the strength and stiffness of T-shaped mortise and tenon joints with stub tenon. PVAc glue was utilized to assemble the beechwood joints with an interference fit. The strength was carried out by measuring the maximal applied load and calculating the ultimate bending moment. Stiffness evaluation was conducted by measuring displacement and calculating the ratio of applied force and displacement along the force line as the ratio of bending moment and rotation angle of the joint. The results were compared with the results of typical mortise and tenon joints. The results showed the effect of different widths of the stub tenon on the strength and stiffness of T-shaped joints. Also, significant differences were revealed between the strength and stiffness of T-joints about different nonsymmetric positions of stub tenons, tenon shoulders, and directions of the force. The investigation showed that the intensity of mechanical properties of nonsymmetric joints is dependent on stub tenon position and load modes.
Keywords: wood joint, stub tenon, strength, stiffness

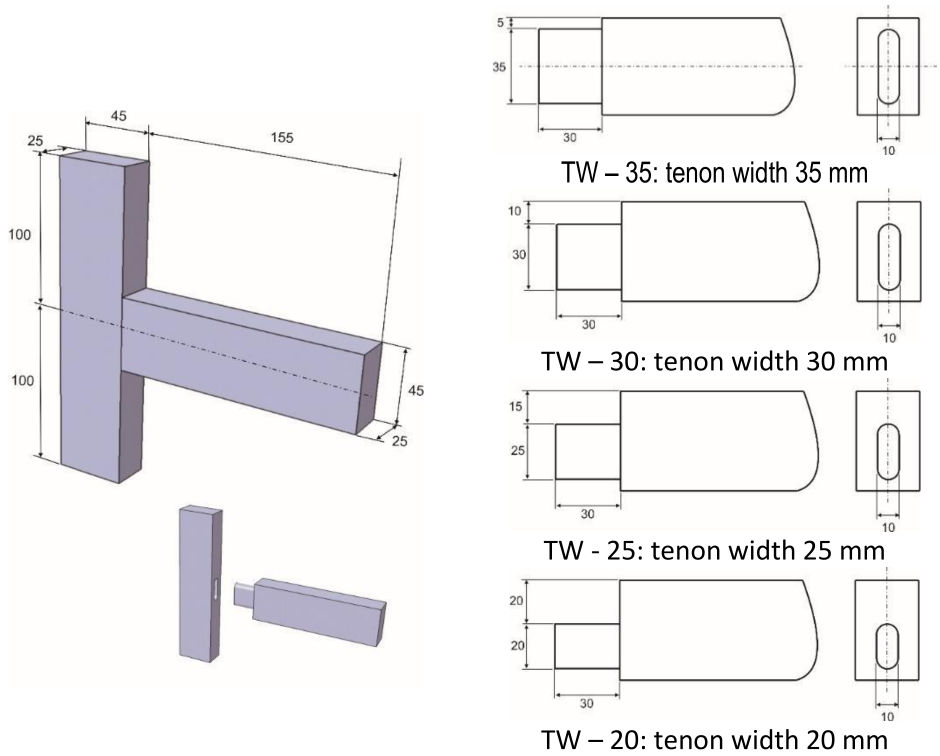
1. INTRODUCTION

Strength and stiffness are the specific indicators of mechanical properties of mortise and tenon joints which are today the most common way of connecting solid wood elements of furniture construction. Numerous factors that affect the above properties of joints were researched to improve the quality of mortise and tenon joints and wood constructions. One of the main factors influencing mechanical properties is tenon geometry. The strength and stiffness of mortise and tenon furniture joints are strongly affected by the length and width of the tenon. Tenon length had a dominant impact on the moment resistance, whereas tenon width more affected stiffness (Hajdarevic et al. 2020; Hu and Liu 2020). Analysis of the effect of shoulders on bending moment capacity of round mortise and tenon joints shows that close-fitting shoulders can substantially increase the strength of the joints (Eckelman 2006).

Also, the type of the mortise and tenon joints have a determining influence on strength and stiffness characteristics under bending load. Unlike joints with symmetrical tenon positions, the mechanical properties of unsymmetrical joints also depend on the place of the tenon and, consequently, the shoulder that actively resists the bending moment. In most mortise and tenon joints for furniture, the tenon shoulders are more complex, and, depending on the load direction, they become a useful structural element of the joint. This paper investigated the strength and stiffness of stub tenon joints used to form corners, e.g., the front leg of the chair. The objectives were to determine the difference between the basic mechanical properties of symmetric and unsymmetric tenon joints and, in particular, to investigate the effect of stub tenon on the mechanical properties of T-joint. The study aimed to explore the strength and stiffness of stub tenon position and tenon shoulder contribute and the capabilities and limitations of applications of unsymmetric stub tenon T-joints.

2. MATERIALS AND METHODS

Figure 1 shows the specimen geometry and four models of T-shaped mortise and tenon joints investigated in this study, which was provided by the furniture manufacturer. All specimens were constructed from beech wood (Fagus sylvatica L.) and had the same geometry configuration. PVAc glue (stress group D3) was used to assemble joints with a round peg shape and with the mortise and tenon interference fit. The joints had the same tenon length (30 mm) and tenon thickness (10 mm) but four different tenon widths (35 mm, 30 mm, 25 mm, and 20 mm). The first model of T- shaped joints included common mortise and tenon joints with symmetrical tenon positions. The other three model T- shaped joints included mortise and stub tenon joints with different nonsymmetric stub tenon positions.



a) b)

Figure 1. T-shaped mortise and tenon joints: a) specimen geometry, b) four tenon widths and positions

Figure 2 shows specimen configurations of the bending test of the joint with symmetrical tenon position and nonsymmetric sub tenon position. The upper and lower ends of the T-shaped joint post were fixed. The load (vertical force F) was applied to the joint's free end of the rail (Hajdarevic et al. 2021). Each model of T- shaped joints with stub tenons was divided into two groups based on the nonsymmetric positions of the tenon in the specimen during the test, i.e. lower (L) and upper (U) stub tenon positions. The test setup is presented in Table 1.

The test was performed on a Zwick 1282 universal testing machine. Force and displacement along the force line were measured simultaneously. The maximal bending moment of the joint was calculated as $M_{max}=F_{max}\cdot l$, where the distance l was moment arms (163 mm). The displacements at the maximum applied load (d_{max}) were used to calculate the stiffness coefficient which was defined by the ratios F_{max}/d_{max} in N/mm (Hu and Liu 2020). Stiffness coefficients of the joints shown in Nm/rad were calculated by ratios M_{max}/φ (Smardzewski et al. 2016).

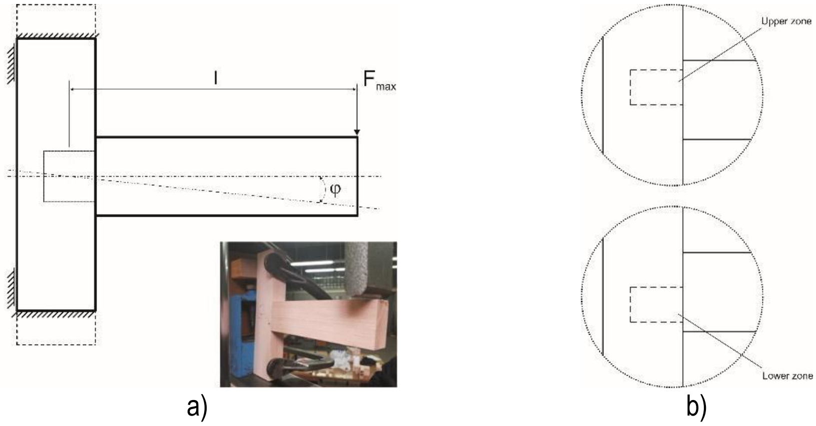


Figure 2. Diagram of joint loading: a) symmetrical tenon position, b) nonsymmetric sub tenon position (upper zone and lower zone)

Following testing, the moisture content (MC) and density were evaluated following ISO 13061-1 (2014) and ISO 13061-2 (2014). Beech wood's average MC value and density were 9.7 % and 0.69 g/cm^3, respectively.

Table 1. Test set-up and description of specimens (see Figure 2)

Specimen group No.	Specimen group mark	No. of specimens	Tenon width (mm)	Tenon position
1	TW – 35	9	35	symmetrical
2.1	TW – 30 L	5	30	lower zone
2.2	TW – 30 U	8	30	upper zone
3.1	TW – 25 L	7	25	lower zone
3.2	TW – 25 U	6	25	upper zone
4.1	TW – 20 L	7	20	lower zone
4.2	TW – 20 U	7	20	upper zone

3. RESULTS AND DISCUSSION

The base results of descriptive statistics of maximal force (F_{max}) and maximal moment (M_{max}) of the T-shaped joints with different tenon widths and positions are given in Table 2. Figure 3 shows the bending moment of T-shaped joints with symmetrical tenon and nonsymmetric sub tenon positions.

Table 2. Descriptive statistics of T-shaped joints strength

T-shaped joint	Maximal force (F_{max}), N				Maximal bending moment (M_{max}), Nm			
	Mean	Median	Standard Deviation	Coeff. of Variation	Mean	Median	Standard Deviation	Coeff. of Variation
TW – 35	1025.7	990.8	244.8	23.9 %	167.2	161.5	39.9	23.9 %
TW – 30 L	932.0	961.4	199.7	21.4 %	151.9	156.7	32.6	21.4 %
TW – 30 U	1052.1	981.0	233.1	22.2 %	171.5	159.5	38.0	22.2 %
TW – 25 L	915.1	932.0	90.0	9.9 %	149.2	151.9	14.8	9.9 %
TW – 25 U	1183.7	1231.2	191.6	16.2 %	192.9	200.7	31.2	16.2 %
TW – 20 L	623.6	637.7	78.2	12.5 %	101.7	103.9	12.8	12.5 %
TW – 20 U	1174.4	1216.4	168.3	14.3 %	191.4	198.3	27.4	14.3 %

Generally, the results reveal that maximal force values and bending moment values of stub tenon joints with the same width but upper and lower tenon positions differ significantly. The maximal bending moment mean values of stub tenon joints in the upper position were higher than the mean values of stub tenon joints in the lower position for all tenon widths. The mean maximal bending moments in the upper stub tenon positions were higher by 12.9 % (tenon width 30 mm), 29.4 % (tenon width 25 mm), and 88.2 % (tenon width 20 mm) than the mean results obtained for the lower stub tenon positions. The differences between the bending moment with two sub tenon positions but the same tenon width were mainly results of active resistance of the tenon shoulder to rotation due to the bending moment as well as larger shoulder surface area when the sub tenon is in the upper position, Fig. 4.

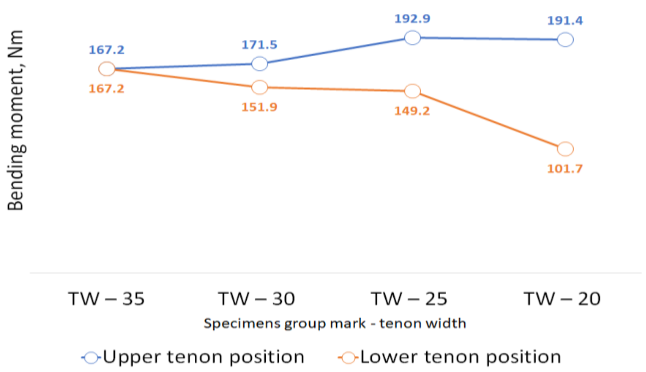
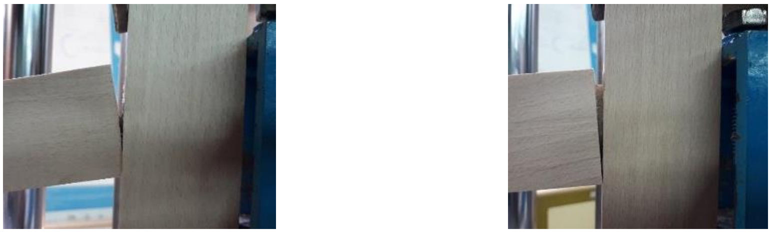


Figure 3. Bending moment of T-shaped joint with symmetrical tenon position and nonsymmetric sub tenon positions

The stub tenon joints in upper tenon positions had 2.6 % (tenon width 30 mm), 15.4 % (tenon width 25 mm), and 14.5 % (tenon width 20 mm) higher mean maximal moments than the symmetrical mortise and tenon joints with tenon width 35 mm. Unlike symmetrical mortise and tenon joints with a tenon width of 35 mm had 10.1 % (tenon width 30 mm), 12.1 % (tenon width 25 mm), and 64.5 % (tenon width 20 mm) higher mean maximal moments than the stub tenon joints in lower tenon positions.



a) b)

Figure 4. Structural shoulder of tenon joint: a) lower tenon position, b) upper tenon position

The base results of descriptive statistics of displacement (d_{max}) and stiffness coefficients (units N/mm and Nm/rad) of the T-shaped joints with different tenon widths and positions are given in Table 3. The stiffness coefficient (Nm/rad) of T-shaped joints with symmetrical tenon and nonsymmetric sub tenon positions is shown in Figure 5.

Table 3. Descriptive statistics of T-shaped joints stiffness

T-shaped joint	Displacement (d_{max}), mm				Stiffness coeff., N/mm				Stiffness coeff., Nm/rad			
	Mean	Median	Stan. Dev.	Coeff. of Var.	Mean	Median	Stan. Dev.	Coeff. of Var.	Mean	Median	Stan. Dev.	Coeff. of Var.
TW – 35	7.9	7.5	2.3	29.7 %	139.2	141.9	41.9	30.1 %	3669.2	3491.8	1115.8	30.4 %
TW – 30 L	11.9	11.5	3.8	32.2 %	87.6	96.4	39.8	45.5 %	2331.0	2565.3	1058.3	45.4 %
TW – 30 U	9.8	7.5	5.3	54.8 %	130.6	152.6	51.7	39.6 %	3472.9	4057.6	1371.8	39.5 %
TW – 25 L	13.3	12.0	4.9	36.8 %	76.9	78.5	27.5	35.8 %	2046.9	2088.9	827.2	40.4 %
TW – 25 U	8.7	9.0	2.1	23.8 %	140.0	136.0	19.1	13.6 %	3721.9	3629.9	505.4	13.6 %
TW – 20 L	12.1	12.0	2.7	22.5 %	54.0	50.0	14.1	26.1 %	1436.3	1566.7	377.4	26.3 %
TW – 20 U	7.4	7.0	1.5	20.0 %	163.7	161.2	39.8	24.3 %	4353.4	4284.6	1105.7	25.4 %

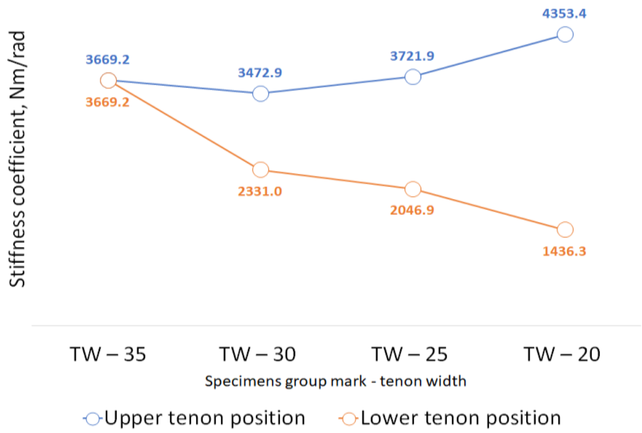


Figure 5. Stiffness coefficient of T-shaped joint with symmetrical tenon position and nonsymmetric sub tenon positions

The mean stiffness coefficients in the upper stub tenon positions were higher by 49.0 % (tenon width 30 mm), 81.8 % (tenon width 25 mm), and 203.1 % (tenon width 20 mm) than the mean results obtained for the lower stub tenon positions. The stub tenon joints in upper tenon positions had about 6 % (tenon width 30 mm) lower, about 1.0 % (tenon width 25 mm), and about 18.0 % (tenon width 20 mm) higher mean stiffness coefficients than the symmetrical tenon joints with tenon width 35 mm. Symmetrical tenon joints with a tenon width of 35 mm had about 58.0 % (tenon width 30 mm), 80.0 % (tenon width 25 mm), and 150.0 % (tenon width 20 mm) higher mean stiffness coefficients than the stub tenon joints in lower tenon positions.

4. CONCLUSION

Bending moment and stiffness coefficients of typical mortise and tenon T-shaped joints with symmetrical tenon positions and T- shaped joints with different nonsymmetric stub tenon positions were investigated. A significant difference was detected between the bending moments and stiffness coefficients of joints with the same tenon width but different stub tenon positions. Active resistance of the tenon shoulder to rotation due to the bending moment and larger active shoulder surface area affected the tested properties. Also, the result showed that the width of stub tenon has a significant effect on the mechanical properties of T-shaped joints. The results show that investigated properties of unsymmetrical joints are dependent on stub tenon position in the joint and load modes.

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ANALYSIS OF CHANGES IN PATTERNS OF WOOD PRODUCTS FOREIGN TRADE IN SLOVAKIA

Marek Hlodák, Hubert Paluš, Michal Dzian, Aleksandra Lazarević

Abstract: Slovakia is a country that produces a number of primary and secondary wood products utilising the domestic wood resources. Domestic supplies of roundwood account for over 70% of the industry's raw wood material. On the other hand, as the wood processing industry is export oriented, the majority of semi-finished and finished wood products enter foreign markets. The main objective of this paper is to describe the changes in structure and patterns of the foreign trade with the main wood products categories in the Slovak Republic during the years 1990-2020. The changes are analysed in terms of the exported and imported volume, value as well as trade directions.
Keywords: wood products, foreign trade changes, import and export analyses

1. INTRODUCTION

Wood represents a sustainable resource which is already playing a key role for the development of economy. Wood represents one of many inputs to the production process and together with other production factors is transformed into a certain number of outputs (Solberg and Moiseyev, 1997). The path of raw wood material from its production to giving the final product to a consumer is relatively long, as it passes several stages of production and different types of markets until the final product fulfils the needs of the consumers. Demand in the wood market depends on the resulting demand for final timber products, where the final products are realized in the consumer market (Baudin and Brooks, 1995; Buongiorno, 1977; Goldstein and Khan, 1985). In a narrower sense, the demand for wood products correlates with the economic growth (Baudin and Kangas, 2003; Buongiorno, 1978), growth in the construction sector (Hurmekoski, 2015; Borzikowksi, 2017), substitution product prices (Anyiro, 2013; Baudin and Kangas, 2003), preferences in the product use (Brännlund, 1988; Michinaka, 2011), demographic developments (Baudin and Brooks, 1995; Buongiorno, 1977) and exchange rate developments and changes (Hurmekoski, 2015; Michinaka, 2011). In the broadest sense, demand is diverted from the development of the overall national economy (Paluš, 2002; Hurmekoski, 2015; Borzikowksi, 2017). All these factors influence the production, trade and consumption patterns of wood products. The main objective of this paper is to describe the changes in structure and patterns of the foreign trade with the main wood products categories in the Slovak Republic during the years 1990-2020. The changes are analysed in terms of the exported and imported volume, value as well as trade directions.

2. METHODOLOGY

Input data were drawn from FAOSTAT databases (FAOSTAT, 2022). We used data for volume and value for following wooden products: coniferous sawnwood, non-coniferous sawnwood, plywood, particle board, fibreboard, plywood, woodpulp, graphic paper, household and sanitary paper. The volume and value of wood products were evaluated from 1990 to 2020. We evaluated the development in the period from 1990 to 2020 for the import and export of selected wood products. We have described the development in terms of quantity and value.

After the analysis, an analysis of the commodity structure of exports and imports was performed in terms of tradable value. We compared the development of exports and imports in 1990, 2000, 2010 and 2020. The results of the analyses were presented graphically.

3. RESULTS AND DISCUSSION

The development of individual wood products in the period from 1990 to 2020 is illustrated in Figure 1 and 2. Changes in the structure of the wood trade in the Slovak Republic separately for imports and exports in the years 1990 to 2020 are in Figure 3 and 4. Figure 1 shows the import of selected wood products in the Slovak Republic in the period 1990-2020. In the period from 1991 to 2020 the import of wood products to Slovakia was gradually increasing. The reason for this is the development of the country as well as the growing need for various forms of wood products. The largest import of coniferous sawnwood in Slovakia was in 2015 when amounted to 358,000 m^3. The largest import of wood-based panels to Slovakia was in 2008 (661,505 m^3). Then follows the import of paper and paperboard, import of which also gradually grew, and the largest amount of import was recorded in 2012 and amounted to 512,543 t. These types of products are mostly imported in terms of quantity, followed by fiber board, woodpulp, plywood and other products.

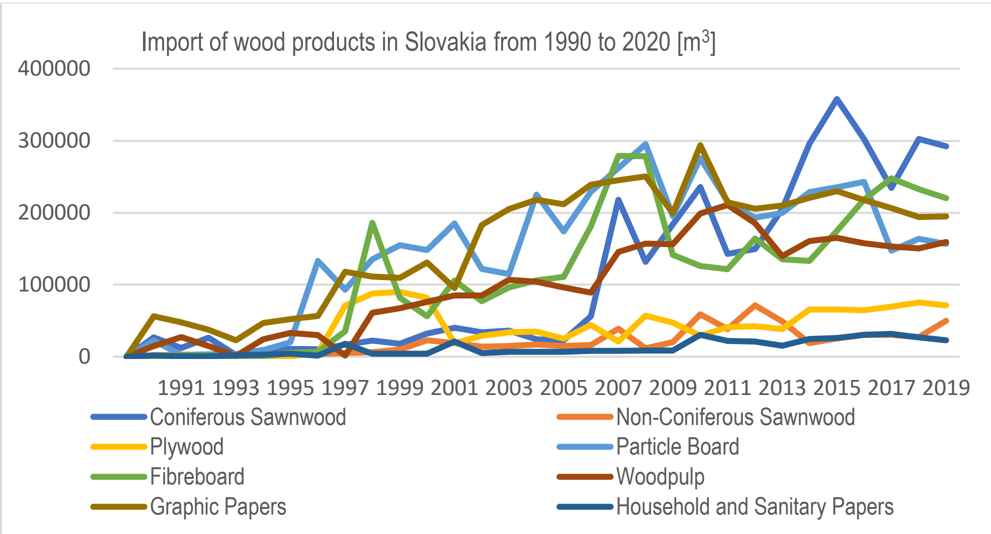

Figure 1. Import of wood products in Slovakia from 1990 to 2020 [m^3]

When it comes to the value of imports in USD, as well as in terms of quantity, imports have gradually grown. The highest value in the analyzed period was reached by graphic paper in 2010 and amounted to 288.2 million USD. This is followed by the import of woodpulp, which reached its highest value in 2011 (174.5 million USD). The difference in values is significant since the prices and added value of products are also very different. For example import of coniferous sawnwood in year 2015 was 358,000 m^3, but valued only for 71,3 million USD. However, what can be seen in Figure 1 is that there were a lot of jumps in imports, especially with fibreboard and coniferous sawnwood.

Figure 2 shows that coniferous sawnwood and graphic paper are the most exported commodities in tems of the trade volume. Their exports grew until 2007 and 2005, respectively, and then gradually declined. The largest exports were recorded for coniferous sawnwood, which gradually grew. In 2001 it reached the volume of 751,000 m^3 and it gradually grew reaching the highest volume in 2020, amounting to 958,890 m^3. It is followed by the export of particle board, which reached the highest volume in 2019 and amounted to 559,277 m^3. Graphic papers, particle board and others had slightly lower exports. The highest value of for graphic paper was 664.4 million USD. To a much lesser extent the exports of other products such as particle board and coniferous sawnwood follow

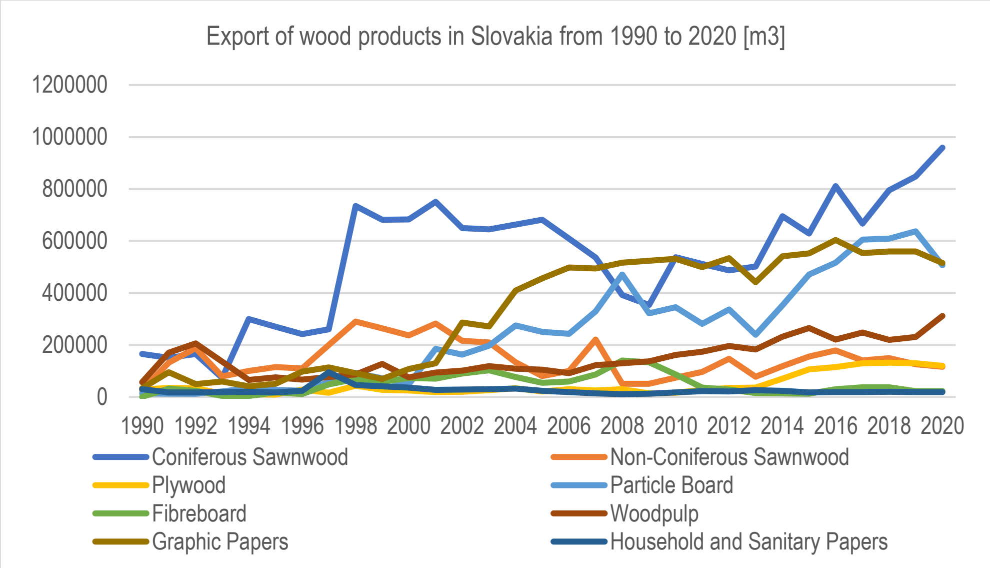

Figure 2. Export of wood products in Slovakia from 1990 to 2020 [m^3]

Figure 3 shows the structure of import of selected wood products in the Slovak Republic in the 1990-2020 in terms of value. As can be seen more than 50% of imports to Slovakia in 1990 were woodpulp (58%), followed by graphic papers with a share of 23%, particle board with a significantly smaller share of 9%. Imports were also concentrated on other wood products, such as fiberboards, plywood and other products, only in a significantly lower percentage. However, in the next decades the situation differed from the year 1990. In 2000, the import of graphic paper increased and became the most imported product with 48% (in contrast to 1990, when it was 23%). This is followed by woodpulp imports of 25% (58% in 1990). The imports in 2010 are similar to imports in 2000 and were concentrated on imports of graphic papers and woodpulp with 38% and 21%, respectively. During this decade the structure of wood products imports has not changed drastically even for the other wood products such as household and sanitary paper, particle board, fiber board and other products. In 2020, the imports of graphic paper decreased to 28%. One of the reasons for that is that in 2020 the domestic production of graphic papers increased and thus the need for its import decreased This can be confirmed by the amount of graphic papers exported from Slovakia.

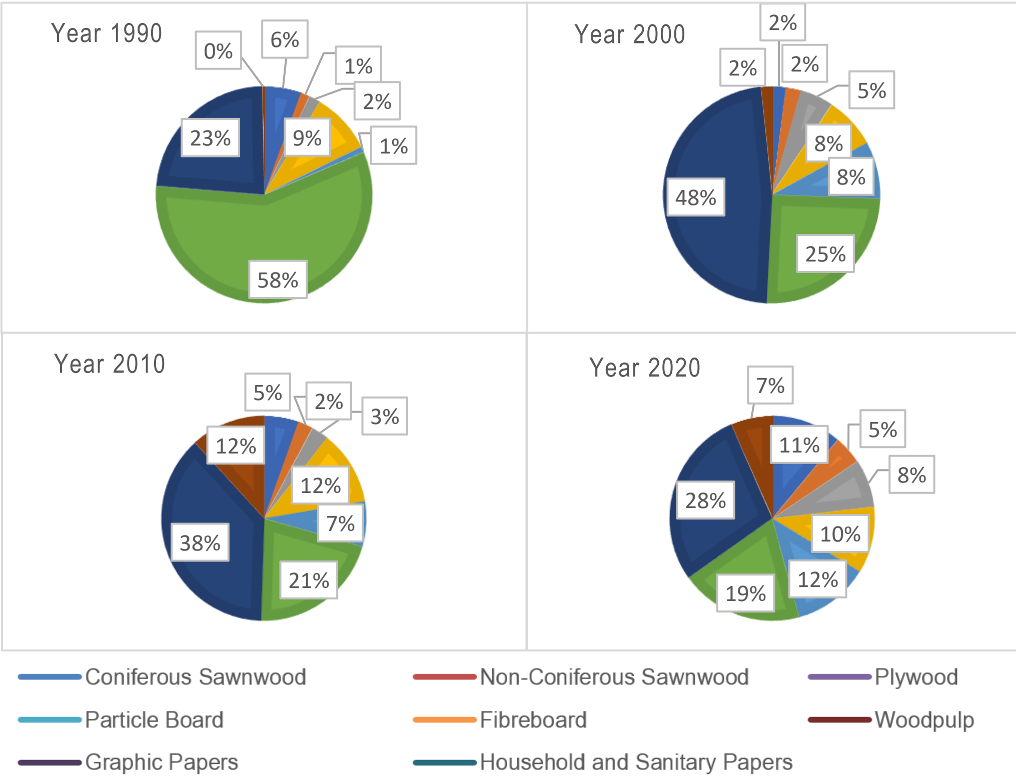

Figure 3. Structure of imports of wood products in Slovakia 1990-2020 [%]

Imports of woodpulp and household and sanitary papers also decreased compared to the previously analyzed period and now amount to 19% and 7%, respectively. What can be noticed is the increased import of fiberboard by 12% due to still missing domestic production capacities.

Figure 4 refers to the changes in the structure of exports of wood products from Slovakia. During the latest decade from 2010 to 2020 there were no major changes, with the dominant share of export of graphic paper (41%). Compared to the exports in 1990 and 2000, woodpulp exports in 2020 fell by 30% and 13%, respectivelly. Exports in 2010 were primarily focused on exports of graphic paper (52%), then on coniferous sawnwood, but in a significantly lower percentage (15%). Woodpulp exports were slightly lower than exports in 2000 at 10%, followed by exports of non-coniferous sawnwood and particle boards at 7%. In generally The biggest difference observed is in plywood exports. Plywood exports ranged from 2-4% between 1990 and 2010, and in 2020 increased to as much as 11%. Year 1990 shows that the largest exports in the analyzed year were coniferous sawnwood, with a share of exports of as much as 44%. This is followed by woodpulp exports with 30%. These two types of products were mostly exported wood products, followed by household and sanitary papers (9%), exported wood products, followed by household and sanitary papers (9%), coniferous and non-coniferous sawnwood (5%), plywood (4%) and particle board (3%).

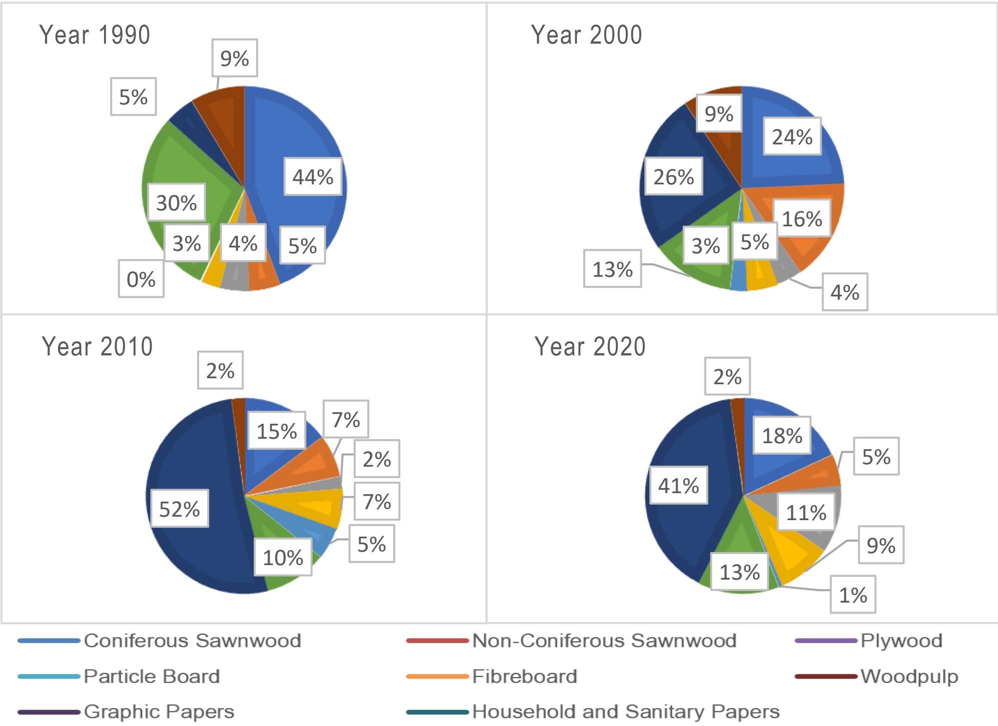

Figure 4. Structure of exports of wood products in Slovakia 1990-2000 [%]

5. CONCLUSION

The time period covered is from 1990 to 2020. The largest import of coniferous sawnwood in Slovakia was in 2015 when it amounted to 358,000 m^3 . As for the import of wood-based panels, it can be concluded on the basis of the analyzed results that it was realized to the greatest extent in 2008 and amounted to 661,505 m^3 . They are followed by paper and paperboard, then fiber board, woodpulp, plywood and other products. In 1990, as much as 58% of imports were fiberboard, followed by imports of graphic paper with 23%. However, in 2020, the situation changed significantly, where imports of fiberboard amounted to only 19%, and imports of graphic paper amounted to 28%. Based on that, it is clear that the structure of imported products has changed in the observed period of time. In terms of exports, since 1990 most coniferous sawnwood has been exported with over 40%, followed by exports of fiberboards with 30%. As with imports, by 2020 the situation has changed. Graphic paper is now the most exported with exports of 41% in 2020, followed by exports of coniferous sawnwood with 18%.

Acknowledgements:
The authors are grateful for the support of the Scientific Grant Agency of the Ministry of Education, Science, Research, and Sport of the Slovak Republic, Grant No. 1/0494/22 Comparative Advantages of the Wood Based Sector under the Growing Influence of the Green Economy Principles and Grant No. 1/0495/22 Sustainability of Value Supply Chains and its Impact on the Competitiveness of Companies in the Forest and Forest-Based Sectors.

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POSSIBILITIES OF PROCESSING OF WOOD BIOMASS INTO GASEOUS BIOFUELS

Viera Horváthová, Andrea Vadkertiová, Jana Šujanová

Abstract Fossil fuel depletion threatens economies around the world and leads to an energy crisis. Therefore, the search for alternative sustainable energy sources is very important. Biofuels are a promising alternative, with biomethane and biohydrogen being important in this regard. The raw material for their production is wood biomass as well. However, due to its complex composition and especially the presence of lignin, wood biomass requires a relatively demanding multi-step technological processing. The work describes the possibilities of technological processing (pre-treatment, dark fermentation, anaerobic digestion) of wood biomass into gaseous biofuels.
Keywords: biogas, biohydrogen, energy crisis, wood biomass

1. INTRODUCTION

The issue of climate change related to fossil fuel emissions is currently an urgent question. The solution is biofuels, which have been the subject of research and industrial practice for several decades. The raw materials to produce biofuels are different, some of them have proven to be uneconomical or unsuitable because they were related to raw materials primarily intended for human nutrition (corn, wheat). Wood biomass is an available non-food source and can provide glucose fermentable onto various products due to its composition. Biotechnological processing of wood biomass is demanding because glucose is tightly bound in the cellulose, which is in interrelationships with hemicellulose and lignin as well. Several methods can be used to process wood biomass. The specific technology depends on the type of wood biomass and on the product that is the target of this processing. In any case, it is necessary to pre-treat the wood biomass. The main goal is to make its main components (cellulose, hemicellulose, lignin) available for subsequent processing by enzymes and microorganisms (Wijeyekoon and Vaidya, 2021).

2.GASEOUS BIOFUELS BASED ON WOOD BIOMASS

Gaseous biofuels such as biogas (a mixture of carbon dioxide and methane) and biohydrogen can be obtained from wood biomass. The European Union is classifying biogas as a renewable energy source. The volume of biogas produced in the world is constantly growing, which, however, necessitates investment in safe and modern equipment. Biogas is produced by anaerobic decomposition of biodegradable raw materials and contains 40 - 70% of methane. However, its content can be increased up to 75 - 90% and such improved biogas can then be applied to natural gas distribution or used as fuel (Mittal, 2018). Biogas together with biohydrogen can be mixed with natural gas and supplied to the network. Biohydrogen can be produced after pre-treatment of wood biomass by dark fermentation. It is an acidogenic fermentation but carried out in the absence of light. There are also other options to produce biohydrogen, for example electrolysis, gasification, biophotolysis or microbial electrolysis (Wang et al, 2008, Islam et al., 2021). The cost of producing biogas or biohydrogen is closely related to the substrate and the cost of its pre-treatment. Therefore, those are sought which are inexpensive (waste biomass) and they provide a hydrolysate suitable for fermentation as well. Schematic processing of wood biomass into gaseous biofuels is shown in Fig. 1.

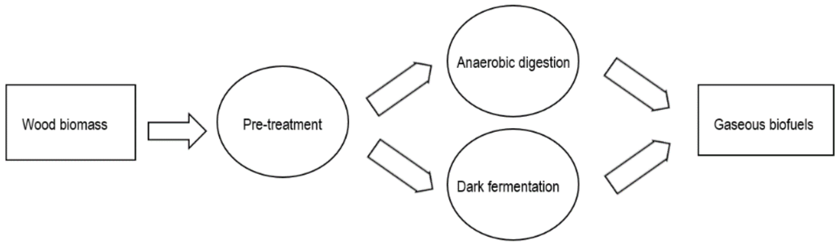

Fig.1.Major technological steps applied to wood biomass in the production of gaseous fuels (adapted Wijeyekoon and Vaidya 2021)

2.1. Pre-treatment of wood biomass

Wood biomass belongs to lignocellulosic biomass. The largest component is cellulose (32-65%, Wang et al., 2019, Wijeyekoon and Vaidya, 2021), which is found in wood biomass in the fibrous form linked to hemicellulose and lignin. This fact causes high resistance to microbial degradation. Several options are already known, but they are constantly being sought that are mild, economical, environmentally friendly and facilitate the subsequent saccharification of cellulose and hemicellulose. The basic methods of lignocellulosic biomass pre-treatment can be divided into mechanical (grinding, milling, chipping), physico-chemical (using acids, alkali agents, ionic liquids, organosolv), thermal (hot water, steam, steam explosion) and biological (using enzymes and microorganism - actinomycetes, bacteria, fungi). The pre-treatment methods are often combined to achieve the desired result and to keep the environmental burden of the technology used to a minimum (Kim et al., 2016, Kumari and Singh, 2018). Usually mechanical treating of wood biomass is the first pre-treatment method. Emphasis is placed on reducing particle size, increasing biomass surface area and reducing the degree of crystallinity and polymerization of cellulose and hemicellulose. Although mechanical pre-treatments generally do not produce any compounds that are toxic or inhibitory to enzymatic hydrolysis or fermentation, they are energy intensive. From this point of view, the use of extrusion is a promising method, and it can be used for a wide range of biomass, including forest, agricultural and energy crops. Akobi et al. (2016) used extrusion to treat poplar chips and found that lignocellulosic crystallinity decreased. Several authors describe the use of physico-chemical methods to pre-treatment pine wood (Shafiei et al., 2014, Salehian and Karimi, 2013), pear (Mirahmadi et al., 2010) or poplar (Yao et al., 2013, Mirmohamadsadeghi et al., 2016). Generally, alkaline pre-treatments are effective on herbaceous plants, agricultural residues, municipal solid waste and hard wood but less effective on biomass with a high lignin content such as soft wood. The use of acids is possible as well, but the disadvantages are the conversion of carbohydrates to furfural and hydroxymethyl furfural (enzyme inhibitors) and increased equipment costs due to their corrosion by action acids. The use of organosolv is a selective method by which relatively pure wood biomass fractions (lignin, hemicellulose and cellulose) can be prepared, but in general it is an expensive method and there is a problem with solvent recycling as well (Wijeyekoon and Vaidya, 2021). Thermal methods involve using of hot water or steam or steam explosion. When using hot water, the mechanically treated wood is heated to a high temperature (160 - 230°C) for several minutes or up to hours. The process carries out at high pressure, when liquid water penetrates inside the biomass and hydrolyses cellulose (4 - 22%), hemicellulose and lignin (35 - 60%). Although this process does not require the addition of chemicals or neutralization steps, it is water and energy intensive. The use of hot water on Norwegian spruce wood is reported by Ghimire et al. (2021), where the aqueous extraction was performed at 140°C for 5 hours. Steam explosion is described by Vivekanand et al. (2013) and Mulat et al. (2018) when using pear wood. The wood biomass was exposed to hot steam under pressure (temperature 210/220°C) for 10 min. This process was followed by decompression to atmospheric pressure, which disrupted the fibrous structure, glycosidic and hydrogen bonds of the biomass. The steam explosion method can be considered an economical approach, given the limited requirements for chemicals, short-term evaporation and rapid depressurization, and relatively low energy consumption (Yu et al., 2022). Biological pre-treatment involves the action of microorganisms or their enzymes on biomass (Usmani et al., 2021, Wijeyekoon and Vaidya, 2021). Process is considered an environmentally friendly and energy-saving that is performed at ambient temperature and pressure without the need for chemicals and sophisticated equipment. However, they are relatively slow and therefore must be combined with other pre-treatment methods. The loss of carbohydrates, which microorganisms use from the substrate during their growth, is a problem as well. Some species of bacteria are suitable (*Pseudomonas sp., Streptomyces sp., Thermomonospora sp., Bacillus sp.*), then ascomycetes (*Trichoderma sp., Penicillium sp., Aspergillus sp.*) and white or brown rot fungi (*Phanerochaet chrysosporium*, *Fomitopsis palustris*). Among the enzymes, hemicellulases and/or lignin-hydrolyzing enzymes (laccase, lignin peroxidase and manganese peroxidase) are suitable in the pre-treatment of wood biomass.

2.2 Anaerobic digestion

Anaerobic digestion is a process for biogas production. It is implemented in practice as well. The process consists of four key steps: hydrolysis, acidogenesis, acetogenesis and methanogenesis. The produced biogas contains mainly methane (55–75%) and carbon dioxid (25–45%) and, depending on the input raw material, also traces of other substances (nitrogen, hydrogen sulphide, ammonia, water). Of these admixtures, hydrogen sulphide is the most problematic, because it has a corrosive effect on engines and technological equipment (if its amounts in biogas above 0.1%). Ammonia is a source of odour. However, when wood biomass is used, the produced biogas will not contain hydrogen sulphide and ammonia (Wijeyekoon and Vaidya, 2021). A wide range of microorganisms is involved in biogas production and insufficient activity of one group can cause imbalance in the whole system and reduce the efficiency of the process. The first two steps of anaerobic decomposition (hydrolysis and acidogenesis) are responsible hydrolytic and fermentation microorganisms (most often the genera *Bacteroides, Clostridium, Butyrovibrio, Lactobacillus*). Acetogenesis may involve acetogenic hydrogen-producing bacteria, which decompose higher organic acids (higher than acetic acid), alcohols and some aromatic compounds (benzoic acid) into acetic acid, carbon dioxide and hydrogen. Their activity depends on the concentration of hydrogen, higher concentrations inhibit it.

Therefore it is important that there are microbial communities in the reactors that both produce and consume hydrogen (e.g. *Syntrophobacter wolinii* and *Desulfovibrio*). Methanogenic microorganisms are involved in the last phase of biogas production, which decomposes the products of the previous phase and form methane and carbon dioxide (e. g. *Methanotrix sp.* and *Methanosarcina sp.*). Biogas (methane) yields depend mainly on the type and methods of pre-treatment of wood biomass. Mirmohamadsadeghi et al. (2016) compared methane yields after processing pine (softwood), poplar (semi-softwood) and berry (hardwood). In general, it has been found that hardwood, even without pre-treatment, provides higher methane yields than softwood. In addition to the use and search for the most suitable pre-treatment methods, the use of a mixture of two or more substrates seems very promising. The joint decomposition of wood biomass and manure is described in their work by Li et al. (2019). The addition of manure to the pre-treated wood biomass brought several benefits, which was then reflected in an increased methane yield of 76%.

2.3 Dark fermentation

At the present, dark fermentation to produce hydrogen is highly studied. From a technological point of view, is similar as biogas production, but it is an anaerobic decomposition reduced only to hydrolysis and acidogenesis. The process takes place in the dark, at relatively low temperatures (30-80 ° C) and slightly acidic pH (pH 5-6) (Najapfor et al., 2016). The product of this decomposition is hydrogen, carbon dioxide, lower fatty acids and some alcohols (methanol, ethanol, etc.). Mixed cultures are usually used because they are more stable and resistant to adverse effects. In addition, the use of monocultures requires aseptic conditions and sterile substrates, which makes the process more expensive. Several authors (Nandi and Sengupta, 1998, Rittmann and Herwig, 2012) state that microorganisms used for hydrogen production by dark fermentation are either facultative anaerobes (e. g. *Enterobacter, Bacillus*) or strict anaerobes (especially the genera *Clostridium* and *Rhodobacter*). There are several works in the literature, which also describes the possibility of using genetically modified bacteria. In this regard, *hyd*A has been found to be a key gene involved in the hydrogen production pathway, especially in the genus *Clostridium* (Klein et al., 2010, Sarma et al., 2019).

3.CONCLUSION

Research into the production of gaseous biofuels is also focused on the use of different types of biomasses. Wood biomass is widely available, it does not use arable land for cultivation, it does not require synthetic fertilizers, the cellulose and hemicellulose are sources of fermentable carbohydrates. The disadvantage is its resistance to direct enzymatic hydrolysis. For this reason, the methods of pre-treatment of wood biomass are also demanding and diverse. Their selection is made according to the composition of biomass, with regard the burden on the environment and with goal to ensure the effective of hydrolysis and fermentation. Gaseous biofuels are mainly biogas and biohydrogen. Both can be produced from wood biomass by anaerobic fermentation after suitable pre-treatment. Production of biogas is a 4-stage process (hydrolysis, acidogenesis, acetogenesis and methanogenesis), for produce biohydrogen is used the first two stages (hydrolysis and acidogenesis).

Acknowledgements: We wish to thank project KEGA č. 012UCM-4/2020 – System applications of foresight processes in the new study programme Safety Engineering

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RESILIENCE THROUGH DIVERSIFICATION: THE CASE OF AGRICULTURE AND FOREST-BASED SECTOR IN BULGARIA

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Abstract: Many small and medium enterprises (SME) apply diversification, in order to alleviate risk factors in vulnerable sectors such as agriculture and forest-based industry. Integration of core and diversified activities results in a number of benefits and effects, that could further multiply if managed properly. Current study explores diversification and its beneficial impacts on the development of agrarian and forest-based companies in their efforts for achieving stronger resilience in times of crisis and force-majeure. The research is focused on the economic and social effects derived from the application of diversified activities in the North-Eastern region of Bulgaria. Results from the empirical study show significant advantages for the SME in agriculture and forest-based sector, stemming from the application of diverse non-typical for them activities, and especially increase of their resilience and sustainable growth. Respondents reported about increased revenues, economic efficiency, improved competitiveness and integration of innovations. Additionally, diversification contributed to their personal development, especially for the elaboration of entrepreneurial skills, strategic planning and leadership competencies. Finally, introduction of non-typical activities by agrarian and forest-based SME helped for the revival of local economy, increased employment, improved cooperation among companies, thus raising the resilience against crisis of the entire region.
Keywords: Diversification, economic effects, social effects, Bulgaria, agriculture, forest-based industry

1. INTRODUCTION AND GOAL OF THE STUDY

Agriculture and forest industry are notorious for their dependence on environmental factors that are almost out of direct managerial control, e.g. natural disasters, climate conditions, crops failures and diseases, etc. (Augere-Garnier, 2016). Therefore, many small companies from those sectors initiate diverse secondary activities, in order to alleviate risk factors in their highly-specialized sector.

Diversification might be defined as a deliberate ex-ante strategy aimed at producing income gains by enriching the portfolio of economic activities (Ellis, 1999). Diversified activities generate various alternative income resources by setting up supplementary production (Buchta & Federicova, 2010), e.g. utilization of wasted materials, decreased economic risk, increase of employment, upskilling of workers, etc. By implementing diversified activities companies often contribute to their economic growth and improve their long-term resilience to adverse shocks or crisis (Lin et al., 2021). Moreover, the balanced management of natural resources, and the collaboration between local communities additionally may contribute to diverse social, economic and environmental benefits for those regions, thus leading to long-term sustainable development.

Diversification as a phenomenon in the agricultural and forest sectors has been explored mostly at micro level (Asfaw, Scognamillo, Caprera, Sitko and Ignaciuk, 2019). The main drivers of integrating diverse activities are numerous, but all of them are aiming at the development of resilient operating systems. Meraner et al., (2015) explore diversification from two perspectives: social/communal and strategic. The first one perceives diversification as process to internalize external components deriving from multifunctional characteristics of the company. The second perspective addresses diversification as a strategy for risk aversion, which is its most commonly cited benefit (Meraner et al, 2015). While for the smaller companies diversification is the only option for survival in front of the climate changes, economic shocks, crop disease or price fluctuations, the well-developing companies need to grasp viable alternatives to manage risk and reposition with a stronger unique selling proposition (Kaliszewski & Młynarski, 2020).

Considering the above, current study explores diversification and its beneficial impacts on the development of agrarian and forest-based companies in their efforts for achieving stronger resilience in times of crisis and force-majeure. The research focuses on the economic and social effects derived from the application of diversified activities in the North-Eastern region of Bulgaria.

The region is famous for its narrow specialization in agriculture and forest-based sectors, which often causes problems for the local companies, as they are most vulnerable in times of crisis or force-majeure situations. The recent COVID pandemics proved the need for alternative sources of income for many businesses (Lin et al., 2021), hence the need to diversify. Our study will set a number of useful opportunities for the small and medium agrarian and forest-based enterprises to grow and develop, thus becoming more resilient and sustainable.

2. DIVERSIFICATION EFFECTS

2.1. Economic impacts

The biggest and most obvious impact from the integration of diversified activities is the **increase of revenues and profits**. This benefit stems both from the new sources of revenues (Kaliszewski & Młynarski, 2020), including entry to new markets as well as from cost reduction, better and fuller utilization of resources for the production of new products (Hurmekoski et al., 2018), or through internal coordination within the entire supply chain (Lin et al., 2021). In this regard, diversification is more useful and successful for the smaller and more specialized farms (Bellon et al., 2020).

Risk reduction is another very popular effect stemming from diversification. Agriculture and forestry are quite vulnerable regarding external forces beyond farmers' control – e.g. weather, natural disasters, force majeure events, plant and animal diseases, etc. (Augere-Granier, 2016). The integration of diversified activities provides a chance to overcome seasonality and in this way to distribute economic risk, or at least to be able to mitigate its negative consequences (Kaliszewski & Młynarski, 2020).

Diversification requires new talent that can be internally developed or externally attracted (Brandth and Haugen, 2011), i.e. **employing more people**, or by prolonging seasonal contracts, assigning new tasks and responsibilities to the current workers, to increase employment in an extensive way.

An excellent example by Paul & Nehring (2005) in the USA focuses on different consequences, stemming from diversification, e.g. c**onnectedness and complementarity of the activities and final outcomes (**Hurmekoski et al., 2018). Thus, product diversification contributes significantly to the good performance metrics of the companies, since the respective impacts are manifold, as many of the new products utilize by-products as feedstock (Hurmekoski et al., 2018).

Notoriously, rural regions are associated with lower income and poverty. Diversification is an often-used tool to **alleviate poverty and unemployment and increase living standards** in remote regions. Asfaw et al. (2019) proved that the diversification impact was stronger for the poorest farms, because the new income will be a significant share of their overall income (Bellon et al., 2020). Therefore, this positive diversification impact is seen mostly in the poorer regions, that need more social and economic support.

2.2. Social impacts

Social impacts are considered as a secondary output from the diversification activities, hence they are often neglected at the expense of financial benefits. One of the reasons is the difficulty to precisely measure the social effects, as well as to identify and report them. Although having mostly indirect influence, social consequences from diversification could significantly reflect the wellbeing of the owners and managers, therefore, they need special attention and exploration.

Initiating new activities, especially not directly connected to the primary ones, requires additional information, knowledge gaining and enlargement of personal interests, skills and scope of the owners and managers of the companies. In this regard, **higher education and having diverse knowledge and skills** of the owners are factors for the inclination to diversify. (Chaplin, Davidova and Gorton, 2004). In the same line, **entrepreneurial skills of owners and managers** are a natural driver and output of diversification in agribusiness. However, leaders need much more support in terms of entrepreneurial management skills, rather than pure financial funding (Morris, Henley and Dowell, 2017; Vik and McElwee, 2011). The same conclusion was reached by Slavova and Ivanova (2019) in their study how the EU programmes stimulated entrepreneurship in Bulgaria.

Additionally, diversification enhances **care and integration of socially vulnerable groups.** Tulla, Vera, Valldeperas and Guirado (2017) examined the beneficial effects of ”social farming” where disabled people and people from vulnerable groups were integrated through their participation in non-agrarian activities.

Finally, the diversified products, focused on indigenous instruments or ingredients, e.g. the farmers, performing rural tourism promote **local culture and crafts** and thus educate visitors about the cultural and historical heritage of the region (Brandth and Haugen 2011).

Overall, the review shows that beneficial effects of diversification go much beyond single positive outcome, but also provide alternative sources of revenue and help for building a stable strategy for resistance to unexpected circumstances and sustainable growth of the agrarian farms and forest-based companies (Sarvasova & Kovalčík, 2010).

3. METHODOLOGY

Current study examines diversification effects and how they influence local farms and population in the North-Eastern part of Bulgaria. The research adopts a qualitative approach, because it allows a deeper exploration of the matter, analysing behaviour, opinion, effects, which are difficult to capture and measure in quantitative metrics (Lune & Berg, 2017). Moreover, the target population (agrarian and forest-based companies applying diversification) in the North-Eastern region in Bulgaria is comparatively small, hence qualitative research could better encompass the respondents and provide in-depth insights. Through convenience sampling, the researchers selected 14 respondents who implemented diversified activities in parallel with their primary production. Data were collected through face-to-face in-depth interviews that lasted between 90 and 120 minutes. Afterwards, the data were transcribed, coded, and analysed through thematic analysis to outline emerging issues and repeated patterns. Table 1 presents the profiles of the respondents. The sample is quite diverse, because it represents as many types of diversified activities as possible, thus ensuring higher validity and reliability of the study.

Table 1. Sample characteristics

Code	Location	Primary production	Diversified activity
R1	Balgarevo village, Dobrich region	Snail farm	Restaurant, Gourmet tourism, Cosmetics, Pharmaceutical products
R2	General Toshevo, Dobrich region	Production of grains and essential oils	Cosmetic and pharmaceutical products
R3	Devnya, Popovo, Lyaskovets	Production of grains and essential oils	Briquettes and bioplastics derived from the primary product residues
R4	Varna	Plant growing Fruits, vegetables	Preserves (jams, jellies, marmalades, pastes, purees and vegetables)
R5	Dobrich	Production of grains and crop seeds	Processed fruits and vegetables Mineral fertilizers; hybrid seeds
R6	Varna	Production of grains and oil cultures; Fruits	Processed fruits and vegetables; Bread and Pastry products; Mineral fertilizers;
R7	Pet mogili village, Varna region	Production of grains	Pellets production from plant residues
R8	Blaskovo village, Varna region	Wine production and vineyards	Wine tourism; boutique winery Horse-riding centre
R9	Prilep village, Dobrich region	Bee growing and honey production	Bee- and honey-based edible products Cosmetics and pharmaceutical products
R10	Krapets, Dobrich region	Production of grains	Guesthouse, rural tourism
R11	Dobrich	Timber production	Furniture and wooden souvenirs
R12	Dobrich	Wooden furniture	Other wooden products for gardening; huts and sheds
R13	Aksakovo, Varna region	Wooden furniture	Other wooden products for gardening
R14	Targovishte	Wooden Furniture	Other wooden products for gardening

4. RESULTS AND DISCUSSION

4.1. Diversified activities

The respondents are quite various in terms of core products and diversified activities. Most of them belong to the Varna and Dobrich sub-regions, which are located along the Black sea coast of Bulgaria. Both sub-regions are famous for their mass tourism profile, larger urban territories, well-developed infrastructure, which is an excellent prerequisite for a stable flow of customers/tourists of the diversified activities. In this regard, R1 and R10 are great examples. The demonstration hall of R1's snail farm is specially constructed to welcome large groups of tourists, whose visits the farmer has negotiated with tour operators from the nearby sea resorts Albena and Golden Sands. The other good example R10 has developed her guest house located close to the beach area, which is very attractive for potential tourists.

Nine of the respondents initiated diversified activities to enhance their primary operations. According to the interviewees, the integration between primary and diversified activities utilizes common supply and distribution channels, thus increasing efficiency and avoiding wasted residues. Motives for diversification are also interesting – enlarging the scope of the production (R3), enriching the product assortment (R4), creation of brand new products (R5), or just taking "…*the strategically correct way to close the supply chain and apply the circular economy model to utilize all residues*…" (R7). As R1 pointed out: "*The only option to stay on the market is to create products for the direct consumers. Therefore, I started a niche restaurant, offering culinary recipes, and at a later stage started producing cosmetics from snail extracts*". To support the same idea R6 said that "…*the combination between different products provides more opportunities for the long-term strategic development*…".

4.2. Economic impacts

All fourteen respondents reported about an increase in operational costs (e.g. new equipment, related to the new activities, e.g. R2 had to equip a lab for chemical analysis of the essential oils, R8 had to buy special machinery for the wine production). Still, as a main positive economic effect respondents identified the increased viability of the farm, **more revenues and new income sources** (Bartolini, Andreoli and Brunori, 2014). R10 is an exception among the rest because the rural tourism she develops has nothing to do with her main agricultural production. However, the guest house is an income source help for the **risk distribution** and resilience towards force-majeure circumstances (Asfaw et al., 2019).

Additionally, R2 claims that the non-typical activities enhanced the primary production, but also improved efficiency and coordination of all activities within the supply chain (Bellon et al. 2020) by enabling a better **internal organization and communication**.

Respondents claim that their companies became more **competitive** and definitely increased **employment** in their areas (R5, R11, R12). Although all respondents shared about certain challenges in finding skilled staff, they did not attribute it to only core or only diversified activities. In this regard, R1 especially emphasised the need for upskilling and reskilling trainings for the workers with diversified activities. He explained that the lack of qualified personnel is one of the crucial barriers to diversification. Therefore, R14 specially claimed about the numerous benefits they provide for their employees to motivate them.

Another important economic impact is the **increase of personal incomes/salaries**, but respondents report a parallel increase in the number of obligations and responsibilities as well (R13 and R14). Also, diversification enabled almost all respondents to further **integrate technological or other innovations,** that additionally enhanced their positioning on the market (R5, R14).

To wrap up, diversification in agribusiness and forest-based sector unanimously led to positive economic effects for the companies, enhancing their long-term sustainable development. Although some of the interviewees reported about certain challenges in the initial introduction of diversified activities, all of them agree that the new products ensured stability and more sustainable growth for their companies.

4.3. Social impacts

Although social effects are difficult to notice and almost not possible to measure, they seem to be equally important for our respondents, along with the economic benefits. All interviewees confirmed a significant **growth of their social contacts**, as well as the establishment of **new partnerships**. The need to communicate with people from different industries (R1, R9, R10), or from different countries (R4, R5, R6, R7) pushed respondents to improve their social skills. R1 shared that "…*my partners from restaurant industry, cosmetics and tourism sector cooperate and assist me to understand better their industry*…". He specifically emphasized that the biggest support he received was not from the local community, but from other partners, not directly related to his primary production. Hence, companies from diverse sectors consider each other more as partners and collaborators, rather than as competitors.

Diversification inevitably demanded **acquiring new skills** and **additional training –** both of the entrepreneur, and the employees. R10 tells about the new standards of service she had to adapt to and follow. She also had to train her employees and make them stick to the new requirements, which was a challenge for all. In the same line, interviewees confirmed that their education and experience helped to catch the novel ideas and launch them successfully (R14). Very often the diversified activity has been a hobby or part of a past project, so the farmers grasped it with passion. According to R9: "*Beekeeping provides a lot of opportunities, provided one has the entrepreneurial attitude and desire to develop. I and my family invested a lot of effort, time, trust, and the positive outcomes are present*."

Another social benefit is the increase of **entrepreneurial spirit**. R1 is a typical example in this regard. He reflected that thanks to the diverse activities he built certain leadership features like integrity, ambition, readiness to learn, self-confidence and leadership (Anderson & Goffee, 2001). The same is shared by R4: "…*since we started with diversified activities, our ambition grew, as well as our entrepreneurial ideas. In this regard, my specific education helped a lot*." According to R8, the ultimate goal is to increase quality, which is vital for the strategic development of the farm.

Respondents highly appreciate the numerous positive economic and social effects of diversification in their business. Moreover, as R10 points out: "…*successful integration of primary and diversified activities has a beneficial impact on the whole region. The municipality collects more taxes, the region revived, additional industries entered. On the other hand, increased consumption additionally enhances the regional economy and results in a positive multiplier effect for all*."

5. CONCLUSION

Results from the empirical research of the North-Eastern region of Bulgaria are in line with similar studies (Bellon et al., 2020; Meraner et al., 2015) but also delivered other valuable insights. Diversification effects caused noticeable changes in the agrarian and forest companies in the researched region. Interviewees realized the positive benefits, derived from the application of non-agrarian activities and it additionally stimulated them to proceed on with the innovative practices. Regarding any negative consequences, the respondents considered them mostly as challenges to overcome, rather than particular barriers or limitations.

Diversified activities are resulting in sustaining the vertical and horizontal connections among the participants in the agricultural and forest-based supply chain, thus increasing the operational efficiency and productivity. In addition, social connections and business relationships were enhanced both within the sectors, but also across other industries. Still, the best results were achieved in the cases of complementarity of the primary and diversified production (R1, R8, R9), i.e. concentric or horizontal diversification, leading to resource advantages, as well as the complementarity and overlapping of activities in core and diversified production (Lin et al., 2021).

The study revealed that social impacts were considered as very important as well in addition to the economic benefits of diversification. Respondents particularly emphasized the increase of their knowledge, skills and entrepreneurial abilities as positive outcomes, derived from diversification. Hence, future research focused solely on social effects would reveal even more details in this matter.

The main limitation of the study is its small scope. In this regard, it could be considered as pilot research in this field and this geographic area.

Acknowledgements: This publication is developed within research project 19/2018 “Economic and social effects from the integration and management of agribusiness and non-agrarian activities in North-Eastern region in Bulgaria”. The project is based on scientific priority “Regional development” supported by the University of Economics-Varna, Bulgaria.

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BUSINESS SYSTEM APPLICATION IN SERBIAN WOOD INDUSTRY - IMPLEMENTATION MODELS ANALYSIS

Miljan Kalem[1], Danica Lečić-Cvetković[2], Aleksandra Lazarević[1], Branko Glavonjić[1], Milanka Điporović-Momčilović[1]

Abstract: This paper present analyzes the research results of business information systems (BIS) application in the wood industry companies in the Republic of Serbia. The main objective of this paper is to research the reasons for BIS application in the business of these companies. An additional objective is to determine the criteria for BIS introduction and selection in their company. Also, some of the additional objectives are to determine the introduction of the BIS strategy and analyze what software companies use. This paper aims to imply to wood industry companies the most popular way of BIS introduction and indicate to most popular software in the Serbian wood industry. The research results show that the largest number is decided for the Frontal introduction of BIS. Also, research results indicate that most number companies are deciding on Custom software development Microsoft Dynamics NAV, and Pantheon.
Keywords: BIS, software, wood industry, Republic of Serbia.

1. INTRODUCTION

Successful company management and production as a key process in production companies is based on quality information, their collection, transmission, processing and making management decisions according to them. Data management is part of information resource management and ensures that a company's data resources accurately reflect the physical systems they represent (Fakhimuddin M. at al 2021).

Lack of quality information disables company management to analyze previously made management decisions and executed business operations, which affects the quality of the new decisions, efficiency and profitability of the company's business. Lack of information related to internal and external processes as well, which affect company's business operations can be stated as a basic problem of a large number of companies in wood industry in the Republic of Serbia (Kalem M. et al., 2020.).

The success of a production process, as a key process of all production companies, largely depends on the efficiency of other processes in the company. Companies that have integrated processes, in which all the information is collected, processed and transmitted between different services in real time, can provide highly efficient production, efficient and profitable business. A prerequisite for increasing the efficiency of business processes in wood industry companies is the implementation of business information systems that provide collection, transmission and processing of large amounts of data that occur in everyday business in various processes. With big data extracted from both internal and external data sources, management accountants could now utilize data analytics techniques to answer questions including what has happened (descriptive analytics), what will happen (predictive analytics), and what is the optimized solution (prescriptive analytics) (Appelbaum, D. et al. 2017). Information system (IS) can be presented as a combination of software, hardware, people, networks, data resources, communications and procedures, and policies that stores, retrieves, transforms, and disseminates information in an organization (O'brien & Marakas, 2011, p. 103).

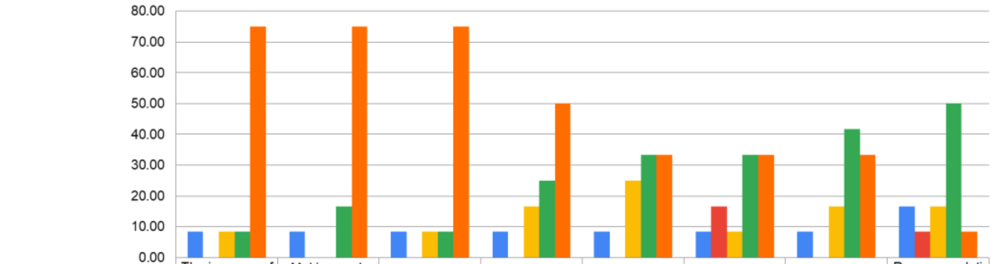
The results of the research presented in the paper Rajković T., et al., 2020, show that only 12 [%] of wood industry companies in the Republic of Serbia use some type of business information system, and that only 3 [%] companies plan to implement business information system in the following period. The results of this research also indicate that the application of business information systems in micro and small enterprises is only 17 [%], with Serbia having the largest number of them. The number of companies which have a business information system and belong to the group of micro enterprises according to the criterion of the number of employees is 0 [%]. In the current era of globalization, management information systems are an inseparable part of an organization where information systems produce output using inputs to meet the needs of achieving management goals (McLeod & Schell, 2007).

2. AIM AND METHODOLOGY

The subject of research in this paper are business information systems and their application in the companies of the wood industry of Serbia. The main goal of this paper is to determine the main reasons why companies that use business information systems in their operations have decided to implement them and which software is most frequently used. In addition, one of the goals is to research which strategy wood industry companies in the Republic of Serbia most often use during the implementation of business information systems. The main purpose of this paper is to point out to the importance of business information systems and help in the process of their implementation. In order to conduct the research for the purposes of this paper, the technique of primary research in two phases was used. In the first phase, a survey of selected companies that apply business information systems in their business was conducted. In the second phase, the analysis of the collected data was performed using the methods of analysis, synthesis and generalization.

3. RESULTS AND DISCUSSION

The first part of the research included the research into the reasons for the application of business information systems in the operations of selected companies. In this phase of the research, the companies were offered 8 reasons for implementing business information systems. Respondents were able to rate each reason with a score from 1 to 5, one if the reason is not important or five if the reason is extremely important. The results of this research are shown in Figure 1.



	The increase of quality and productivity of different business processes	Making work easier for the employees – increase employees' productivity	Processing and availability of all the data in real time (Up-to-date Data)	Timely reporting / compliance with regulations	Integration of all business activities in the company	Enabling real-time support for the customers and suppliers	Standardization of work procedures	Recommendation from the past users and their good experience with using EPR
1 - Not important	8.33	8.33	8.33	8.33	8.33	8.33	8.33	16.67
2	0.00	0.00	0.00	0.00	0.00	16.67	0.00	8.33
3	8.33	0.00	8.33	16.67	25.00	8.33	16.67	16.67
4	8.33	16.67	8.33	25.00	33.33	33.33	41.67	50.00
5 - Extremely important	75.00	75.00	75.00	50.00	33.33	33.33	33.33	8.33

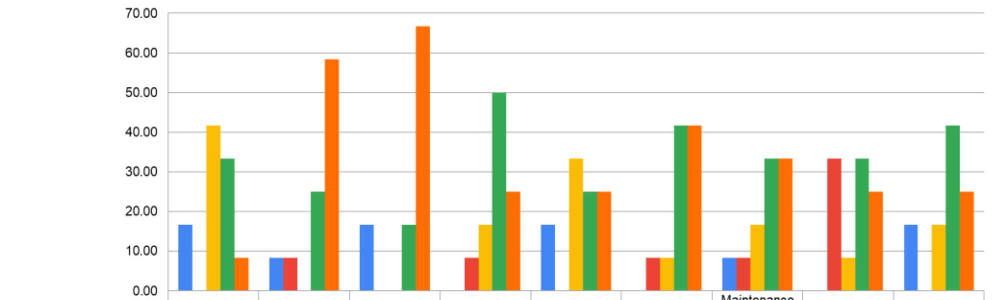
Figure 1. The reasons for applying business information systems in operations

Based on the research results shown in Figure 1, it can be seen that most companies have implemented business information systems for the following reasons: increasing the quality and productivity of various business processes, making work easier for employees - increasing employee productivity and processing all data in real time. A total of 75 [%] of companies that have business information systems consider these reasons to be extremely important for the implementation of business information systems in their business.

As one of the important reasons for the introduction of business information systems in the company's operations, timely reporting / compliance with regulations and integration of all business activities in the company were pointed out. A total of 50 [%] of companies answered that this opportunity provided by the business information system was an extremely important reason for its implementation.

Opportunities provided by the business information system, such as integration of all business activities in the company, providing real-time support for customers and suppliers, standardization of work procedures, for most companies are less important reasons for introducing business information system in business. A total of 33.33 [%] companies cited these reasons as a motive for introducing BIS in their business. The least important reason for the introduction of BIS in business is the recommendation of other users and their good experience with it.

The following research is related to the criteria for choosing a business information system. The answer to the question of which criteria are most important when choosing a business information system is shown in Figure 2.



	Software price	Possibility of customizing to the specific needs of the company	Possibility of software upgrade	Time needed for the implementation of the software	Implementation cost	Available support/consulting from the software suppliers	Maintenance cost (annual cost of maintenance and system support)	Information competence of the employees	Information infrastructure of the company
1 - Not important	16.67	8.33	16.67	0.00	16.67	0.00	8.33	0.00	16.67
2	0.00	8.33	0.00	8.33	0.00	8.33	8.33	33.33	0.00
3	41.67	0.00	0.00	16.67	33.33	8.33	16.67	8.33	16.67
4	33.33	25.00	16.67	50.00	25.00	41.67	33.33	33.33	41.67
5 - Extremely important	8.33	58.33	66.67	25.00	25.00	41.67	33.33	25.00	25.00

Figure 2. Basic criteria for choosing the appropriate business information system

From the obtained responses, it can be seen that the possibility of software upgrade is the most important criterion when choosing a business information system, a total of 66.67 [%] of companies consider this criterion the most important. The criterion of the possibility of customizing to the specific needs of the company takes second place. A total of 58.33 [%] companies consider this criterion extremely important. The next criterion that is significant for the companies is the support during the implementation of software in everyday business. A total of 41.67 [%], consider this criterion important when choosing software.

Also, from Figure 2 it can be seen that the price of software is the criterion that is the least important when choosing a business information system, i.e. only 8.33 [%] of companies believe that this criterion is important when choosing a business information system. Based on the results shown in Figure 2, it can be concluded that it is extremely important for Serbian wood industry companies to implement a business information system that system allows business flexibility for a longer period of time.

Other criteria that were offered, such as software implementation costs, maintenance costs, IT competences of employees and IT infrastructure of the company are the criteria that are less important when choosing software, but it should be noted that these criteria are taken into account when choosing software.

The next research question was related to the most common strategy which the wood industry companies of the Republic of Serbia choose when introducing the business information system. The results of this research are shown in Figure 3.

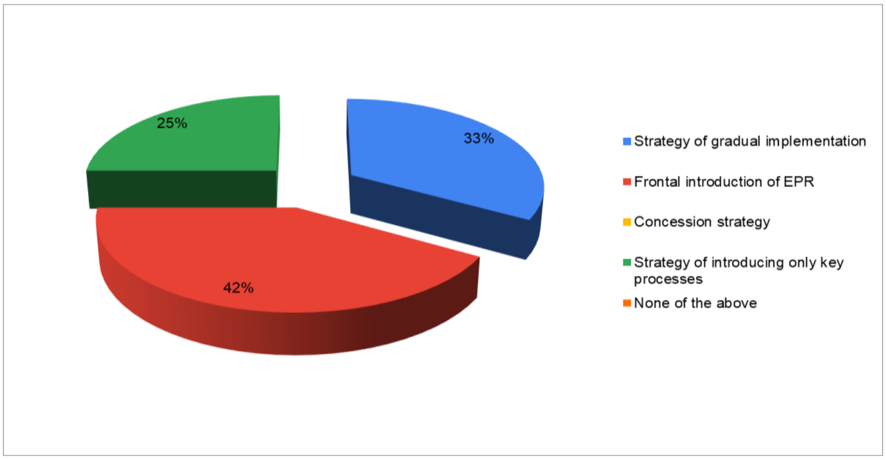


Figure 3. Strategy application during the introduction of EPR system

The results of the research shown in Figure 3 indicate that the wood industry companies of the Republic of Serbia most often determined for the Frontal introduction of business information system, a strategy that implies the removal of the old system and introducing ERP system in the entire company. A total of 42 [%] of companies that have business information systems applied this strategy during its introduction. The total number of companies that implemented the strategy of gradual implementation of the business information system in business is 33 [%], while the strategy of introducing only key processes was applied in 25 [%] companies that have business information systems. It can be seen in Figure 3 that the wood industry companies of the Republic of Serbia did not apply the concession strategy or any other strategy when introducing the business information system. Based on the results of the research, it can be concluded that the largest number of companies decide to completely change the way of doing business.

When it comes to the analysis of the installed software in the companies of the wood industry of the Republic of Serbia, the results of this research are shown in Figure 4.

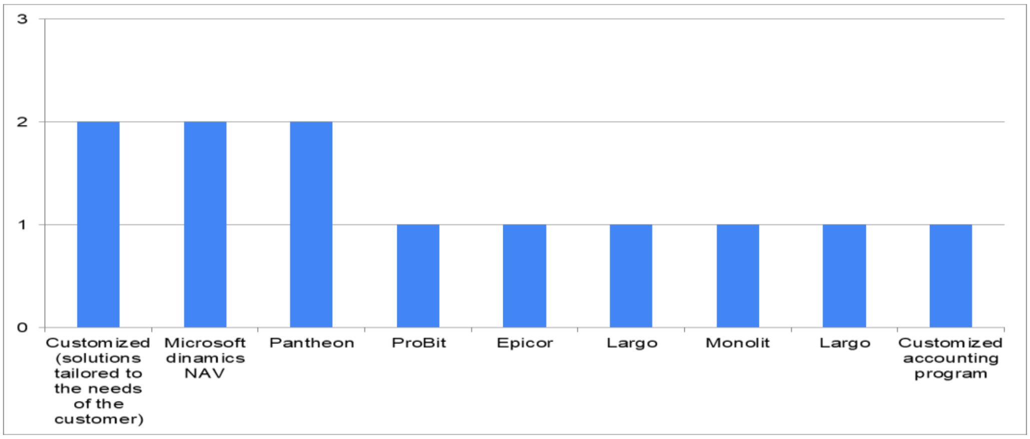


Figure 4. Types of software mainly used in the companies

Based on the research results shown in Figure 4, it can be concluded that out of a total sample of 12 companies that use business information systems, most companies use Customized, solutions tailored to their needs, then MicrosoftDynamics NAV and PANTHEON. All of these three software are used by two companies from the sample. Other types of software can be found in only one of the companies from the sample.

4. CONCLUSION

Based on the research results, it can be concluded that wood industry companies of the Republic of Serbia implement business information systems in their business due to the desire to increase the quality and productivity of various business processes, then make work easier for employees, increase employee productivity.

Also, the research results indicate that when choosing a business information system, the most important criterion is the possibility of later software upgrades, followed by the ability to adapt the software to the specific company requirements and support provided by the software supplier to the user during implementation. The results of the research also show that most companies give the least importance to the price of software when choosing software.

When introducing a business information system, wood industry companies in the Republic of Serbia usually decide for its frontal introduction into business, a strategy that implies abolishing the old system at once and introducing a business information system in the entire company. Also, the results of the research show that in the wood industry companies of the Republic of Serbia, the most common solutions are customized software created at the request of the user, MicrosoftDynamics NAV software and Pantheon. Other software is present in only one of the companies from the sample.

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QUANTIFICATION OF THE REQUIRED RETURN ON INVESTMENT IN THE SPECIFIC CONDITIONS OF THE FOREST-BASED SECTOR IN SLOVAKIA

Martina Kánová, Josef Drábek

Abstract: The article is focused on the application of progressive methods of investment management in the part of valuation of economic efficiency and investment decision-making in the forest-based sector in Slovakia. The aim of the article was to verify the selected methodology for determining the required return on capital in wood, pulp and paper and furniture branches and to find out the fundamental differences resulting from the specific conditions of given industries. We analysed selected indicators for capital structure and economic performance of wood processing industries in Slovakia. Methodologically, the article uses procedures for the Weighted Average Cost of Capital (WACC) and Capital Asset Pricing Model (CAPM) for determining the cost of equity, considering the risk premium. The results contain quantification of the required rate of return on comparable investments based on current market conditions and business environment, describe the relevant conclusions of the analysis, point out the common and different features, trends, challenges, and opportunities of the forest-based industries in Slovakia.
Keywords: investment management, economic efficiency, return on investment, wood-processing sector, Slovakia

1. INTRODUCTION

Investment decision-making is one of fundamental parts in business management and company needs to apply appropriate methods for measurement and management of business performance. Theoretical fundamentals for valuation of investment effectiveness are well described (Levy and Sarnat 1986, Ward et al. 1996, Renkema and Berghout 1997, Brealey and Myers 2003, Baum and Hartzell 2012 and others). While discounted cash flow valuation is only one of the three ways of approaching valuation of investment, it is the foundation on which all other valuation approaches are built (Damodaran 2012). One of the key inputs in discounted cash flow analysis, based on the conversion of future values to the present value, is discount rate.

In corporate finance, the discount rate is the minimum rate of return necessary to invest in a particular project or investment opportunity. The discount rate reflects the necessary return of the investment given the riskiness of its future cash flows. Discount rate is often called the opportunity cost of capital (Brealey, Myers and Allen, 2014; Polách et al., 2012; Scholleová, 2008), i.e., the hurdle rate used to guide decision-making around capital allocation and selecting worthwhile investments. The discount rate estimates the risk and potential returns of an investment – so a higher rate implies greater risk but also more upside potential.

When considering an investment, the rate of return that an investor should reasonably expect to earn depends on the returns on comparable investments with similar risk profiles.

There are several approaches to determining the discount rate for investment decisions (described in eg. Brealey, Myers, Allen, 2014; Fotr, Souček, 2011; Valach, 2011), based either on the capital market or on the capital structure of the company. The average cost of capital can be the basis for determining the discount rate. Model of the weighted average capital cost (WACC) is used to determine the discount rate based on the calculation of cost of capital obtained from various sources. The use of the WACC model requires to determine the cost of debt as well as cost of equity.

To calculate the cost of equity, it is possible to use the risk premium model, derived from the capital asset pricing model (CAPM), which takes into account not only the variability of the company's own profits, but also the profitability of other companies, included in the beta coefficient. Theoretical fundamentals for determining of parameters in CAPM and current values for countries and regions describe Damodaran (2015), Scholleová (2009) or Klieštik (2008). From the perspective of investors, the beta coefficient is the exposure of an asset (or security) to systematic risk and determines whether it is more or less volatile than the market as a whole. The most frequent use-case of beta coefficient in corporate finance is the CAPM, in which beta is a critical component of calculating the cost of equity – i.e. the required rate of return for equity investors.

Investment decision-makings should be regarded in each business entity as the crucial factor for its long-term prosperity. An acquired decision affects the performance of the company as well as its competitiveness in long time. If a competent investor has an interest to make a qualified investment decision, it means that he must primarily determine the time and risk factor (Merková, Drábek and Jelačić, 2013).

The aim of the article was to verify the selected methodology for determining the required return on capital in wood, pulp and paper and furniture branches and to find out the fundamental differences resulting from the specific conditions of given industries. We analysed selected indicators for capital structure and economic performance of wood processing industries in Slovakia.

2. MATERIAL AND METHODS

The study uses procedures for the Weighted Average Cost of Capital (WACC) and Capital Asset Pricing Model (CAPM) for determining the cost of equity, considering the risk premium.

Weighted average cost of the capital (WACC) calculation was determined by the formula:

$$WACC = r_d * (1 - t) * \frac{D}{C} + r_e * \frac{E}{C} \quad (1)$$

r_d – cost rate of debt
t – income tax rate
D – Debt capital
C – Capital (C=E+D)
r_e – cost rate of equity
E – Equity

Cost of equity was determined based on the Capital Asset Pricing Model (CAPM) in this study, which is given by:

$$r_e = r_f + \beta * (r_m - r_f) \quad (2)$$

r_f – risk-free premium
β – the systematic market risk (beta coefficient)
(r_m – r_f) – risk premium

Beta coefficient provides a method to estimate the degree of an asset's systematic (non-diversifiable) risk. There are two distinct types of beta measured in corporate finance:
Levered Beta → Inclusive of Capital Structure Effects (D/E Ratio)
Unlevered Beta → Removed Capital Structure Effects (D/E Ratio)

Value of β coefficient was calculated by formula:

$$\beta_{levered} = \beta_{unlevered} * \left[1 + (1 - t) * \frac{D}{E}\right] \quad (3)$$

t – income tax rate,
D – Debt
E – Equity

Industry sectors categorized according to methodology (Damodaran, 2022) were following in the study:

1. Furniture/Home Furnishings
2. Paper/Forest Products
3. Total Market
4. Total Market (without financials)

In terms of regional breakdown according to given methodology, Slovakia is included into group of Emerging Markets.

Data were processed by using statistical and analytical-synthetic methods, inductive and descriptive statistics through the Microsoft Excel and software STATISTICA 12.

3. RESULTS AND DISCUSSION

The results contain quantification of the required rate of return on comparable investments based on current market conditions and business environment, describe the relevant conclusions of the analysis, point out the common and different features, trends, challenges, and opportunities of the forest-based industries in Slovakia.

Table 1. Data for Beta Coefficient by Industry Sector: Emerging Markets, Slovakia included (Source: Damodaran, 2022)

Industry Sector	Number of firms	Levered beta	D/E Ratio	Tax rate	Unlevered beta
Furn/Home Furnishings	250	1.16	15.23%	15.23%	1.05
Paper/Forest Products	187	1.17	65.83%	12.93%	0.79

Table 1 presents strong difference between Furniture and Paper industry in unlevered beta coefficient, what is an integral component of the CAPM model, and it quantifies higher systematic risk and thus higher expected return in Furniture. Paper sector has beta<1 with low market sensitivity.

Table 2. Calculation of risk premium for Slovakia (Source: own)

Geometric Average Historical Return	S&P 500	10-Year US T.Bond	Risk premium (US)	CDS (SVK)	Risk premium (SVK)
	(r_m)	(r_f)	($r_m – r_f$)		($r_m – r_f$)
1928-2021	9.98%	4.84%	5.13%	1.03%	6.16%

Return rates of S&P 500 and 10-year US Bond presents Table 2 as base for calculation of country risk premium. Rating of the Slovak Republic according to Standard & Poor's is A + since July 2015 and according to Moody´s A2; the default spread is (Damodaran, 2022): 1.03%. Adding that spread to a risk-free rate should yield the pre-tax debt cost for a company.

Table 3. Calculation of Beta coefficient, rate of Equity and WACC for selected industry (Source: own)

Indicator / Sector:		Furn/Home Furnishings	Paper/Forest Products
βu	Unlevered beta	1,05	0,79
D/E	D/E Ratio	15%	65%
t	Corporate tax rate	21%	21%
βl	**Levered beta**	**1,17**	**1,20**
rf (SVK)	Risk free rate (SVK)	1,529%	1,529%
(rm-rf) SVK	Risk premium (SVK)	6,16%	6,16%
re	**Rate of Equity**	**8,76%**	**8,91%**
rd	Rate of Dept	2.07%	2.07%
rd*(1-t)	Rate of Dept after tax	1.64%	1.64%
D/C	Dept share	0.13	0.395
E/C	Equity share	0.87	0.605
WACC	**Reqiured rate**	**7.84%**	**6.04%**

Table 3 summarize the results of calculation of beta coefficient, rate of equity and WACC. Starting point is different between furniture and paper/forest products, in favour of lover unlevered beta and risk in paper/forest. However, significantly higher D/E ratio in paper increases levered beta in this sector to value 1.20. Both sectors have similar levered beta, but each for a different reason.

Risk-free interest rate means the return that risk-free assets bring to the owner. Government bond yields are most often used. At the end of 2021, 10-year government bonds (NBS, 2022b) had a zero yield, but since the beginning of 2022 they have seen a significant upward trend, in March 2022 the yield was 0.993%, in April 2022 the average nominal yield to maturity was 1.529%. Currently rising risk-free rate in Slovakia as well as US risk premium means higher rate of equity calculated based on CAPM model, but it do not cause differences between furniture and paper sectors.

Debt costs were determined on the basis of current interest rates of commercial banks on loans to business (non-financial) units. These represented an interest rate of 2.07% for 1Q 2022 for new business (NBS, 2022a).

The calculation of the WACC showed differences in the sectors, which were caused by the different capital structure. WACC is higher in furniture (7.84%) compared to paper/forest products with the result of wacc at the actual level 6.04%.

The wood processing industry in Slovakia is currently in a difficult situation, but there is still possibilities for better investment management and potential of positive impact in performance of companies (Merková, Drábek and Jelačić, 2015). Quantitative analysis at the level of the wood-processing industry confirmed significant impact of investment to growth of sales and productivity; the subsequent analysis of the structure of value added showed a strong correlation between wages and value-added growth (Merková et al., 2012). Also, according to several economic indicators, productivity growth and wages, the paper sector appears to be a sector with potential for the Slovak economy. The calculated required rate of return demonstrates that the paper sector, despite a higher debt, appears to be more stable and less risky.

3. CONCLUSION

Investment management of companies requires a qualified approach to determine the required rate of return on invested capital and the paper quantified it in selected forest and wood processing industries in Slovakia. These industries should consider a higher discount rate when investing than the total market, which indicates a higher unlevered beta coefficient for furniture sector and a higher debt ratio for paper/forest industry.

Acknowledgements: We wish to thank the Slovak Research and Development Agency (grant number APVV-19-0612) and the Cultural and Educational Grant Agency of the Ministry of Education, Science, Research and Sport of the Slovak Republic (grant number KEGA 005TU Z-4/2020).

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INVESTMENT AND INNOVATION ACTIVITY IN WOOD-PROCESSING INDUSTRY OF SLOVAKIA

Martina Kánová, Petra Lesníková

Abstract: The aim of the article was to analyse actual status and trends in innovation activities as part of Sustainable Development Goal (SDG) Industry and innovation by The Agenda 2030 as the most comprehensive set of global priorities for achieving sustainable development, with focus on Slovakia, sector of small and middle enterprises (SMEs) as well as forest-based industries of Slovakia. We compared and analysed partial indicators of innovation index of EU-27 countries, in area of business investment there were indicators concerning R&D expenditure in business sector, innovation expenditure and number of enterprises providing ICT training. R&D expenditure as important indicator of innovation potential was analysed in wood, pulp and paper and furniture sectors. We also considered the biggest barriers for realization of innovation activities and determinants of insufficient innovation development. Database Eurostat of EU and DataCube of Statistical Office of the Slovak Republic were used for obtaining of source data. Results quantify selected investment and innovation ratios, describe relevant conclusions considering actual innovation status conditioned by several factors in wood processing industry of Slovakia.
Keywords: investment, research and development, innovation activity, wood-processing sector, Slovakia

1. INTRODUCTION

Sustainable development is firmly anchored in the European Treaties and has been at the heart of European policy for a long time. The Agenda 2030 (United Nations, 2015) for Sustainable Development and its 17 Sustainable Development Goals (SDGs), adopted by the UN General Assembly in September 2015, have given a new impetus to global efforts for achieving sustainable development (European Commission, 2021).

The issue of SDGs can be described as phenomenally complex. The fulfillment of SDGs is still a challenge for Slovakia. There are many ways which this issue possible to improve. This also applies the forest and timber sectors which can contribute to fulfillment of SDGs not only by innovations, but at first by striving and adhering to goals related to social area (Lesníková and Kánová, 2020).

Trend of Slovakia in SDG 9 Industry, Innovation and Infrastructure as partial indicator of innovation index is moderately increasing, and major challenges remain (Sachs et al., 2021).

Research and experimental development (R&D) comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society and the use of this stock of knowledge to devise new applications (Frascati Manual, 2002 edition, § 63).

In time of growing globalization and digitization, innovation is becoming an increasingly important factor in determining the success of business. They provide higher growth for companies, increase efficiency, competitiveness and enable for companies to create new markets (SBA, 2020). The Europe 2020 strategy (European Commission, 2010) sees innovation as a driving force for our future growth. The Government of the Slovak Republic consider the sustainable development as one of the basic pillars of the knowledge society and declares this in its strategies and policies (Ministry of Economy SR).

Wood-processing industry (WPI) of Slovakia noted no innovation development focused on increase the competitiveness of production and efficiency increasing, and without solution of the availability of financial resources needed to implement innovative plans can expect a significant decrease in the competitiveness and long-term recession (Merková and Drábek, 2010). In wood-processing industry can positively assess the labour productivity growth, the most significant in pulp and paper, where is recorded long-term growth above average of industrial production, especially in periods with high inflows of FDI into the mentioned sector (Merková, Drábek and Polách, 2011). The significant impact of investment to growth of sales and productivity was found in quantitative analysis of the effects of FDI in wood processing industry (Merková et al., 2012). The study focusing on industrial enterprises in Slovakia (Rajnoha et al., 2018) showed that the better performance, as well as distinctive feature of intangibles and research & development investments, are typically in foreign-owned firms.

The aim of the article was to analyse actual status and trends in innovation activities as part of Sustainable Development Goals (SDGs) Industry, innovation and innovation by The Agenda 2030 as the most comprehensive set of global priorities for achieving sustainable development, with focus on Slovakia as well as forest-based industries of Slovakia.

2. MATERIAL AND METHODS

For analysis of investment and innovation activity, we have selected indicators of expenditure to research and development as % of GDP at the national level, and the mass and structure of gross fixed capital formation and investment in research and development as % of total investment at the sectoral level. Database Eurostat of EU and Statistical Office of the Slovak Republic were used for obtaining of source data.

At transnational level, we compared the data of countries:
EU-27 countries
The best performer in EU
V4 group countries

Industries categorized according to NACE classification were following:
C – Manufacturing
16 – Manufacture of wood and of products of wood and cork (Wood)
17 – Manufacture of paper and paper products (Pulp and Paper)
31 – Manufacture of furniture (Furniture).

Components of indicator Gross expenditure on research and development (% of GDP) by sector were not analysed separately, we processed the agregated All sectors (Total).

Categories of indicator Gross fixed capital formation by industry and by asset (flows) according to Eurostat database analysed in the paper were:
N11G Total fixed assets (gross)
N1171G Research and development, gross

3. RESULTS AND DISCUSSION

Expenditure on R&D has set optimum 3.7 according to the average of the best performers, and levels are: 1.5 for green threshold, 1.0 for red threshold, and 0 for lower-bound (Sachs et al., 2021). As presented the data (Table 1), the best performing EU country is Sweden with average R&D investment at the level 3.36% of GDP during period 2000-2020, with increasing trend since 2014. Average of EU-27 is in green zone at the level 2.32% in 2020 (average 1.99% during 2000-2020). The Czech Republic, with which Slovakia has a common past, achieves significantly better results, the country belongs to the green zone since 2011, with actual value 1.99% in 2020 (average 1.50% during 2000-2020). Average R&D expenditure below 1.0% during 2000-2020 (presented in Figure 2) reached Poland (0.81%) and Slovakia (0.69%), however, Poland has shown a significant upward trend and the country has reached mid-level values since 2017. Slovakia, as the only country in the V4 group, is in the red zone with a slightly growing trend, at the level 0.91 in 2020.

Table 1. R&D Expenditure in selected EU countries (Source: own)

Descriptive Statistics: R&D expenditure (% of GDP) in selected EU countries							
Group	Valid N	Mean	Median	Minimum	Maximum	Variance	Std.Dev.
Sweden	19	3.36	3.36	3.10	3.87	0.03	0.18
EU-27	21	1.99	1.97	1.78	2.32	0.03	0.17
Czech R.	21	1.50	1.33	1.10	1.99	0.12	0.35
Hungary	21	1.15	1.13	0.79	1.61	0.06	0.24
Poland	21	0.81	0.72	0.54	1.39	0.07	0.27
Slovakia	21	0.69	0.64	0.45	1.16	0.04	0.19

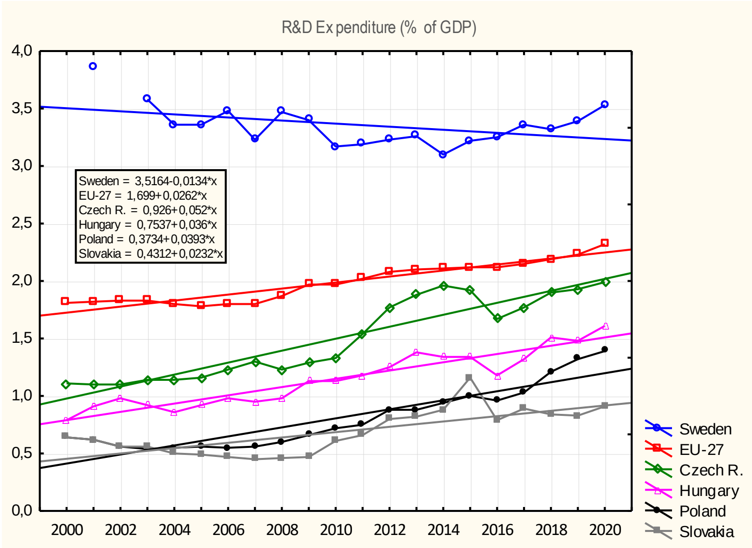

Figure 1. R&D Expenditure in selected EU countries (Source: own, data Eurostat)

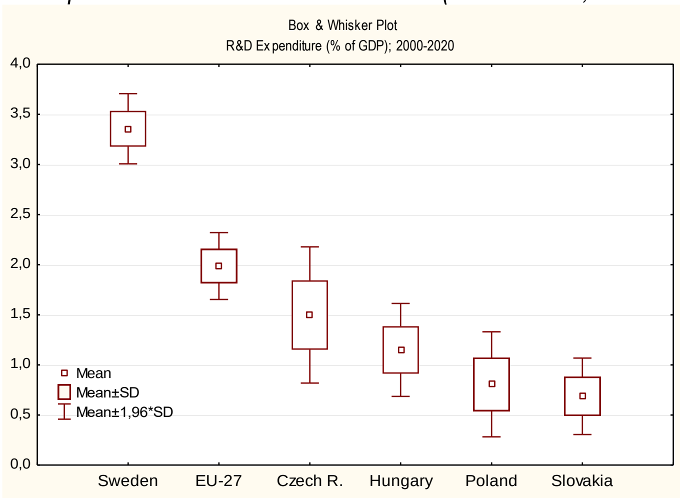

Figure 2. Box & Whisker plot of R&D Expenditure (Source: own, data Eurostat)

From the data from the Statistical Office of the Slovak Republic, which monitor the share of innovative and non-innovative enterprises in the total number of SMEs, it was found that since 2008 the share of enterprises that carry out some type of innovation activity within the company has decreased (SBA, 2020). There were 28 % of enterprises with innovation activity in Slovakia during the period 2016-2018 (SOSR, 2020) with 0.7 % decrease compared to the previous survey (SOSR, 2018). Ability to innovate was higher in industrial sector (34.6 %) than in service (26.5 %). Main component of innovation expenditure was the acquisition of machinery, equipment, software and buildings (42.7 %). Compared to 2016, in 2018 the highest increase of the share in total expenditures was for purchasing external R&D (by 6.3 %).

R&D investment share as % of total investment in given sector during period 2000-2020 is described in Table 2. Slovak industry invested to R&D with the average 4.05% of total investment and this aggregated group exceeds wood processing industries. The highest average R&D investment share among wood processing reached the furniture industry 6.11%, however, the median value 1.51% is also below the level of whole industry (3.58%). Separate WPI sectors lag in gross fixed capital formation in research and development, as particularly evidenced by the median presented in Figure 3. Slovak industry invested to R&D with increasing course for 21 years (y=1.9+0.2x), contrary, Slovak furniture sector has decreasing trend (y=15.52-0.86x). Almost no R&D investment is in wood and pulp & paper sector.

Table 2. Descriptive statistics: R&D Investment in WPI sectors (Source: own)

Descriptive statistics: R&D Investment share as % of total investment in a sector							
Group	Valid N	Mean	Median	Minimum	Maximum	Variance	Std.Dev.
C-Industry	21	4.05%	3.58%	2.04%	6.36%	0.03%	1.60%
Wood	21	0.49%	0.00%	0.00%	6.64%	0.02%	1.46%
Pulp, paper	21	0.01%	0.00%	0.00%	0.11%	0.00%	0.02%
Furniture	21	6.11%	1.51%	-3.78%	50.54%	1.54%	12.41%

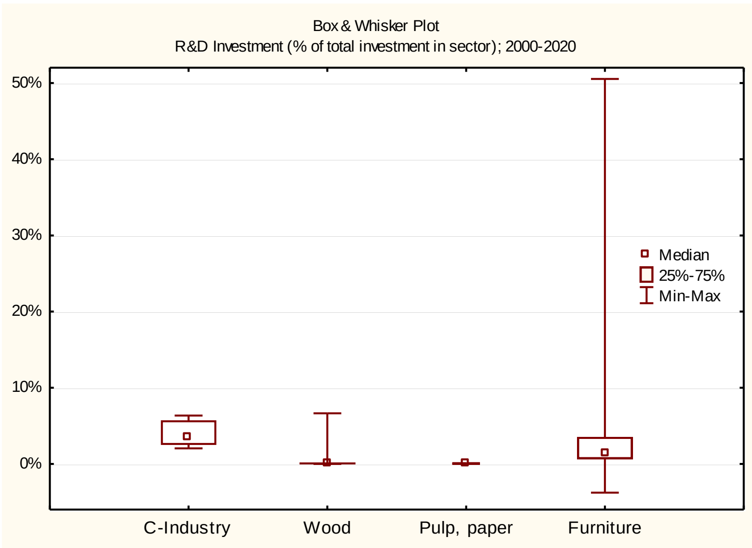

Figure 3. R&D Investment in WPI sectors (Source: own)

R&D investment is subcategory of Intellectual Property Product, which also contains Investment to computer software and databases; and WPI sectors invest more to these and other parts of fixed capital; the largest fixed capital formation in wood processing is in machinery and equipment and weapons systems.

According to the data (SOSR, 2018), the wood-processing enterprises identified too high innovation costs as the biggest barrier to realization innovative activities. In the field of paper and pulp industries the enterprises marked the difficulties in obtaining government grants or subsidies, and it is the same in furniture enterprises. Other factors were the lack of internal finance, lack of skilled employees, or too much competition in the market.

For some businesses, R&D is an occasional, rather than an on-going activity and it is therefore more difficult to identify and measure (Frascati Manual, 2015).

For long-term and sustainable economic development are innovation and R&D investments principal. At the national as well as sectoral level the Slovakia and wood processing lags the EU average and also V4 countries, the volume of innovative expenditures and R&D investments are at the low level. There are certain ways how this issue is possible to improve, recommended innovation culture linked with investment to human capital and technological investment. For wood processing innovation development, an innovation culture appears to be one of key factors. There is a need to promote training not only towards expertise, but especially the ability to specify the innovation strategy, to introduce an innovative corporate culture and to drive innovations (Kánová and Lesníková, 2021). The main priority for the development of the forestry and timber sector should be the modernization of technology in order to increase the efficiency of production, which would increase the competitiveness of companies in Slovak wood processing industry.

3. CONCLUSION

In terms of R&D expenditure in EU countries, Sweden is the best performer, the Czech Republic as the leader of V4 group is approaching the EU average, in contrast to Slovakia with low values. It is possible to evaluate positively the increasing trend of R&D investment in Slovak industry. Among wood processing branches, the furniture sector made the most significant R&D, however, with a declining trend. Low level of R&D investment is in the Wood, the Pulp & Paper have not been realised the R&D investment for a long time due to the high innovation costs, difficulties in obtaining grants or subsidies, but also missing innovation strategy, innovative corporate culture and driving of innovations.

Acknowledgements: We wish to thank the Slovak Research and Development Agency (grant number APVV-19-0612) and the Cultural and Educational Grant Agency of the Ministry of Education, Science, Research and Sport of the Slovak Republic (grant number KEGA 005TU Z-4/2020).

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MARKET OF WOODEN APARTMENT BUILDINGS

Vladislav Kaputa, Janka Táborecká, Miroslava Triznová, Martina Nosáľová

Abstract: Timber construction system is well known in Europe in case of residential houses. Dramatically rarely, wooden products are used in the construction of multi-apartment buildings. The paper focuses on the evaluation of the situation on the market of wooden multi-apartment buildings. It deals in more detail with the implemented projects and provides an overview of previous studies that focus on preferences, expectations, or consumer satisfaction in connection with buildings where engineered timber is used. The paper also introduces attitudes and preferences of Slovak consumers associated with the choice of (new) housing in apartment buildings.
Keywords: wooden apartment buildings, wooden multi-storey constructions, preferences, attitudes

1. INTRODUCTION - WOODEN CONSTRUCTIONS

The demand for wood has increased in recent years due to new technical possibilities and environmental concerns (Leszczyszyn et al, 2022). Simultaneously, issues regarding the low degree of efficiency and sustainability in the construction industry are highly discussed (Švajlenka & Kozlovská, 2020). Currently, wood is applied increasingly as a construction material rather widely across the EU countries. However, the development patterns of wooden housing do vary greatly by region in Europe (Anttonen, 2015). Wooden housing was always part of cultures. One of the examples is so called Swiss “chalet style”. In Norway, it transformed into the country’s national style when adding dragons (O’Leary, 2010). The English exported it to Jamaica and New Zealand, and to India, as the preferred style for colonial hill stations (Kennedy, 1996). In Europe, it became the style associated with leisure and tourism. (Cieraad, 2018). As Toppinen et al. (2018) states, the construction industry is usually not perceived to be an innovative business in meeting consumer expectations or transforming their core business models into consumer-driven ones. However, the industry has started to recognize consumers’ diversifying preferences. Recently, studies on consumer’s sustainability related choices towards green building have started to gain more ground.

Based on Lazarevic et al. (2019) study the lack of a shared vision for Wooden Multistorey Construction (WMC) is key attribute that is slowing down the development of this new sustainable trends in wooden housing. Also, Viholainen et al. (2021) study confirmed that lack of clarity of WMC is decelerate whole business ecosystem and that the barriers of collaborative ecosystem development include both the lack of clarity in the shared goals between actors and weak end-user involvement. The study introduces barriers such as “urgency and lack of time due to several overlapping projects”, “lack of communication within sub-groups” or “lack of shared understanding on sustainability aspects of material between business and end-users”.

The share of wood construction in total construction varies greatly between countries. The study of Leszczyszyn et al. (2022) conducted in European countries and Chile revealed that most of the end-users (consumers) understood the term “wooden house” as referring to a year-round single-family house. However, the perception of meaning varied depending on the respondent’s origin. Most respondents from the European regions indicated the above interpretation, while the Chilean respondents probably associate wooden houses with a summer house or a temporary housing solution. In Chile, the currently predominant building types, such as reinforced masonry houses and reinforced concrete buildings, are more often chosen because of – among other factors – their tested adequate seismic performance.

In the Nordic European countries, the rise of wooden multi-storey construction has turned out to be the most evident construction-related new business opportunity in the emerging bioeconomy (Topinnen et al., 2018). Currently, right in these forest-rich European countries, the development and acceleration of wooden multi-storey construction as a set of innovative building technologies has gained political support and attracted the public (Toivonen et al., 2021). In Finland, wood is a traditional construction material, and the predominant material in single-family and other detached and semidetached houses (Hurmekoski et al., 2018). There are ambitious objectives for the use of wood in public construction for the future, to improve the competitiveness of wood as a building material. While the share of wooden buildings in all public building construction was approximately 15% in 2020, this is expected to increase to 45% by the year 2025. Sweden is considered as a pioneer in the field of wooden multi-storey houses (Anttonen, 2015). The regulations have allowed the use of wood in large-scale constructions. Sweden strongly promotes wooden construction and aims to increase its share of multi-family houses (Leszczyszyn et al., 2022). According to their findings, there is a need to promote wood construction based on its technical and economic benefits rather than its societal ones. In Norway, wood has been a traditional construction material, importantly, the regulations have always allowed the construction of wooden three-storey houses. In Denmark in comparison to other Nordic countries, the construction tradition has been based more on the Central European traditions (Anttonen, 2015).

2. OBJECTIVE AND METHODS

The objective of the paper is to improve the understanding of consumer perceptions of Wooden Apartment Buildings. Literature review is the base of the paper. It is focused on the European market of wooden apartment buildings. Especially, studies on attitudes, satisfaction, and preferences of consumers for living in wooden apartment buildings are investigated. There is range of terms on wooden constructions for residential purposes used by different authors. In this paper, we use original term implied in each cited study.

The article also brings findings from the questionnaire survey of a sample of Slovak respondents. It focuses on preferences when choosing new home. To filter suitable respondents to this issue, we used an instrumental question: "Are you considering a change in housing, or, have you changed your housing recently? To distribute the questionnaire, we used the "snowball" method, where respondents are also the distributors of the questionnaire – sharing it through the social networking platform.

3. PERCEPTIONS ON WOODEN CONSTRUCTIONS IN GENERAL

While many countries have a political will and strategies to increase the use of wood in the construction sector, it is necessary to assess and understand the level of knowledge and preferences regarding these construction types. The research results of Leszczyszyn et al. (2022) indicate strong regional and cultural differences regarding the acceptance of some of the opportunities and barriers related to the development of wood construction. The most important factors turned out to be the guaranteed safety, quality, and durability of the structure, as well as its ecological sustainability. West European residents identified positive feedback from family, friends, or neighbours as important sources of motivation to choose to live in a wooden house, while Eastern and Southern European residents emphasized lower construction and/or maintenance costs. Northern Europeans appreciated the availability of modern building construction and design. In turn, for Chilean respondents, the most important incentive to live in a wooden house was a government subsidy for construction.

Viholainen et al. (2020) in their paper studied the citizens' views in seven European countries (Austria, Denmark, Finland, Germany, Norway, Sweden, and the UK). The results indicate that citizens across these different countries shared many similar views, although cross-country cultural differences were also present. The UK citizens were most often concerned about the suitability of wood as a construction material in their humid climate. Citizens of Finland, Norway, and Sweden were most approving of wood use, likely because of the strong tradition of building with wood and the availability of domestic raw material. Citizens of Austria, Denmark, Germany, and the UK were concerned about responsible forest management practices as a prerequisite for accepting wood as a construction material.

According to study of Lähtinen et al. (2021), consumers in the Nordic region are similar in their housing value expectations and prejudices against building with wood, but the urban consumers are the most prejudiced against wooden housing. This study reveals that especially consumer housing values for life-cycle ecological sustainability, materials and urban lifestyle were very similar for Nordic countries. On the other hand, for more culturally dependent issues, as "perceptions on aesthetics and natural milieus", more differences were detected. The research of Nagy et al. (2021) studied consumers´ perspective on wooden multi-storeyed buildings (representing approximately 10% of newly built multi-story houses in the Swedish housing system). The aim was to contribute to an understanding of this matter that may lead to a social acceptance of the forest-based bioeconomy and to Swedish consumer awareness of the concept and of a particular product (wooden multi-story buildings) representing the forest-based bioeconomy. The results show consumer awareness of forest sequestration capacity but less awareness of the connection to the forest-based bioeconomy and the role of wooden multi-story buildings.

Young adults in Sweden are looking on following attributes: low price; proximity to public transportation, balcony, feeling of safety, proximity to shops and services. they have strong desire for having a feeling of safety around a dwelling. Results reveal that sustainability aspects play insignificant roles in a housing decision of young adults in Gothenburg region (MIJIN, 2020). However, according to results sustainability is not strong attribute of housing decision among young adults, it is indisputable that many, especially young consumers, care about the value and tend to show great loyalty towards a company with sustainable products and services (MIJIN, 2020).

In contrast to the very positive image of wood in general, wood for construction purposes is viewed with some ambiguity. In general, the image of wood as a building and construction material is positive among consumers in many European countries, although it is less positive than for other end-uses like furniture (UN-FAO/ECE, 2007). Petruch and Walcher (2021) explore the attitudes towards timber construction among young millennials in Austria. Although that timber construction is generally perceived positively, a clear disparity existed between the mostly advantageous assessment of timber construction against other construction methods and the actual willingness to build with wood. Only 14% thought that multi-story buildings should be increasingly built out of wood. The positive perception of wood as a building material is not always equal to a willingness to live in multi-story wooden buildings. More positive attitudes are to living in partly wooden construction, where according to Karjalainen (2021) the residents' attitudes towards wooden facade renovation and additional floor construction were generally positive, most of the surveyed residents considered that wooden facade renovation and additional floor construction would increase the attractiveness of residential areas. According to the study made by Lähtinen et al. (2019) in Finland, there are two main consumer categories based on their perceptions of sustainability benefits of wood: the ones favouring ecological and physio-technological benefits of wood and the ones favouring aesthetic and well-being benefits of wood.

Australian study (Marfella and Winson-Geideman, 2021) was focused on perceptions among the broader pool of relevant stakeholders towards Engineered Wood Systems (EWS) as structural alternatives or complements of traditional materials, such as steel and concrete. A nation-wide survey with stakeholders at the forefront of adoption in structural design, construction, and property development, indicates that the demand for timber in multi-storey projects has promising prospects of growth, but faces circumstantial industry-wide hurdles in the short to medium term. Awareness of benefits and inclination towards more use of timber among designers are positive factors that provide a promising base for further adoption. The translation of positive front-end design attitudes into adoption, however, requires holistic long-term investment efforts with industry-wide education. The pathway to innovation for timber in multi-storey projects needs to grow beyond mere promotional strategies of its benefits, seeking to expand technical knowledge through education and reaching out beyond a group of already committed and knowledgeable stakeholders at the forefront of adoption.

4. WOODEN APARTMENT BUILDINGS

During the last two decades, the timber building sector has experienced steady growth in multi-story construction. Svatoš-Ražnjević et al. (2022) claimed that there has been a growing number of research focused on trends, benefits, and disadvantages in timber construction from various technical perspectives, but there is no extensive literature on the trajectory of emerging architectural typologies. Their study examines the architectural variety and spatial possibilities in current serial and modular multi-storey timber construction by analysis of 350 multi-storey timber projects built between 2000 and 2021. It's not just a matter of wood. Their study reveals that steel and concrete, as well as additional structural elements such as beams or combinations of structural systems, are present in the multi-storey timber buildings.

Although the consumer perceptions of the environmental quality of wood can be identified, the practical meaning of environmental attributes can still be vague for most consumers. Consumers consider the environmental quality of wood to be important (Toivonen, 2012). According to the study of Hoibo et al. (2015), some respondents, especially the younger ones prefer wood, including some applications in apartment blocks where wood is currently not commonly used. Younger people with strong environmental values are the best target for increasing wood-based urban housing (Hoibo et al., 2015). A new generation that is considered more environmentally friendly is on the rise. From the perspective of the forest-based industry, this presents a great opportunity to place wooden practices in the minds of future generations as a way to build or renovate in the future (Karjalainen, 2021). But on the other hand, it is mainly younger people, who generally brought up more sustainability-related concerns regarding multi-story timber constructions (Toppinen et al., 2018).

The study of Nyttel (2022) deals with young (Swedish) consumer perceptions of Wooden Multistorey Construction (WMC). It shows that they did not consider the material of construction to be important when considering an apartment purchase. Location and price were of greater importance and associated with values of well-being, safety and freedom. Aesthetic appeal of WMC-apartments was mainly perceived, and they connected this attribute with the value of well-being. WMC-apartments were also considered to be environmentally sustainable what is connected to reducing climate impact and the value of universalism.

5. RESULTS OF THE SLOVAK SURVEY

To enrich the introduced topic, we present selected results of our survey of preferences for living in apartment buildings. The final sample consisted of 52 respondents. Out of a total sample of 194 respondents, it represents 27% of those who in the long-term view prefer to live in an apartment (compared to living in a family house). As a location, all respondents preferred the city (city centre or suburb) over the rural alternative. The main reasons were: i) availability and quality of infrastructure (hub of schools, medical care, and municipality services), ii) leisure opportunities, iii) work perspective and availability of jobs.

By far the most frequent advantage of living in an apartment was "the apartment is less demanding (for maintenance and care) compared to the house". The less frequent reasons were "more attractive real estate location" and "lower price". Brick followed by concrete (or aerated concrete) are the most preferred construction materials for a new apartment building. No negative attitude was noted towards these two materials. Wood and wood composites followed, even though modern wooden buildings are still unknown in Slovakia. In the survey, this construction material had higher preferences than the steel construction. Several negative attitudes have been reported with both materials.

In addition, we list the most important factors considered by respondents when planning the reconstruction of the apartment. They mentioned the aesthetic aspect (home design) as the most important. This is followed by the service life of materials and equipment and the minimization of costs. They consider the environmental suitability of materials and equipment used, their safety (including health security), maintenance intensiveness and, finally, the speed of reconstruction to be less important factors..

6. CONCLUSIONS

The markets of European countries using wood as a construction material have both – similarities and differences. The preferences vary from the age and location. A positive perception of wood does not automatically result in a willingness to live in multi-story wooden buildings. To identify the target group of consumers for wood-based urban housing, current studies point to young people who have unconventional approach to innovative things.

In this generation those with strong environmental values are concentrated. Studies showed that even in the generation of millennials, a positive attitude towards wooden structures does not clearly lead to a willingness to live in them. If we consider the entire population, it is necessary to be aware of the benefits we want to highlight to the consumer in marketing communication: ecological and physio-technological or aesthetic and well-being benefits. As a compromise solution, mixed materials constructions appear to be acceptable to a wider range of residents.

Acknowledgements: The authors would like to thank the Scientific Grant Agency of the Ministry of Education, Science, Research and Sport of the Slovak Republic, grant No. 1/0475/22 "Environmental consumer and environmental citizen", grant No. 1/0495/22 "Sustainability of Value Supply Chains and its Impact on the Competitiveness of Companies in the Forest and Forest-Based Sectors" and grant number 1/0494/22 " Comparative Advantages of the Wood Based Sector under the Growing Influence of the Green Economy Principles". This publication is also the result of the project implementation: Progressive research of performance properties of wood-based materials and products (LignoPro), ITMS: 313011T720 supported by the Operational Programme Integrated Infrastructure (OPII) funded by the ERDF.

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MODEL FOR CRISIS MANAGEMENT IN THE FOREST SECTOR OF BULGARIA

Damyan Kirechev, Emiliya Kirecheva

Abstract: In the context of the deepening economic crisis and the deterioration in the quality of natural resources, forests and the forestry sector face a number of threats: increasing pressure on forests for energy production; deforestation for agriculture; increasing illegal logging and timber trade; deterioration in the quality of forest resources; increasing frequency of forest fires, etc. The forestry sector in Bulgaria is facing serious challenges related to overexploitation of forest resources. Based on a theoretical analysis of crisis management, a model for crisis management in the forest sector in Bulgaria is proposed. The main risks generating crises are outlined and practical solutions and mechanisms to overcome them are proposed. The thesis advocates the need for the implementation of adequate models for crisis management in the forest sector in order to combat climate change, protect biodiversity in forest ecosystems, in the context of the European Union's Forestry Strategy 2030.
Keywords: crisis, crisis management, forests, integrated model, disasters

1. INTRODUCTION

The forest territories in Bulgaria at the end of 2020 amount to 4.27 million ha (38.4% of the country's territory, of which 3.92 million ha are forests) (35.3% of the country's territory) (MZH, 2021), 73% of forests and 4.3% of protected forests are owned by state farms. Forests in Bulgaria have a modest contribution to the economy (only 0.3% of gross value added), but are of great importance People are dependent on forests because they are the source of many ecosystem services and the natural habitat of many species, and human activities in forests provide food and material resources for the economy. carbon, forests have an important role to play in mitigating climate change, so maintaining and protecting the health of forests is largely crucial to human prosperity.

Currently, forests around the world are under severe pressure as a result of intense human activity and natural disasters. In addition, changes in the environment and climate are putting increasing pressure on the quantity and quality of ecosystem services provided by forests. According to the FAO (FAO, 2022), forest loss has accelerated in recent decades as a result of increased exploitation of forest resources due to increasing extreme natural and meteorological phenomena. This calls for conservation and maintenance actions for future generations.

Changes in the environment in which forests operate have a full impact on companies operating in the forestry sector. According to the data of the Executive Forest Agency, the number of licensed logging operators is about 3 thousand companies and over 8 thousand individuals. The number of timber processing enterprises is over 1,200, producing almost EUR 400 million (4,5 % of industrial production) and employing over 12,500 people. The logging process in Bulgaria is characterised by a low level of technical and technological equipment - old machinery, insufficiently qualified workers, low labour productivity, poor transport infrastructure. Wood processing enterprises are technologically developed - mostly small and medium-sized enterprises.

In the current dynamic conditions, the market economy, the competitive environment, the changes in the policy and the legislation, the state regulation of the processes and other environmental factors create conditions for the manifestation of crisis phenomena in the forest sector. At the same time, the forestry sector is constantly exposed to natural and climatic risks that disrupt the viability and sustainability of logging and processing organizations. This requires improvement of the management system in the long run, creating conditions and prerequisites for the implementation of preventive actions in connection with potential crises. The high frequency of crises is a consequence of the dynamism and turbulence of the environment, which determines the significance of the problem. In this sense, the purpose of the report is to analyse the main risks of crises and the crisis management system. This is a reason to propose a principled model for effective crisis management, with an emphasis on preventive action against crisis situations and selection of an appropriate strategy for overcoming the crisis. The study proposes a strategic approach to management processes, given the importance and long-term vision of management decisions made by management in crisis situations.

2. MANIFESTATION OF CRISES AND CRISIS MANAGEMENT

2.1. Concept of "crisis" and crisis management"

The manifestation of the concept of "crisis" has profound dimensions and have been the subject of theoretical research from antiquity to the present day, undergoing various historical transformations over time. Etymologically, the term "crisis" is associated with concepts such as "danger". In English-language literature, the terms "crisis", "emergency" and "disaster" is used to distinguish crises. "A 'crisis' can be seen as 'an event that is expected to lead to an unstable and dangerous situation affecting a particular person, group, community or society as a whole'. "Emergency" is manifested as "an extraordinary situation that may cause changes". The term "Disaster" includes physical crises of a natural or technological nature that result in sudden and catastrophic changes. It can be assumed that the content of these concepts gradates as a consequence of the strength of difficulty and complexity of the problems they create. As part of the systems of society, the object of attention in the second half of the 20th century became the "crisis in organizations" or "organizational crisis". In the broadest sense, this means a process that threatens the existence of the organisation. To summarise, it can be assumed that a crisis is any event involving danger and leading to instability in which urgent and important decisions have to be taken.

P. Shoemaker (Schoemaker, 1997) notes that crisis management is a multidisciplinary process. The theoretical concept of crises is based on many sciences - management theory, psychology, sociology, economics, etc. Crises cause the need for change by affecting the behaviour of organizations and individuals within them (Zafirova, 2014). The concept of crisis management has had a steady evolution over time, especially in the last four decades depending on changes in the environment. R. Littlejohn (Littlejohn, 1983) was the first to offer a scientific explanation for crisis management and assumed that crisis management should consist of a systematic approach so that the organization continues to function normally in its activities. Mitroff & Kilmann (Mitroff & Kilmann, 1984) added that the planning process teaches the organization how to deal with hazards more effectively and perceived crisis management as a never-ending and continuous process. An in-depth study of the crisis management process is a Stephen Fink's monograph (Fink, 1986). A comprehensive and encompassing definition of crisis management is by Shrivastava, Mitroff, Miller& Miglani (Shrivastava, et al., 1988) as a process with a holistic approach that identifies the potential impacts that threaten the organization and is a framework for ensuring sustainability and an effective response that protects stakeholder interests, reputation, brand and organizational values. American scholar T. W. Coombs (Coombs, 2007) explains crisis management as a set of factors designed to combat a crisis in order to reduce the damage done. According to Coombs, crisis management is a process involving four stages: 1) prevention (attempting to prevent or avoid the crisis); 2) preparation (diagnosing crisis vulnerability); 3) response (applying and implementing actions, testing the crisis); and 4) revision (evaluating the actions and reactions to the crisis). It can be summarized that crisis management is a process in which an organization mobilizes its efforts in solving a serious problem threatening stakeholders or society.

2.3. Crisis management in the forest sector

Crisis management and forest sector organizations have been relatively less studied in the academic literature in recent years. The literature search revealed few major studies on the topic. Greger, Figuric & Posavec (Greger, et al., 2003) analyze the application of crisis management in forestry and wood processing industry. Posavec, Greger & Figuri (Posavec, et al., 2003) offer a mechanism for Business analysis as an instrument of crisis management in forestry and wood processing. Jonkov, Ivanova § Grigorov (Jovkov, et al., 2005) identify symptoms of crisis in forestry management in Bulgaria and suggest a direction of removal the symptoms of crisis in forestry management in Bulgaria. Carina & Keskitalo (Carina & Keskitalo, 2011) draw attention to the need to implement a crisis plan in relation to the adaptation of the forestry sector to climate change. Kotiaho, Ollikainen, & Seppälä (Kotiaho, et al., 2017) address sustainability issues in the EU forestry sector. Jumiyati et all (Jumiyati, et al., 2019) draw attention to changes in land use that can lead to crises in the agroforestry complex. A more in-depth study on the management of economic crises in the forestry sector has been done by Panyavina, Rafailov & Vovchenko (Panyavina, et al., 2019), which identify factors influencing the occurrence of crisis situations in forest enterprises and propose the use of indicators to determine the limits of crises in organizations. Key issues of risk management in the woodworking companies are analysed from Nováková, Pauliková & Čekanová (Nováková, et al., 2017).

Crises in the forest sector can be analysed at the organisational and sector level. The environmental changes that can lead to crisis situations are based as a variety of factors. Panyavina, Rafailov & Vovchenko identify two groups of factors determined by the environment:

1) External environment factors - based on changes in the economy, changes in the market. Additionally, factors related to politics, legislation, competition, etc. can be mentioned.
2) Factors of the internal environment - related to management, production, investment, marketing activities, finance, etc.

Forest disturbances can also result from catastrophic disturbances and intense human activity. Climate change can affect the frequency and intensity of extreme weather events and lead to forest disturbances. Natural disturbances may occur mainly as a result of forest fires, droughts, floods, insect outbreaks, which may intensify in the coming years. In recent years, forest fires in Europe (especially in southern Europe) have become increasingly destructive (SURE, 2020), (FOREST EUROPE, 2020). The size and intensity of forest fires, combined with a lack of knowledge and management tools, make them difficult to control. Prolonged drought increases the level of fire danger. Drought fires and windstorms are stimulating unprecedented bark beetle outbreaks in many European countries, degrading forest quality. Additional pressure on forests can come from the introduction of invasive species and pests that are spreading due to climate change and international trade. Additional stresses on forests are caused by intensive human activity - deforestation linked to land use changes, illegal logging, etc.

3. MODELS FOR CRISIS MANAGEMENT IN THE FOREST SECTOR

Over time, different models of crisis management have appeared in the literature and in practice, some of them based on the classification of crises, others on the stages of their life cycle, others on their forms, etc. The following distinction can be made: some models cover the entire process from crisis prevention to crisis exit or liquidation (starting before the crisis occurs), while other models describe the procedures from the onset of the crisis to its end. The approaches applied in crisis management models are based on process or event. - the process approach or the event approach:

1) The traditional approach to the event focuses on the reaction (response) when the crisis started. Such functional activities are critical to successful organizational crisis response and recovery. The application of this approach in the forest sector is appropriate for crisis management at the sector level to address the consequences of adverse events occurring in forests primarily as a result of catastrophic disasters).
2) The process approach reinforces the belief that managers should take measures to avoid crisis. This allows the perception that crisis management is a continuous managerial process. The process approach to management is more applicable to overcoming organisational crises in the forestry sector.

One of the earliest models of crisis management in organizations was Steven Fink's model (Fink, 1986), which identified four stages of the crisis life cycle: 1) Pre-crisis phase (crisis symptomatology); 2) Acute phase (crisis manifestation); 3) Chronic phase (continuing effects of the crisis); 4 Crisis resolution (exiting the crisis once it no longer affects stakeholders). According to Fink, the role of managers is to recognize the warning signs of crisis.

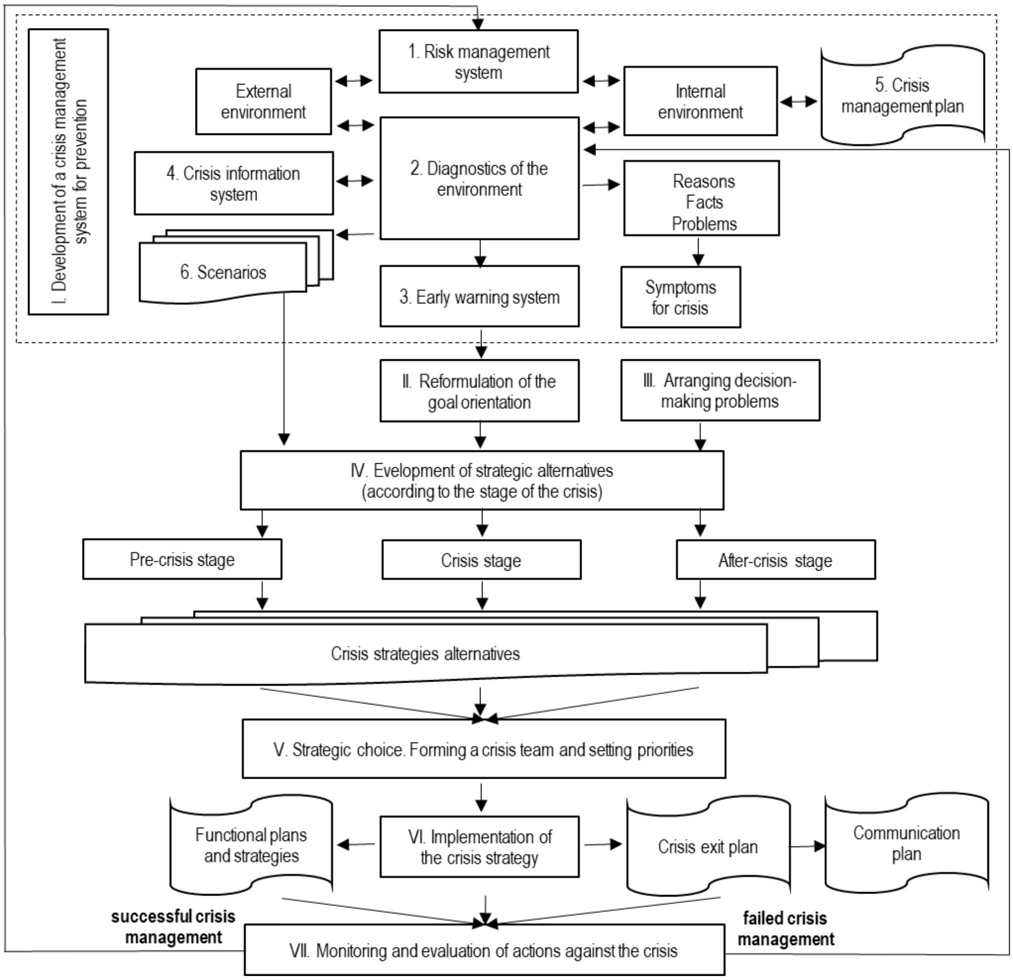
The model of Mitroff, Shrivastava & Uduevidia (Mitroff, et al., 1987) is considered as one of the first basic models for crisis management. The model focuses on the causes of crises and the derivation of options for preventive action. Mitroff (Mitroff, 1994) later developed the model further by dividing the crisis management process into five phases: 1) signal detection; 2) investigation and prevention; 3) damage limitation; 4) recovery; and 5) cognition.

An integrated relational model for crisis management is that of T. Jaques (Jaques, 2007), which is based on the notion that crisis prevention and crisis preparation are part of the overall crisis management process. He includes four stages in his model: 1) crisis preparation; 2) crisis prevention (prevention); 3) crisis management; 4) post-crisis management.

Most existing models focus on crisis prevention, not just crisis response, which requires continuous analysis and assessment of the potential for crisis. Organizational crisis management is mostly based on the process approach and the concept of the crisis life cycle. This gives rise to the interdisciplinary nature of the crisis management process.

3.1. An integrated model for crisis management in organisations

The development of an integrated model for crisis management in organizations is based on the strategic approach. The focus of its application is the definition of a crisis organizational strategy and is based on the prevention and management of crises. Crisis management can be based on a corporate or functional unit.



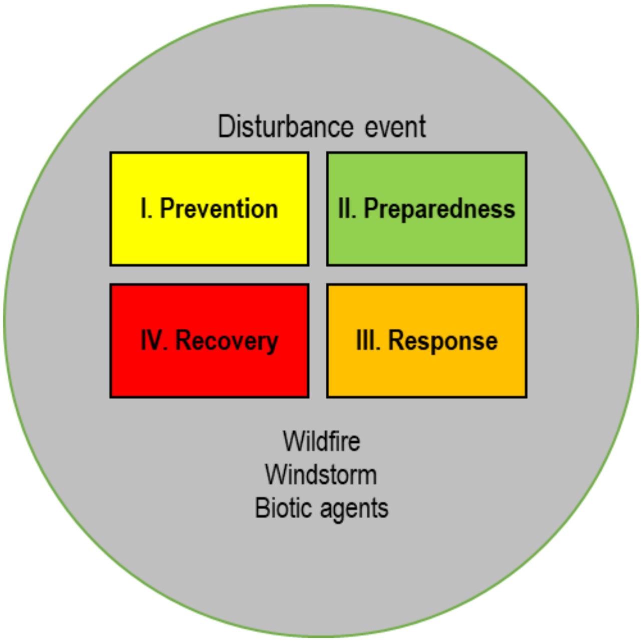
Adapted from: (Zafirova, 2014)

Figure 1. Concept for an integrated model of crisis management

Organizational efforts should be directed at preventing failures and incidents as well as adverse changes with the micro environment. Safety measures and improving the use of resources are crucial so that organizations can more easily deal with potential crises. The model presents only those activities that affect forest sector organisations, which are typical and have a link to the strategic management process and are well received in practice. The model is based on the respect of several principles: systematic and continuous stages; equivalence of operational and strategic decisions; definition of clear criteria, approaches, factors and indicators; manageability of processes; proposing multivariate solutions, etc. The application of such an approach requires a perceived need for its implementation; the availability of specialists with professional knowledge, skills and competences; and the sufficiency of information for decision-making. Although the model is conceptual and systemic in nature its implementation can have a universal effect in forest sector organizations (Figure 1).

3.2. Management model of disaster crisis

Crisis management in the forest sector related to natural disasters can be studied independently. The European Forest Risk Facility (SURE, 2020) proposes four stages in the forest disaster crisis management cycle (fires, storms, pests) presented in Figure 2:



Adapted from: (SURE, 2020)

Figure 2: Phases in the crisis management cycle for disaster risk reduction in forest

Within these crisis management phases, the following activities can be implemented:

1) Prevention - implementation of adapted forest management; implementation of fire-fighting activities; fire felling and other forest protection measures; strengthening of surveillance; maintenance of fire-fighting equipment; creation of favourable infrastructure; preparation of forecasts for the occurrence of pests and elements; awareness of the population, etc.

2) Preparedness - implementing contingency plans related to disruptive events; keeping trained individuals ready to take action; maintaining infrastructure; improving capacity of institutions and municipalities; maintaining regular monitoring, etc. In line with the Strategic

Development Plan for the Forest Sector 2014-2023, a Forest Fire Protection Programme has been developed in accordance with national legislation. Forest fire protection activities against pests are reported with internal legislation.

3) Response - implementation of specific activities undertaken in the course of the disaster - fire suppression; removal of abandoned wood; logging; pesticide treatment, integrated pest management, etc. Actions can vary depending on the severity of the disaster and the organisation set up.

4) Restoration (return to normal conditions) - through afforestation, reclamation, etc.

In Bulgaria, legal and organizational conditions have been created for prevention and maintenance of forests from disasters, but there are still serious problems mainly with shortage of people, technical means for firefighting, financial problems, monitoring problems, etc.

Effective crisis management in the forest sector can play a significant role in mitigating disaster risk, ensuring sufficient crisis management capacity and enhancing forest resilience.

4. CONCLUSION

Crisis management in the forestry sector is systemic in nature and is implemented at both the organisational and forestry sector levels. In the theory and practice of crisis management, there are diverse models for crisis and disaster management. In a dynamic external environment, the forest sector is affected by crises that lead to disruptions in the viability and sustainability of forest holdings. The role of introducing preventive actions to mitigate crises and adverse events is expanding and the responsibility for crisis responses is increasing.

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ENVIRONMENTAL MANAGEMENT SYSTEMS IMPLEMENTATION IN THE CROATIAN WOOD INDUSTRY

Kristina Klarić, Josip Graho, Lucija Marković

Abstract: The ISO 14001 standard is today the most widely used indicator by which organizations around the world want to communicate to the public and stakeholders that they are environmentally responsible. This standard sets out the requirements for the certification of environmental management systems and is intended for organizations that seek to manage their environmental responsibilities systematically. In this paper, the certification of the environmental management system according to the ISO 14001: 2015 standard in the wood industry of the Republic of Croatia is investigated. The paper used the primary data collected by the survey questionnaire. The content of the questionnaire referred to the motives for the implementation of the ISO 14001 standard, as well as its benefits and obstacles. Secondary, financial data from the Bisnode database were also used to analyse profitability. The collected financial data of certified organizations were then compared with the averages of the relevant sector and the overall economy within the Republic of Croatia. The results showed that the main motive for the implementation of the ISO 14001 system is to improve the image, the biggest benefit of the implementation is to achieve a competitive advantage, while the high costs are the biggest obstacle to certification.
Keywords: ISO 14001; benefits, obstacles; motives; wood industry

1. INTRODUCTION

With the rapid development of industry and the emergence of environmental awareness, the need for the development of a standard that would serve to improve the environmental management system arose. The British Standards Institution (BSI) published the environmental management system standard, BS 7750, in 1992, which is seen by many as the inspiration for ISO 14001 Environmental Management Systems standard (Inoguchi *et al.*, 1999; ASQ, 2022). Accordingly, in 1996, the standard ISO 14001:1996 was adopted and published and since then the standard version has undergone several revisions. Since its establishment in 1996, the ISO 14001 standard has been revised twice: in 2004 and 2015. The 2004 version of the standard, contained only marginal changes compared to the first version of 1996; however significant change of the contents of the standard occurred during the next revision in 2015 (Bravi *et al.*, 2020), and that version is currently in effect.

Since its publication in 1996, the ISO 14001 has been implemented in almost 350,000 organizations in 195 countries worldwide (ISO Survey, 2020). This standard for environmental management systems has been on the rise ever since its publication, but in some time periods declines are recorded. A decline in the number of certificates was in 2008 due to the Great Recession. There was also a significant decline in the number of certificates during the last transition period of the last revision of the standard (ISO 14001:2015). The rate of increase for 2020 has been greater compared to previous years with + 12 % mainly due to an important increase in China (ISO Survey, 2020) almost half of the total number of certificates is from China. Trends in the number of certificates in the sector of wood and wood products have largely followed the trends in the total number of certificates, so the financial crisis and last revision manifested themselves in a declining trend in the number of certificates (Figure 1).

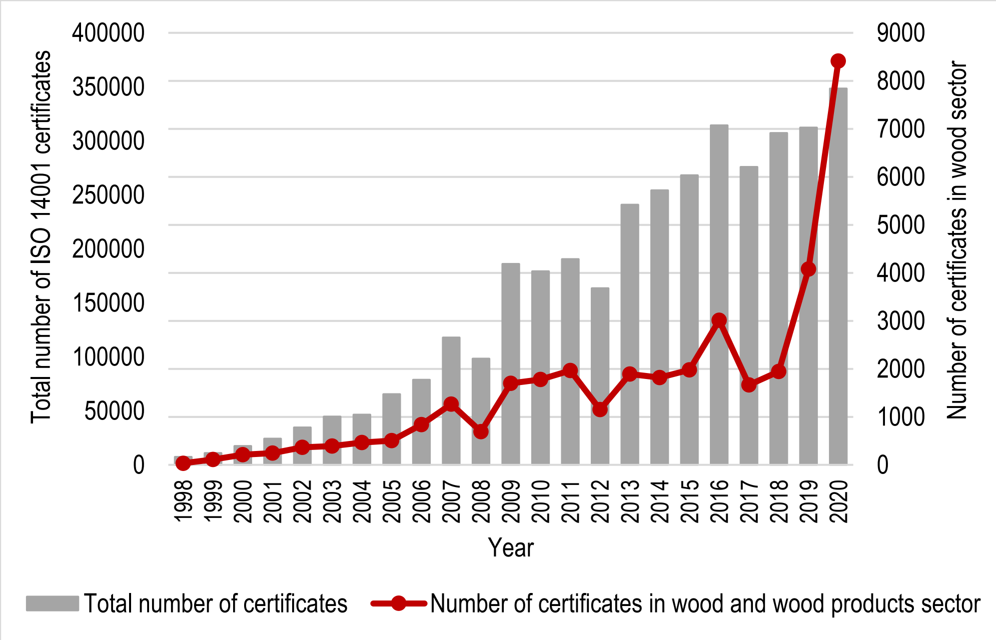

Figure 1. Number of valid ISO 14001 certificates in total and in the wood sector

The ratio of the number of certificates in the sector of wood and wood products to the total number of certificates ranges from about 0.4 % to about 2.4 %. This indicates that organizations within that sector did not show much interest in implementing the most well-known and widespread standard for environmental management. Furthermore, in the Republic of Croatia, the number of certificates in the wood industry sector is relatively small compared to the overall ISO 14001 certification. The percentage of certification in the wood industry concerning the overall certification ranges from approximately 0.5 % to approximately 1 %. The data clearly show that organizations within the wood industry have not accepted the principles of sustainable development and environmental management systems, and this trend should be influenced to increase the implementation of the standard in organizations within the wood sector.

This paper investigates the certification of environmental management systems according to ISO 14001: 2015 in the wood industry of the Republic of Croatia. It will be explored the impact of the standard implementation in organizations, their satisfaction, and possible business improvement. The relationship between the financial data of certified organizations and the sector average and the overall economy will be explored as well to determine the impact of ISO 14001 certification on business.

2. MATERIALS AND METHODS

Primary data were collected by a questionnaire on a sample from wood industry sector organizations in the Republic of Croatia that are holders of ISO 14001 certificates. The questionnaire was divided into 6 parts: general data; other certificates; motivation for implementation; barriers to implementation; the impact of the outbreak of the SARS-CoV2 virus on business (Corona crisis). Questions regarding ISO 14001 were based on a five-point Likert scale, where 5 represents the highest importance and 1 the lowest importance. The survey was sent by e-mail to respondents and was conducted in the period from May 20, 2021, to August 2, 2021. Out of 16 certified organizations, 10 participated in the research. The Bisnode financial database was used for analysing the financial performance of certified organizations. The following financial indicators are used: Earnings before interest and taxes – EBIT; Efficiency of total equity – EU; Return on Assets – ROA; Return on Equity – ROE; Return on Sales – ROS.

3. RESULTS

According to Figure 2, it was shown that the respondents rated the image improvement factor as the biggest reason for implementation, which shows that the main motive for implementing the ISO 14001 standard was to achieve a better image compared to competitors. It is important to emphasize that the organizations believe that one of the main motives was of an environmental nature, *i.e.* the organizations emphasized that waste reduction was the motive that initiated the certification process. Access to green procurement is a motivating factor for the implementation of the ISO 14001 system with the lowest average score. This points out that in the Republic of Croatia environmental policies are not sufficiently developed, and implemented that would lead the economy to the development of environmental protection systems.

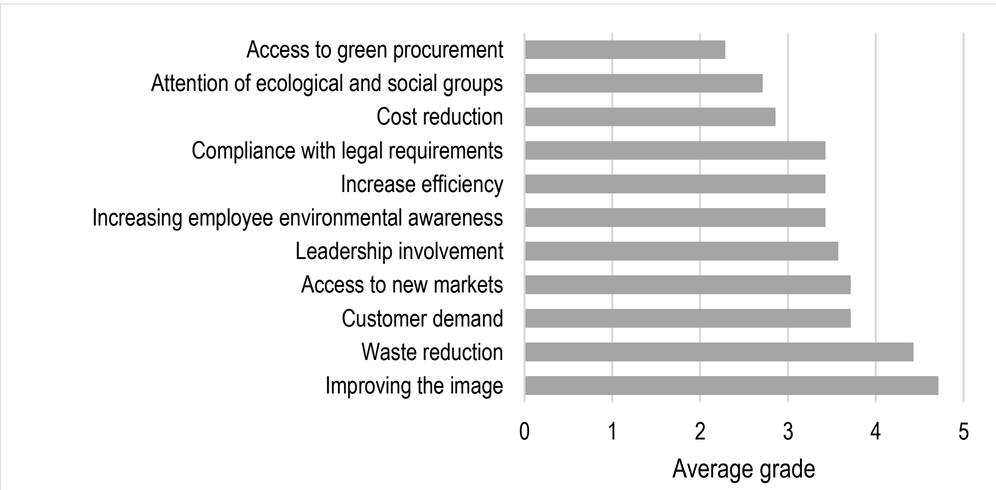

Figure 2. Reasons for ISO 14001 certification

Regarding the benefits of implementation (Figure 3), respondents answered that achieving competitive advantage and improving processes and procedures were the biggest benefits of implementing ISO 14001. It can also be seen that organizations believe that implementing the standard can bring many benefits, such as facilitating compliance with legal requirements, improving the work environment and improving product quality. Among the lowest-rated benefits of ISO 14001 implementation are cost reduction, increasing productivity and/or efficiency and achieving financial benefits. Due to the above-mentioned, it is clearly evident that organizations do not consider that the ISO 14001 standard implementation reflects positively on finances.

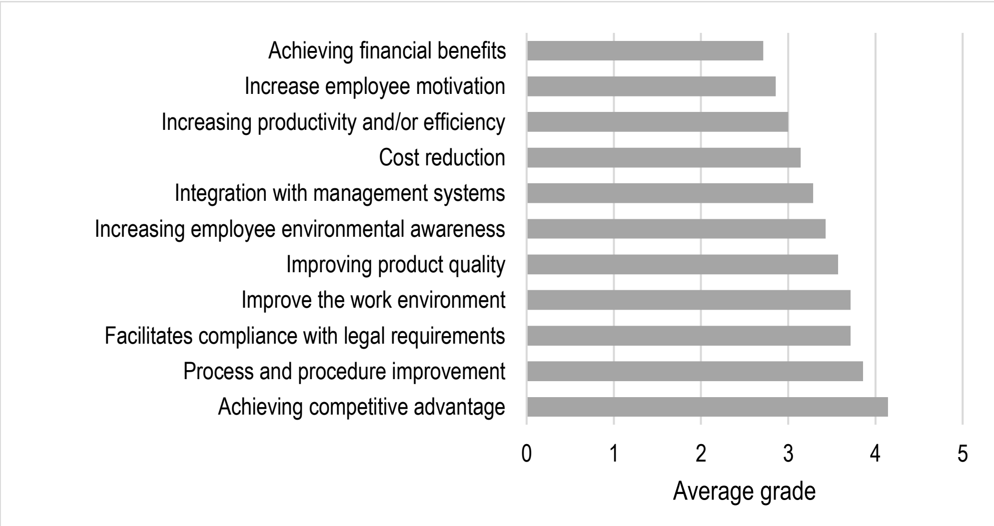

Figure 3. Benefits from ISO 14001 certification

Despite the many benefits that have motivated organizations to be certified under the standard for environmental management systems – ISO 14001, there are obstacles to certification that many organizations encounter. In Figure 4, it can be seen how organizations perceive that there are several obstacles to ISO 14001 certification, as many as four obstacles have a mean score above 4.0. Thus, the two biggest obstacles are related to financial factors; the biggest obstacle is the high costs to be paid to the certification body, and the second reason is the high costs that the organization has to bear in the case of implementation of the ISO 14001 system. Furthermore, the main obstacles are related to higher costs of certification, consultants, and implementation costs in general, but also to too extensive certification documentation that may refuse organizations to implement the standard. The obstacles that the respondents considered the least important are lack of knowledge about implementation and availability of materials for implementation.

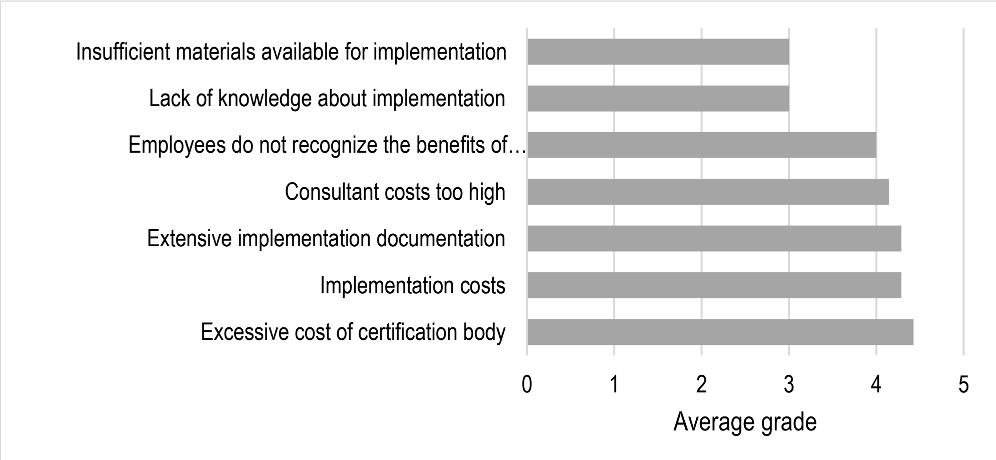

Figure 4. Obstacles during the implementation of ISO 14001

The survey was conducted during a pandemic caused by the spread of the SARS-CoV2 virus, and 86 % of respondents said they were affected by the Corona crisis. Out of the total number of certified organizations surveyed, 71 % took financial support for entrepreneurs to preserve jobs. Only 14 % respondents took a COVID-19 loan, while 15 % said they did not take any form of financial support, stating that they did not were affected by the Corona crisis.

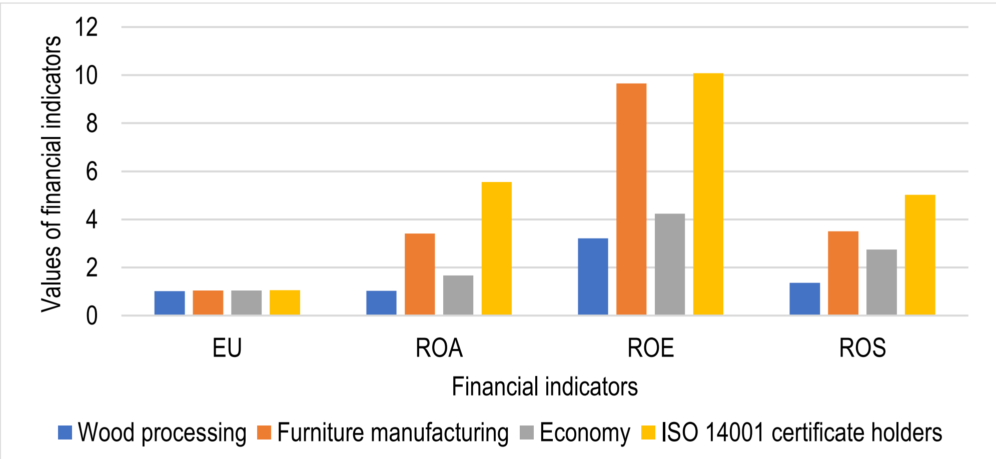

Figure 5. Financial performance of certified organizations

A comparison of selected indicators of financial performance of ISO 14001 certified organizations with the sector of wood processing, furniture production and the economy as a whole is shown in Figure 5. ISO 14001 certified organizations have higher values in most financial indicators. This leads us to the conclusion that these organizations have better financial performance. Although the financial results of certified organizations are better, the results should be taken with a grain of salt as the number of certified organizations is very low.

3. CONCLUSION

According to the primary data from the survey, we can conclude that organizations believe that the ISO 14001 certificate has a positive effect on the awareness of their employees and company management for environmental protection, and believe that the certificate also gives them an advantage over non-certified organizations in terms of improving competitiveness. For these reasons, for most organizations, improving their image and gaining an advantage over competitors was one of the main motives for conducting the certification process. Despite the many benefits of ISO 14001 certification, there are obstacles to implementation, and most of all are reflected in the financial side of certification. Most organizations state that not only the costs of implementation are too high, but also the costs of consultants and certification bodies. These results are quite interesting, because the results of financial performance of ISO 14001 certificate holders are better than the wood industry and the economy as a whole. It should be noted that the motivation factor for the implementation of the ISO 14001 system related to access to green procurement has the lowest average score compared to other factors. This tells us that in the Republic of Croatia we do not have sufficiently developed and implemented environmental policies that would lead the economy to the development of environmental protection systems. In the Republic of Croatia, there is a very small number of ISO 14001 certified organizations in the wood industry sector, so the sample of research was very limited. In relation of abovementioned, it would be good to repeat this research if the number of certified organizations in the Republic of Croatia increases.

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POSSIBILITIES OF BEECH WOOD COLOUR MODIFICATION BY STEAMING IN THE PRODUCTION PROCESS

Jarmila Klementová, Ivan Klement

Abstract: The colour of wood is one of the basic requirements in the selection and product demand of customers. This feature is characterized by the visual aspect of wood and its importance increases in the production of furniture, musical instruments and other products made from wood. The article deals with colour modifications of beech wood by atmospheric steaming process. Steaming process is one of the ecological ways of changing the colour of wood without any chemicals. Because of this fact, colour changes arising from the steaming of beech samples using different initial moisture content and different thicknesses of the experimental samples were measured and evaluated. The colour change was measured by using device Colour Reader CR-10 and graphically evaluated using the program Coloroid. These data are relevant knowledge in terms of the reverse of market requirements into the production processes.
Keywords: organic products, colour modifications, beech wood, hydrothermal treatment, steaming

● INTRODUCTION

The wood is one of the oldest and most popular natural materials with versatile use. For its properties, it is used in various industrial sectors. In recent years the interest in the massive wood furniture has greatly increased. The hydrothermal treatment of wood by steaming is the technical operation which changes its characteristics remarkably (Trebula, Klement, 2002). The result of steaming highly depends on the wood species. Wood colour depends on many parameters, such as species, age and grain direction as well. The surface colour change of wood during steaming is essentially due to the chemical reactions of the accessory compounds and cell wall components (Klement, Vilkovská 2019). Most woods darken in colour after steaming and the discoloration increases when wood is dried at elevated temperature. Dominant impact on final shade has initial moisture content, temperature and steaming time as well. In this paper, the issue of the influence of the initial moisture content of the beech wood on its colour change by the atmospheric steaming is solved. (Klement *et al*. 2019) This colour change is remarkable and is required because it is an ecological method, free of the chemicals and pigments (Tarmian et al. 2011). At present, this trend and demands for the use of natural materials and technologies are increasing. The customers increasingly demand environmentally friendly material for the furniture and accessories in their interiors. It is suitable for the production of furniture, as well as kitchen accessories, in direct contact with the treatment and consumption of food. This technological modification of the colouring, highlights the natural beauty of wood as a natural material. (Klementová *et al*. 2016) The hydrothermal treatment of the wood is the process by which the combined effect of the action of heat and steam, or water are applied to the wood. There are changes of its physical, mechanical and chemical properties. The changes in the properties may be temporary or permanent. The wood colour changes associate with chemical changes of the lignin as well as with the reaction of the products of degradation of polysacharides and extractives (oxidation, condensation). There is a formation of new chromophore structures in the lignin, which together with other changes of the wood substance causes discoloration of the wood colour (Klement *et al*. 2009). This allows the technology to change the colour to be carried out efficiently with a minimum holding of colour defects of wood. The aim of the work was to determine the influence of initial moisture content and the thickness of beech samples on the change of the wood colour by the steaming process. The assessment of the colour changes of wood and the setting of specific conditions for their achievement is perspective in terms of satisfying the individual requirements of the customers, with an emphasis on the ecological aspect of the products.

2. MATERIAL AND METHODS

Beech wood was used for experimental measurements. Samples were divided into two groups, based on the thickness: 1. group 25×110/900 (mm); 2. group 50×110/900 (mm). For measurements were used 34 samples for each group. Initial moisture content (MC) was not equal in all samples. In Table 1 are shown groups of measured initial MC and identification of samples as well. W1,2,3 is number of sample and H25/50 is thickness. Detailed values of MC:

23. Average MC of surface and central layers above FSP was 78.4%,
24. Average MC of surface layers below FSP was 20.7% /Average MC of central layers above FSP was 31.1%,
25. Average MC of surface and central layers below FSP was 22.4%.

Table 1. Groups of measured initial MC, identification of samples and their thickness

Distribution of moisture content in samples	Thickness (mm)	Identification of samples
MC of surface and central layers was **above** FSP	25	W1H25
MC of surface and central layers was **above** FSP	50	W1H50
MC of surface layers was **below** FSP/ MC of central layers was **above** than FSP	25	W2H25
MC of surface layers was **below** FSP/ MC of central layers was **above** than FSP	50	W2H50
MC of surface and central layers was **below** FSP	25	W3H25
MC of surface and central layers was **below** FSP	50	W3H50

The moisture content was measured using gravimetric method according to STN EN 49 0103. Moisture content was calculated using equation (1):

$$MC = \frac{m_w - m_0}{m_0} \ (\%) \quad (1)$$

m_w - weight of the wet sample (g)
m_0 - weight of the absolutely dry sample (g)

Atmospheric steaming was used with drying temperature of 100 °C. Total steaming time was 8 hours. All of the samples were measured before and after drying with moisture gradient.

The samples were separated into 3 layers (thickness of samples 25 mm) and into 5 layers (thickness of samples 50 mm), in which the moisture content of each layer was determined by the oven-dry method. The moisture gradient was calculated using equation (2):

$$\Delta MC = w_m - \frac{\Sigma w_s}{2} (\%) \quad (2)$$

ΔMC - moisture gradient
w_m - middle moisture content (%), w_s - surface moisture content (%)

Surface colour change was measured on all samples before steaming process. All samples were conditioned at room temperature 20 °C after steaming. Colour measurements were done using CR-10 Colour Reader (Konica Minolta Sensing, INC., Sakura, Japan). Colour changes were determined by CIELAB Colorimetry system. The colour changes were obtained as a comparison of the measured values with the parameters L^*, a^*, and b^*. After the steaming, the colour change was measured just below the surface, and the other two (25 mm samples), or three (50 mm sample) places, as is shown in figure 1. A layer of the wood between individual places of the measurement was removed by the milling machine (Kivader, Klement, 2012).

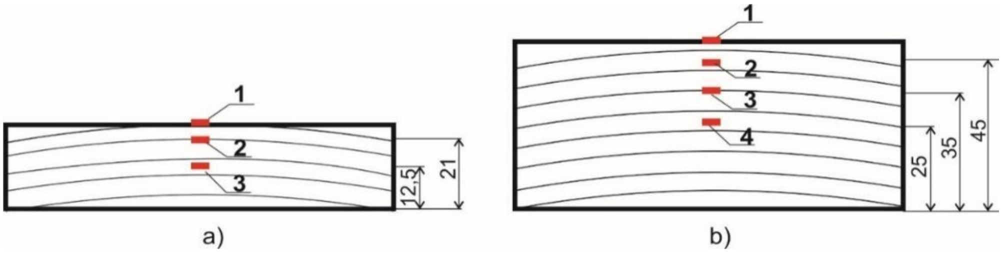

Figure 1. Places of measuring the wood colour a) 25 mm samples; b) 50 mm samples

The measured colour values before and after steaming were evaluated according to the equation (3) for calculating colour difference *ΔE**:

$$\Delta E = \sqrt{(L_2^* - L_1^*)^2 + (a_2^* - a_1^*)^2 + (b_2^* - b_1^*)^2} \qquad (3)$$

L^* - lightness of the colour in the range from -100 (black) to +100 (white), while L_1^* is before steaming and L_2^* is after steaming
a^* - the coordinate is shade between red +60 and green -60, while a_1^* is before steaming and a_2^* after steaming
b^* - the coordinate with the shade is between yellow + 60 and blue -60, while b_1^* is before steaming and b_2^* after steaming (Cividini et al. 2007).

The measured values and their subsequent comparison should lead to a better understanding of the effect of MC on the change of beech wood colour under atmospheric steaming process.

3. RESULTS AND DISCUSSION

In Table 2 are shown groups of measured initial moisture content and moisture gradient samples as well.

Table 2. Values of moisture content and moisture gradient

Samples	Moisture content (%)		Moisture gradient (%)		Steaming time (h)
	before steaming	after steaming	before steaming	after steaming	
W1H25	76.8	55.9	4.8	3.1	8
W1H50	80.0	57.0	6.8	3.1	
W2H25	26.9	32.9	9.3	6.2	
W2H50	24.5	25.4	10.1	7.2	
W3H25	17.3	22.3	3.5	3.4	
W3H50	19.1	24.2	6.3	6.4	

Figures 2 and 3 shows average values of colour difference ΔE^* (1) for each group of the samples of different thickness (25 mm and 50 mm). Based on the experimental measurements it is clear, the biggest red-brown staining was present on the surface of 25 mm thick samples.

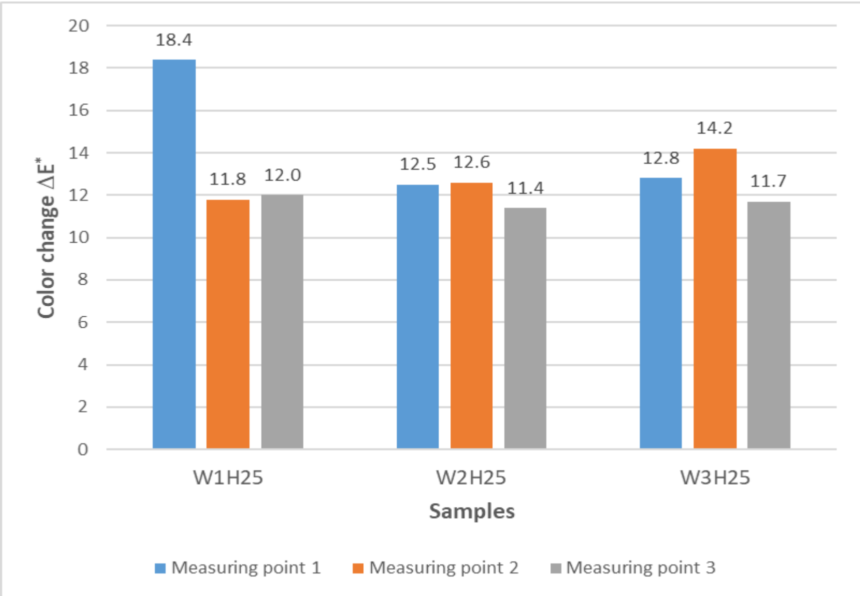

Figure 2. Effect of measuring points on the cross section of material for the change of colour ΔE^* for thickness 25 mm

Moisture content across the thickness of these samples was over FSP. Initial moisture content of these samples was 76.8%. The colour difference expressed by ΔE^* has reached the value 18.4. The colour difference ΔE^* of 50 mm thick samples, which moisture content across the thickness was at the FSP, reached the 16.4 value. Based on the citated work Cividini et al. (2007) all measured ΔE^* had different colour except measuring point 4 for 50 mm thickness.

The smallest colour change of surface layer occurred on the samples of 50 mm thickness, which MC across the thickness (before the steaming process) was below the FSP. The average surface MC of these samples before steaming process was 15.3%. The overall colour change ΔE* value of these samples was 12.0. The colour change was approximately same for samples with MC of the surface layer below FSP (even for the samples which MC in the middle was above FSP). The colour change expressed by the colour difference ΔE* was in the interval from 12.0 to 12.8 units. The average colour change measured at the measuring point No. 2, fluctuated from 11.8 to 14.2 for 25 mm thick samples and from 13.2 to 14.0 for 50 mm thick samples. The higher colour change for 25 mm thick samples was measured on the sample with MC on the cross section below the FSP. More noticeable colour change was measured for the samples of 50 mm thickness.

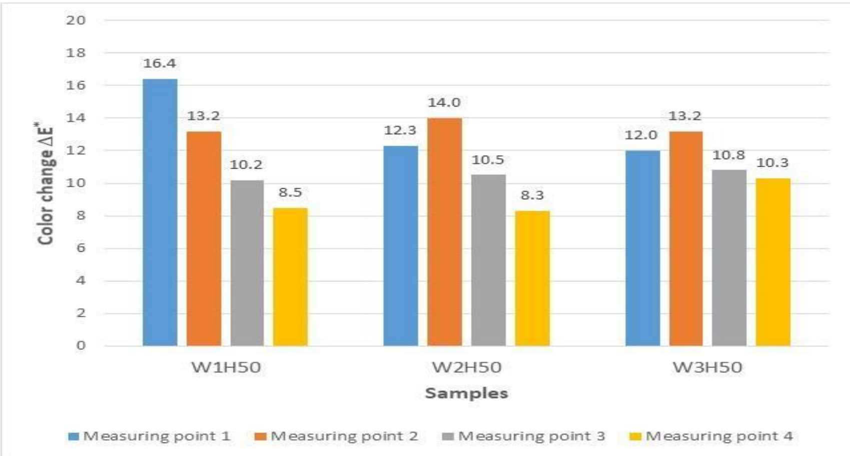

Figure 3. Effect of measuring points on the cross section of material for the change of colour ΔE for thickness 50 mm*

For the samples of 50 mm thickness, with initial moisture content of the surface layer below FSP and moisture content in the middle of the sample above FSP, the colour difference had a value of 14.0. For measuring point, the biggest colour change was measured on the samples of 25 mm thickness with initial moisture content through cross section above the FSP. For the samples of 50 mm thickness, the biggest colour difference ΔE*=10.8) was measured on the samples with initial moisture content across the cross section below FSP.

4. CONCLUSION

Colour changes were most pronounced in surface layers of all samples. Middle of the sample 25 mm had highest value of ΔE* = 12 and initial MC of surface and central layers were above FSP. The biggest colour change occurred in the surface layer samples of 25 mm thickness and initial MC in the entire cross section above FSP, expressed as the colour difference ΔE* = 18.4. Different colour change was in 50 mm samples (ΔE* = 12) with an initial MC in the entire cross-section below the FSP. The smallest colour change measured in 50 mm sample ΔE* = 8.3 in the middle. Initial MC of surface layers was below FSP/ MC of central layers was above FSP. The acquired knowledge about the change of the wood colour during the steaming influenced by initial moisture content and thickness of the samples of steaming are important for the success of achieving the desired colour change of wood. The market for furniture and home accessories is constantly bringing new trends in materials, design, and styles, but the ecological treatment and natural materials are still a popular product.

Acknowledgements: We wish to thank the Scientific Grant Agency of the Ministry of Education, science, research and sport of the Slovak Republic and the Slovak Academy of Sciences - project VEGA No. 1/0063/22.

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AN APPROACH TO ASSESSING AND IMPROVING THE EFFECTIVENESS OF VISUAL INSPECTION PROCESSES FOR LARGE-SIZE PRODUCTS FROM THE FURNITURE INDUSTRY

Krzysztof Knop, Robert Ulewicz

Abstract: The article presents an approach to analysing and assessing the results of human visual inspection for large-size products in the furniture industry, in order to increase the effectiveness of inspectors in non-conforming products detection. The Kappa method described in the AIAG's Measurement System Analysis (MSA) manual and the PQ-MSA+ program were proposed to use as an online tool for studying the effectiveness of visual inspection processes based on the sample products photos due to the specific benefits resulting therefrom. It has been shown that the PQ-MSA+ program can be a particularly useful tool in the assessment of the visual inspection system for large-size products from piece and series production in the furniture industry. The conditions for the correct use of the Kappa test based on photos of the products were shown. The advantages and disadvantages of such a solution are summarized. It was indicated that the PQ-MSA + program can be a very helpful tool in training quality inspection employees. Thanks to the use of the Kappa method and the PQ-MSA+ program, it is possible to significantly reduce the costs associated with errors in the visual inspection of especially large-size products in the furniture industry.
Keywords: visual inspection, effectiveness, MSA study, PQ-MSA+ software, furniture industry

1. INTRODUCTION

Quality inspection plays an important role in the furniture industry because a large number of elementary features that must be maintained in order to guarantee the proper quality of the product determines the quality of the final product [4]. Thanks to quality control and quality inspection, companies in the furniture industry are able to obtain information on the quality level of their processes and products, and the degree of meeting customer requirements [5, 6]. Quality inspection offers great opportunities for the development and improvement of manufacturing processes [3]. Human visual inspection is of particular importance in the process of conformity assessment of manufactured furniture and furniture elements. It is used for the inspection of non-measurable or measurable features of products in the furniture industry when the measurement of such features is difficult or economically unjustified [2]. The goals of the visual inspection of furniture and furniture elements are, above all, maintenance, but also continuous improvement of product quality, early detection of non-conformities, reduction of losses and customer complaints [4]. Despite their imperfections and a high risk of non-conformity undetected, manufacturers of products in the furniture industry still widely use traditional visual quality control methods, supported by measurements of auxiliary measuring devices [3].

The quality inspector, while visually assessing the conformity of products to the requirements, may make mistakes [2], because he is not an infallible unit. During visual inspection of the furniture or its components, non-conformities may not be detected or even rejected due to errors in quality inspection, the so-called errors of the Ist and IInd type [3]. In order to improve the effectiveness of visual inspection processes, it is a practice, in enterprises that use visual inspection systems, to conduct periodic studying to determine how those assigned an inspection function performs well in detecting product nonconformities [3]. The automotive industry proposes to use the Kappa study procedure in this regard, based on a specially prepared, physical sample of products containing a certain number of good and non-conforming products and presents guidelines in this regard in the MSA reference manual [1, 2, 3]. In the case of products from the furniture industry with large dimensions (such as for example, chests of drawers, wardrobes, sofa beds), conducting such studies may be significantly difficult due to many reasons, including the need of completing the required product samples for evaluation and collecting them in one place. For assessing the effectiveness of the visual inspection system for this type of products, it can be used an approach based not on physical samples of products, but on photos of these products and the dedicated online PQ-MSA+ application [7]. The aim of the article is to present the possibility of using the Kappa study according to the MSA guidelines with the use of the PQ-MSA+ program for the assessment of the visual inspection system of large-size products in the furniture industry, define guidelines for increasing the credibility of such a solution and to summarize the advantages and disadvantages of the solution.

2. METHODOLOGY

The original Kappa study procedure presented in the AIAG reference manual called MSA [1, 2] is dedicated to attribute-based inspection systems that result in a zero-one decision about the quality status of the product (nonconforming product - 0, conforming product - 1). Visual inspection is an example of such an inspection system. Kappa study originally included the following steps [1, 2]:

1. Selecting 3 Inspectors.
2. Selecting 50 products, comprising a specified number of conforming and nonconforming products. Parts selected for selection should be 1/3 conforming, 1/3 nonconforming and 1/3 "on the borderline" of conforming or nonconforming. The results in the whole sample will be only conforming and nonconforming (1 or 0).
3. Independent classification of products by an inspector-expert to define a reference value for all assessed products (50).
4. Independent classification of products by individual inspectors (3). The inspectors evaluate the products one by one (i.e. the first one the first 50 pieces in one trial, then the second one, and the third one and again from the beginning, to completing three trials). Each inspector evaluates each product 3 times (in three trials), as a result, each product is evaluated 9 times. The products to be assessed are set up randomly. The value of compliance of the product with the requirements is not known to the inspectors (they do not know whether the product is good or not).
5. Recording of results and determination of key inspection system capability indicators: Kappa Rate, False Alarm Rate, Miss Rate, Effectiveness.
6. Developing a report that includes interpretations of the results obtained, suggestions for opportunities to improve the effectiveness of the visual inspection system.

There are specific requirements and recommendations for conducting the Kappa study (in the original version):

1. care should be taken that the inspectors do not know their previous decisions as well as the expert's decision, otherwise, the test result will be strongly distorted,
2. it is recommended that the inspector does not know which part is being assessed and that the records be kept by an independent person not participating in the study (only the person who recording results knows which product was assessed and what previous decisions were made),
3. the study should be carried out in an ordinary control environment in which the inspectors work on a daily basis and assess the conformity of the products with the requirements,
4. it should be ensured that the assessment is carried out within the normative time, i.e. that the decision by the inspector takes no longer than under normal production conditions,
5. it is recommended that the single study refers to conforming and non-conforming samples of the same product [1, 2, 3].

Therefore, carrying out the Kappa study in an enterprise requires certain, advanced preparatory actions [2]. It is necessary to prepare a specially selected and sufficiently large sample of products. These studies, due to the fact that in the original version are based on physical samples taken from the process, are much easier to perform when the products are relatively small and it is possible to collect them all in one place for the purpose of physical assessment by the inspectors. In the case of large and heavy products (large furniture), conducting such studies is much more difficult, because a sufficiently large working space must be provided for the completion of a large sample of products, which in the practice of a given plant and with certain space limitations may be difficult or even impossible to implement. In the original Kappa study, this study relate to one particular product and various nonconformities of this product evaluated visually, therefore they are easier to carry out in the case of products manufactured in large series or mass production, where it is not difficult to prepare a sufficiently large sample for studying. In unit and small batch production, collecting a large sample of products specifically selected for Kappa study is more time and cost consuming. The effort and cost of such Kappa study is significant and may discourage the company from conducting it. In response to these problems and limitations, it is possible to conduct the Kappa study based not on physical product samples but on product photos. For this purpose, it is possible to use PQ-MSA+ software from a Polish supplier - GRETOM Consulting Tomasz Greber, dedicated to Kappa study based on product photos [7].

3. RESULTS

The PQ-MSA+ software enables MSA analyzes for attribute data based on product photos, meeting all the requirements contained in the MSA manual as to the result indicators for assessing the effectiveness of the visual inspection system. GRETOM Consulting has created two variants of the PQ-MSA software: 1. PQ-MSA: the basic version of the software for computers with Windows, 2. PQ-MSA+: the application extended with additional functions and facilities in the form of an internet platform. The comparison of the functionality of both versions of the programs is presented on the website [7].

The PQ-MSA + application is available online from any device (computer, smartphone, tablet) that supports the browser (excluding Microsoft Internet Explorer) and has access to the Internet. In order to gain access to the PQ-MSA + platform, a person who wants to conduct a Kappa study online logs in to the website www.pqmsa.pl. Creating an MSA on the PQ-MSA+ platform begins with creating the test. After logging in to the platform, the person supervising the Kappa study in the company (read: Administrator) gets the opportunity to prepare the Kappa study. For this purpose, he creates accounts for three or more users - Inspectors (he can also divide them into groups) and uploads photos of products with their descriptions, creating a test. The test parameters required to be entered are the test name; the time that the Controller will have to make a decision about the defect of the product; the number of repetitions of photos in a given test and the test passing threshold. Then, for each photo, the Administrator adds a question, determines which answer is correct, and introduces additional descriptions. Finally, the Administrator assigns the accounts of Inspectors who are to complete the test. In order to start a test, Inspectors log into the application and select the test to be performed. The photos are displayed in random order while the test is running. The inspector only has to decide whether the product shown is good or defective. After completing the test, the controller has the option of checking incorrect answers with an additional description. Analysis results can be exported to an *.xls file. If the inspector obtains the agreed test result (in accordance with the previously defined pass rate), he can also print a personal certificate. The PQ-MSA+ program allows the creation of two types of tests: educational and exams. Educational tests can be used to train employees. In this case, the Inspectors may view all questions with correct answers and explanations without a time limit. The test is available any number of times. Exam type test allows for conducting a proper Kappa study. After completing the test, the Controller has the opportunity to check his results and questions to which he gave incorrect answers and if he has achieved the required result, to print the certificate. The view of an exemplary furniture product (table - specifically the table top) assessed by the PQ-MSA+ application is shown in Fig. 1.

Fig. 1. View of a sample photo of the furniture product assessed by the Controllers for compliance with the specification using the PQ-MSA+ application - exam module of the program

Possible variants of conducting a single Kappa study using the PQ-MSA+ application for the purpose of assessing compliance with the requirements of large-size furniture products and assessing the effectiveness of quality controllers in this matter are presented below:

- According to the number of types of components / finished products assessed in a single Kappa study: a) one specific type (e.g. furniture boards, wardrobes), b) different types (e.g. wardrobes, chests of drawers, couches, etc.),
- According to the origin of components / finished products assessed in a single Kappa study: a) only from internal control, b) only from complaints, c) both from internal control and from complaints,
- According to the degree of intensity of non-compliance on components / finished products and their potential ease of detection by the inspector in a single Kappa study: a) large non-compliance - easily noticeable, b) non-compliance with the average degree of intensity - rather noticeable, c) non-compliance with a low degree of intensity - hardly noticeable,
- According to the number of inspectors participating in the single Kappa study at the same time: a) 3, b) more than 3,
- According to the origin of the inspectors in a single Kappa study: a) from the QC department, b) operators at workstations, c) mixed set.

There are specific considerations that can increase the credibility of Kappa study based on product photos. A very important issue that must be met is the appropriate quality of the photos of the products themselves (compliant and non-compliant) and in particular the appropriate presentation of the non-compliance of the product on them. Photograph parameters such as magnification, angle, resolution, and exposure will be important. Therefore, it is recommended that photos of products should be taken by a person who has a good photographic workshop with equipment (camera, telephone) that guarantees the appropriate quality of photos. The quality of the photos directly influences the possibility of subsequent detection of non-conformities by the Inspectors. An independent person (e.g. head of the QC department) should perform a pre-test in order to verify the correct quality assessment of products based on photos, before the actual performance of such tests by the Inspector.

Certain advantages and disadvantages of PQ-MSA+ software can be demonstrated for the purpose of the Kappa study. PQ-MSA+ software advantages are: a) speed of preparation of tests and their carrying out with the use of photos of products, as well as less effort and cost of such tests; b) the possibility of multiple uses of photos of product samples for the purpose of subsequent periodic tests, also the possibility of mutual exchange of these photos between different company branches (for the feedback information and preventive purposes); c) access to various language versions, which allows for assessments and training of foreign-language employees, d) the possibility of additional use of photos of products for training purposes; e) access to all statistics required in the MSA manual for the Kappa study; f) 24h access to the examination from the level of various devices.

The general disadvantage of the PQ-MSA+ software is the approach to the assessment of the visual inspection system based on product photos. Product photos will never reflect the "quality" of a physical product sample, so they may hinder or facilitate the detection of non-conformities. The product conformity assessment process itself cannot take place in a physical place where the visual inspection process is performed. Despite these two limitations, the approach to assessing the effectiveness of the visual inspection system using photos and the PQ-MSA+ program may be the only good solution in the case of testing the visual inspection system of large, heavy products in the furniture industry and significantly reduce the time of preparation and implementation of such tests in the company and the costs of related to it. The valuable knowledge gained from Kappa's research on the effectiveness of a company's visual inspection system can be used to improve the effectiveness of the visual inspection process.

3. CONCLUSION

The article presents the possibilities of using the Kappa study and the PQ-MSA+ program for the quality compliance assessment of large-size products from the furniture industry based on photos of the products. The original Kappa test method was presented in accordance with the guidelines of the MSA manual, based on a physical sample of products, and the functionality of the PQ-MSA+ program based on photos of the products. The PQ-MSA+ program has been shown to meet all of the inspection system performance indexes for the original Kappa procedure. It was determined that the PQ-MSA+ program can be a particularly useful tool in the process of conformity assessment of large-size, heavy products, coming from unit and small-lot production of products and their parts from the furniture industry. Possible versions of such research in companies in the furniture industry have been presented. The benefits of using this program and the disadvantages of such a solution have been demonstrated. To sum up, the Kappa study and the PQ-MSA+ program dedicated to this study can be a good tool for verifying the effectiveness of detecting non-conformities in products from the furniture industry and increasing the awareness and knowledge of employees. The authors recommend Kappa research and training in companies in the furniture industry using the PQ-MSA+ software.

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IMPLEMENTATION OF ERP SYSTEMS IN HIGHER EDUCATION CONTEXT: FUNCTIONALITIES AND CHARACTERISTICS

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Abstract: Thanks to the development of digital technology, today almost all business segments and services of companies today operate with the support of information systems. Enterprise Resource Planning (ERP) systems in the context of information management systems integration present the "backbone of any organization", especially for manufacturing companies where the efficiency of their application is significant. Continuously adapting and implementing innovative and advanced technological solutions in the education process of institutions is crucial for several reasons. Firstly, to improve their performance - maintaining high quality and competitive education; secondly, meeting labour market demands. This paper aims to enhance the discussion on the importance of ERP systems, especially in the higher education context, by focusing on functionalities and characteristics attributed to ERP solutions integrated into the education program at the Faculty of Forestry and Wood Technology University Zagreb.
Keywords: ERP, GoSoft, Higher education, Competencies, Wood Technology

1. INTRODUCTION

Today, many employees are directly or indirectly involved in information processing, and the growth trend is becoming more frequent. All information in human activity that shows up somewhere is repeated and processed somewhere else. An information system is a formal part of the communication system of a particular business unit. It consists of a group of people and machines that process and use the information and enter into inter-communication relationships to achieve business process goals. Each system can be represented with four essential elements - input, output, transformation process, and feedback. The introduction of digitalization in production has multiple advantages. In addition to the previously mentioned simple and efficient production planning and management, it is also very effective in determining the model of machine maintenance as an element of the production system (Pavlinić 2019). Respectively, the digitization of production processes allows the application of predictive maintenance. Predictive maintenance based on collecting relevant data sets creates maintenance models. It estimates the life cycle of machine elements, which facilitates the assessment of downtime schedules to replace worn parts, adjust maintenance costs, reduce waste, and produce more precise capacity (Nah et al., 2001).

Thanks to digitalization, employees no longer need to create a paper registration with a poor data overview. There is a big advantage of digitalization in data processing using the database. The Enterprise Resource Systems (ERP) serves as an integrator of all company activities and departments, like Sales, Purchase, Logistics, Production, etc. They allow all services accessible to all other services related to business information. The usage of them is beneficial for production companies like wood processing companies are, where availability of information, monitoring of activity, and forecasting are needed to increase productivity and efficiency (Kremenjaš et al., 2021; Kremenjaš, 2019; Perić et al., 2022; Perić et al. 2019 a; Perić et al. 2019).

Recent studies on this topic conducted among wood processing companies that have declared to use ERP systems in the Republic of Croatia (Kremenjaš et al.; 2021; Kremenjaš, 2019; Perić et al. 2019 a; Perić et al. 2019 b; Perić et al., 2017) have shown implementation of ERP system partially. There are many examples where the production as a department is late with the ERP implementation (or never introduced). Implementation requires the full elaboration of production. This elaboration can be the number of workers at workplaces, the analysis of inputs and outputs of the goods, the list of machinery, precisely defined by the preparatory-final time of the machinery, etc. The software was mainly used for financial management - invoicing, billing, purchasing, and inventory management. On the other side, its most minor usage was for activities such as monitoring production processes and integrating all business departments. However, they pointed out the positive side of using ERP systems - improving the availability and quality of information or more accessible and faster communication with customers. The reasons for this can be substantiated by the fact that, like many other technological advances, ERP systems are complex pieces whose implementation demands great resources, e.a. human and financial, and time, which is one of the main reasons for not fulfilling their potential (Snider *et al.*, 2009).

The requirements for information systems in the wood processing industry go beyond the increased productivity, achieved through better logistical and IT support. The needs of companies in this sector extend to facilitated exchange of technical drawings and technological processes, material ordering, product labelling and dispatching, and finally to carrying out invoicing and payments in line with current standards and protocols in developed countries (Majdandžić, 2004). Certainly, Information Technology (IT) and educated IT employers are pivotal in managing such companies.

2. PROFESSIONAL PRACTICE AND LABOUR MARKET

Students' knowledge in higher education must follow the development and digitalization to prepare for the need of labour market demand. The project entitled "Development and implementation of professional practice at the Faculty of Forestry" has a mission to raise the quality of study by implementing professional practice in the mandatory study program. Moreover, to bring closer the cooperation of the Faculty of Forestry and Wood Technology with the wood industry- the real sector. This form of cooperation develops and raises the quality of the study program and the students' knowledge/skills. In addition to realizing practical experience in the real sector, the project enabled the faculty and the development of a carpentry practicum that students will further use for final and graduate theses and new innovative projects. By going through a carpentry practicum, the student can simulate the production process of a small company and, with the help of an ERP system that is digitally applied for further education at the faculty, find better optimization and understand the system of production resources planning. With such a modern form of the study program, the students have the opportunity before entering the labour market to gain the necessary competencies and skills, particularly in understanding ERP systems and their application in today's development companies. This paper aims to enhance the discussion on the meaning of ERP systems, especially in the higher education context, by focusing on functionalities and characteristics attributed to ERP solutions integrated into the education program at the Faculty of Forestry and Wood Technology University Zagreb.

3. GOSOFT ERP SOLUTION

The ERP software was provided for the implementation of Project activities and innovation of teaching materials. The following paragraph describes and explains the ERP system. It is an ERP system named GoSoft of the company GOinfoZG. GoSoft is an ERP system specializing in the manufacturing and wood processing industries and is the most applicable in this sector. Its most significant advantage is its modularity. In addition to the GoSoft classic client version, it can be customized to the specific needs of users. The software package covers all the main functions of the production company such as Sales, Purchases, Logistics, and Production. It is based on interactive data entry and connectivity of all functions in a single information system, enabling business monitoring in real-time. Starting from making customer offers, launching production work orders, processing technical-technological procedures related to products, procurement of materials with material operations, quality control, planning material needs, planning production capacities, and finally, the shipment of materials and products and their invoicing (Gračanin et. al. 2005). Planning of Goods in GoSoft is performed according to the MRP planning system. Planning needs are enabled in the order form, minimum inventory, or serial, and can be focused on the entire production or individual product. The direction of the use of this type of ERP is based on a business process without paper, where all necessary invoices, documents, records, and drawings are available within the system's database, and sending them is possible via e-mail or the internet. The software also comes in the WEB version, which is most used in the production department for scheduling production. The user interface is in the Croatian language, which makes it easier for end-users to apply him (winfonfo. si/hr).

Within this paper, particular emphasis is placed on *several main Modules* that offer the possibility of planning and managing production processes. They are integrated into the Project Activities and in teaching materials of the Institute for the Organization of Production.

3.1. Technical Data Modul

Within this module, students have the opportunity to learn how to define products and the most essential technology procedures of manufacture for every product they use or produce. In other words, they must combine previous knowledge from other college courses, like Wood finishing technology, Wood product construction, Design of wood products, Production Organisation, Product planning, Accounting, Technological work preparation, etc.

The Technical Data module is the basis for the system's business functions where the product is defined and developed. Within the module, primary data are defined: products with all their characteristics: name, structure, technology, price, draws, classification keys with which products are classified, price lists, codification, component reviews, list of jobs, list of standard operations, etc. Within this module, when entering a new product (Item) it is necessary to establish the structure of the product (component) and the technological procedures of the manufacturer. Moreover, it is also essential to distinguish purchasing products, products from cooperation, tools, and devices, from production products; each of them follows different procedures.

The production technology for a particular product is defined by the place where operations are carried out. Following proper operations (description of operations, time, preparation process), a catalogue of standard operations is envisaged to determine technological procedures (www.goinfo.si/hr).

By defining the structure and technology of the product, i.e. standard technological operations and jobs, the *first step* of production management has been completed, which allows the production of the ordered product (item) (Pavlinić, 2019).

The program provides different ways of planning the needs of products: with or without the MRP (Material Requirements Planning) planning option. For example, products marked with MRP planning options are not commissioned without a Purchase Plan. In contrast, products without an MRP planning are products from everyday use, ordered through the state of the minimum inventory. From this, students can learn the principles of Inventory Management.

3.2. Sales Modul

In this module, students can learn to explore how the Sales Module offers support to sales services in terms of various documents, analyses, statistics reports, and some necessary records in business dealings with customers and business partners.

The basis for working in Sales Module are documents such as offers, orders, confirmations of orders, invoices, and shipping orders. The process starts with the *Customer's inquiry*, from which the Offer is made. When the customer accepts the Offer and makes the payment (depending on the partner), the next step is launching work orders. Work orders - *purchase orders* are launched to the Purchasing Department (if inventory in the warehouse is missing) and to the Production Department - *production work orders*. Finally, the last work order from Sales Department is a *shipment note* – a process where an ordered product is shipped from the warehouse of finished products to the customer. The flow chart of the above-mentioned activities is shown in Figure 1.

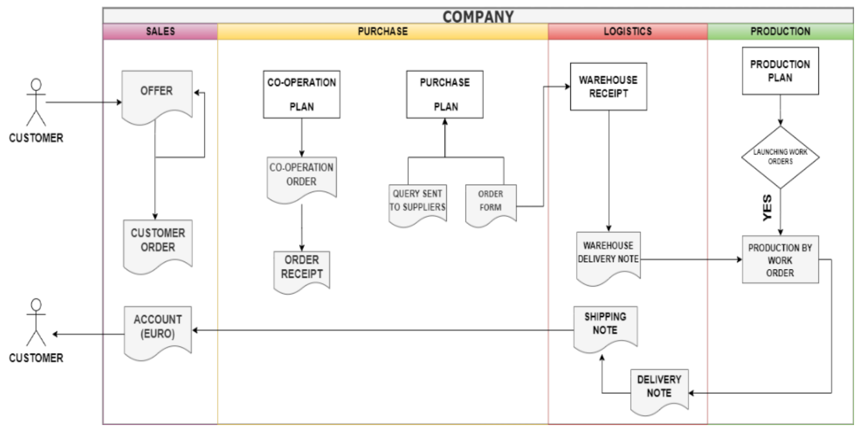

Figure 1. The Flow chart of business and production processes in GoSoft (source: authors work)

All documents can be saved in different records and sent by e-mail and they are linked to customer and item codes, which allows an overview of the realization of work and an overview of the data of ordered items.

Further, the Sale Module is also linked to booking inventory of warehouses and planning material needs. The above-mentioned is the basis for planning commercial orders. This can be tracked by reviewing the Sales Plan within the sales module. The Sales Plan shows all planned products to be made (lists all 'customer orders' and 'forecasts'), the projects to which they are related, their quantities (needs), and delivery dates. A brief review will be given of the procurement sub-module in the following text

3.3. Procurement Module

The Procurement module offers support to procurement services in creating various documents (inquiries, offers, order forms), various analyses, and some necessary records when dealing with suppliers. The module is linked to the master data module (articles, business partners), the inventory management module, and the planning module, which determines the ordering needs. Creating a procurement document is connected by an action within GoSoft called 'Preplanning action', which is the *second step* in the production management process. Preplanning is an action that breaks down the structure of a product (item) and analyses each part of which it consists of.

All this is needed for creating work orders in Production Department for parts that need to be produced or to create work orders in Procurement Department for all parts that need to be procured (work orders are created automatically every morning). Upon completion of the re-planning process, work orders are created. Mentioned work orders in the procurement sub-module are visible in the Purchase Plan.

The Purchase Plan is a 'display' of all procurement orders, in other words, presents a list of products that need to be procured, to meet the needs of the Production Plan. It is the basis for Purchase order creation. When the Purchase order document is created, the procurement process considers complete. The Purchase plan should be checked daily or weekly to avoid repro materials being out of stock.

3.4. Warehouse Module

GoSoft offers several ways to manage warehousing processes and adapts to their requirements depending on the needs of the company. Warehousing processes such as receiving goods at the warehouse, releasing goods into production, handing over finished products to the warehouse, and shipping them out of the warehouse are carried out using barcodes and scanners.

4. The Accounting and Salary Module

In this module, students are further introduced to payment transactions, such as accruals at the end of the business day, payment orders, and billing at the end of the month. The Accounting and Salary module includes the system unit of accounting monitoring, planning, and analysis of funds and controls the revenue and expenditures of enterprises. The Accounting module consists of financial bookkeeping, accounting balances of the account of customers, suppliers, and part of the liquidation, material bookkeeping, bookkeeping of basic assets and small inventory, travel orders, and salaries. The salary module keeps basic employee data, salary calculations, and various personnel records.

3.5. Production Module

Modul Production shows users and students the possibility of monitoring and managing production activities. Modul enables the planning of material needs, cost calculation, supervising the technological data, production capacity planning, quality control, maintenance of machinery, etc. This part of activities is essential for students to understand because they significantly impact delivery time.

The basis for work in this module is the document Work Order. The working work order is the main holder of information on all production and procurement activities. Work orders are issued to the level of elements with the necessary component and technology. They show all planned events in the future, current situation, and already performed operations in Production and Procurement. In GoSoft Work Orders in the Production can be automatically created with pre-planning action (explained in the Sales Module) or entered manually. Gosoft has five basic production order statuses used within the production module: PF, PL, LN, LA, and KO. Planning orders are sent to production and enable an overview of capacity occupancy.

PF Work Orders are Work Orders that are arising by manual creation, i. e. not generated by a pre-planning action. PL work orders were arising through a pre-planning action, which is the only difference from the work orders of PF. Both Work Orders are planning orders they should be manufactured but are not yet active. LN status means launching a Work Order where any PF or PL moves to LN status through a standard action - launching a work order. When recording the output of needs from the warehouse into production, the work order of LN status automatically turns into LA-launched active status, meaning that work has started.

The requirements are issued from the warehouse to production by a document called the Warehouse Delivery Note.

Once the needs have been launched, the work of machines or workers on technological operations should be booked. This action is managed by a recording of quantities of manufactured products, the operating time of the machine, and the worker. The procedure is repeated as many times as the operation exists. When the requested finished product is produced, the last action is delivering a product to the specific warehouse by document Delivery Note. By this action work order automatically turns into status KO — finish i.e. finished. This means that the finished product officially left the production department, and the production capacities for further needs are released. The next step is followed by creating a document Shipping Note - which automatically makes changes in bookkeeping entries for inventory. Following the example of the shipping note, the final step of this process is the creation of ‘invoices’ within the sales module, and thus the process of planning, monitoring, and managing the production process within GoSoft is completed (Pavlinić 2019, GoSoft).

4. CONCLUSION

The digitalization of business has become a necessary step in achieving a competitive advantage. ERP systems in business provide multiple benefits in planning and monitoring production, which is very important for manufacturing companies where the wood processing sector belongs. Because today for them, quality, delivery time, and customer satisfaction have become synonymous to achieving business efficiency. By implementing ERP software in the Project of Professional Practice and teaching activities of the Faculty of Forestry and Wood Technology, students can have insight into all the advantages and complexity of an ERP system. Furthermore, acquiring the necessary digital competencies makes it easier for them to enter the labour market and broadens their view of setting up and running their own business.

Acknowledgements: This article has been supported by funds of the project 'Development and implementation of professional practice in the Forestry Faculty studies', funded by the European Social Found (EFS). Operational Programme Efficient Human Resources 2014-2020.

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CONTRIBUTION OF FOREST-BASED INDUSTRY IN LOW CARBON CIRCULAR BIOECONOMY: LIFE CYCLE ASSESSMENT OF SELECTED WOOD-BASED PRODUCTS USING SIMAPRO SOFTWARE

Tajana Kruhak, Andreja Pirc Barčić, Kristina Klarić, Ivana Perić, Darko Motik, Ivana Ostoić

Abstract: The Europe's forest-based industries have an important role in strengthening the European low-carbon circular bioeconomy. The role of the wood industry is essential for the global environment in the context of the sustainable development. Climate change and limited wood resources are the most important motivations for conducting as much as possible activates regarding sustainability in the wood-based sector. The Life Cycle Assessment (LCA) is one of the methods used to provide a scientific measure of a product's sustainability and environmental performance. Further, the purpose of an LCA is to measure the environmental impacts of a product system throughout its life cycle. LCA can be considered the broadest environmental assessment tool, which assesses significant environmental aspects and their impact from extraction to production, use and end-of-life phase via a holistic approach with the life cycle perspective. According to numerous literature reviews, LCA can be used in situations ranging from quick LCA using generic data from different databases to a complex LCA with a high level of imported data. There are numerous software tools available for LCA, but the leading software is *SimaPro*. *SimaPro* has more than 30 years' application experience in industrial and academic environment. It provides scientific information and ensures clarity of results. In this study, generic data of selected wood products from the *Ecoinvent* database using *SimaPro* software were used.

Keywords: wood-based sector; sustainable development; LCA; *SimaPro* software

1. INTRODUCTION

Following objecting from society and pressure form policymakers' issues about energy crisis, climate change, and pollution problems, the modern industry actors are working towards a low-carbon circular bioeconomy. According to Stegmann et al. (2020) in a circular bioeconomy, renewable bio-based resources are used as feedstock for products and services, while material and energy flows are cascaded and recycled in a closed-loop system to achieve sustainable production. As wood is very positive in term of sustainability, and circular economy principles are our future, this shall give wood industry advantage in banding and gaining a competitive advantage over other industries (Pirc Barčić et al., 2022). Traditionally, life cycle analysis (LCA) approaches are key tools used to assess impacts through product life cycles, but they present limitations regarding the accounting of multiple ecosystem service-related issues, at both the land-use and supply chain levels. The LCA is proved to be a powerful method to diagnose and manage environmental impacts in complex product systems. The idea of LCA was to obtain or provide product information from which the consumer would choose between several alternatives considering differences in environmental effects of the product. This information may be provided by industry, environmental or consumer organizations or by the public sector

(Guinée et al., 1992), but also from the scientific community whose objective is to provide environmental soundness (Đuka et al., 2017). Furthermore, climate benefits of wood-based products can be demonstrated through life-cycle assessment (LCA). Comprehensive LCA for woodbased systems is more complex than for many non-wood alternatives (Sathre and González-García 2014), this can be explained by the specifics of wood as a material which makes wood production processes more complex compared to other materials. There are numerous software tools available for LCA, but the leading software is *SimaPro*. *SimaPro* has more than 30 years' experience in industrial and academic environment. It provides scientific information and ensures clarity of results. In this study, a generic data of selected wood products from *Ecoinvent* database using *SimaPro* software were used.

2. MATERIALS AND METHODS

SimaPro is one of the leading sustainability and life cycle assessment software for the last 30 years, and is being used by companies, consultancies and universities. This software provides solution for collecting, analysing and monitoring of sustainability performance data of products and services. Developed by *PRé Sustainability*, *SimaPro* can be used for various applications, such as sustainability reporting, carbon and water foot printing, product design, generating environmental product declarations and determining key performance indicators (About *SimaPro*, n.d.). Based on research done by Lopes-Silva et al. (2019) *SimaPro* is, along with *GaBi*, one of the most used software tools in literature and in the market as commercial LCA tool. The software is available as a desktop version or with an option to use cloud-based modules.

For the purpose of this paper *SimaPro* version 9.3.0.3 (Expert user package) was used. Data was taken from the *Ecoinvent* v3 database, that covers more than 10000 processes. The *Ecoinvent* database, developed by different Swiss institutions, offers one of the most consistent and transparent life cycle inventory databases, that provides support for environmental assessment of products and processes worldwide. The Functional unit used for this overview was m^3 wood product. For the purpose of the analysis, the *ReCiPe* 2016 Midpoint (E) method was used (V1.06.).

3. RESULTS

3.1. Inventory and impact assessment result

The Ecoinvent database contains around 18,000 reliable life cycle inventory datasets, covering a range of sectors (*ecoinvent* Database, n.d.). For each dataset available, Life Cycle Impact Assessment (LCIA) provides relevant impact assessment methods, and compatible impact categories. To demonstrate the functionalities of the *SimaPro* software, regarding the analysis of the environmental profile of a product, the Laminated timber element was chosen. The datasets were taken from the *Ecoinvent* v3 database, and the *ReCePe 2016 Midpoint* (E) was used as a default method.

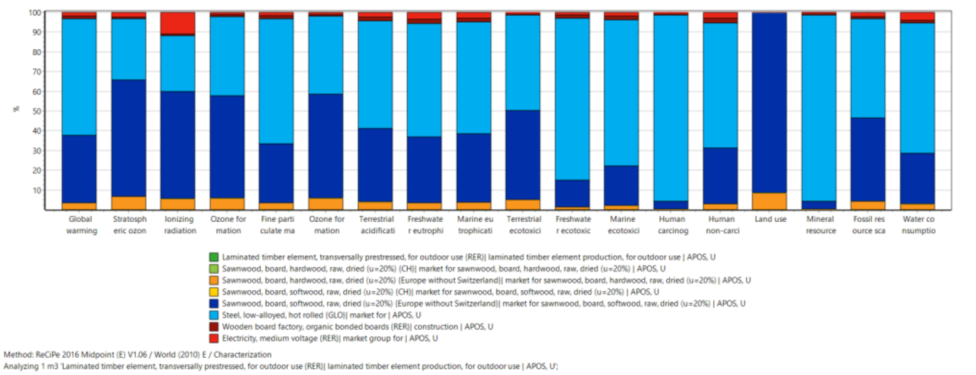

Figure 5. Characterization results - Inventory and impact assessment result - Laminated timber element, transversally prestressed (Source: SimaPro version 9.3.0.3)

Different units of each category are shown on a percentage scale. The colours indicate the relative contribution of different parts of the product. Analysis (Figure 1.) of the laminated timber element (transversally prestressed) shows that the highest impact on the environment in the process is accounted to steel (coloured light blue). Represented example of laminated timber element is transversally prestressed with steel, which is used for improving the strength of the latter element used in construction. Detailed information regarding the product were not available through the *SimaPro* software.

In the results window, there are several possible uses, such as Life Cycle Inventory results (the list of emissions and results), following the different impact assessment steps (through Characterization, Damage assessment, Normalization and Weighting), and process contribution analysis (that shows relative contribution of each individual process to an impact category or to another indicator) (Goedkoop et al., 2016).

3.2. Overview of the life cycle presented as a network

In order to generate the process network, it is necessary to choose the *Network* option. As a result, there will be generated a network flow chart (Figure 2.), that is not completely visible. Due to this the *SimaPro* software calculates the influence of processes, but by default it determines “cut of value”, so that only 12 processes are shown. To display all processes, it is necessary to set “cut-of-value” to zero.

The Network option allows a display of all processes together. Each box represents a process, and the arrows represent the flows between the processes. The red bars, located on the right side of the boxes, indicate the environmental load generated by each process and its upstream processes. Choosing the *indicator selector,* it is possible to specify which indicator or LCI (Life Cycle Inventory) result is going to be represented by the red bars. There is also an option to select any single impact category or inventory result.

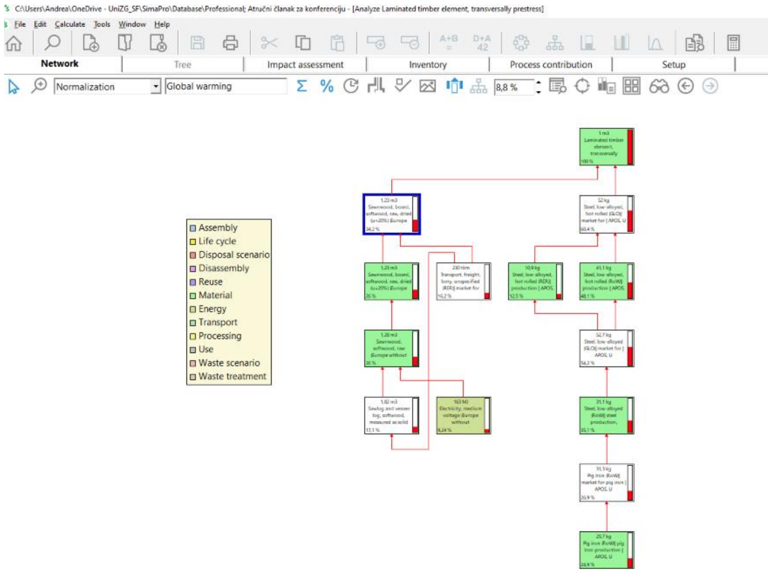

Figure 6. Overview of the life cycle presented as a network (cut-off value = 8,8 %) (Source: SimaPro version 9.3.0.3)

3.3. Comparison of Inventory and impact assessment result of two wooden products

The *SimaPro* software offers the possibility of comparing the products in with a *Compare* option. For the purpose of this paper, the life cycle of two different wood products were compared: Laminated timber element (transversally prestressed) and Oriented strand board. *Calculate* option results in displaying the comparison (Figure 3.) of the environmental impacts of the life cycle of both products. When the life cycles are compared, impact category by impact category in the characterization tab, it appears that the life cycle of Oriented strand board (marked light green) has a higher environmental load for almost all impact categories. For an example, Kutnar and Hill (2014) and Gu et al. (2021) noted that the embodied carbon in OSB (361 kg CO2 eq) is higher in comparison to Laminated timber elements (Cross laminated timber = 110~158 kg CO2 eq; Glue laminated timber = 80~515 kg CO2 eq). Explaining in more detail, Kutnar and Hill (2014) showed that the adhesives used in OSB are responsible for the largest fraction of emissions what is especially significant considering the low total volume they represent in the final products. In laminated timber, emissions derive mostly from timber harvest and initial lumber production of the softwood, but also from the energy and adhesives required to bond the lumber. In addition, production process and technology of OSB boards is more complex than laminated timber production, because it consists of more specific sub-processes, and there are more different input materials used. Werner and Richter (2007) reviewed the results of approximately 20 years of international research on the environmental impact of the life cycle of wood products used in the building sector compared to functionally equivalent products from other materials. With regard to greenhouse gas emissions, in compariosn to other materials wood is shown as a better alternative.

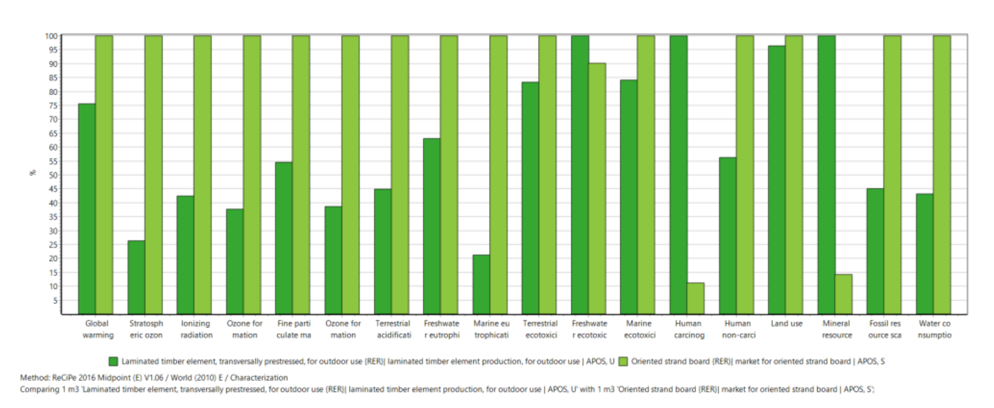

Figure 7. Results of the comparison between two wood products (Source: SimaPro version 9.3.0.3)

4. CONCLUSION

Wood use as a multifunctional material is expected to increase significantly in carbon-negative housing, as well in furnishings. The results generated in this study are based on relevant resource extraction, production, and transportation data sources, in tandem with scientifically grounded assumptions and estimates. It is essential that a transparent and standardized approach to LCA is used to assess the ecological and environmental consequences of the materials, use phase, and end of life. Unfortunately, the values can differ significantly between studies. The use of different input data, functional units, allocation methods, reference systems, and other assumptions complicates comparisons of the LCA studies. This is often the case with many past and present LCA studies and must be emphasised when using LCA as a tool in the decision making process. It is essential that research on wood processing and the wood products place more accent on the interactive assessment of processes parameters, developed product properties, and environmental impact, including recycling and disposal options at the end of the service life towards upcycling after their service life based on the cradle-to-cradle concept. The methodology of environmental impacts' comparison of products proposed in this paper allows engineers and architects to identify the product with better environmental peformances.

Acknowledgements: This article was published as a part of the project "Istraživanje i razvoj inovativnih drvnih zidnih obloga, pregradnih i nosivih zidova za održivu gradnju u poduzeću Spačva d.d. – KK.01.2.2.02.0244" (Research and development of innovative wooden wall coverings, partition and load-bearing walls for sustainable construction in the company Spačva d.d.) by Spačva d.d. and partner University of Zagreb Faculty of Forestry and Wood Technology. The project was co-financed by the European Union from the Operational Program Competitiveness and Cohesion 2014-2020, European Fund for Regional Development.

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GREEN DEAL: OPPORTUNITIES AND THREATS FOR THE FOREST- AND WOOD-BASED SECTOR IN POLAND

Władysław Kusiak, Łukasz Sarniak, Leszek Wanat, Marek Wieruszewski

Abstract: The study analysed the potential consequences of the implementation of the Green Deal scheme for the Polish forestry and wood-based sector. The SWOT analysis method was applied, based on the programme documents and sector reports. Secondary data available in online databases were also used, using selected open-source analytical tools. Finally, conclusions and recommendations for sector policy in the forestry-based sector in Poland were formulated
Keywords: forestry, forest and wood-based sector, forest economics, Green Deal, Poland.

1. INTRODUCTION

The Green Deal is an invitation to discuss the future of forestry in Europe. The topic of active forest management in areas, part of which are designated natural protected areas, is a sensitive issue, discussed by scientists and forestry practitioners. The problem concerns, among others, the assessment of forest management plans. It is asked to what extent the implementation of these plans has an impact, for example, on forest protected areas? Against this background, Poland is involved in a dispute with the European Commission.

In this perspective, key questions have been formulated. What is the scale of the problem? Does rational logging in forests, of which protected nature areas are a part, contradict the model of sustainable forest management? Do the undertaken actions violate the principles of integral economics, whose subject, besides the human world, is the forest?

2. MATERIAL AND METHODS

The aim of the study was an attempt to assess the potential consequences of the Green Deal system implementation for the Polish forestry and wood-based sector. The temporal scope analyzed primarily the period of economic uncertainty. The time of the pandemic from 2020 until the war conducted by the Russian Federation against Ukraine in 2022 was taken into consideration.

The SWOT analysis method was applied, based on the programme documents and sector reports. Secondary data available in online databases were also used, using selected open-source analytical tools. The study was carried out against the background of the state of the art, in the perspective of selected scientific and professional publications relevant to the forestry and wood-based sector. Finally, conclusions and recommendations for sector policy in the forestry-based sector in Poland were formulated.

3. RESULTS AND DISCUSSION

The European Union (EU) accounts for approximately 5 % of the world's forests and, contrary to what is happening in many other parts of the world, the forested area of the EU is slowly increasing. European forests are an important factor in mitigating climate change. Socio-economically, forests vary from small family holdings to state forests or to large estates owned by companies, but they also provide a wide range of ecosystem services.

Forests, because of their natural, recreational and at the same time economic function, are changing. Figure 1 shows the changes in forests area [%] of selected European countries (1990-2020) against the total forest area [%] in those countries.

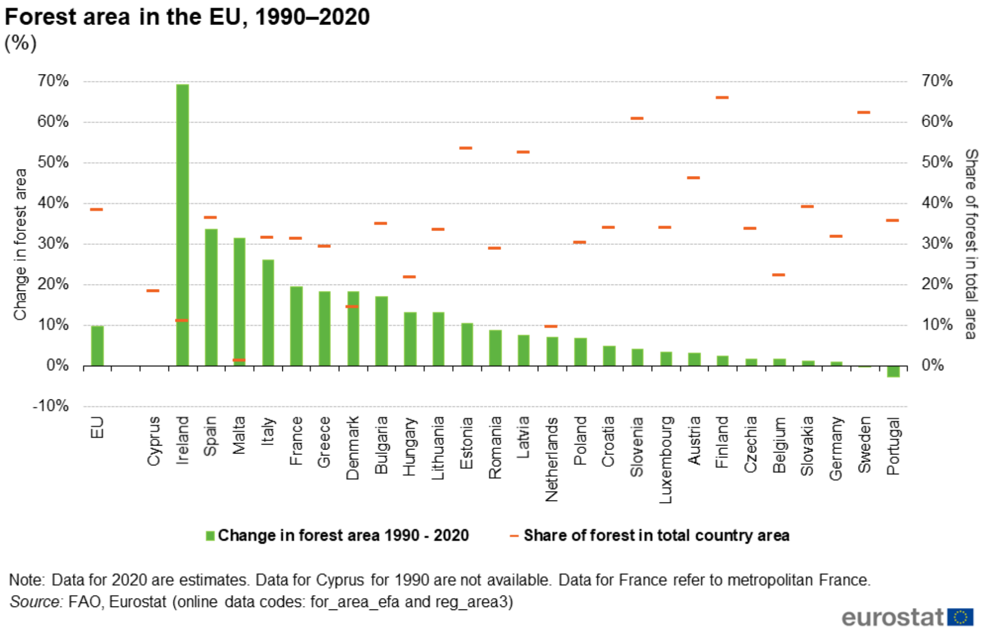

Figure 1. The changes in forests area [%] of EU and European countries (1990-2020) [%]
Source: Own elaboration based on [https://ec.europa.eu/eurostat/, accessed on 13.05.2022]

In 2020, the European Commission adopted the document: "EU Biodiversity Strategy 2030 - Bringing nature back into our lives". This strategy is to combine the protection of biodiversity with counteracting climate change within the framework of the European Green Deal program. Implementation of the provisions of this Strategy will lead to the legal protection of 30% of the land area, to the exclusion of 10% of this area from total use and to the cessation of the use of the so-called "old-growth forests". In the spatial and legal context (ownership rights) of Poland, the exclusions from use concern mostly state forests (managed by the National Forest Holding State Forests). This may mean that even about 2.5 million ha of forests need to be placed under strict protection.

Just a general analysis of the documents allows us to find the following results, which will be the consequence of the Strategy. The effect of strict protection in this area will be a significant reduction in roundwood harvesting in Poland, estimated at up to 40% (this is due, i.a., to the age structure of the stands), which would lead to the loss of thousands of jobs.

Therefore, a significant reduction in the harvest of roundwood would cause significant economic changes in the very well developed Polish timber industry. Entrepreneurs would have to replenish the quantities of wood missing in Poland and Europe (collapse of supply resulting from the introduced restrictions and price increases). Wood would then be purchased in countries that do not apply the principles of sustainable forestry (for example Brazil, since Russia and Belarus are out of business due to economic sanctions due to the war). Increased harvesting would result in increased deforestation. It would also significantly alter biodiversity in those countries that would close the demand gap in the wood market by cutting down forests. Thus, a substantive discussion of the opportunities and threats of proposed institutional picies is necessary. Even the best goal does not justify measures whose consequences will be the opposite of important environmental perspectives (Figure 2).

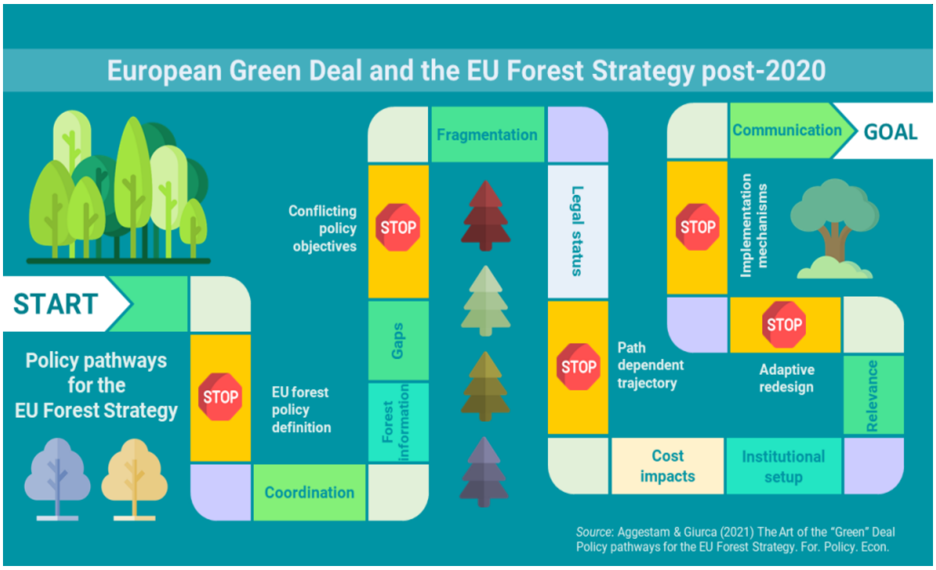

Figure 2. European Green Deal and the EU Forest Strategy
Source: Own elaboration based on [Aggestam and Giurca, 2021, accessed on 13.05.2022]

Forestry strategic planning should balance and prioritize. It is man, acting in symbiosis with nature, who is its tenant, not the other way around. It is necessary to verify the conflict between the sustainable approach and the understanding of integral management. They are not, despite appearances, the same thing.

Polish forestry, implementing the principle of sustainable development, has increased the forest cover of the country from 21% in 1945 to 30% at present (with an increase in forest area by about 3 million ha). Various forms of nature protection have been introduced on half of the forested area. By rational use of wood resources, it increases forest resources by about 35 million m^3 every year. Rare and vanishing plant and animal species are protected, water is retained in the forest. These activities have resulted in an increase in the average age of Polish forests to 59 years and an increase in the abundance from 125 m^3/ha in 1968 to 286 m^3/ha currently. These results were obtained by allowing a model of multifunctional forestry that combines biodiversity conservation with responsible use of forest resources. The large-scale nature conservation carried out in the National Forests on an area of more than 7 million hectares is a more effective method of protecting biodiversity than that carried out only on excluded areas, and, according to experience to date, this strategy should be continued.

4. CONCLUSIONS

Based on the comparative and descriptive analysis, the following conclusions and recommendations were formulated:

A. The development of the Green Deal program should be continued, but taking into account the forest specificities of each EU member state.
B. An important topic of discussion should be large-scale nature protection and its effectiveness. The division of forests into production and total protection areas does not find evidence of the effectiveness of this way of protecting biodiversity.

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NATURE-INSPIRED SUSTAINABLE SOLUTIONS FOR AN ARCHITECTURAL ENVIRONMENT

Manja Kitek Kuzman, Nadir Ayrilmis

Abstract: The deeper understanding and use of light-weight principles, such as a high degree of differentiation of material and structure, in combination with the development of computational strength design, simulation, and fabrication methods, enables novel constructions in design and architecture. The use of different lightweight materials, such as engineered wood products (EWPs), now makes it possible to implement nature-inspired and bio-based solutions in interior design and building sectors.
An adaptive robotic fabrication process makes possible a necessary scaling-up and handling of complex interrelations between the pattern shapes and the behavior of novel materials. 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. Some contemporary case studies will be studied, such as: material efficient shell structures, kinetic – movable & adaptive energy minimizing façades, origami-based building, multi-combinations of lightweight principles, structurally optimized by combing nature inspired fibre reinforced composites, interior spaces and accessories created based on biophilic principles and designed according to the biomimicry methods. A variety of natural processes using biomimicry and nature-inspired solutions will be studied and taken into consideration.
Keywords: nature-inspired, digitalization, architecture, timber, sustainable

1. WOOD AS A SOURCE OF BIO-INSPIRATION

Bionics or biologically inspired engineering is the application of biological methods and systems found in nature to the study and design of architectural -engineering systems and modern technology, and is based for bioinspired materials. Organic, flowing natural forms have always been the inspiration for creating a built environment. Nature has developed the forms of organisms and their processes in terms of maximum optimization. Organic architecture finds inspiration in nature and is based on studies of forms in nature. Organic architecture began to imitate elements from nature and the natural environment, and today there is a new type of ideology that combines natural science and architecture in order to achieve complete unitybetween the building and nature. Ruskin wrote that ”forms which are not taken from natural objects must be ugly”[2].

In recent years, biomimetic and bio-inspiration have become an important focus in materials research and engineering. A bio-inspired material may be defined as “a synthetic material whose structure, properties or function mimic those of a natural material or living matter”.

Wood is extremely versatile material and as a raw-material suitable for sophisticated bio-based products. Wood offers more because it represents an inspiring source of ideas for new light-weight, cellular, and sustainable materials with enhanced properties (Figure 1).

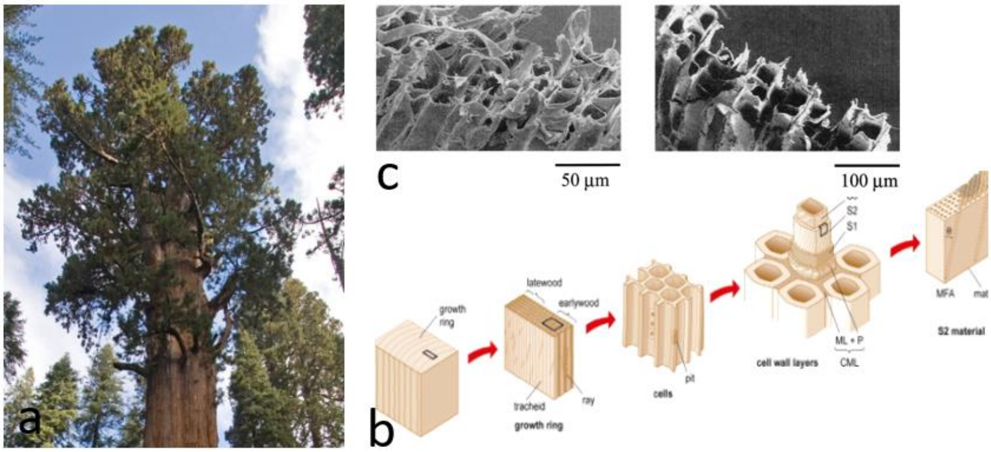


Figure 1: Hiearchical structure of wood: a - the tallest trees Sequoia sempervirens,b - levels of hierarchy from the macroscopic to the nanometre scale [5], and c - different fracture surfaces of Norway spruce fractured under tension [6].

1.1. Digital wood design

Digitization of the planning process is included in the wood industry and wooden structures. The so-called "digital wood design" is characterized by innovative techniques used in architecture that enable a high level of prefabrication and ensure the greatest possible freedom in architectural design with the highest quality of wooden construction [1]. The future of sustainably designed wooden architectural structures is a combination of visible wood, digital design and advanced machining technologies.

Wood is a natural composite and has been used throughout history as a durable construction material. Renewable wood is an ecologically healthy raw material, but only if its extraction, processing and use are sustainable. Modern, design-ambitious architectural constructions today demand even greater spans from the material with minimal diameters of load-bearing elements and shapes that solid wood does not allow. The wood industry is developing a number of new wood-based engineering products that maintain the sustainable character and physical properties of this natural material, while following trends in organic forms that sometimes even defy the laws of gravity. Appropriate methods of processing and treatment of wood products can reduce or completely eliminate unwanted defects in solid wood, while using basic engineering principles to improve its properties and adapt the construction, cross section and shape of such a composite to the intended use. Wood and wood engineering materials, including glued laminated wood, cross-laminated wood, PSL, LSL and LVL products, solid wood, veneer plywood, various fiberboards, veneer panels, chipboard, OSB board, lightweight panel composites, wood-elastic composites, modified wood, wood fiber insulation boards, etc. are an ideal material for building complex construction forms with digitally supported design and fabrication technology [9].

After the planning phase, the digitized processes continue in the implementation phases. Modern wooden constructions are also created in the processes of digital design and production. These processes use computer-aided design- CAE (Computer-Aided Engineering), computer-aided design - CAD (Computer Aded Design) and computer-aided manufacturing - CAM (Computer-Aided Manufacturing) [6]. Today, manufacturers cover all phases in the entire construction process: from technical development to construction, use and maintenance.

1.2. Materialization of complex and efficient geometries in timber construction

Complex building shapes are much easier to achieve with modern tools. The list of materials has also expanded – besides originally used concrete, metal bars and plastic, wood in various forms is also applicable (from solid construction, wood composites to 3D printing). Today, wooden constructions take on organic forms and co-create organic architecture (Figure 2), They stand side by side with the traditional buildings, which requires a digitized implementation process, where all components are quickly, flexibly and accurately designed and executed with digital processes in workshops. Checking the design with 3D models, the possibility of static assessment of the structure, solving technical problems in production, assembling parts or the entire structure on the construction site results in rapid construction of the building on site and a small number of finishing works.

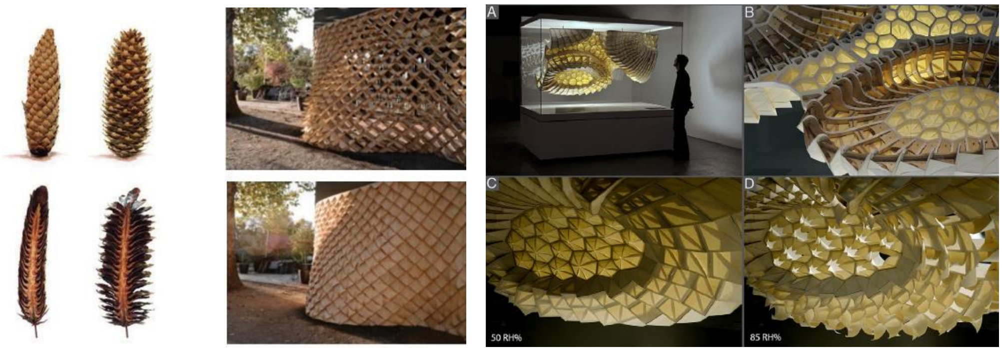
a b c d

Figure 2. Wooden constructions with organic forms: a - Kilden Performing Arts Center, Norway; b - Metropol Parasol, Spain; c - House of bread, Austria; d- La Seine Musicale, Boulogne-Billancourt – Paris, France [9].

Besides digital processes for development of the organic architecture, modern architects sometimes include traditional techniques, such as origami, applied to different dynamic paneling shapes for various purposes, e.g. acoustic performance control, stability and load bearing capacity of the building etc. Different patterns can be tested through digital simulation and, at the same time, paper folding. One of the main advantage relies on the possibility to perform variations: the resulting geometry can be obtained in real-time, allowing a dynamic and interactive optimization process. A good example is double-layered diagrid facade structure- a Timber Wave prototype constructed at the University of British Columbia Campus, as a product of digital design (Figure 3). The aesthetic of the prototype is stunning, due to the waved shape, which also contributes to its structural stability.

Figure 3. Wooden structures as a product of digital design and implementation: Timber Wave prototype, doubly curved timber assembly, at the University of British Columbia Campus [3].

Transfer of biological principles to architectural systems based on hygro-copically actuated wood-veneer composite systems is well presented in HygroScope installation at the Pompidou Center. It explores a novel mode of responsive architecture based on the combination of material inherent behaviour and computational morphogenesis. The dimensional instability of wood in relation to moisture content is employed to construct a climate responsive architectural morphology (Figure 4, Figure 5). Project HygroSkin – Meteoro-sensitive Pavilion as a climate-responsive architecture, is the first building application of meteoro-sensitive morphology where material adapts its form in unison with the environment. Modular wooden skin is designed and produced utilizing the self-forming capacity of initially flat laminated-veneer sheets to form conical surfaces based on the material's elastic behaviour (**Chyba! Nenašiel sa žiaden zdroj odkazov.**).



a b

Figure 4. a - Facade membrane - biological principle of shape change triggered by hygroscopically induced dimensional change with ambient humidity and functional principle of flexible façade [4], b - HygroScope installation at the Pompidou Center, Paris, France. Suspended within a humidity controlled glass case the model opens and closes in response to climate changes with no need for any technical equipment or energy [7].

a b

Figure 5. a - An example of a wooden structure based on a "wooden bimorph" [9]; b - A series of photographs in which a flat structure automatically transforms into a symmetrically curved structure, development of Self-Assembly Lab, MIT [3].

The travelling pavilion's modular wooden skin is designed and produced utilizing the self-forming capacity of initially flat laminated-veneer sheets to form conical surfaces based on the material's elastic behaviour. The material adapts its form in unison with the environment (Figure 6).

Figure 6. The HygroSkin Pavilion at FRAC Centre, Orleans-la-source, France [10].

2. CONCLUSIONS

In recent years, biomimetic and bio-inspiration have become an important focus in materials research and engineering as well as architecture and design. By utilizing this approach, recently some architects, engineers and designers have endeavored to create more sustainable designs. The deeper understanding and use of light-weight principles, such as a high degree of differentiation of material and structure, in combination with the development of computational strength design, simulation, and fabrication methods, enables novel constructions in architecture. Flexible design tools and CNC (Computer Numerically Controlled) processes allow the design and construction of advanced wooden architectural structures of new dimensions and shapes. The framework for the manufacture of components consists of mathematically accurate parameterized models of the structure and its components, which ensure that the deviations in the phases of manufacture, processing and installation are as small as possible. Nature-inspired sustainable solutions are innovative approaches to organic architecture in context with circular economy and the New European Bauhaus iniciatives.

Acknowledgements: We wish to thank Slovenian Research Agency, Program P4-0015 and P4-0059.

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IMPACT OF THE COVID-19 PANDEMIC ON THE FURNITURE MARKET IN SERBIA

Aleksandra Lazarević, Branko Glavonjić, Miljan Kalem

Abstract: The furniture industry is one of the strategic industries in Serbia, with about 30,000 employees. The subject of research in this paper was the furniture market in three selected regions in Serbia with the aim to consider the influence of certain factors on the demand for furniture during the COVID-19 pandemic, as follows: prices, quality, payment terms, brands, promotions, terms of purchase, frequency of furniture purchase, assortment, and online shopping. The methods used for the research included field research, surveys and analysis of the obtained data. The sample size included 210 respondents who were selected by random sampling method. When it comes to the impact of the COVID-19 pandemic, research shows that it did not significantly influence consumers' decision to buy furniture. Preference is given to domestic producers, both because of the availability of products and because of the more affordable price. When it comes to quality of furniture, the research showed that the 63% are satisfied with the ratio of price and quality, as well as the range offered on the market. The terms of payment are satisfactory, with the 58% customers opting for cash payments. On the other hand, the choice of the manufacturer is based on previous positive experience or recommendation, while going to the salon is the choice of 92% customers, compared to online shopping (8%). The conducted research is important for producers, distributors, and traders of furniture, as well as for the academic community because, for the first time, research was conducted on this topic in Serbia.
Keywords: furniture, industry, consumers, research, market

1. INTRODUCTION

The furniture industry in Serbia has been going through a very difficult period in the last fifteen years after the global economic crisis. During the crisis (2008-2010), companies that employed a large number of workers were forced to lay off workers at one point, and some small producers even closed their production facilities. In the post-crisis period, the furniture industry began to gradually recover, develop and become one of the strategic industries in Serbia. It succeeded thanks to, among other things, the quality raw materials that Serbia has. According to Glavonjić et al. (2008) hardwood forests, and predominantly beech and oak, account for about 64 percent of forests in the region. The quality of oak differs from one country to another with the highest quality resources found in Romania, Croatia and the north-west region of Serbia. Furniture manufacturers have taken advantage of the availability of quality raw materials and started to increase the degree of finalization of products. At the beginning of 2022, the wood industry employs over 30,000 workers in over 2,400 companies and about 3,800 entrepreneurs engaged in the production of furniture and wood products. However, the COVID-19 pandemic, which affected the whole world, left serious consequences on the Serbian industry, including the furniture industry. According to The German E-Commerce and Distance Selling Trade Association (BEVH), in March 2020, the demand for products necessary in self-isolation, such as food + 55.8%, medicines + 88.2%, and hygiene supplies +29,2%, rapidly grew. At the same time, there is a moderate growth rate of electronic retail of 1.5%. Other retail categories experienced a significant decline in sales, namely: footwear -31.1%, clothing -

35.4%, electronic devices -20.9%, IT equipment and devices -22.7%, furniture -27.8%, etc. (Mulyk, 2020). Taking into account the previously stated allegations, it is clear that there is a need to use relevant scientific tools to obtain relevant answers to various market questions that are important for furniture manufacturers, distributors and traders as well as academia because for the first time a research was conducted on this topic in Serbia (Glavonjić et al., 2020).

Furniture consumption depends largely on demographic trends (population, number of households and structure, age group of the population), housing construction and the amount of gross domestic product (Oreščanin D., 1994), while market research is the presentation, recording and analysis of all facts related to the sale of products and services from producer to final consumer (Milanović D., 1975). Therefore, in this paper, a study of the furniture market was conducted in terms of demand during the Covid-19 pandemic and the factors that most influenced the demand for furniture in Serbia.

2. AIM AND METHODOLOGY

The subject of research in this paper is the demand of furniture during the COVID-19 pandemic and thus connect the attitudes of consumers on the issue of quality, price, terms of sale and other indicators that affect the demand for furniture in the three selected regions in Serbia. The aim of the paper was to obtain answers from consumers to questions of importance for certain indicators that significantly determine their attitudes and decision-making on the purchase of furniture. Some of the analyzed factors, which are analyzed in this paper are: price, quality, payment terms, brands, promotions, purchase conditions, frequency of furniture purchase, assortment and online shopping.

Every scientific explanation is a complex process that contains a multitude of thought and logistical actions, which define the relationships and connections between the phenomena that are being researched. The Covid-19 pandemic has opened up a number of questions. Based on that, this paper used research methods that included field research (customer surveys), as well as analysis of the obtained data. Field research was conducted in three selected regions in Serbia, at selected points of sale, at several locations. 210 respondents participated in the research, in the time period October 2021-February 2022. The survey was conducted using the face-to-face interview technique, random selection of respondents, aged 25 to 65. For these purposes, 10 key issues have been defined that are important for making appropriate conclusions about the impact of the Covid-19 pandemic on the demand of furniture in Serbia. For the analysis of the obtained data, scientific methods of data analysis and synthesis were also used.

3. RESEARCH RESULTS AND DISCUSSION

The COVID-19 pandemic, declared by the World Health Organization (WHO) in March 2020, caused unimaginable shocks on the demand side, especially in the field of consumer goods (Fast-Moving-Consumer-Goods – FMCG). As basic anti-pandemic measures, locking policy, reduced contacts and physical distance, have caused the accumulation of basic foodstuffs, declining demand for by-products and increasing the share of e-retail (Marić R., Đurković-Marić T., 2020). As a result, the global furniture industry, like most industries, experienced a shortage of demand for its products during this period and was forced to reduce production capacity. The research in this paper is of great importance in order to show the situation on the furniture demand market in Serbia in that period. The analysis also included a graphic presentation of the most important answers to the questions.

Bearing in mind that the Covid-19 pandemic in Serbia started in March 2020 and that it was still ongoing at the time of conducting the research and writing the paper, the survey of respondents began with a question related to the impact of the Covid-19 pandemic on the purchase decision furniture. The obtained results showed that the Covid - 19 pandemic affected, on average, all three selected regions, with only 21% of respondents giving up buying furniture. For the remaining 79% of respondents, the pandemic had no impact on their decision to purchase furniture (fig. 1). On fig. 1 can also be seen individually for each region. What can be noticed is that in larger consumer centers, such as Belgrade and Novi Sad, significantly fewer respondents decided to give up shopping, only 10% that is 17%, while in a smaller consumer center, such as Kragujevac, that the percentage is significantly higher (36%). Therefore, the percentage of consumers who did not give up shopping varies from region to region, and shows the purchasing power of the population in the surveyed regions.

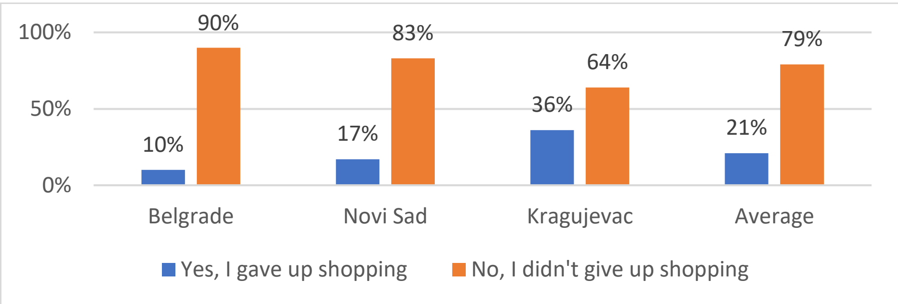

Fig. 1. Impact of the Covid - 19 pandemic on the decision of the respondents to buy furniture

Based on the interviews with the respondents, it was concluded that the largest number of respondents decided to change the furniture due to the long time spent in their apartments/houses, as well as the restrictions that accompanied going on vacation outside of Serbia.

The second question referred to the time period that elapsed between two furniture replacements in the respondents' apartments or houses. Based on the results shown in fig. 2, it can be concluded that the furniture in most households in the selected regions changes after the expiration of a period of 8 years, even over 50% in all three selected regions. That percentage ranges from 57% to 85%. The replacement of furniture also depends on the purchasing power of the population, so the results obtained by region are expected. In the discussion with the respondents, the Covid-19 pandemic did not greatly influence the decision to replace the outdated furniture, it only slowed down the selection a bit and thus prolonged the time of purchase.

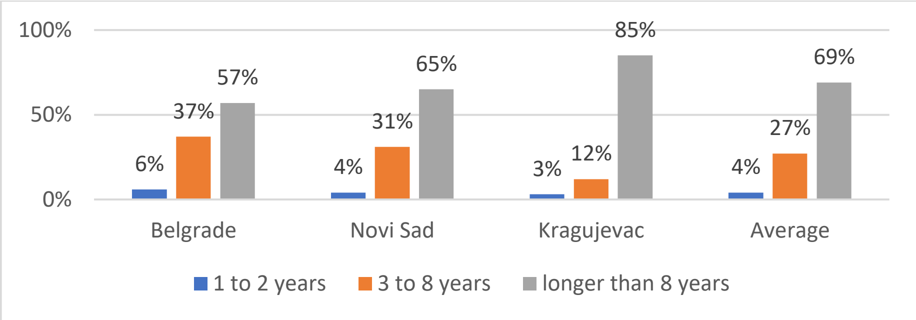

Fig. 2. Overview of the time period in which households replace furniture in their residential buildings

The third question aimed to get an answer to the question of whether buyers prefer to buy furniture from domestic or foreign manufacturers. The results of the survey show that on average in all three regions 87% of respondents preferred domestic furniture manufacturers, while 13% prefer furniture from foreign manufacturers. This is to be expected, considering that the offer of furniture produced in Serbia is of good quality in relation to the selling price, while the prices of foreign producers are significantly higher and are not affordable to the majority of the population. Related to that is question number four, which referred to the relationship between the price and quality of furniture offered in furniture stores in Serbia. On average, 63% of respondents said they were satisfied with the price-quality ratio, while 37% said they were not. These were mostly buyers who had already bought furniture from a manufacturer and after some time had to return it due to damage. It should be noted that the majority was satisfied with the price and that it was the respondents who decided on furniture of medium price range. When it comes to the influence of the brand on making a decision to buy furniture (question number 5), 81% of respondents answered that the brand is not important to them. The answer that the brand is important in making a decision to buy furniture was given by 11% of respondents, and 8% answered that the brand is important to them, but it is not crucial for making a decision to buy, on average for all three regions. The highest percentage of people who decided to buy branded furniture was in Belgrade (14%), where the purchasing power of consumers is the highest and they can therefore afford branded furniture.

When it comes to the method of payment, the majority of respondents (58%, on average in all three regions) stated that they pay for furniture in cash. In Kragujevac 45% of respondents were decided for cash payment for furniture, then 60% in Novi Sad and 69% in Belgrade, while to a much lesser extent they decide to buy furniture in installments and checks, and very little to buy on credit (1%), which can be seen in fig. 3.

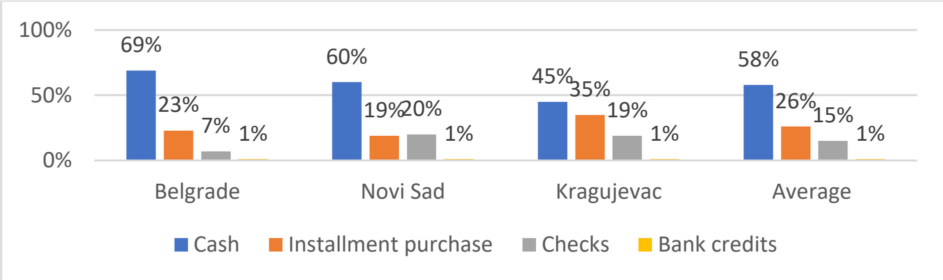

Fig. 3. Presentation of the method of payment used by the respondents when buying furniture

When buying furniture, the respondents took into account and analyzed a larger or smaller number of indicators such as: quality, price, appearance, material, existing ambience, brand, comfort, design and others. For the largest number of respondents, the most important indicator for the purchase of furniture was product quality (35.7% of respondents). In second place was the price (13.3%), followed by comfort (5%), material (2%), appearance (1.4%), the existing environment in which the furniture should fit (1.3%) and design (1.3%). Considering that the respondents mentioned several indicators that were decisive for their purchase of furniture, we also have combinations of answers:

1. quality and price are crucial for 21% of respondents
2. quality and appearance is important for 7% of respondents
3. quality and material is the answer of 12% of respondents.

Assortment of furniture offered by the manufacturer gives a true picture of it to the consumer. For customers is important to have a choice. When asked whether they were satisfied with the assortment of products of domestic furniture manufacturers, over 77% said they were satisfied, while less than 23% were dissatisfied with the assortment of products offered. The results of the survey show that most respondents are satisfied with the assortment of furniture from domestic manufacturers, explaining that they have a great choice and the ability to find what they need.

The next question was aimed at getting an answer from the respondents how they make the final choice of furniture in terms of whether it is enough for them to see how the product looks on the Internet or in a catalog or they still need to see its physical appearance in furniture stores. The answer that a review of the catalog or website is enough to decide on the purchase of furniture was given by an average of only 8% of the total number of respondents in all three regions, while 92% of them decide to go to a furniture store. A large number of respondents had the decision to go to a furniture store to see and choose furniture when shopping. In the conversation with the respondents, the dominant approach was that they have to see the product live, try it and touch it. They often get information through catalogs and the Internet, but after that they go to the salon to make the final purchase decision. A catalog or website is sufficient, when choosing furniture, for a very small number of respondents. The last question in the survey was about the use of online furniture shopping. The results of the respondents' answers show that only 14% of the total number of respondents used online furniture purchase, and 86% did not buy furniture through online platforms. Of the 14% of respondents who said they buy furniture online, 9% said they had previously been convinced of the characteristics of the products in salons or had seen someone, and only then ordered online. This number would have been even lower if the Covid-19 pandemic had not followed. Respondents' comments were that furniture is not something they would risk buying online because they are not sure of the quality until they see the product live.

4. CONCLUSIONS

Based on the results obtained by this research, it is concluded that furniture has been used in Serbia for many years. As many as 50% of the respondents said that they change their furniture after more than 8 years. The Covid - 19 pandemic did not significantly influence the decision to buy furniture. The attitude of consumers is that they spend more time in apartments and houses, so they made the decision to buy furniture during the pandemic in order to better arrange the living space in which they lived and worked online. When it comes to furniture manufacturers, respondents mostly opted for furniture from domestic manufacturers and to a large extent (63%) are satisfied with the relationship between price and quality of products offered. When choosing furniture, the most important thing is the quality, and then the price of the product. Online purchase of furniture has not yet taken root among the respondents. The reason for that is that the furniture does not change often and represents a higher financial expense, so the respondents prefer to go to salons to see the furniture live. Improving the online purchase of furniture would be achieved through better presentation and product information.

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RELATIONSHIP BETWEEN INDICATORS OF THE WOOD PROCESSING INDUSTRY AND ECOLOGICAL INNOVATION

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Abstract: The article is aimed at the assessment of relationship between indicators of the wood processing industry and ecological innovation. The situation is evaluated in terms of innovation activity overview consisting of three areas: wood and cork, manufacture of pulp, paper and manufacture of furniture. Indicators relevant to the analysis of parameters of ecological innovation and innovation activities in Slovakia are sorted by selection of examined indicators. The study of dependencies between innovation activities of wood processing industry and ecological innovations in Slovakia is realized by correlation and regression analysis to identify basic causalities and coherence among monitored parameters. The findings of the study point to below average innovation activity in the wood processing industry which is caused especially by innovation funding. Further results of the analysis mention the existence of causal relationships between indicators of the wood processing industry and ecological innovation where we found out that ecological innovations are not dependent only on innovation activities of wood processing industry in Slovakia.
Key words: innovation, ecological innovation, innovation activity, wood processing industry, Slovakia.

1. INTRODUCTION

Global economic and environmental challenges and growing political awareness of sustainable economic growth have given new impetus to the development of innovation in many economics sectors including forestry and wood processing. Innovations that decrease impacts of renewable resource use on ecosystems are of central importance with the aim to ensure environmental sustainability.

There has been a significant growth of academic papers focused on different formulations of eco-innovation in recent years. Nevertheless, a research inspection advises that terms like eco-innovation, bio-innovation or sustainable innovation describe very similar things. However, many definitions have been proposed for "eco-innovation". The first definition is by Fussler and James (1996) who described eco-innovation as the process of developing new products, processes or services which provide customer and business value but significantly decrease environmental impact. The European Commission defines eco-innovation as "the creation of novel and competitively priced goods, processes, systems, services, and procedures designed to satisfy human needs and provide a better quality of life for all with a life-cycle minimal use of natural resources per unit output, and minimal release of toxic substances".

The concept of eco-innovation is increasingly linked to the concept of bioeconomy, which aims at sustainably meeting food needs and some of the material and energy needs of societies while preserving natural resources and ensuring environmental services of good quality through innovation to sustainability (Jankovský et al., 2021; Loučanová et al., 2021; Parobek et al, 2016, Gasova, Stofkova, 2010; Stofkova et al, 2016, 2017).

Sustainability has been the leading principle in forestry for centuries. The sustainability concept, within the forest sector, has evolved from a narrow focus on sustainable wood production to a much broader evaluation of environmental, social, and economic sustainability for whole value chains. Forest-Wood-Chains are defined as chains of production processes (e.g. harvesting–transport–industrial processing), which are linked with wood products.

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 essential link between the present and future of each company. 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.

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, Nosáľová, 2020; Olšiaková et al., 2016; 2020; 2021; Straka, 2013; Štofková, 2013; Havierniková, 2012).

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., 2011; Kaputa et al, 2016). Thus they identify the specific product characteristics regarding the customer requirements.

The specification of mentioned elements presents a significant impulse in order to identify trends and to determine consecutive procedures, improvements and innovations for chosen products (Šupín, 2009; Loučanová et al., 2014).

The aim of the paper is the assessment of the relationship between indicators of the wood processing industry and ecological innovation in Slovakia.

2. Methodology

The relationship between the indicators of the wood processing industry and ecological innovations in Slovakia is evaluated through the analysis of the researched properties and processes. We analyse the issue within the individual parts of the wood processing industry - Wood and cork, Manufacture of furniture and Manufacture of pulp, paper in the paper.

The data are obtained from the database server The Eco-Innovation Scoreboard and the Eco-Innovation Index (2022) and Statistical office of the Slovak republic (2022). Indicators relevant to the parameters analysis of ecological innovation and innovation activities in Slovakia are sorted by selection of examined indicators. Subsequently, the study of dependencies between innovation activities of wood processing industry and ecological innovations in Slovakia is realized by correlation and regression analysis.

The obtained findings describe the innovation activity of wood processing enterprises in several aspects and ecological innovation, identifying the basic causalities and coherences.

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 unfinished or suspended innovation activities.

The share of enterprises with innovation activity was in particular sectors of economic activity different and varied in the range from 14.9 % to 70.7 % in Slovakia. The average value was 34.6 % in industry and 26.5 % in services (Statistical office of the Slovak republic, 2022).

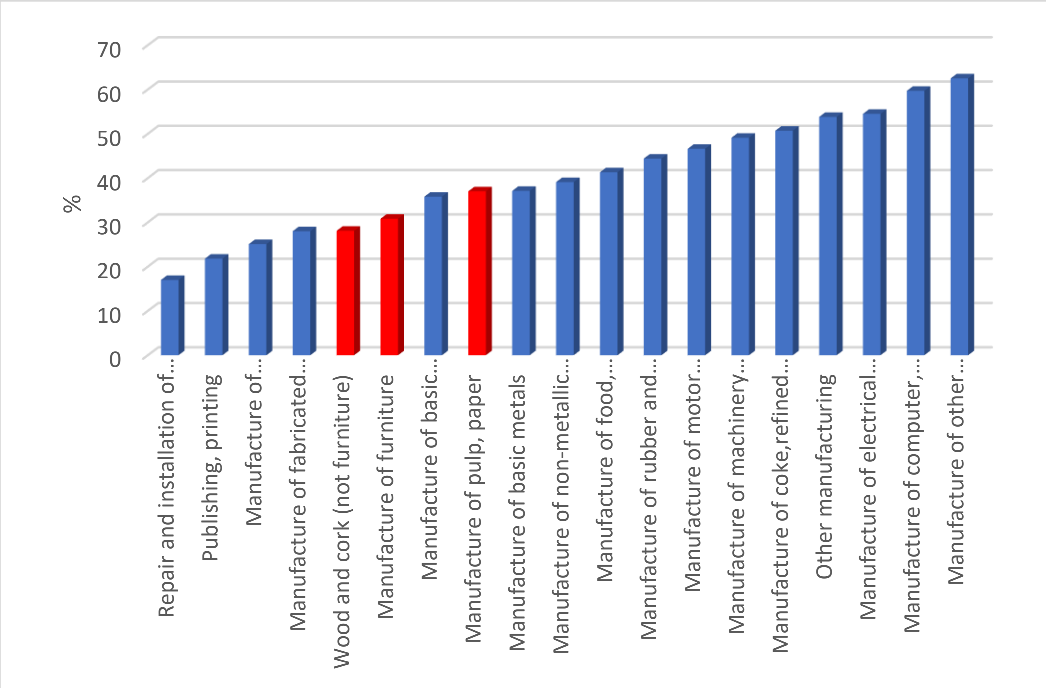

Figure 1 The share of enterprises with innovation activity from the total number of enterprises in industry
Source: Statistical office of the Slovak republic (2022)

The wood processing industry's innovation activity in terms of furniture production is 30.8 %, 37 % in paper and paper products and 28.1 % in wood processing industry On average, innovation activity in the wood processing industry is 27.33 % in complex. This value does not reach the average of the innovation activity of enterprises in Slovakia, so we can say that it is below average.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.657453
R Square	0.432245
Adjusted R Square	0.242993
Standard Error	12.41782

Observations	5

ANOVA

	df	SS	MS	F	Significance F
Regression	1	352.1932	352.1932	2.283969	0.227894
Residual	3	462.6068	154.2023		
Total	4	814.8			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	118.8989	39.23549	3.030391	0.056294	-5.96597	243.7637
X Variable 1	-1.93598	1.281019	-1.51128	0.227894	-6.01275	2.140794

Figure 2 The results of statistical analysis

The analysis of the dependence between innovation activities of wood processing industry and ecological innovations was carried out for Slovakia. The result of the correlation analysis is the first part of the regression statistics output. The value of the correlation coefficient is 0.6574. The closer this value is to 1, the stronger the dependence. In our case it is a medium high degree of tightness of the relation between innovation activities of wood processing industry and ecological innovations in Slovakia. The value of R-Square is the value of the determination coefficient and in our case; it is the value of 0.4322.

This multiplication value of 100 indicates that the selected regression line explains the variability in average innovation activities of wood processing industry to about 43.22 %. The other represents unexplained variability, the impact of random factors, and other unspecified effects. Adjusted R-square also considers the number of estimated parameters and the number of measurements. The Standard Error should be as small as possible.

In the ANOVA section, we test a null hypothesis that argues that the chosen model to explain dependency is not appropriate. The F test is used to evaluate this claim. Significance F = 0.2278 > 0.05 (α - significance level). It means we reject H0, so eco-innovations are dependent only on innovation activities of wood processing industry.

CONCLUSION

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. It means we reject H0, which eco-innovations are not dependent only on innovation activities of wood processing industry. This was also reflected in the results of the evaluation of innovation activities in the wood processing industry and ecological innovations. Ecological innovations are not dependent only on innovation activities of wood processing industry in Slovakia.

ACKNOWLEDGEMENTS

The authors would like to thank the Scientific Grant Agency of the Ministry of Education, Science, Research and Sport of the Slovak Republic and the Slovak Academy of Sciences, grant number 1/0475/22 "Environmental Consumer and Environmental Citizen", grant number 1/0495/22, "Sustainability of Value Supply Chains and its Impact on the Competitiveness of Companies in the Forest and Forest-Based Sectors" and grant number 1/0494/22 "Comparative Advantages of the Wood Based Sector under the Growing Influence of the Green Economy Principles".

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IMPACT OF THE FOREST - RESOURCE POTENTIAL AT FORMATION OF THE „NEW "ECO-SETTLEMENTS

Petar Marinov

Abstract: Forest resource potential is a basic factor in the Earth's biosphere system. On the other hand, it is the basis for the formation of the village forest and green infrastructure. In the development of the material - the aim is to present a new perspective (paradigm) for the forest resource potential, its impact on the ecological way of life in urban settlements. The publication attempts a methodological approach (application of a mathematical model), based on the ratio of forests (urban forests and green areas) to the population in the village. The basing of the forest resource potential and the green areas are based on certain principles and factors influencing the formation of the "New" eco-settlements in the urbanized areas.
Key words: Forest resources, eco-villages, urbanization and green infrastructure.

1. INTRODUCTION

Forest resource potential is that "product" extracted from forests that serves to meet the social and economic needs of the population. In recent decades, these same forest "resources" have emerged as a basic environmental need (necessity) for the growing human population on a global scale. Forest resources, on the one hand, are a natural resource that develops and forms ecosystems and they can be classified as renewable resources on the planet. With the intellectual development of human civilization, the forests or the resources in them begin to be exploited in different ways depending on the range and latitude. The development of industrialization and subsequently the process of urbanization and suburbanization, affect forest areas, and the latter are beginning to become part of the urban environment (Mihailova, 2019).

The term "Settlement Forest" began to be used in the late nineteenth and early twentieth centuries, when the intellectual human potential realized that wood may have a purpose other than its conventional use. The basis of the creation of various concepts and paradigms during the time periods of human development is the forest resource potential, regardless of its form.

The concept of Sustainable Development is based on modern philosophy in the coming decades of the XX and XXI centuries. It has its prehistory in the early 1970s of XXth century, with a number of previous events, reaching 1987, when the World Commission on Environment and Development (UN, WCED, 1987) adopted the report of the Brundtland Commission – "Our common future". For the first time, an attempt is being made to define sustainable development. The definition is as follows: sustainable development is development capable of "meeting current needs without compromising the ability of future generations to meet their own needs".

The philosophy of "Green Infrastructure" is a continuation of the conceptual idea of Sustainable Development on a global scale, and as a concept emerged in the 90s of XXth century in the United States. Attention is beginning to be paid to green areas and spaces in the urban environment of big cities, the connection between natural resources and man. The basis for the concept is the "ecosystem", its impact on the socium, an element of this system. The terminology was quickly included in the specialized literature, began to find application in activities related to the conservation of flora, fauna and green spaces in urban environments. It is quickly taking the place of a new paradigm related to the "new way" of perceiving green spaces. Literary sources provide a number of interpretations and definitions related to this concept. One of the definitions was made according to a 2012 study by the European Commission on Science for Environment Policy - In-depth report on Green Infrastructure:

"… Green infrastructure is a network of natural and semi-natural areas, functions and green areas in rural and urban areas, terrestrial, freshwater, coastal and marine areas. In its broader concept, it also includes natural resources, such as parks, forest reserves, hedges, restored and preserved wetlands and marine areas, as well as artificial features and bike lanes".

Many authors believe that the formation of new eco-settlements can be based on existing ones (Harvey, 2005), rather than by creating new ones in separate areas. The development is based (as a philosophy) on the New Urbanism movement in the United States in the early 1980s of XXth century; creation and operation of zero carbon buildings; providing 30% of housing in the city to be private and formed on green areas (green infrastructure spaces), constituting 40% of the urbanized area. The idea of creating such eco-villages dates back to the 19th century, and this type of utopia was first adopted in 1817 by the industrialist Robert Owen (1771-1858), who built the village of New Lanark, near Glasgow, for his workers, Scotland. Subsequently, other similar ideas were developed, as a model can be used the built industrial city - Saltaire by Sir Tit Sol (1803-1876) for 1500 workers. The modern idea over the decades has been developed mostly by wealthy industrialists who have realized that better living conditions accumulate high and quality production activity. The concept of the "New Town", which is based on the idea of improving the quality of life through sustainable urban development in the cities, was rooted in early 1898, with the formation of the "Garden Town" Association in England. The idea for its creation is based on the book by Ebenezer Howard (1850-1928) "Tomorrow a Peaceful Path to Real Reform "(1898). Four years later, the book was published under the title "Garden Cities of Tomorrow" (1902), which popularized the author himself and his ideas. In 2020, the world's population is over 7,7 billion people, of which 56,2% live in urban areas. The global population growth, the climate change, the biosphere disruption, the continued use of conventional natural resources, and last but not least, the concentration of the human population in urban areas, necessitate the creation of a new paradigm, principles and factors to develop a new philosophy for the formation of the "New" Eco-settlements.

2. MATERIALS AND METHODS

The presented mathematical model for creating a new type of eco-village is based on the number of inhabitants of the urban area, as each of them must have a minimum area of 20 m² (Radovanova, 2021), public forest plantations, or 40% of the administered territory should be green spaces (Dobrev, 2012). We will call such a settlement good for living. The purpose of the mathematical approach is to create a model applied in scientific research - the ratio between the population, depending on the area of the village (Dokuzova etc., 2014), and the available urban forest resources, could be defined as:

S km² - area of the settlement; **40%** - from the territory of the settlement with green area; **N** - number of inhabitants of the settlement in thousands of people; **K** - coefficient for a good settlement

Where:

There is 40% of S km² or **$4 \times 10^{-1} \times S$ km²,** green area in the village

On the other hand, this area is: **$20 \times 10^{-6} \times N$**

Therefore: **$20 \times 10^{-1} \times N = 4 \times 10^{-1} \times S$ km²**

$N = 20\,000 \times S$ km²

Presentation: Let in the eco-village which has green areas 40% of its territory and live N number of inhabitants - we could give the following equation as a solution:

$K = (2000 / N)$, hence the relation is:

A) Good settlement **$K = 1$** B) In a better settlement **$0 > K < 1$**

C) In a worse settlement **$K > 1$** D) In the worst settlement **$K \approx 0$**

In the development of the scientific material, the definitions: “New City”, “Garden City” and the “New” Eco-settlements should be considered as synonymous terms. A historical approach and a comparative analysis have been applied in the research.

1. RESULTS AND DISCUSSION

In the formation and development of the idea of the “New” Eco-settlements, the need of mandatory cultural change in the formation of the mentality must be considered. The change is necessary to such an extent that the principles and factors of building the new image of human society could be rationalized. This is important and necessary from the point of view that the old model of functioning in urban areas does not work and will lead to the destruction of human civilization. Therefore, a new paradigm shift “dressed” in new principles and factors will integrate the human society into the processes of the biosphere with new understandings and approaches. The experience gained in preparing the forest strategy in England (Forestry Commission, 1998) is based on four main principles: quality, integration, partnership and community support. The presentation of this type of “policy” can be applied as a basis for the development of the next “New” Eco-settlements. In this type of settlements, the use of four types of forests can be applied, which will have a direct impact on the quality of life of a certain society, striving to improve the quality of socio-economic life: 1) Forests for commercial purposes; 2) Forests for regeneration and economic recovery; 3) Forests for public benefit, recreation and tourism; 4) Forests for nature protection and environmental protection.

The creation and development of a new type of ecological settlement must be based on factors, principles and mathematical models. On the other hand, they must be linked to the philosophy, existence and functioning of this type of settlement (Mutafov, 2021). Any change in these requirements will lead to compromises, change and failure of the whole concept. The application of various ***factors*** (without claiming to be exhaustive on the examined subject), will support the development of the eco-village, in vertical and horizontal direction:

3. Social – basic, on which the philosophy for the functioning of the "New" Eco-settlements or conceptual doctrine is built. This type of factors should be aimed at the environmental - friendly way of life in the village.

4. Economic - directly related to the functioning of the settlement (Tsvyatkova, 2021). They are the economic drivers of investment policy aimed at creating a new generation of technologies that serve the social activities.

5. The ecological factor will be indicative of the "New" Eco-settlements. Maintaining an ecological environment will be a basic obligation of every resident in vertical and horizontal level. Recycling of all types of waste products, household or industrial, will be mandatory. Production facilities and transport will meet certain requirements and standards, subject only to the ecological way of life.

6. The climatic factor is the subconscious reason for the creation of this type of city. Climate changes as a result of the overexploitation of the earth's natural resource potential has led to the introduction of new paradigms in the socio-economic way of life. Climate change on a global scale has happened many times on the planet, but in the last 30-40 years there have been many abrupt changes and a large number of abnormal climatic phenomena. The change in the microclimate of certain regions of the Earth has a direct impact on the global weather forecast. The construction of the "New" Eco-settlements and their functioning on the basis of a natural way of life may slow down the apocalyptic pictures of ecological catastrophe on the planet.

7. Infrastructure factors are key-factors to the functioning of the "New" Eco-settlements, in the construction of the green infrastructure. They will have a basic meaning. In turn, they can be grouped as follows: underground and aboveground.

The application of ***principles*** (without claiming to be exhaustive on the subject under examination) is essential for the functioning and development of the eco-village in combination with the above-mentioned factors. Each system or subsystem must be developed and work only in the direction of environmentally friendly lifestyle:

8. The educational system should be aimed at forming a new type of thinking and consciousness. The new knowledge must ask questions and look for answers targeted at the eco-village. It must be considered as a living organism - a symbiosis between man and nature. Education should be a priority area for all age groups.

9. The relationship between the number of population and green spaces presented in the form of forest-resource potential in the new eco-villages is one of the most important principles on which the whole philosophy is built.

➢ Geodemography includes - births, deaths, natural and mechanical growth and migratory mobility. The new type of eco-village will require the maintenance of approximately the same population. In the case of an increase (which is inevitable), it should be smooth and meet the above-mentioned two other factors (the methodology is based on the population number to the corresponding green areas). With the mechanical growth of the population, "corrective" measures must be introduced in order to facilitate the way of life in the settlement. An important element in the Green City will be the even distribution of the population throughout the territory, thus avoiding a number of inconveniences in socio-economic life.

10. The green city should be an administratively independent unit, as a way of managing in the boundaries of the land. If centralized management is imposed in the country, the settlement should be excluded from such a scheme; the self-management is important in decision-making. The administrative management of the settlement must be electronic. In this case, all administrative services (systems) will be connected in one common scheme.

11. The application of new technologies and technological solutions must be consistent and focused on the ecological way of life of people. They must solve the problems of citizens related to their way of life. Their application must be in the fields of transport, recycling of all kinds of waste products and last but not least in industrial activities.

Giving an accurate definition of the “New” Eco-settlements at this stage is quite difficult and will probably be inaccurate, due to the practical reason that currently nowhere in the world, there is no such settlement that fully satisfies its needs and wants through alternative energy or to process over 95% of waste from household, industrial, transport or other activities.

The author of the research presents his definition of the "New" Eco-settlements, based on the above presented factors and principles without claiming completeness and comprehensiveness of the topic: **“**Urbanized synergetic area with appropriate principles and factors, fully integrated in a single technological system governed solely by the environmentally friendly way of life in the socio-economic sphere of the people”.

The synergy between the mathematical models applied in the creation of the new ecological settlements, the urban forest resources, the principles and the factors is the essential relation between them. On its creation and functioning in future periods depends the socio-economic prosperity of the human population inhabiting the “New” Eco-settlements. The village forest has an impact on people's health, their physical and mental recovery, as well as the preservation of the overall forest resource potential (Petrov, 2021). For this reason, urban forest resources must be integrated into sustainable development and habitat management strategies and considered as part of a non-renewable natural resource. In general, the process of urbanization must be linked to urban forest resources.

2. CONCLUSIONS

In the first decades of the XXI century, there were large-scale discussions (on a global scale) related to improving the quality of life in urban areas (Yarkova and Mutafov, 2017). In this regard, the elaborated study, without claiming to be exhaustive, gives a point of view (minimum) on solving environmental problems in general in the settlements and a new look at the creation of “new” and modern settlements. They stepped on a new paradigm based on a mathematical model, principles and factors, defending the existing and future development of human society as a whole. The settlement forest in the urban zone or in the areas of the settlement is essentially important for regulating the local climate - reduces the strength of winds, controls water flows in horizontal and vertical directions, filters air and sunlight. It prevents the effect of the city's “heat island”, which automatically reduces the amount of electricity in residential buildings. To maintain the standard of clean air in the settlements, the city's forest resources appear as “protective filters”. The forest-resource potential is the basis for the creation of a new type of settlements. Observance of the principles and factors for the formation and functioning of the new eco-settlements is essential for the population inhabiting these areas. The “New” Eco-settlements will completely change the “old” way of life of the people living in these new spaces. The real task of these new settlements will not consist only in the construction, functioning and use of new socio-economic-environmental needs, but the creation of a modern paradigm related to new cultural ecological thinking.

ACKNOWLEDGEMENTS

We express our gratitude for the financial support of the National Scientific Porgram “Intelligent plant production“, to Component 4: Artificial Intelligence and Digital Technologies - Engine of Innovative Management Systems, Sectoral Dynamics and Change in Quality of Life. WP 4.3. Rural development and human capital driven by artificial intelligence and digital technologies.

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DIGITALIZATION AND LOAN ACTIVITY IN THE TIMES OF UNCERTAINTY - SOME EVIDENCE FROM BULGARIAN BANKS AND WOOD BASED INDUSTRY

Rumyana Marinova

Abstract: The processes of digitalization have changed the business models of banks, allowing the use of more comparable information about banking transactions on the one hand and significantly accelerating the lending activities of banks - on the other. In a highly competitive environment, the innovative development and digital nature of the products offered by banks also impose specific requirements regarding their accounting and assessment of the risks they pose. The supply of credit products in times of crisis imposes stricter banking standards in lending to enterprises and the introduction of specific risk indicators by economic sectors. The main thesis is that in conditions of uncertainty, the provision of real-time accounting information through the use of digital technologies offers opportunities for rapid access to information and rapid restructuring of information and reporting processes on the one hand, but on the other - imposes stricter control over the lending activities of banks. Bulgarian banks and wood based enterprises have been studied with regard to the specific industry risks in lending and the development of digital banking services. Our results support the view that the digitalization of banking operations allows for current rethinking and assessment of business risks as a result of the change to new digital business models, as well as their adequate reporting in corporate reports.
Keywords: loan activity, digitalization, reporting, business model, banks, wood based industry, risks

1. INTRODUCTION

Uncertainty has become one of the main features of the business environment in Bulgaria in the last two years. In the context of the COVID-19 pandemic, the Bulgarian wood based business faced serious challenges related to reducing the volume of activity, breaking the supply chain, increasing the price of resources, uncertainty regarding the planning of future activities, etc. In early 2022, when some recovery in both the macroeconomic and business performance of companies began, Europe faced a new crisis related to the start of the war in Ukraine, which again put various unknowns to the companies and increased uncertainty and competition in the business environment.

The banks will face a situation of increased dynamics in the risks associated with the book value of assets and liabilities and profitability. In a highly competitive environment, the innovative development and digital nature of the products offered by banks also impose specific requirements regarding their reporting and assessment of the risks they pose. The provision of credit products in times of crisis imposes stricter banking standards in corporate lending and the introduction of specific risk indicators by economic sectors, as different industries have different specific risks, which manifest themselves in varying degrees of uncertainty.

Our study covers leading Bulgarian banks and enterprises operating in the wood based industry in terms of defining the specific industry risks in lending and the development of digital banking services. We share the thesis that the digitalization of banking operations requires ongoing rethinking and assessment of business risks within the bank as a result of the transition to new digital business models, as well as critical thinking about the activities and risks inherent in borrowers from the so-called wood based industry.

2. LOAN ACTIVITY IN CONDITIONS OF UNCERTAINTY

The banking sector has a key role in the development of an economy, playing the role of a major driver of economic growth and has a dynamic role in the transformation of free capital resources and their optimal utilization so as to achieve maximum productivity. The Bulgarian banking system enters 2022 well-capitalized, highly liquid and profitable, according to data provided by the European Central Bank (ECB). (European Central Bank, 2022) Loans to the non-financial corporations sector at the end of the first quarter of 2022 amounted to 145 thousand, increasing on an annual basis by 2.4%. The amount of these loans is BGN 38,985 billion, an increase of 7.9% on an annual basis. Compared to the end of the previous quarter, the number of loans to the non-financial corporations sector increased by 2.7% and their amount by 3.6%. (BNB, 2022). Despite the COVID crisis, both deposits and loans in the banking system continue to grow - proof that confidence in banks remains high and that rapid adaptation to changing conditions and the introduction of a number of digital solutions has a positive effect on the development of the banking industry.

The lending process is complex, multi-layered, taking into account the specific risks for each industry and based on the established internal rules in the respective bank. The changes in the banking sector that have occurred as a result of the crises are largely related to the digitalization of banking operations. Despite the negative effects on economic development, COVID-19 has definitely managed to accelerate the digitalization process in the banking sector, with digital acceptance in Europe rising to 95% as a result of the COVID-19 crisis, an increase that would take two to three years in most industries at pre-pandemic growth rates. (Fernandez, et al., 2020) According to the same survey, banking has the most engaged users, with 82% of respondents saying they will continue to use online banking services to the same or greater extent. This in turn means that in practice the business model of banks has already changed. The digital environment for performing a significant part of the operations changes the way of organizing the banking activity, opens many perspectives for its optimization, gives customers opportunities that they did not have before, but also raises very important questions related mainly to the risks brings this new business model and their adequate evaluation and prevention. Adapting to the new reality created by the pandemic has led to an increase in digital products, services and relationships between banks and wood based companies.

In the relevant literature on the topic, along with the typical ones, two new risks are considered, which are the result of the change of the business model of the banks - cyber risks (part of the operational risks) and climate risks. The ECB's document on supervisory priorities for the period 2022-2024 defines three main priorities, the third of which relates to emerging risks. Exposure to climate risks is identified as a major emerging risk; counterparty credit risk exposures; - risks in the assignment of IT activities and cyber resilience. (European Central Bank, 2022), which means that the European regulatory body considers that banks need to pay special attention to these risks. At the same time, according to an another report by the ECB (European Central Bank, 2022) 72% of banks do not disclose at all whether the risks associated with climate change are significant for their activities, while only 4% disclose all related risks.

At the same time, 34% of banks that do not disclose such information have indicated to the ECB that these risks are significant in defining their risk profile.

In their study, Krasnova, Lavreniuk and Nikitin point out that in conditions of uncertainty, market risk has a significant impact (31.27%), which is a typical and new. After analyzing the business model of the bank, they found that credit risk has the most significant impact in the corporate business segment. It is concluded that there is a need to move from traditional profit-oriented risk management, to risk-oriented. Such an approach will help reduce potential financial costs and increase the bank's stability. (Krasnova, et al., 2022)

As already noted, credit risk is the most significant risk arising from the nature of banks' business. According to Atanassova and Popova, disclosing the credit risk of a requirement considered formal can become one of many tools to stabilize the position of certain banks, especially with a view to creating a positive image of the bank to consumers of public information. (Atanassova & Popova-Yosifova, 2018) That is why we believe that focusing on the business model and its impact on credit risk management is extremely important. And the digital world raises the question of digital risks – cyber attacks, theft of user data from the bank's customer files, phishing attacks on the bank's customers using digital services, etc. Pentti Hakkarainen notes that there is a growing trend in threats of distributed denial of service (DDoS) attacks often by temporarily interrupting or stopping the service on its host server. (Hakkarainen, 2020)

A report by the ECB's supervisory authority identified a number of cybersecurity concerns that banks' unsatisfactory management of the risks associated with outsourcing IT activities, along with their growing dependence on third-party IT service providers (including cloud service providers), raises concerns that require more serious oversight (European Central Bank, 2022). In order to optimize the disclosure of risks in the activities of banks, we believe that the bank must provide sufficient quality information on credit indicating sector-specific risks for wood based enterprises. In the same way, the risks associated with cybersecurity and the impact of climate change, which we believe are directly related to the cost of credit, should be assessed. According to the guidelines of the European Banking Authority (EBA) from the end of 2020, the assessment of credit exposures by banks should take into account - the type of debtor, the sector of the counterparty, the type of collateral and in which geographical area it is made. We share the view of Bernini et al. That banks should view digitalization as a key driver to be seen not in a stand-alone perspective but in a combined approach. (Bernini, et al., 2021)

We studied the financial statements of the top five banks in Bulgaria from the so-called First group, according to the grouping of the Banking Supervision Department of the BNB as of January 31, 2022 for the period 2020 - 2021: UniCredit Bulbank, DSK Bank, United Bulgarian Bank, Eurobank Bulgaria, First Investment Bank. In their financial statements, banks present summary information on the structure of loans by sector of the economy. The relative share of loans granted to wood based enterprises cannot be specified, as this industry is included in the so-called Manufacturing sector. All five surveyed banks report in their 2020 financial statements that credit risk management is carried out through regular analyzes of debtors' creditworthiness and credit rating. Exposure to credit risk is also managed through the acceptance of collateral and guarantees. For example, FIBank states that it has provided loans to companies in different fields of activity, but in the same economic sector - production, due to which the exposures have a similar business risk. (FIBank, 2020) However, information on cyber risks, as well as on the risk associated with climate change, are not subject to detailed disclosure by the five

Bulgarian banks surveyed, as well as information on specific risks by sectors of the economy and in particular the wood based sector. (Table 1)

Table 1. Specific risks disclosure by top 5 Bulgarian banks

Bank	Disclosure of specific cyber risks	Disclosure of specific climate-related risks	Industry specific credit risks
Unicredit Bulbank	Yes	Yes, without impact assessment	No
DSK Bank	No	No	No
UBB	Yes, without impact assessment	Yes, without impact assessment	No
Eurobank Bulgaria	No	Yes	No
FIBank	Yes, without impact assessment, only as part of operational risk	No	No

Source: Annual financial statements for 2020 of banks surveyed

3. WOOD BASED INDUSTRY - LENDING AND SPECIFIC RISKS IN THE CONTEXT OF DIGITALIZATION AND UNCERTAINTY

Bank digitalization opens up many opportunities, but also hides many risks, and some of these risks affect credit recipients, affecting the price of credit. The wood based industry in Bulgaria was also affected by the COVID-19 pandemic and the problems that have arisen are mainly related to the interruption of supply chains, which has led to problems with the supply of raw materials, their processing and the delivery of finished products to the end customers. According to BNB data as of March 2022 on the number of loans granted to enterprises in the Manufacturing sector, part of which are wood based enterprises, there is an increase in loans by 275 or 1.3%, which means an increase of 9.6% to BGN 769,747 thousand. (BNB, 2022) The enterprises in the manufacturing sector received 22.5% of the total credit resource as of March 2022. These data show a trend of recovery of sector and increased demand for credit in order to overcome the backlog as a result of the pandemic and disrupted supply chain.

Feng and Audy offer a broader framework for analysis consists of four main components, including digital technologies related to each of the supply chain's business activities; network infrastructure; next generation system intelligence; and the joint digital ecosystem of the forest industry supply chain. These components are essential for the transformation of the forest industry to become truly interconnected between actors in the supply chain. (Feng & Audy, 2020) This means that the sector, which until recently was perceived as less high-tech, should take quick steps to catch up with others in the supply chain in which it participates, or else it will be incompatible with it. In some countries, the banking industry even plays a significant role in managing these processes, such as China, where special requirements have been introduced requiring Chinese financial institutions to formulate clear policies for managing credit-based lending and investment decisions in wood based and forest industries. The main risks that arise in the context of digitalization and uncertainty regarding lending to wood based enterprises should be an element of banking policy in the analysis of the industry in which the borrowers operate. Some of these specific risks, which may ultimately affect the creditworthiness of wood-based enterprises, can be defined as follows:

- ✔ Risk in implementing new technologies for digital banking;
- ✔ Risk of job loss in the optimization of certain financial and accounting processes in enterprises;
- ✔ Risk of disruption of the supply chain due to incompatibility of the digital technologies used
- ✔ Risk of the impact of the activity on climate change and the related increase in the risk premium of environmental nature when granting loans;
- ✔ Risk of reduction of raw materials provided by the Forest industry, as the wood based industry is dependent in the supply chain for available forest raw materials and supplies.

Defining risks is very important for both the lender and the companies themselves and as Locateli et al. noted, risk management cannot eliminate risk, but aims to take action to reduce the likelihood of it occurring and to reduce the impact when they produce. (Locatelli, et al., 2018) They point out that it would be useful for all actors in the forest sector to identify the level of risk they are willing to take ("risk appetite") and to build up contingency plans and contingencies to deal with any unexpected loss or business interruption. The authors also point out that there are synergies between these different types of risks. For example, climate change is an operational risk that can affect profitability, thus creating market risk that, if significant, can ultimately lead to default, ie. credit risk. With regard to Bulgarian enterprises in the sector, Atanasov points out that the disclosed information in annual financial statements is mainly descriptive without specifying certain KPIs that characterize non-financial reporting and risks in surveyed enterprises. (Atanasov, 2020) The lack of sufficient disclosures on non-financial risks corresponds to Sujuan and Na's argument regarding the paper industry that attention should be paid to the impact of systemic financial risks on the paper industry as part of the wood based industry. (Sujuan & Na, 2019) All these statements show that no risk should be underestimated and every opportunity that arises should be assessed from the standpoint of the risks it brings to business.

3. CONCLUSION

As a result of the review of the existing literature and the conducted research, it can be summarized that the digitalization in the field of banking in the conditions of uncertainty caused by the global pandemic COVID-19, acts as a catalyst for change in order to increase the efficiency of lending, but also poses a number of risks to both banks and wood-based companies, which we have considered. The presence of risks that are specific to this sector of the economy, arising from digitalization and the transition to sustainable business models, requires banks and corporate managers to have a clear focus and complex solutions. This gives us reason to believe that a holistic approach should be applied in the assessment of risks and their management, which will lead to building a comprehensive picture of the business, both by its creditors and company managers in terms of its adequate management.

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SUSTAINABLE CUT OF OAK COPPICES AND PINE PLANTATIONS IN BULGARIA

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Abstract: Half of the wooded land of Bulgaria (54% by 2015) are forests in the process of conversion. These are 1,392,000 ha of coppices (3:1 oak and beech) being in a process of conversion into high forest, and 683 000 ha of pine plantations (1:1 Scots pine and Black pine) being in conversion into broadleaved high forest (mainly oak). The annual allowable cut for these forests is planned mainly "according to the single stand condition", i.e. rather on intuitive base. In the present work, formulae and computer simulation are applied to calculate the sustainable harvest for Bulgarian conversion forests based on public forest-inventory data. The result is that in the coming decades the removals from these forests will triple due to the entry of large masses of wood into maturity. In about 40 years, timber harvest will return to its current level, but with a much more balanced age structure of the forests in the oak belt.
Keywords: allowable cut, conversion coppice, oak

1. INTRODUCTION

In Bulgaria, conversion policy started in the postwar years. It involved conversion of coppice forests into high forest by aging and also re-afforestation of devastated forests and bare land with pine plantations. This policy aimed to improve both productivity and quality of forests. It had its reasons, its successes and its failures.

The usual way of planning the harvest in coppice forests, according to the single stand condition, 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. For pine plantations, formula methods have not so far been used for another reason - they have only recently begun to reach maturity.

2. IMATERIALS 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 in Bulgaria (a number of 1 300 000) have been included, in particular all coppice forests and all pine plantations.

2.2. Method

In the present work, we determine sustained harvest by computer simulation for a period of 500 years. The length of the period is selected long enough to cover at least 3 generations. Classical simulation (Fortschreiben) by growth and yield tables was used to model the results of growth and harvesting (Gadow, 2005). It assumes that the oldest stands are the first to be cut and that all clearings are immediately afforested or regenerated in natural way. To that purpose, the conversion forests were subdivided into strata according to tree species and site class (Ertragsklasse). Using the database, the distribution of the area and the volume by age was determined for each stratum.

Allowable cut from the existing transitional forests was calculated according to a version of the Black Hills Formula (Davis, 1950), which has the advantages (1) that it is commonly used in Bulgaria and (2) that it does not depend on the fact that the parameters of the transitional forests are different from the parameters of those that will replace them. Allowable cut from the next generations of forests was determined by the Hundeshagen formula, which quickly leads to the normalization of the age structure.

Black Hills Formula has been used in the form

$$y = \frac{M}{A}$$

y – allowable cut
M – mature growing stock of the considered forests
A – planned period for its utilization

This formula is preferred в Bulgaria by ecological and silvicultural reasons – it strictly keeps the prescribed rotation age: in the absence of a mature stock it calculates zero timber harvest, $y = 0$. It is a special case of the Black Hills Formula

$$y = \frac{M + 0.5I}{A}$$

obtained postulating that mature forest stands with negligible increment $I \approx 0$ are cut.. Of course

$$M = \sum_{j=b}^{\infty} V_j$$

b – age of the youngest forest stands in which use is allowed,
V_j – growing stock of forests at age j.

In the present work $b = u - A$ with $A = 15$ for conversion coppices and $A = 20$ for coniferous plantations, u being the rotation period. Both values are acceptable according to Bulgarian regulations (according to their terminology, coppice forests are planned according to the age formula, and coniferous plantations - according to the maturity formula).

The Hundeshagen formula is applied in the form

$$y = pV$$

p – normal forest's harvesting rate

V – total growing stock of the managed forests

$$p = \frac{N_u}{N_1 + N_2 + \ldots + N_{u-1} + N_u}$$

N_j – normal growing stock (Ertragtafelvorrat) in m³/ha of the tree species at age j

u – rotation period

$$V = \sum_{j=1}^{\infty} V_j$$

The Hundeshagen formula is not officially recommended for use in Bulgaria, but it is close to the officially recommended von Mantel formula, which is its proxy

$$y = \frac{2}{u} V$$

We assumed that coppices of beech and oak will turn into high forests of the same tree species and will remain so forever. However, in coppice *Q. cerris* forests, it is assumed that in the third generation, the *Q. cerris* will be replaced by pedunculate oak.

Pine plantations were assumed to be replaced by seed oak, which is the primary vegetation in the belt of plains and hills. However, for Scots pine plantations located over 1000 m asl. the natural regeneration ot the Scots pine by seed was assumed since they are in the natural range of Scots pine.

3. RESULTS

Detailed results can be read from table 1. *Figures* 1, 2, 3 and 4 illustrate the plausibility of simulation results for the instance of the development of oak coppices of the 1st site class (Ertragsklasse I) over the full 500-year period. *Figure* 1 traces the evolution of the age of harvested forests. Generation change is indicated by vertical lines. The first generation covers the time before the first vertical line. This line marks the end of the conversion period. Horizontal lines indicate rotation ages and age 60 y, which is a benchmark for the ability of forests to regenerate by seed.

In *Figure* 1, the logging age fluctuates during the conversion period within a relatively narrow range around the recommended logging age and remains above the level of 60. The first means that no significant aging of forests occurs. The second means that their ability to regenerate by seed is assured. In the middle of the 3rd rotation, the age of the oldest forest stands reaches to 140 years. This 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. With a sufficiently long horizon of the simulation, this final state is a normal forest with a rotation of 140 years. The growing stock gets stabilized at the end of the second rotation at a value of 130 m³/ha, which is much less than the current 300 m³/ha, however. This is expected, nevertheless, because a normal forest can hardly have the growing stock of a forest, dominated by old stands.

Figure 1. Evolution of harvest age

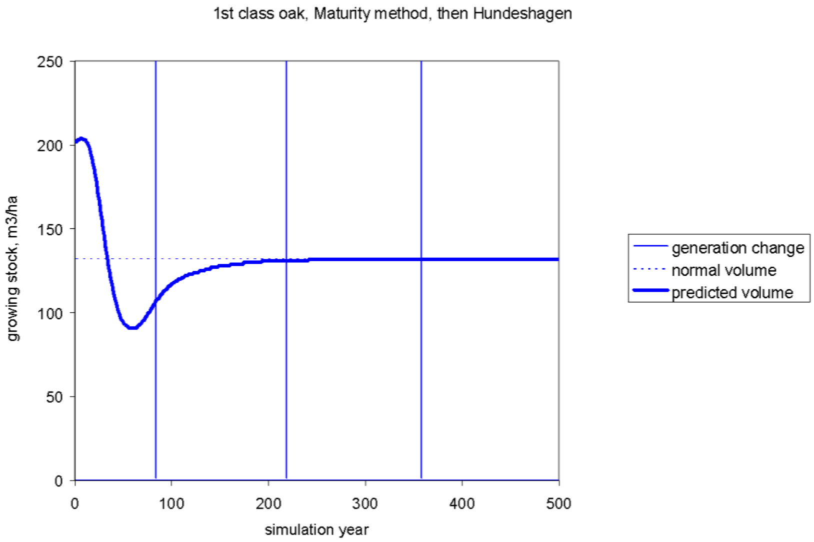


Figure 2. Evolution of growing stock

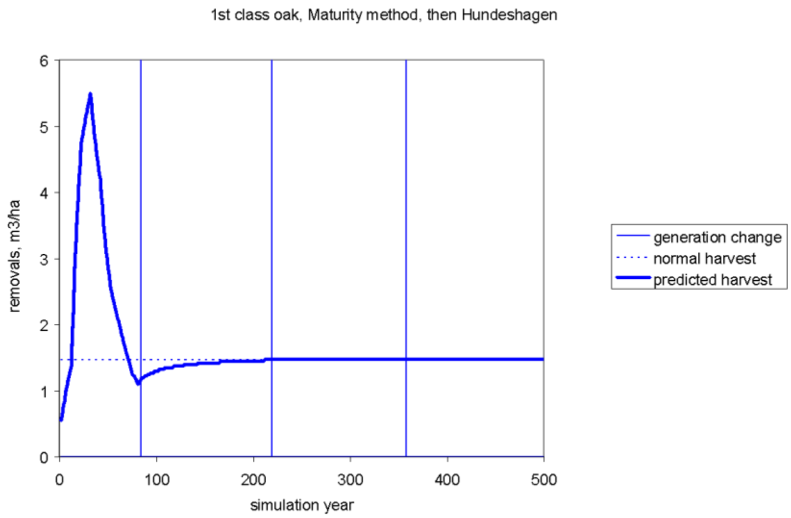
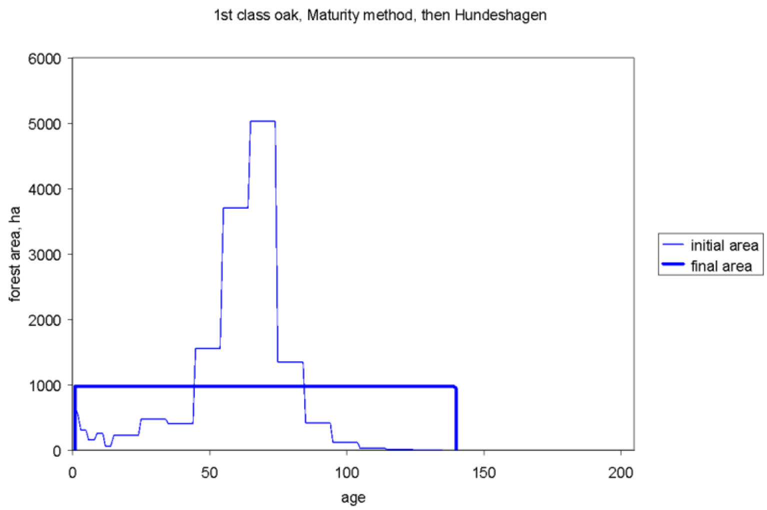


Figure 3. Evolution of yearly harvest



4. CONCLUSIONS

The probable duration of the conversion period of existing conversion forests is about 70 years. Normalization of the age structure will be reached in about 170 years. The final growing stock achieved through normalization will be significantly lower than the current one (40% of it). However, the annual harvest will be the same (99% of the current level). During the conversion period, significantly higher annual harvest than the current one is predicted, after which it will gradually fall to its current level.

Table 1. Overview of results

initial tree species:	Oak	Beech	Scots pine	Black Pine	total
area, ha	1 244 771	274 027	317 790	236 061	2 072 649
area, %	60	13	16	11	100
normative harv. age initial forest	76	76	60	60	68
harv. age of initial stand, y	79.8	80.6	69	68.2	74.4
difference row 5 – row 4	3.8	4.6	9	8.2	88
target tree species:	Oak	Beech	Oak	Oak	
target rotation age:	128	120	128	128	126
final maximum stand age:	128	120	128.2	128.2	126.1
normal volume, 1000 000 m³	96.2	48.4	19.4	15.5	179.6
final volume, 1000 000 m³	96.2	48.4	19.4	15.6	179.6
stabilization year:	173	212	127	118	146
conversion time, y	65	60	76	75	69
initial volume, 1000 000 m³	154.0	53.3	85. 5	64.0	356.9
final : initial volume, %	63	88	26	27	43
final : initial volume, normal %	80	111	22	21	67
initial annual harv.rate, %	0.83	0.83	0.36	0.36	0.595
initial annual harvest, m3	1 278 323	442 634	307 866	230 643	2 259 466
final annual harvest, m³	1 166 021	623 506	249 611	197 563	2 236 701
final : initial annual harvest, %	91	141	81	87	99
final annual harvest rate, %	1.24	1.692	1.24	1.24	1.353
conversion time ann.harv, m³	2 741 665	937 080	1 650 035	1 321 427	6 650 207
conversion time : initial, ×	2.1	2.1	5.4	5.7	2.9
ann.harv, simul. years 1-20, m³	3 262 513	1 009 603	3 113 778	2 480 010	9 865 904
years 1-20 : initial, ×	2.6	2.3	10.1	10.8	4.4
ann.harv, simil. years 21-40 m³	3 234 869	1 135 826	1 956 782	1 557 659	7 885 136
years 21-40 : initial, ×	2.5	2.6	6.4	6.8	3.5
ann. harv., rest of conv.per., m³	1 592 461	614 519	644 581	508 638	3 360 199
rest of conv. period : initial, ×	1.2	1.4	2.1	2.2	1.5

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CONTRIBUTION OF HIGHER EDUCATION QUALITY IMPROVEMENT TO THE SAFE AND SUCCESSFUL OPERATING IN THE GLOBAL WOOD-BASED ENVIRONMENT: STUDENT'S PERSPECTIVE MEASURED BY SREQUAL MODEL

Lucija Marković, Kristina Klarić, Andreja Pirc Barčić

Abstract: Nowadays, operating wood-based companies in the global environment is becoming more and more challenging. Wood industry and forestry are two important sectors of the Croatian economy. The Croatian mainland is covered with ½ area of forest and forests land. With so much forest area on our land, we should know how to preserve our forest and fully utilise our wood through wood based industry. With aim to ensure safe and sustainable economy development within wood-based sector, it is important to offer high educated people who will use their knowledge and skills to manage and improve it. The Faculty of Forestry and Wood Technology in Zagreb continues to develop its study programmes and their quality in order to motivate and produce highly educated and capable young engineers who will be able to respond to modern labour market demands. The purpose of this paper is the application of the SERVQAUL (GAP) model, which uses its questionnaire to measure expectations and perceptions of the quality studies of individual students during their education process. The study will be conducted on students of the Faculty of Forestry and Wood technology who have participated in professional practice, and are supposed to be a good indicator of increasing the quality of education process in higher education. The results will reveal deficits in the quality of the study programs and contribute to its further development.
Keywords: SERVQUAL model, higher education, wood industry, forestry, study program quality

1. INTRODUCTION

Although the term quality is quite widely used by practitioners and academics, there is no generally agreed definition of it, since different definitions of quality are appropriate under different circumstances (Elshaer, 2012; Šiško Kuliš, 2010). The quality of higher education in the Republic of Croatia has been monitored and evaluated by the Croatian Agency for Science and Higher Education since 2005 by implementing good international practice in the field of quality assurance (Bezjak *et al*., 2018). Research on the quality of higher education is aimed at analysing student satisfaction during enrolment in the Faculty, during studies, and after graduation just before entering the labour market. Despite many years of analysing quality in higher education, conflict still dominates regarding the features of services, with academic institutions on one side, and market for services offered by higher education on the other (Badari *et al*., 2007). Using the SERVQUAL questionnaire model, the aim of this work was to explore the expectations of students before and during their studying at the Faculty of Forestry and Wood Technology. A questionnaire for students who participated in the implementation of the EU project "Development and implementation of professional practice in the studies of the Faculty of Forestry" was conducted. The results will potentially contribute to the development of the study program of the Faculty of Forestry and Wood Technology.

2. MATERIALS AND METHODS

Apart from the fact that today the quality of business is measured by client satisfaction, the same practice has begun to be applied in education. The quality of education was directly adjusted by the student satisfaction to adapt the study program to the needs of users - students. Measuring the quality of education from the student's point of view is a newer approach, because today students are considered the most important stakeholder in higher education institutions. One of the models used to measure customer satisfaction is the SERVQAUL model which will be also used in this paper.

2.1. SERVQUAL model

Service quality model (SERVQAUL model) used to measure service quality through analysis of customer satisfaction and customer expectations. The model developed by Parasuraman *et al*. (1985) showed that there are many discrepancies or gaps in the perception of the quality of service and the service itself for the user. These gaps can be major obstacles in trying to provide a service that consumers would perceive as a high quality. That is why in many scientific papers and professional studies SERVQAUL model can also be used as the GAP model. After further research, Parasuraman *et al*. (1991) defined the SERVQUAL model according to precisely defined categories of questions for the user. They divided the questions into 5 main categories that can be used for various scopes in which the quality of customer service is measured:

- ✔ TANGIBLES – a group of question items to get answers about the appearance of physical facilities, equipment, personnel, and communication materials
- ✔ RELIABILITY - a group of question items to get answers about the ability to perform the promised service dependably and accurately
- ✔ RESPONSIVENESS - a group of question items to get answers about the willingness to help customers and to provide prompt service
- ✔ ASSURANCE - a group of question items to get answers about the knowledge and courtesy of employees and their ability to convey trust and confidence
- ✔ EMPATHY - a group of question items to get answers about the provision of caring, individualized attention to customer.

Furthermore, the SERVQAUL model is divided in two groups of questions through these 5 different categories. The same questions are formed to measure perceived and expected service quality. The difference between these two groups of questions results in an assessment of the quality of service applying the following equation:

Q (quality of service) = P (perceived service) – E (expected service).

2.2. Application of the SERVQUAL model at the Faculty of Forestry and Wood Technology

In this paper, we used a modified SERVQUAL model. The SERVQUAL questionnaire was modified by applying items related to the student's expectations and perceptions before and during their studying at the Faculty of Forestry and Wood Technology. The number of items in the categories was also modified.

Table 1. Modified SERVQUAL questionnaire

	Questionnaire categories	Category index	Number of questions per category
1.	TANGIBLES	A	(A1-A10)
2.	RELIABILITY	B	(B1-B6)
3.	RESPONSIVENESS	C	(C1-C7)
4.	ASSURANCE	D	(D1-D4)
5.	EMPATHY	E	(E1-E6)

In line with modern approach, the questionnaire was prepared in digital form using TYPEFORM survey tool which allows the questionnaire to be filled out on a mobile phone, computer, or tablet. The form of the question is customizable, so option with one question per page is used, preventing any possibility to correct respondents' answers while answering the questionnaire. Therefore, process of filling in the questionnaire itself was accelerated and simplified for the respondent. The responses were combined into an Excel sheet and the mean values, standard deviations and quality of service according to the SERQUAL model was calculated/presented.

3. RESULTS

The questionnaire was conducted among the students who participated in the implementation of the EU project "Development and implementation of professional practice in the studies of the Faculty of Forestry". The questionnaire was sent to 25 students of the Faculty of Forestry and Wood Technology by email with an accompanying link and QR code. The response rate was 68% (17 of 25 responded to the questionnaire). The first part of the questionnaire was about respondent profile: gender, studies and average grades during the studies.

As seen in Figure one, out of 17 respondents 8 (47%) of them are male, and 9 (53%) of them are female. The average grade of graduate study respondents is 3,5 and 67% are female and 33% are male. At the undergraduate level, where 50% of the respondents are males and 50% are females, the average grade of the study is 3. The sample is significantly different depending on the type of study because of a notably smaller number of graduate students, to be more exact, only 5 graduate students participated in professional practice.

The results of the questionnaire were analysed according to the students' answers separately for each category of questions. First, it is calculated the arithmetic mean of all respondents in each category separately and divided into student expectations and perceived service of education at the Faculty of Forestry and Wood Technology.

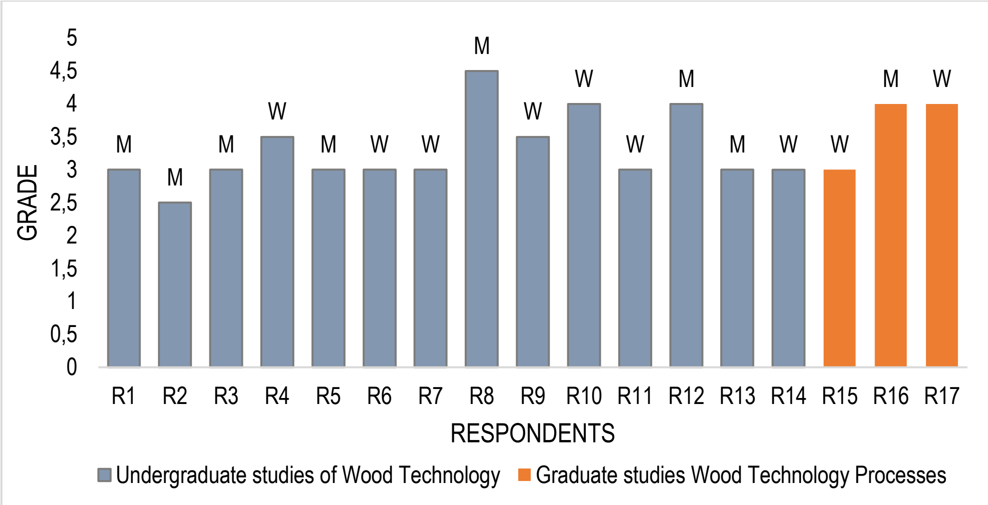
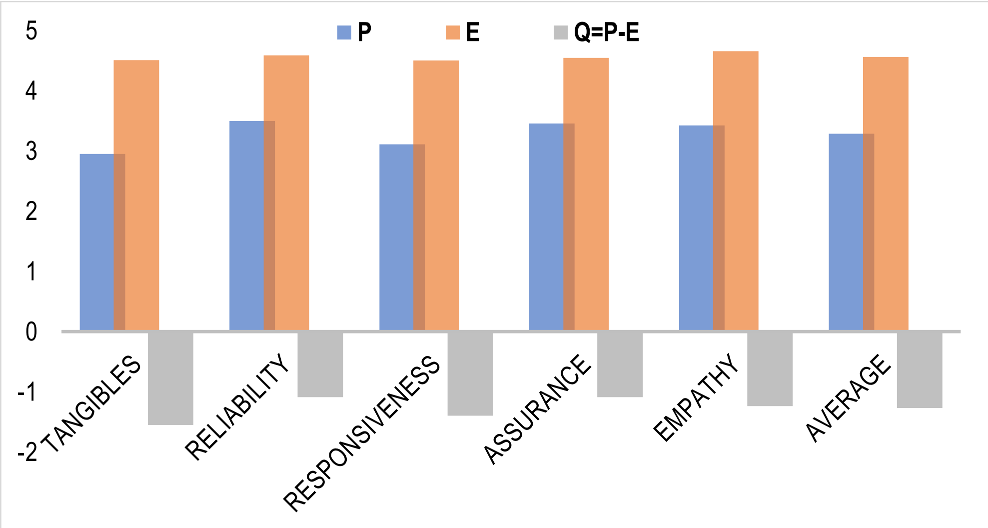


Figure 1. Respondent profile (gender: M-male; F-female)

Furthermore, the arithmetic mean of all questions within categories is shown in the Figure 2. Additionally, the SERQUAL quality equation (1) for subtracting the arithmetic mean of expected service from the arithmetic mean of perceived service is used. As seen in Figure 2., all values for quality service are negative. A negative value represents a gap in quality service, and indicates that improvements in the quality of studies are needed. In category tangibility, students' expectations are very highly rated (E = 4,506; SDP = ± 0,429), but perceived service is the lowest ranked of all categories (P = 2,953; SDP = ± 0,991), so the highest gap between excepted and perceived quality of education service is obtained for this category of questions (Q = -1,553). Furthermore, reliability and assurance had the similar average responses regarding expected and perceived service quality which resulted in the lowest gap rate (Q = -1,088). Categories that include responsiveness and empathy show similar results with the quite high gaps and results indicated lots of improvement. In addition, results for quality of service for the perceived service of empathy category is P = 3,422; SDP = ± 0,342, while regarding expected service the highest average values compared to all categories are noted (E = 4,657; SDE = ± 0,646). The result regarding the gap value suggests that numerous improvements in this area are needed (Q = - 1,235).

As shown in Figure 2., the highest gap is noted in the category tangibility service, (Q=-1,553). The result in line with research conducted by Goumairi *et al*. (2014) where the most negative difference in the tangible group also was obtained. Aforementioned results indicates that students of the Faculty of Forestry and Wood Technology expect more modern equipment for more successful results during their studies. Equal and lowest gap were found regarding question categories reliability and assurance (Q= -1,088), which are in line with research of Goumairi *et al*. (2014) who noted the lowest values for the reliability group. Unlike the results of quality of tangibility service with physical resources at the Faculty, students are very satisfied with the organization and empathy at the Faculty of Forestry and Wood Technology. Data analysis is consistent with the research of Krsmanovic *et al*. (2014) which also points to the rank of the characteristics by the gap score, from lowest to highest which is shown in Figure 2.: RELIABILITY = ASSURANCE < EMPATHY < RESPONSIVENESS < TANGIBLES.



Legend: P - arithmetic mean of perceived service; SDP - standard deviation of arithmetic mean of perceived service; E - arithmetic mean of expected service; SDE - standard deviation of arithmetic mean of expected service; Q - quality of service value, the gap (1)

Figure 2. Gaps between perception and expectations for every category

4. CONCLUSION

The purpose of this paper was the application of the SERVQUAL (GAP) model, in order to measure expectations and perceptions of the quality studies of individual students during their education process. The study was conducted within students of the Faculty of Forestry and Wood Technology who have participated in professional practice and was a good indicator of increasing the quality of the education process in higher education. The quality of the service was assessed according to the modified five dimensions of the SERVQUAL model. The results generally showed that students from the Faculty of Forestry and Wood Technology have a negative perception of the service quality. The highest gap was defined in the category of tangibility service, which defines the appearance of physical facilities, equipment, personnel, and communication materials. The results revealed deficits in the quality of the Faculty facilities and mainly equipment. Because of that fast-moving forward modernization of technology Faculty should be in step with active developing of the study program and constantly implementing new technology that contributed to their further development.

Acknowledgements: We wish to thank all the students that were willing to fill out the questionnaire to contribute by potentially improving the quality of education at Faculty of Forestry and Wood Technology

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This article has been supported by funds of the project "Development and implementation of professional practice in the Forestry Faculty studies" funded by the European Social Found (EFS). Operational Programme Efficient Human Resources 2014-2020.

MICRO FORESTS AS A WAY IN EU AGRICULTURE TO IMPLEMENT "GREEN POLICY" AND CREATE SUSTAINABLE BIOMASS

Mihaela Mihailova

Abstract: Micro forests have proved to be a way to solve multiple problems created by humanity in sustainable way. As part of the new CAP every farm will have to at least dedicate 3% of arable land to biodiversity and non-productive elements, with a possibility to receive support via eco-schemes to achieve 7%. Research of the effect of implementation of micro forests will be graphically presented after using several cabinet research methos. The Miyawaki Method is the main focus of the research and its synergy with the CAP and bioeconomy. In Bulgaria there are existing problem for achieving better biodiversity because there are still many plots of land that are small and that result in smaller habitats as well as interference from near agricultural lands from their treatment. This research will focus on what benefits will there form implementing micro forest and creating habitats and easily replaceable biomass. Our aim is move towards more sustainable biomass production and simultaneously create better habitats that will foster biodiversity in synergy with greener policies.
Keywords: Micro forests, CAP, Green policy

1. INTRODUCTION

The 2023-2027 CAP plans will be in line with environmental and climate legislation. As part of the new policy every farm will have to at least dedicate 3% of arable land to biodiversity and non-productive elements, with a possibility to receive support via eco-schemes to achieve 7%. Under current EU legislation, EU Member States have to ensure that accounted greenhouse gas emissions from land use, land use change or forestry are balanced by at least an equivalent accounted removal of CO_2 from the atmosphere in the period 2021 to 2030.To achieve this goals Bulgaria will face some challenges that are part of its specific characteristics. The transition from planed agriculture have created fragmented small plots of land where the implementation of policies hinders achieving the wanted effect. (Petrov, Velev, Vasilev, 2018 :118). The process of fragmentation of inherited land continues due to unchanged legislation and the change of generations (Yovchevska, 2019). The small plots that are bordering agricultural land if used for biodiversity with will be affected by agriculture practices. To negate such risks, we aim to find a viable solution to several problems by implementing the Miyawaki method and prognosing what change to the ecosystems it would bring based on stipulations. Because of deforestation raw material for bioeconomy is lost, biodiversity is jeopardized and goals that are set by numerous EU and UN policies can't be met. Creating micro native forests as responses to large-scale environmental challenges can be a viable solution. The forests attract biodiversity, including insects and new plant species and can contribute to carbon sequestration and help with biomass demand.

2. METHODOLOGY

2.1. The Miyawaki Method

The Micro Forest projects are based on the work of Japanese botanist Akira Miyawaki, who pioneered a method of planting young indigenous species close together to quickly regenerate forests on degraded land. Planting should center on the primary trees of the location and following the laws of the natural forest (Blue Planet, 2006). The potential natural vegetation

(Tuxen,1956) of the region is based on the remaining naturel vegetation there, from there we can find the main tree species of the native plant communities of the region (Miyawaki 1999). Plant communities that have been destroyed are also generally quite difficult or sometimes impossible to restore (Miyawaki 2001), that makes preservation and sustainable biomass creation of high importance. Its benefits include lowering temperature, making soil nutritious, supporting local wildlife and sequestration of carbon as well as biomass creation. The idea is to mimic nature while creating these tiny cross-sections of tiny islands called Miyawaki forests. The current level of CO_2 is thought to be the highest in 20 million years.

Fig.1 Creation of micro forests
Source: (Marie, 2010) Les successions écologiques.

Miyawaki forest key-numbers: Multistratal quasi-natural forest – Miyawaki method; Planting density: 2 to 7 trees per m². Green surface area: 30 times more than a meadow; Survival rate (Natural Selection): 15 to 90% (can be in the high if using cocooning); Growth rate: 1.5 m/year [rainforest], 1 m/year [temperate forest], 0.3 m/year [Mediterranean forest]; Growth stabilization: from 15-20 years [temperate zone], 30-40 years [tropical zone]; Final average size: 20 m [upper layer.], 4m [lower layer]; Density after stabilization: 0.5 to 2.5 trees per m²; Biodiversity (fauna): 18 times more (mean of different species).

To achieve such sustainable development and bioeconomy based on renewable biomass, a sustainable approach in all economic sectors has become essential. The potential that Miyawaki forest present can be based on several of findings: By natural selection, the trees grow about 10 meters tall in 10 years, and 20 meters tall in 20 years (Miyawaki, 2014). In about three years the trees grow 2 to 3 meters high, and the crown covering the forest floor comes to keep the sunlight from coming in (Miyawaki, 1999). Seedlings are distributed randomly and at high density 30,000 per hectare instead of 1,000 per hectare, with stakes for support and later it for easier creation using plant cacoons that makes the possibility of survival as high as 90% (Jurriaan, 2016). Native forests can be restored if it is taken sufficient care for the first several years after planting (Miyawaki, 1999). If we want to implement biodiverse plots in middle of arable land use for food production we have to take in to consideration that the plots should have a correct shapes, that can be cultivated around, Miyawaki forest present the unique opportunity of densely populated plots that crated biomass quicker than a regular forest, and help absorb emissions as well create biodiversity. Sustainable development, as a concept associated with balancing the natural resource potential of the planet will be the base of new bioeconomy (Marinov, 2020).

3. RESULTS AND DISCUSSION

3.1 Making a forest in Bulgaria

Each forest begins with a survey of nearby trees to determine natural species in the area. In Bulgaria there are about 87 species of trees. A Tiny Forest typically includes between 20 and 40 different tree and shrub species and saplings are planted three per square meter (Bleichrodt, 2015). In Bulgaria currently, 15 species of trees are protected by the Biodiversity Act 2. If the habitat conditions allow it is possible to use micro forest for further protection of these 15 species (Kuzmanov, Peev B&D, 1993). For a multi-layered process, we have to choose different species of plants like shrub layer (6 feet), sub-tree layer (6-12 feet), tree layer (20-40 feet) and canopy layer (above 40 feet). We do not place the same species next to each other. Most articles recommend for this forest to be watered once a day and to keep the forest free from weeds for the first two years. In Bulgaria lack of adequate watering system will create a problem, but a simple drip irrigation system can be placed where used water bottles are reused for new purpose or we can implement the cacoon method. Learneartheasy (2021) point ten types of trees are recommended for carbon capturing 6 of which can be found in Bulgaria and planed: Oak has adapted to thrive in many climates. Red Mulberry has delicious seasonal fruit and high carbon capturing capacity as well can be food for different species. London Plane (Platanus x hispanica) is an excellent choice for urban planning, very tolerant of pollution and root-cramping, resistant to cold and disease. Pines are the most carbon-effective conifer. Dogwood and trees like Black Walnut can store more carbon in a smaller tree.

3.2. Biodiversity boost

Creating a Miyawaki forest is about setting up a real forest ecosystem. Over the years, flowering plants, herbs, mosses, and mushrooms will appear under the cover of trees. The forest provide shelters for many animals: birds, insects, small mammals. Animal biodiversity of a Miyawaki forest is on average 18 times higher than that of a conventional forest. Depending on the species, we can observe from 2 to 162 times more. Across the 11 Tiny Forests Wageningen University researchers have conducted, volunteers observed 636 animal species. They also identified 298 plant species in addition to the original species planted in the plots. Maintenance of the forests occasionally involves thinning out aggressive weeds, but in general new plant species, such as wildflowers that appear, are allowed to grow (Bleichrodt, D. 2015). Protecting forests is key to fostering biodiversity they harbour most of the Earth's terrestrial biodiversity (60,000 different tree species, 80 percent of amphibian species, 75 percent of bird species, and 68 percent of the world's mammal species). This first-ever global forest biodiversity assessment discovered that between 1970-2014, forest wildlife has halved across the planet. Species richness decreases as logging intensity increases In particular, mammals and amphibians would suffer a halving of species richness at logging intensities that means that forest density is a factor for better biodiversity as shown by Miyawaki forest.

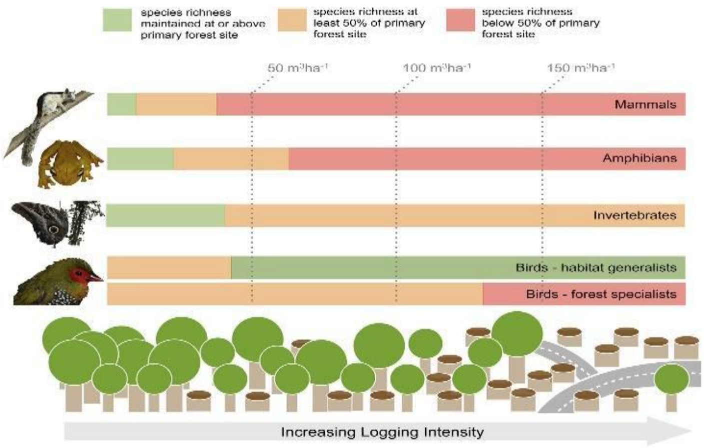
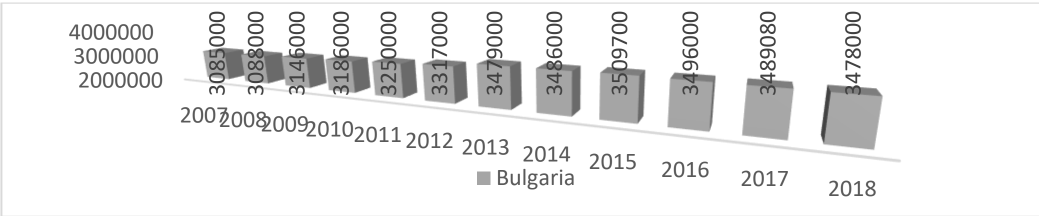


Figure 2. Logging effect of biodiversity
Source: Burivalova, Z., Hakkı Şekercioğlu, C., Koh, L. (2014) Thresholds of Logging Intensity to Maintain Tropical Forest Biodiversity

Humans undermine forest biodiversity in a number of ways: clearing for agriculture and grazing; replacing old forests with plantations; poaching wild animals and illegally harvesting wood. At the same time climate change is already starting show its effects. The situation of biodiversity in Europe varies, for example, in Bulgaria and Romania, which are still widely considered to have a rich biodiversity (due to more traditional non-intensive farming practices and smaller farms), some studies have concluded that it was sufficient to maintain the existing biodiversity status (Sutcliffe et al., 2015). The potential of ecological focus areas to deliver biodiversity benefits depends on how farmers manage them. In case of creating forests around land used for agricultural purposes the habitat will help foster species that help with pollination, lower the wind erosion and water erosion and change the level of biodiversity.

Figure 3. Decline in farmland biodiversity due to intensification of land use
Source: ECA.

In the years after Bulgaria become a member of EU because of CAP and bigger market for agricultural production the arable land in the country has increased by 12,74%. This has effect on biodiversity and natural habitats its equal to 393 000 ha. Bigger area that is used for agriculture means smaller area protected by laws and included in protected land for biodiversity and special habitats as well as previously tree areas being converted into agricultural lands.



Firgure 4. Arable land in Bulgaria (ha)
Source: National statistical institute

3.3 Carbon and climate change

Preliminary carbon sequestration data shows that the Micro Forest planting method is on par with other forms of reforestation. Eeach forest sequestered about 127.5 kilograms of carbon in 2020. An average 250-square-meter forest will eventually sequester 250 kilograms of carbon annually. The biomass of a Miyawaki forest of 100 m^2 and of average age (a few decades) represents a stock on the order of 6000 kg of carbon dioxide, i.e. two thirds of the annual carbon emissions reports of a European person. Each year the forest absorbs 50 kg of additional carbon dioxide.Based on the assumption that an average created Miyawaki forest is on average a 0,82ha, and the new CAP policy stats that every farm will have to at least dedicate 3% of arable land to biodiversity and non-productive elements, with a possibility to receive support via eco-schemes to achieve 7%. We have calculated 2 scenarios, and based on it a big carbon ofset will happen if even 3% of ariable land is planted with micro forests.

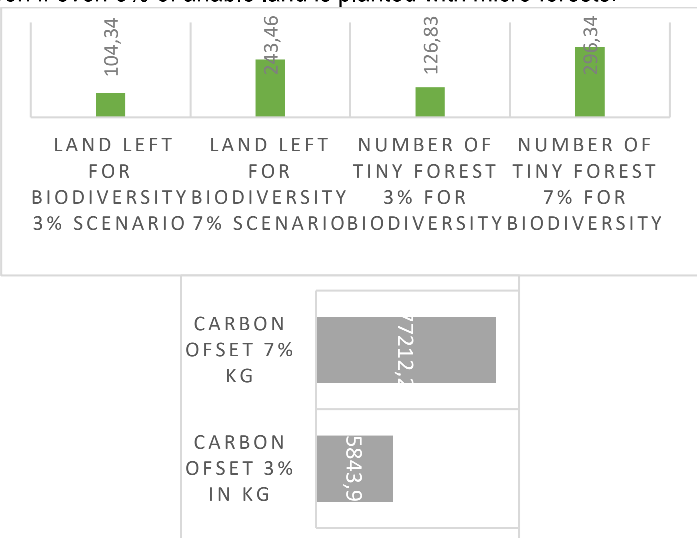


Figure 5. Land for biodiversity and Tiny forests (thousands) and carbon offset (thousands)
Source: Calculated based on data from NSI

3.4 Biomass creation

Biomass fuels are a renewable resource because they can be replaced fairly quickly (times ranging from one growing season to perhaps one or two decades) without permanently depleting Earth's natural resourcesThe average biomass per tree was 71 Kg (twigs/branches 27 Kg, stem 24 Kg, roots 14 Kg and leaves 6 Kg. Many of the fast growing trees with short life-span can be changed with new ones and this biomass used for bioeconomical production. The demand for renewable energe in Bulgaria has risen by 15%. Creating new and fastly renewable biomass will be high preority for the future and Micro forest can help the demand.

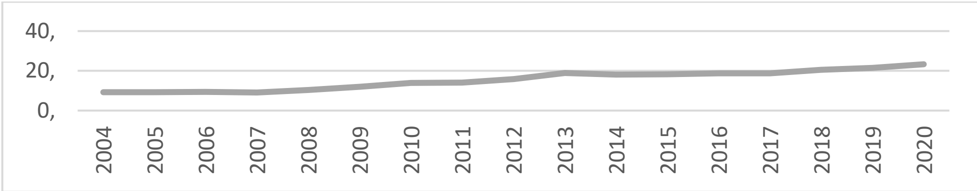


Figure 6. Share of renewable energy in gross final energy consumption
Source: Eurostat

CONCLUSION

Our climate and biodiversity crises stem in part from our manipulation of the landscape. It is time we reintroduce what has been stripped by replanting our forests in an effort to heal from the ecological trauma we have caused. Whether grown in public or private spaces, establishing Miyawaki Forests could be part of this solution. Having a concept of the best adapted vegetation to a particular area can help afforestation projects to create forests that benefit native wildlife. The Miyawaki Method is an effective way of jump starting the creation of a forest or woodland, with considerable benefits for carbon capture and recreating biodiversity.

Acknowledgements: This work was supported by the Bulgarian Ministry of Education and Science under the National Research Programme "Healthy Foods for a Strong Bio-Economy and Quality of Life" approved by DCM # 577 / 17.08.2018".

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THE CHALLENGES AND OPPORTUNITIES OF CIRCULAR ECONOMY IN MACEDONIA

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Abstract: The circular economy (CE) has become the focus of a recent major EU policy program, which aims at the transformation towards environmentally sustainable modes of production and consumption. This has moved parts of the forest and related bio-based industries to envision their operations in terms of CE.
Circularity can help to prevent depletion of the earth's limited material resources, which are vital for human's modern society. CE strategies of slowing and closing loops of resources have the ultimate goal of keeping materials useful (i.e. in-use) while avoiding losses (dissipation) and hibernation of materials; therefore, appropriate indicators that can measure these aspects are necessary. The transition to a CE requires companies to evaluate their resource flows, supply chains, and business models and to question the ways in which value is created.
Macedonia is making efforts to promote building sustainability and CE and focuses on the strategic goals related to the catalysis of green industry and green production, which is included in the new industrial strategy 2018-2027. Investments in the transformation of green economy and energy are key priorities, and this year, despite the economic crisis, maximum efforts are made to increase and promote the CE in the country that will contribute to more sustainable use of resources, for more sustainable production, consumption and better waste management. Hence, projects involving the CE in Macedonia have been started in several fields and some of them with emphasis on bio-based industries will be presented in this paper.
Keywords: circular economy, Macedonia, sustainable urban development

1. CIRCULAR ECONOMY PERSPECTIVE

The circular economy (CE) emphasises closing material loops to retain material value. CE proposes a framework in which outputs from every stage of the life cycle become inputs into another, offsetting the need for new materials and energy-intensive manufacturing activities, while also reducing waste. CE has been positioned as an essential systemic perspective that can help to mitigate the loss of material, function, and embodied value created by traditional consumption [11].

However, achieving these benefits requires engaging value-chain stakeholders in behavioural and social system transformation, and designing industrial economic and production systems to enable, accept, and support system circularity [14]. CE is among the key contemporary policy goals in Europe. Therefore, sustainability and life cycle thinking are increasingly the center of attention [9].

1.1. New Opportunities for EWPs in Circular Economy

Building the foundation for the CE is one of the cornerstones of the EU Green Deal [4], Europe's prime policy agenda for the transformation of the economy to a sustainable model. CE has become the focus of a recent major EU policy program, which aims at the transformation towards environmentally sustainable modes of production and consumption.

This has moved parts of the forest and related bio-based industries to envision their operations in terms of CE. However, the meaning and implementation pathways of the concept often remain vague and ambiguous. At the same time, bio-based industries have a long history of discussing and partly realizing wood cascading. This concept strongly overlaps with CE ideas [10].

The Circular Economy Action Plan [7] paves the road for reducing pressure on natural resources to create sustainable growth, and jobs while being a prerequisite to achieve the EU's 2050 climate neutrality target [2]. For the business sector, the transformation to CE means potentially large market opportunities, but also disruptive challenges in production and customer relations. In the new circular paradigm, resources and products become interchangeable, and companies gain access to a huge secondary resource base, which is already in use but can easily be reconverted for the same purpose or a new function. This shift reduces and eliminates the need to access primary resources as main feed into the economic system. Secondly, producers are enabled to actively manage their 'stock' of products in use by their clients, applying advanced digital tools, and giving them better control over quality and quantity of their resources. Companies that achieve this paradigm shift in their business model will gain a clear competitive advantage. Building with wood including renovation is seen as a major emerging market with a high potential for long-lived, circular products using nature-based materials, notably wood. Europe's growing need for housing leads to a large demand for materials for construction, renovation and interiors. It has been identified as an important sector in many EU policy strategies, i.e. the Bioeconomy Strategy [3]. A sustainable bioeconomy for Europe [3], the EU Green Deal [4], the Circular Economy Action Plan [7], the Renovation Wave [5], and the New EU Forest Strategy [8]. The New European Bauhaus [6] has launched a co-creative movement to design sustainable ways of living, linking architecture, civil engineering, art and culture, social inclusion and urban development, and will further accelerate research and innovation in circular construction materials and nature-based solutions.

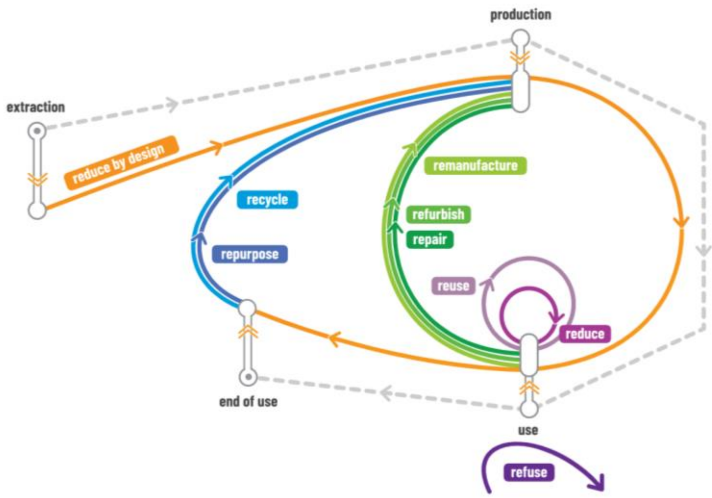

Figure 1. Circular Economy processes based on value retention loops [15]

The EU's targets to promote the CE and become a recycling society bring about many changes and provide new opportunities [9]. The transition to a CE requires companies to evaluate their resource flows, supply chains, and business models. CEoffers a framework for transforming wasteful and inefficient linear systems into cascading systems that retain the inherent value of products, reduce negative externalities, and improve resource-efficiency.

In Figure 1, CE processes based on value retention loops, are represented. All nine principles contribute directly or indirectly to increasing resource efficiency and decreasing environmental impacts.

1.2. Relation EWPs and circularity – an opportunity

Engineered wood products are becoming more recognized in the Circular Economy as climate friendly, sustainable alternative for use in new construction and/or renovation, interiors, furniture, and a range of innovative applications. Wood engineered products can effectively store potentially large amounts of carbon and keep them in reuse and recycling loops for a long time through additional lifecycling phases. Wood products are thus expected to play a major role in the decarbonization of the building sector and other industries. In Figure 2, forest-based sector material flows are represented as opportunities for circularity.

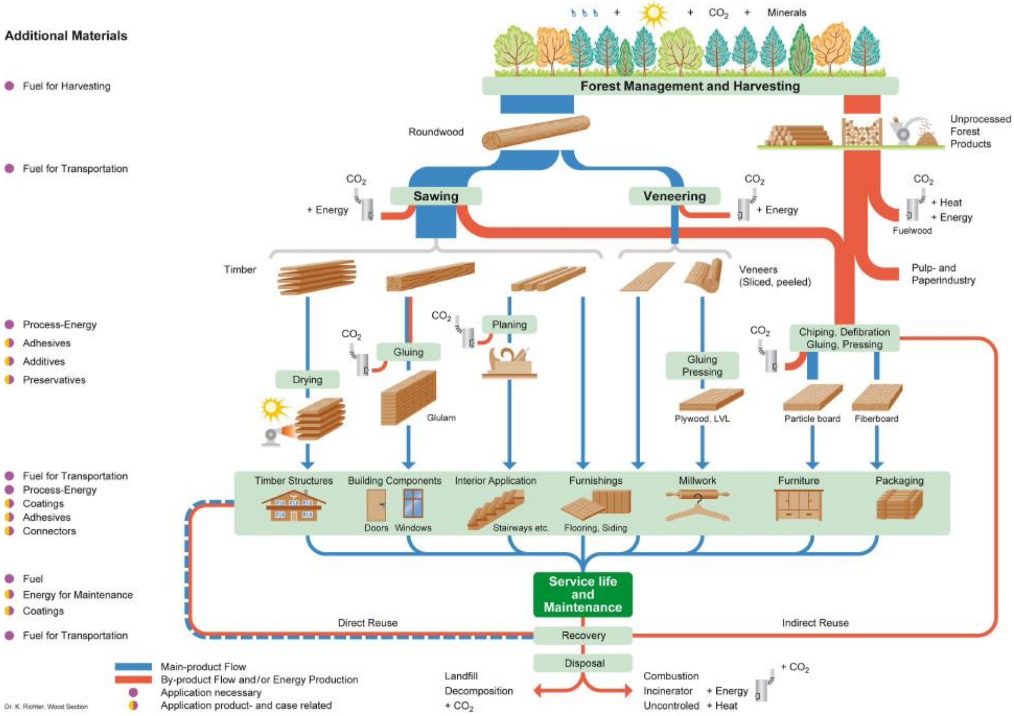

Figure 2. Forest-based sector material flows: opportunities for circularity [12]

2. CIRCULAR ECONOMY IN MACEDONIA

The New European Bauhaus [6] is a creative and interdisciplinary initiative that connects the European Green Deal to our living spaces and experiences and demands imagination and building of a sustainable and inclusive future, emphasizing the sustainability, inclusiveness and aesthetics in the New European Bauhaus projects. CE is an important part of this initiative. Macedonia is following this trend, making efforts to promote sustainability and CE which is included in the new industrial strategy 2018-2027. Investments in the transformation of green economy and energy are key priorities. CE is highly promoted in the country in order to contribute to more sustainable use of resources, sustainable production, consumption and better waste management. Projects involving CE in Macedonia have been started in several fields, such as the food industry, textile industry, mechanical engineering, medicine etc. In 2021, the European Bank for Reconstruction and Development launched a new program for the Western Balkans and Turkey, aimed at removing obstacles towards the transition to circular economy [13]. Further on will be presented successful creative Macedonian CE project as a case study.

2.1. Cinderela Project in Macedonia as a Model of Circular Economy

The Cinderela project "New business model of CE for sustainable urban development and construction" implemented by the Civil Engineering Institute Macedonia (CEIM) in the area of the factory Makstil Skopje, Macedonia (Figure 3) is an example of Circular Economy Project in Macedonia. Within this project, the construction materials that were applied were obtained during the process of smelting scrap metal, and were based on secondary raw materials. These construction materials were used for revitalization of a degraded space in a parking lot, reconstruction of an access road and partition walls made of prefabricated concrete blocks [1].

Figure 3. Cinderela project "New business model of circular economy for sustainable urban development and construction" implemented by the Civil Engineering Institute Macedonia (CEIM) in the area of the factory Makstil Skopje, Macedonia: before and after pictures [1]

For the construction of the parking lot with an area of 6500 m^2 and a street with an area of 2150 m^2, as a buffer unit and asphalt unit were used about 11,000 tons of processed black slag. On the other hand, for the construction of partition walls made in the Factory Karpos in Skopje, prefabricated concrete blocks were used. These blocks were made of concrete with the addition of 20 percent white slag as a substitute for cement [1].

This project closes the circle of the CE and achieves the set goal of zero waste. On the output side, the steel sheet, which can be completely recycled and which participates with 85.5% of the output, as by-products we have 10% black slag, 2% white slag, 1.5% covarine (iron oxide) and 1% filter dust. Filter dust is used for further processing (zinc extraction). This is an excellent example of using secondary industrial raw material as a building material to reduce the amount of landfilled waste, to protect primary resources and at the same time to provide a cheaper and faster solution for road reconstruction.

3. CONCLUSIONS

The circular economy has become the focus of a recent major EU policy program, which promotes environmentally sustainable modes of production and consumption. Macedonia is following these tendencies and projects involving the CE have been started in several fields.

Cinderela project "New business model of CE for sustainable urban development and construction" implemented by the Civil Engineering Institute Macedonia (CEIM) in the area of the factory Makstil Skopje, Macedonia proved the success in the implementation of European projects. This type of pilot project contributes to the development of knowledge and demonstration of good practices that are essential, encouraging construction companies to build circular business models that would increase their competitiveness by offering more sustainable services.

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PRESENTATIONS OF WOODEMA COUNTRY MEMBERS AT EXPO 2020

Maja Moro

Abstract: In this article, we present a comparison of the presentations of the member countries of the scientific association WoodEma at the EXPO 2020 fair, according to the three main areas of promotion: Mobility, Opportunity and Sustainability. Also we discuss a presentations of WoodEMA country members on the world famous WOOD SHOW held in March 2022 in Dubai, United Arab Emirates.
Keywords: WoodEMA country members, EXPO 2020, wood show

1. INTRODUCTION

The International Association for Economics and Management in Wood Processing and Furniture Manufacturing WoodEMA, i.a. (Association) is an international, nonpolitical, non-profit and open legal entity enrolled into Register of Association of the Republic of Croatia (1). The Association consists of six member institutions from Europe (Croatia, North Macedonia, Poland, Serbia, Slovakia, Slovenia) and one institution from the United States of America (Louisiana). List of members of the association is 105, of which 64 members from 12 different countries are currently active.

World Expos, officially known as International Registered Exhibitions, are a global gathering of nations dedicated to finding solutions to pressing challenges of our time by offering a journey inside a universal theme through engaging and immersive activities. World Expos welcome tens of millions of visitors, allow countries to build extraordinary pavilions and transform the host city for years to come (2). For 170 years, World Expos have provided a platform to showcase the greatest innovations that have shaped the world we live in today. Expo 2020 Dubai is the first World Expo ever hosted in the Middle East, Africa and South Asia (MEASA) region (3). After being postponed for a year due to the Covid-19 pandemic, the fair was held from October 1, 2021 to March 31, 2022, and 192 countries participated in an event that lasted six months, 182 days to be precise (4).

WoodShow started its journey in Dubai, United Arab Emirates in 2005 and since then it has established itself as the only dedicated and unique platform for the wood and woodworking machinery industry in Middle East and North Africa region. Today, WoodShow series (Dubai, Cairo, Gabon and Indonesia) is catering to more than 600 exhibitors and brands of wood, woodworking machinery and forestry industry every year and welcoming more than 30,000 quality visitors from more than 100 countries around the world in the four shows. WoodShow aims to contribute significantly in the growth of the wood and forestry industry through its four platforms and help the exhibitors and visitors interact and discuss the possible synergies to increase the scope of their business (5).

This article offers a focus on WoodEMA member countries presentations at the recently held EXPO 2020 and WOOD SHOW 2022 in Dubai.

2. MATERIAL AND METHODS

The basis for this research is data collected from various websites, primarily the WoodEMA association (1), and the recently held world fairs EXPO 2020 (3) and WOOD SHOW (6). The database includes data on the number of WoodEMA members from 12 countries, architects or bureaus who designed the pavilions at EXPO 2020, and the slogans with which they presented themselves. Also database includes the exhibitors from WoodEMA member countries at WOOD SHOW 2022.

The methodology includes elements of descriptive statistics, as well as a visual comparison of the main slogans and messages that WoodEMA member countries presented at the Dubai trade fairs.

3. RESULTS AND DISCUSSION

For the first time in World Expo history, every participating country had its own pavilion. Most of the countries are represented themselves through the three main areas: Mobility, Sustainability and Opportunity, while some took the places in special areas named Al Forsan and Jubilee, showing an immersive cultural experiences and what makes each country unique.

Twelve WoodEMA countries member are presented in this analysis with official two-letter abbreviations (7). The comparisson of the countries according to area of presentation on EXPO 2020, is shown in Figure 1.

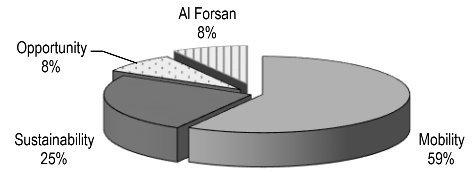

Figure 1. Comparisson according to area of presentation on EXPO 2020

The comparisson of the number of active WoodEMA members, according to countries and area of presentation on EXPO 2020, is shown in Figure 2.

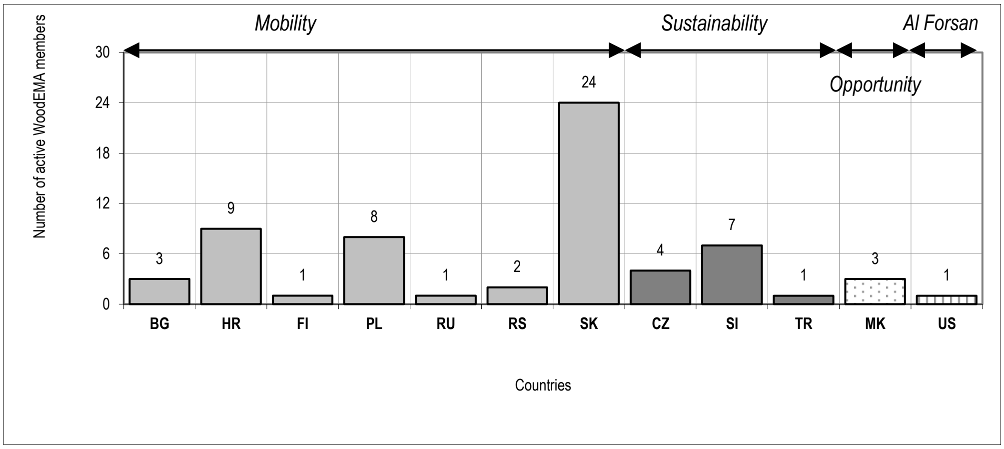

Figure 2. Comparisson of active WoodEMA members

The main slogan of Expo 2020 Dubai was ‘Connecting Minds and Creating the Future’ through sustainability, mobility and opportunity.

3.1. Mobility District

We live in a world of unlimited relationships. We explored the horizons that drive human progress, while mobility continues to change the way we live, connect with people, understand different cultures, and share knowledge and ideas. We have experienced how the Mobility District creates connections that move the world forward, breaking the divide between the physical and digital worlds to build a harmonious, global society where information, ideas and goods are exchanged faster than ever before (3).

Almost 60% of WoodEMA country members were presented in this district. Architects or bureaus who designed the national pavilions at EXPO 2020, and the main slogans with which they presented themselves in Mobility District are shown in Table 1.

Table 1. Comparisson of slogans in Mobility District

Country	ISO code	Architect	Main slogan
Bulgaria	BG	Alexander Brainov	A joint and positive creation of the future via innovation
Croatia	HR	Ante Vrban	Great minds who influenced today's world
Finland	FI	JKMM	Sharing future happiness
Poland	PL	WXCA	Creativity inspired by nature
Russia	RU	Tchoban SPEECH	Russia - an infinite source of creativity
Serbia	RS	A3 Architects Studio	Creating ideas inspired by the past and shaping the future
Slovakia	SK	Ivan Kulifaj	Motion of the future: hydrogen and aerospace

3.2. Sustainability District

Every day, more and more of us are moving in a sustainable way towards a future in which we all live in balance with our only home: planet Earth. As we join forces, small actions grow into positive global movements that will help communities protect and preserve the world around us (3). As we explored the Sustainability District, we saw some of the world's most advanced technologies in action, which countries are doing to advocate for sustainability, and experienced how the human race can enjoy living in harmony with nature in the future of high technology.

Exactly one quarter of WoodEMA member countries were represented in this district, and the results of this analysis are shown in Table 2.

Table 2. Comparisson of slogans in Sustainability District

Country	ISO code	Architect	Main slogan
Czech Republic	CZ	Formosa AA	Czech spring
Slovenia	SI	Robert Klun, Sandi Pirš	Slovenia. Green and smart experience.
Turkey	TR	Dream Design Factory	We rise to the future for a sustainable world

3.3. Opportunity District

There is a ripple effect in everything we do. Even one person can be the key to unlocking eight billion opportunities that can help individuals and communities create a better tomorrow, today. It is time to unleash the potential within yourself and be the bearer of change (3). We have witnessed how our lives and actions are interconnected in the Opportunity District. We met people all over the world who turn dreams and aspirations into the reality of tomorrow and empowered ourselves to shape the future by unlocking the potential within ourselves.

Just one of WoodEMA countries member were represented in this district, and that is a North Macedonia, with pavilion signed by architects bureau Thematic District Pavilion,and main slogan: “A home at every turn”.

3.4. Zone Al Forsan

The United States Pavilion was in the Al Forsan Special Zone, located between Sustainbillity and the Opportunity District. The architect was Woods Bagot, and the main slogan was: "Dynamic and always changing." The United States is a dynamic society that has shaped the modern world and supports freedom and prosperity around the world. We boarded the moving track and looked at exhibitions that show how freedom creates opportunity for all. We also enjoyed the main show in US pavilion: "The sky is no longer the limit ".

3.5. Wood Show Dubai 2022

At the three-day WOODSHOW fair held from 15 to 17 March this year at the Dubai World Trade Center, new initiatives were introduced to shape the experience for more than 300 exhibitors and more than 8,000 participants making business networking and knowledge sharing more accessible and efficient (6) . Seven WoodEMA member countries participated in the fair with a total of 44 stands where they presented their products. According to the number of stands, the most represented were Turkey and Russia. The distribution of WoodEMA member countries by the number of stands at the wood fair is shown in Figure 3.

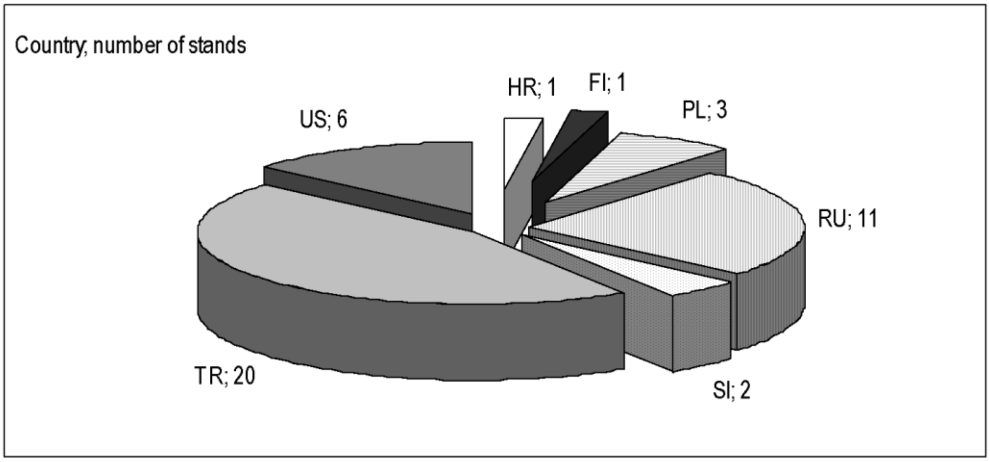

Figure 3. Distribution according to number of stands on WOODSHOW 2022

4. CONCLUSION

International Association for Economics and Management in Wood Processing and Furniture Manufacturing WoodEMA, i.a. is international, non-political, non-profitable and open Association founded in 2007. Association's goal is to promote science and results of scientific and professional work of its members, mutual scientific co-operation, as well as to support the science and professional development in the Association's field of work. Exchange of knowledge and researh results among members, also scientific and professional education are some of activities to achieve these goals. It is also extremely important to visit world fairs, adopt new ideas and initiatives and exchange experiences gained among members of the association, and relevant institutions within each country member.

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THE PAPER-BASED PACKAGING – A CONSUMERS PERCEPTION AND TRENDS

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Abstract: Choosing adequate packaging material to ensure the full functionality of packaging is an important task for companies. Nowadays companies have accessed to packaging more innovatively and creatively. The environmental concerns of packaging are dominated by material-related aspects. A personal interest in the environment and sustainability has also risen. Consumers are assumed to take an active part in solving environmental problems by recycling and choosing sustainable packaging. The article points out the perception of packaging by consumers according to various studies. As the main important packaging function is considered the protection function. It is very important for consumers whether the packaging is recyclable or reusable. Paper as a packaging material is experiencing a revival, as consumers perceive it as a high-value and environmentally friendly material.
Keywords: packaging material, paper-based packaging, consumer, trends

1. INTRODUCTION

The packaging protects the product against the deteriorative effects of the external environment; communicates with the consumer as a marketing tool; facilitates and makes use more convenient and time-saving (Yam et al., 2005). It significantly influences the consumer decision-making process and thereby affects the marketability of the product itself (Kotler et al., 2007). To fulfill the needs of society in relation to sustainable development, the packaging should meet the environmental, social, and economic dimensions (Lindh et al., 2016). Based on the literature review, there are several ways of the packaging functions classification. The traditional perception of packaging classifies the main functions of packaging into four basic categories: protection, communication, convenience, and containment (Paine, 1991, Robertson, 1993 In Yam et al., 2005). Furthermore, the functions of packaging vary depending on its type (Hellström and Nilsson, 2011) and are not totally exclusive – for example, the communication function can also help to enhance food protection and convenience.

Numerous consumer behavior studies examine consumers' perceptions of packaging as well as shopping intentions (Kauppinen-Räisänen & Luomala, 2010; Wilke et al., 2011, In Prakash & Pathak, 2017), referring to the change in consumers' attitudes toward product packaging. While according to older studies packaging was described as an indifferent part of the product, current studies point to its change to an attractive part. However, a positive first impression of the packaging does not persist, if the packaging is not user-friendly and functional. The packaging must be easy to use, providing relevant information and at the same time fitting into storage spaces (Löfgren and Witell, 2005). In today's competitive environment, product packaging is becoming an effective tool to differentiate the product in an effort to gain a competitive advantage. At the same time, it can significantly influence the consumer during the purchasing process (Belch, Belch, 1999, In Hussain et al., 2015). According to Rettie and Bruwer (2000), 70% of purchase decisions are made while viewing the products. A complete understanding of the customers' needs is a requirement for the ability to develop packaging with optimized performance (Magnusson et al., 2013). Innovative packaging can improve the quality of consumer life by creating an enhanced safer, nutritious, or more attractive food product by using non-traditional packaging functions prolonging durability, improving quality, and safety while being environmentally friendly (O'Callaghan and Kerry, 2016; Biji et al., 2015).

2. METHODS

The article deals with packaging and its function, especially paper-based packing. It points out the perception of packaging according to various studies conducted among the Slovak respondents aimed at their preferences for the packaging functions and material. The considered studies are those carried out by the authors of this article in the years 2016-2018.

Table 1 The considered studies aimed at packaging

2016	**Loučanová – Kalamárová – Olšiaková**	**The need of introduction of eco-innovation aspects in packaging from the customers' perspective**
2017	Loučanová – Kalamárová – Parobek	Innovative approach to product packaging
2018	Nosáľová – Loučanová – Parobek	Perception of intelligent and active packaging with regard to packaging from wood-based materials
2018	Loučanová – Nosáľová – Parobek – Dopico	The Kano Model use to evaluate the perception of intelligent and active packaging of Slovak customers

Subsequently, the article focuses on the environmental concerns and the perception of paper-based packaging as the most recycled packaging material in Europe. The recycling rates of Slovakia in comparison with the EU for the years 2010-2019 were shown graphically using MS Excel, according to the secondary data of Eurostat - Packaging waste statistics (2022). Several studies e.g.: Paper packaging market - growth, trends and forecasts for 2022 – 2027 (2022); Sustainable Packaging Trends 2020 (Evergreen Packaging, 2020); An analysis of European plastics production, demand, and waste data (Plastic Europe, 2020) were used to point out to the trends and possibilities of paper-based packaging.

3. CONSUMER PERCEPTION OF PACKAGING FUNCTIONS AND MATERIALS

Consumers are assumed to take an active part in solving environmental problems by recycling and choosing sustainable instead of regular packaging. In their perceptions of sustainable packaging, they consider the type and the amount of packaging material selected, as well as the aspects relating to recycling, refills, and reusability (Dopico et al., 2021).

Taking into account our study results (Loučanová et al., 2016, 2017; Nosáľová et al., 2018) the differences in the perception of the packaging functions based on the respondents' needs, attitudes, values, expectations, and interests are significant. Clearly, the protection function is still perceived as the primary one, when approximately half of the Slovak respondents consider it as very important or the most important in the context of the product packaging. Since consumers increasingly tend toward sustainability, also the importance of the ecological function is still increasing, and Slovak respondents perceive it as attractive. This is also reflected in the perception of innovative packaging, where the ecological function of packaging is perceived as attractive too. Slovak respondents also in terms of packaging innovation are most inclined to packaging that is reusable, returnable, or recyclable (this feature is the most important for 67% of respondents). Within the perception of materials that meets the eco-innovation aspect, Slovak respondents for such materials consider mostly wood and paper. It is still perceived as the environmentally most friendly packaging material and there are wide possibilities to use more wood-based materials as active forms of packaging.

4. THE PAPER-BASED PACKAGING – PERCEPTIONS AND TRENDS

Globally, the packaging industry is growing, but the average useful life of packaging material is decreasing. This negative trend is caused by the widespread usage of single-use packaging in the fast-moving consumer goods sector (Bocken et al., 2022). Packaging is a primary user of virgin materials. In Europe, around 40 % of the total plastic demand is used to produce packaging for the end-use market (Plastics Europe, 2020). Reusable packaging business models have emerged to help tackle such environmental problems.

A long-known alternative to any kind of plastic packaging is paper, which is used in a wide range of packaging applications. Paper as a packaging material is experiencing a revival, as consumers perceive it as a high-value and environmentally friendly material (e.g. Lindh et al, 2016; Fernqvist et al, 2015; Kalamárová et al., 2017; Loučanová et al., 2020). According to the Report: Paper packaging market - growth, trends, covid-19 impact, and forecasts for 2022 – 2027 (2022), the increasing consumer consciousness regarding sustainable packaging, as well as the strict regulations imposed by various environmental protection agencies are the factors driving the market for paper packaging. Also, the rapid growth of online shopping and delivery-on-demand services has increased the usage of cardboard and paper-based bags.

In Europe, the paper industry was constant in its use of paper. On the other hand, given the high utilization rate, the paper has the advantage of being bio-based, biodegradable, and recyclable paper. Paper-based packaging is the most recycled packaging material in Europe, with an 84% recycling rate (Eurostat, 2019). Furthermore, studies from the Institute for Energy and Environmental Research (Oloyede and Lignou, 2021) showed a significantly lower impact of paper-based packaging on the environment compared to many other materials.

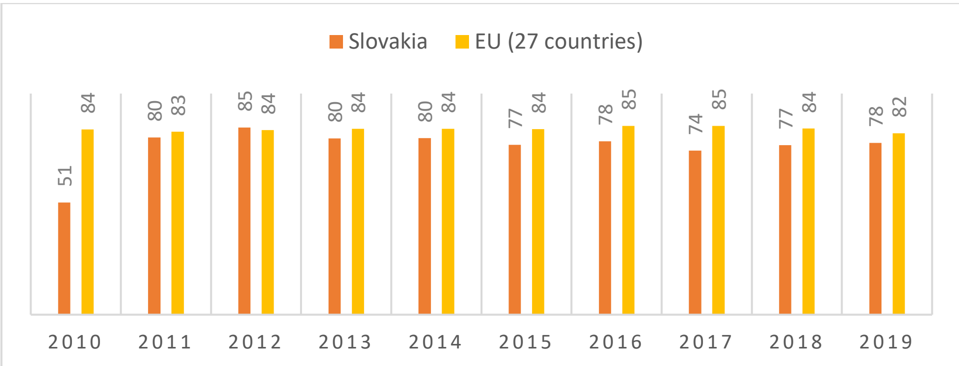

Figure 1. Recycling rates of paper and cardboard packaging
Source: authors' computation, according to Eurostat statistics (Eurostat, 2019)

European paper recycling value chain meets its set target and reaches a 73.9% paper recycling rate in 2020. In 2020 as well as in 2019, there were 16 European countries including

Slovakia that exceeded recycling rates of 70% (European paper recycling council, 2020). Figure 1 illustrates the recycling rates of Slovakia in comparison with the EU.

In the context of packaging material, research underlined that the observed naturalness of products is higher when products are presented in sustainable packaging (e.g., paper) than when they are presented in conventional packaging (e.g., plastic) (Magnier et al., 2016). Paper and wooden packaging is frequently associated with the least harm to the environment, compared to plastic (Fernqvist et al., 2015). Paper is generally based on renewable, biodegradable, and recyclable raw materials and is often perceived as an environmentally friendly material (Oloyede and Lignou, 2021). Consumers strongly associate paper with nature (Magnier et al., 2016). In the study of Kaputa et al., (2017), paper packaging is valued for its functional attributes such as simplicity of handling and storability (by two-thirds of the Slovak respondents). This attribute is even more valued than ecological attributes (sorting possibility, recycling) of paper packaging.

In food packaging, there are various progressing opportunities for more paper (Oloyede and Lignou, 2021). The findings of De Temmerman et al (2020) show that the health perception of paper is higher than the one of plastic packaging material. Fernqvist et al. (2015) confirm that paper/cardboard is associated with positive emotions such as homely, freshness as well as a feeling of healthiness. Subsequently, healthy packages lead to decreased consumption, therefore paper packaging leads to lower consumption compared to plastic packaging (De Temmerman et al, 2020). Compared to other generations, millennials see the strongest connection between being eco-friendly, healthy, and having a better quality of life and they demand healthier foods and beverages using packaging materials that are healthier too (Evergreen Packaging, 2020). Applied to packaging, this means that healthy packages could lead to decreased consumption due to health goal activation, which could be a field of use also for in this direction positively perceived paper-based packaging.

5. CONCLUSION

Apparently based on the above presented various studies results, packaging material choice is an important but difficult task. Nowadays more innovative and creative access is needed, taking into consideration the environmental concerns as well as personal requirements. Consumer demand and emerging regulations will continue to drive the movement toward sustainable packaging. Bio-based packaging materials such as paper and paperboard are ideally positioned to capture some of this market growth. There is a focus on paper as material since environmental appropriateness could be better communicated to the final consumers' market, applying research findings such as paper packaging functional attributes, a potential usage as active forms of packaging as well as the health goal activation by positively perceived paper-based packaging.

Acknowledgments: The authors are grateful for the support of the Scientific Grant Agency of the Ministry of Education, Science, Research, and Sport of the Slovak Republic, Grant No. 1/0475/22 Environmental Consumer and Environmental Citizen; Grant No. 1/0494/22 Comparative Advantages of the Wood Based Sector under the Growing Influence of the Green Economy Principles and Grant No. 1/0495/22 Sustainability of Value Supply Chains and its Impact on the Competitiveness of Companies in the Forest and Forest-Based Sectors.

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SAFETY OF WOODEN TOYS AS A PREREQUISITE FOR COMPLIANCE WITH THE REQUIREMENTS OF EUROPEAN TECHNICAL STANDARDS

Renata Nováková, Viera Horváthová, Eva Habiňáková

Abstract: The CE marking confirms that the product complies with the relevant requirements of European technical standards. The basic requirements concerning the safety of wooden toys include requirements such as safety, health protection, consumer protection and environmental protection. The products that are associated with children's toys are called designated products. The procedures that manufacturers need to know before making wooden toys are closely linked to EN 71-1. The content of our contribution will point out the most important documents that are associated with the production of wooden toys.
Keywords: safety, consumer protection, environmental protection, product, wooden toys

1. WOODEN TOYS - TRADITION OR TREND?

We currently witness the return of traditional materials. One of them is wood. Traditional techniques and new design is a trend in the production of wooden toys. Traditional wooden toys belong to childhood. In the past, children received toys only on special occasions, they were passed down from generation to generation and carried values and traditions. In addition to these features, wooden toys have several other positives, such as:

A) wooden toys are stable - as wood is a durable material, wooden toys are not subject to destruction as quickly as plastic toys,
B) wooden toys support child's healthy mental and physical development - wooden toys are simple, they do not overload the children's senses with noise and light. The child is forced to use his imagination, creativity, mind and motor skills when playing with a wooden toy,
C) wooden toys are ecological - untreated wood has antiseptic effects, it destroys bacteria. Various wood species are used for the production of wooden toys and thus support the positive attitude of children towards nature and natural materials that can be recycled well.
D) Wooden toys support the healthy development of the child both mentally and physically,
E) wooden toys are safe and have a long service life.

Wooden toys are an integral part of a rich portfolio of products for children. We know various types of wooden toys. From the simplest ones such as wooden horse, through wooden games such as bowling, cricket, dominoes to educational toys such as puzzles, magnetic toys, puzzles, wooden learning towers to musical instruments for children. Some wooden toys are also part of the national cultural heritage, such as wooden toys produced in one of the largest production factory of toys in Kyjatice. The technology used in their prosuction is unique. Ornaments are made in the form of engraving and scraping.

In Slovakia, but also abroad, there are more manufacturers who offer about 400 types of various safe wooden toys in their range of products. There are well-known online stores such as Hravosdrevom.sk, or the Hungarian manufacturer FAUNA. In most cases, we see smaller craftsmen such as MAŠEK company from the Czech Republic, or dynamically developing company BAJO from Poland. (1)
A common feature of larger and smaller manufacturers of wooden toys is the reference to their safety. Children's toys generally belong to designated products. This means that they must meet important quality criteria aimed at the strictest health and hygiene standards, but of course there are also guarantees of environmental friendliness and support for local industry. The product therefore includes logos declaring the highest quality criteria.

1.1. Sustainability and quality of wooden toys

Suppliers as well as manufacturers are increasingly trying to protect the safety of children and therefore they are not indifferent to the origion of wood they use to produce their toys. When buying wooden toys, we can notice the FSC - Forest Stewardship Council logo.(3)

Figure 1. Logo FSC

The above mentioned label guarantees that the timber used for the production of the products has not been logged illegally but comes from responsibly managed forests. According to FSC principles, forest management must be sustainable not only from an environmental point of view, but also from an economic and social point of view.
There must be no excessive logging in the forests. Rare woods such as forests must be protected, there must be no degradation of rare areas, neither of water, soil or other

environmental values. Likewise, workers' rights must not be violated in FSC-labeled forests. No gambling with their health and safety at work is allowed.

FSC certification is based on 10 international principles and 70 specifying criteria. The key principles are:

1. respect for national and international conventions,
2. considering and raising the long-term social and economic standards of employees and local people,
3. preservation of ecological principles such as biodiversity protection,
4. no water, soil and rare ecosystem damage,
5. protection of high value forests, in the territory of the SR e.g. forests, yew forests,
6. viable management plan and continuous monitoring of economic objectives, as well as environmental impacts and forest condition.

In Slovakia, about 10% of the forests hold the FSC certificate. There is a relatively strong support from the government for FSC certification. It must be said that the area of certified forests in our country has doubled in the last four years and in 2022 it already amounts to 328 thousand hectares.
Another mark declaring the product's conformity with the requirements and at the same time quality criteria is the "CE" mark:

Figure 2.
Conformity marking of the product in the European Economic Area (5)

Wooden toys are included under the so-called designated products that are subject to strict quality requirements. The CE marking is affixed to products that comply with European Union legislation. If the manufacturer affixes the CE marking to a product, he assumes that his product is in conformity with all legal requirements for such marking and may to be sold throughout the European Union and Turkey. To give you an idea of which countries are involved, this includes the 27 EU Member States and the EFTA countries - Norway, Iceland and Liechtenstein.
Conformity is required with all the requirements that are imposed by the manufacturer's guidelines on his product. Any other marks of conformity which would be associated with the

CE marking must not be affixed by the Member States to their national provisions. If manufacturers wish to use other markings or symbols, the following conditions must be met:

- function other than the CE marking must be maintained,
- any confusion with the CE marking is excluded,
- the visibility and legibility of the CE marking must not be impaired in any way

2. STN EN 71-1-A1 - SAFETY OF TOYS. PART 1: MECHANICAL AND PHYSICAL PROPERTIES

This European Standard specifies requirements and test methods for the mechanical and physical properties of toys. It applies to toys for children, where toys are understood to be any products or materials designed or intended, whether or not exclusively, for the use by children under 14 years of age. It concerns new toys, taking into account the time of foreseeable and normal use and the fact that the toys are used in a specified or predictable way, taking into account children's behavior. It contains special requirements for toys intended for children under 36 months, children under 18 months and for children who are too young to sit without support.

According to Directive 2009/48 / EC, "intended for use" means that the parent or supervisor must be reasonably able to predict, on the basis of the functions, dimensions and parameters of the toy, whether it is intended for children of that age group.
This European Standard EN 71, collectively called Toy Safety, consists of the following parts (4):

1. Mechanical and physical properties
2. Flammability
3. Migration of certain elements
4. Kits for chemical experiments and similar activities
5. Chemical toys other than experimental kits
6. Finger paints - Requirements and test methods
7. Toys for physical activity intended for domestic use
8. Organic chemical compounds - Requirements
9. Organic chemical compounds - Sample preparation and extraction
10. Organic chemical compounds - Analytical methods
11. N-nitrosamines and N-nitro sable substances
12. Smell board games, taste sensation board games, cosmetic sets and taste sensation sets
13. Trampolines for domestic use (4)

2.1. Safety assessment

We can say that it is common practice for original manufacturers to sell their toys to various importers who want to place them on the market as their own. This is also done in the case of the above-mentioned toy retailers. Following the Toy Safety Directive, the importer is considered to be his the producer of ,0own brand and must, inter alia, draw up technical documentation. It then follows that the manufacturer of his own mark must apply for EC type-

examination in his own name and will be issued with an EC type-examination certificate which supports the CE marking of the toy. There will be no demonstrable link to the original producer on the market. On the other hand, we must say that the original manufacturer has technical documentation that can be used by the manufacturer for his own brand.
As a result, the wooden toy offered for sale by the manufacturer's own brand will be identical to the original toy, except for the labeling, and will also contain instructions for use. All other elements of the technical documentation can be applied to a wooden toy of one' own brand. The own brand manufacturer is legally responsible for ensuring that the toy meets the requirements of the Directive.

It is also important to specify which documents need to be submitted to the notified body. These are as follows:
(a) the name and address of the manufacturer and, if the application is lodged by the manufacturer's authorized representative, the name and address of that manufacturer,
(b) a written declaration that the same application has not been lodged with any other notified body,
(c) a representative sample of the production envisaged. Additional samples may be required from the notified body if this is necessary to carry out the test program,
(d) supporting evidence for the adequacy of the technical solution. Under supporting evidence we understand e.g. the results of the tests carried out by the appropriate laboratory of the manufacturer, as well as by other testing laboratories on his behalf and under his responsibility.

Each construction of a wooden toy must be subjected to a verification test. The results of these tests should be recorded in one or more test reports. The manufacturer can do this himself or by an external source. Test reports should be prepared in accordance with the provisions of ISO IEC 17025: 2005 General requirements for the competence of testing and calibration laboratories. The reference to standards must include the date of issue of the standards used. The complete documentation must also include details of how the manufacturer will ensure the conformity of the wooden toy in the future and after any changes to the design or parameters of the toy or changes to the harmonized standards.
Updating the safety assessment is a very important part. The update is performed in cases where:

- new information is available,
- changes are made to the product (design, raw materials, additives, colors, etc.) that will affect the safety aspects,
- change of legal requirements,
- consumer complaints that the product poses a risk (eg allergic reactions, possibility of splinters),
- the products have been withdrawn from the market due to the risk.

In the European area, several pieces of legislation apply to toys in general and thus to wooden toys. A common feature is the ban or restriction of chemicals and mixtures used in toys. For

other substances, it is decided to ban or restrict them, and for others, it is discussed that their use in toys is undesirable.
Without claiming to completeness, we list the following legislation:

1. Directive 2009/48 / EC on the safety of toys,
2. Directive 2011/65 / EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment,
3. Regulation No. 850/2004 on persistent organic pollutants,
4. Regulation No. 1907/2006 on the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH).

Current legislation can be found on the EU website.

3. CONCLUSION

Manufacturers of wooden toys state that their primary goal is the safety of children. Ensuring and maintaining the safety of children's wooden toys is a relatively difficult matter and many manufacturers may be discouraged by the procedures for obtaining the necessary certificates. On the other hand, more and more young families are decide for the so-called "return to nature" and natural materials. Wooden toys are timeless, stylish and nowadays said to be popular. However, they are not always the cheapest ones. This is minly due to manufactory production and often handicraft processing based on the author's professional level. Wooden toys are often part of sculptural and painting production and are covered by intellectual and copyright rights. These facts also make them unique. In addition, they are not harmful to health, they are of good quality, they have a long service life, they strengthen memory and creativity and they can acquire a higher value over time.

Acknowledgements: We wish to thank project KEGA č. 012UCM-4/2020 – System applications of foresight processes in the new study programme Safety Engineering.

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MYSTERY SHOPPING AS A TOOL OF QUALITY EVALUATION IN STORES WITH FURNITURE

Miriam Olšiaková, Erika Loučanová and Martina Nosáľová

Abstract: Mystery shopping is one of the methods of marketing research, which focuses on determining the quality of services provided in companies. Mystery shopping is realized through mystery shoppers who behave like regular customers. They are specially trained observers who follow pre-set instructions and evaluate companies according to various criteria and elements that affect customer satisfaction. Its use is very widespread and in addition to the services where it was originally applied to a greater extent, it is also used by retailers to monitor the strengths and weaknesses of the store, which is related not only to staff but the overall environment that affects the customer's final impression of the seller. The paper presents results of the mystery shopping realized in selected stores of a concrete seller supplying furniture and home accessories in three different cities. With regard to the results of the survey, we propose measures to eliminate the identified shortcomings to subsequently increase customer satisfaction resulting from the relevant store visit.
Key words: furniture stores, mystery shopping, customers, satisfaction.

1. INTRODUCTION

Mystery shopping is a method by which we can identify both routine and non-routine problems. Mystery shopping refers to persons who are not common customers, but they introduce themselves as customers to find out how normal customers are treated. People who realize mystery shopping, can be the top leaders of the organization or consultants with special expertise in this field. In typical mystery shopping member of the top management of the company represents a customer and does everything as a customer (Mateides, Ďaďo, 2004).

This test method does not only allow clarification of the quality of own service, but it can be also used for various purposes. It is usually used to measure the quality of the service delivery to the customer. In this situation the mystery guests can be aimed at the compliance of specific standards, guidelines or demands, or they can be instructed to review the quality of the service on a scale. Mystery guests are also used to visit not only the own service locations but also locations of competitors, benchmarking becomes a way to judge your own activities against those (Mateides, Ďaďo, 2002, Hesselink, Wiele, 2003).

Mystery shopper programmes are applied as a tool for evaluating and improving customer service. The development and implementation of a mystery shopper programme is understood as a sequence of related steps closely linked to human resource management and employee involvement. The process begins with setting the objectives of the programme and ends with implementing change. The results of shopping programmes should be used to provide diagnostic information on service delivery rather than as performance appraisals of individual employees (Erstad, 1998).

However, achieving a better position over the competition requires more than just measuring customer satisfaction through questionnaire surveys. At present, it is no longer enough to provide better services, processes, and relationships than competition. Now is the time to create something special in the customer experience, as this is the only way to create a competitive advantage in the market. Organizational change should then be driven by a broader focus on customer expectations and more ways to measure customer satisfaction. Customer-based customer satisfaction data is needed; however, they will not be enough to continue the process of change over time. To achieve this, mystery shopping can provide more incentives for change (Van der Wiele et al. 2005).

Another possibility to attract customers is to provide services that are perceived in a positive way by customers. These possibilities include furniture innovations such as providing special services in the form of maintaining and repairing services, remanufacturing of used furniture; servitization (furniture leasing or renting) etc. (Loučanová et al., 2022, Olšiaková et al., 2016).

2. METHODOLOGY

In order to find out the level of quality of sales services, we carried out mystery shopping in three chosen stores with furniture of a specific furniture seller in its three branches in Zvolen, Banská Bystrica and Brezno. The examined seller has established an international network of stores and it supplies a variety of products from small items designed to enhance the home, through the interior and exterior furniture. Mystery shopping took place in three stages – at the end of January, in February and the last one in April 2022. We carried out a total of 9 mystery shopping. After making the "secret purchase", we analysed the situation in individual periods for each visited store, then we compared the visits for each monitored area and finally we carried the total evaluation of the best store of all. The secret purchase was made on the basis of a pre-prepared scenario. We evaluated determined aspects that may affect customers when shopping. We recorded the information from the observation in the evaluation scale consisting of 5 values. Value 1 means that the monitored aspect meets requirements as little as possible, a value of 5 means that the aspect meets all requirements. The evaluation scale contains four main criteria, which are divided into several partial ones:

1. store exterior - store availability, cleanliness in front of the store, parking possibilities, store signage,
2. interior of the store - atmosphere in the store, cleanliness of the store, division of the store, furniture layout,
3. behaviour of employees - greeting the customer after arrival at the store, appearance of staff, offer of assistance and abilities of the employee,
4. purchase ending - reaction of the employee to the rejection of the purchase, the length of time spent at the cash register, additional services offer, greeting when customer is leaving the store.

The maximum number of points that could be obtained was 80, of which 20 points for meeting the evaluated criteria in the area of the exterior, interior, for behaviour of employees and the behaviour of employees when paying for products and finally leaving the store. An important criterion was the employee's reaction to our refusal to buy furniture immediately.

The visits were carried out at a comparable time in order to maintain objectivity in the evaluation. The first round of visits was realized in the current week in the morning, the second round on Friday afternoons and the third round on weekends, when we expected higher store attendance.

3. RESULTS AND DISCUSSION

3.1 Exterior evaluation

Each of the visited stores is located in a kind of complex with other stores. Although each store has a certain number of parking spaces directly belonging to the store, there is a larger parking lot in their vicinity, intended for visitors of neighbouring shops. We can consider this fact as positive, because if the parking capacity belonging to the furniture store is occupied, it is possible to use the already mentioned larger parking lot.

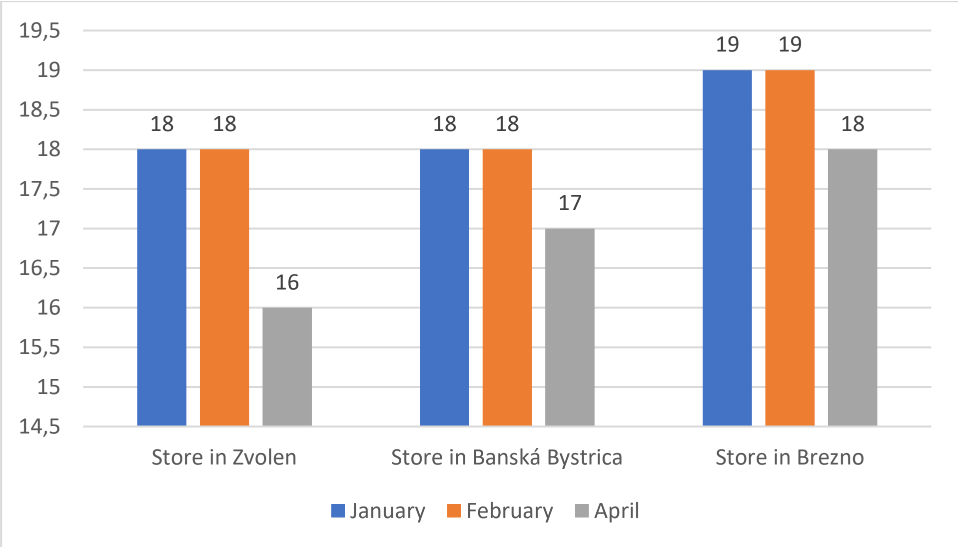

Figure 1. Exterior evaluation
Source: Own processing

As all three monitored stores are located in a complex with multiple stores with similar size of the parking lot, the differences in individual ratings are minimal. If there was a certain point reduction, it is mainly due to the fact that in the period under review, parking spaces were more occupied than during another visit of the store and therefore it was more difficult to find a suitable parking place.

The largest point reduction was recorded for all monitored objects in April. The fact that we made visits before Easter, when purchases were more frequent at other retailers sharing parking spaces, may have been a reason of this fact, and therefore it was much more difficult to park.

In aspects such as cleanliness in front of the store, store signage achieved the same rating for all monitored objects, so that all stores meet the required criteria in these areas.

3.2 Interior evaluation

When evaluating the interior of stores, we also recorded similar values. Within the interior, we focused on the overall atmosphere, which was completed by lighting, store temperature, its division, product layout as well as their overall offer and availability.

Despite the efforts to provide the customer with a wide range of products in different price ranges, we note certain shortcomings, which are again common to all three evaluated stores. As each of them specializes in selling furniture of different types and purposes, different sizes, in some places we had a cramped feeling from the amount of goods that surrounded us. The layout solution also has its disadvantages, which are manifested mainly in the higher number of customers in the store. We consider the arrangement of products in stores to be slightly chaotic and due to the amount of goods and their arrangement in the store, we felt lost. We evaluate this aspect with a lower number of points. However, we perceive as a big positive that each of the stores maintain order inside, which has a positive impact on customers´ impression when visiting the store.

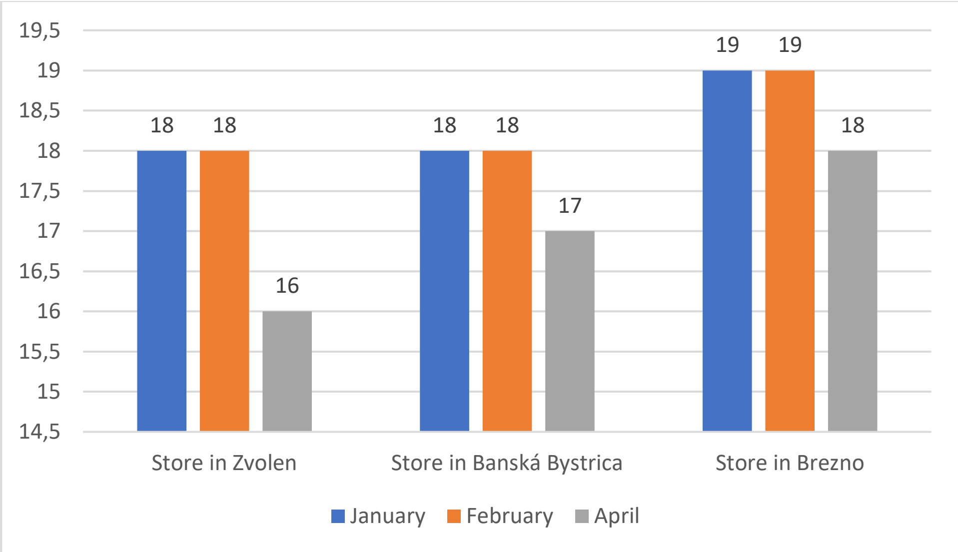

Figure 2. Interior evaluation
Source: Own processing

Although the range of products is almost the same, as it is the same retailer with many branches, the feelings of visiting the store are not the same. We perceive more positively the store located in Brezno, which seems to be the most organized and if there are not too many customers in it, then the atmosphere itself creates a pleasant feeling in customers.

3.3 Behaviour of employees

In order to intensify the positive impression of a visit of the store, it is necessary to select suitable employees who present the brand in personal contact with customers. Unfortunately, we have different impressions of the approach of employees to customers from individual visits. In this case, the best evaluation achieved the store in Brezno, where we came across helpful staff during each visit. The loss of one point in the case of the last visit was related to higher attendance at the store that day, so we had to wait longer to contact the store employee.

The weaker evaluation of the stores in Banská Bystrica and Zvolen reflected the need to find an employee to provide us with necessary information, which adversely affects the impression of a store visit. It is necessary for employees to stay close to customers if they need aid in relation to the product under consideration. On the other hand, the employee was willing to answer our questions.

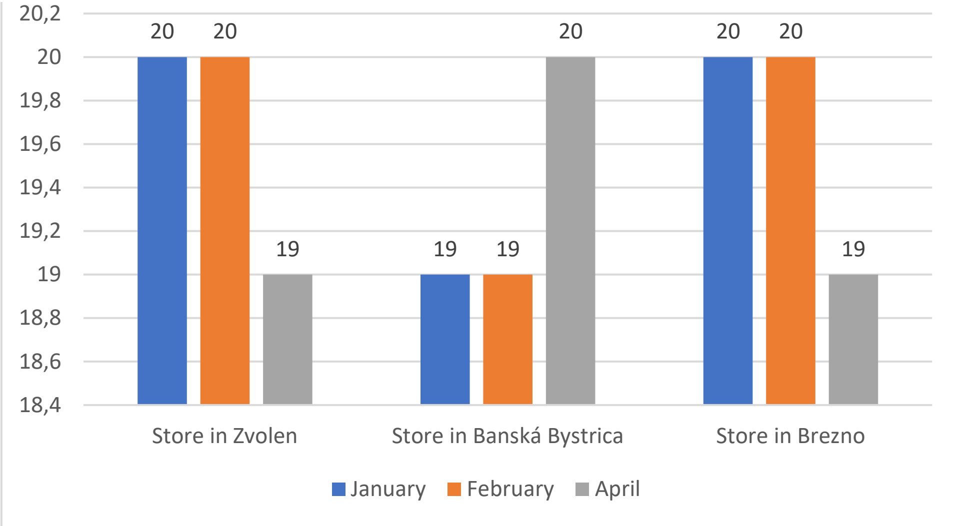

Figure 3. Evaluation of employees´ behaviour
Source: Own processing

3.4 Purchase ending

Regarding the end of our visit to the furniture store, we noticed minor differences in this area, specifically in the final greeting to the customer when leaving the store. In 3 of the 9 visits, the final greeting was missing, but in 2 visits this shortcoming is pardonable because of the fact that the nearest employee was a cashier and she just paid attention to the paying customer, so it is possible that she did not register our departure and greeting properly.

We did not notice any other serious shortcomings. The council councils were equipped smoothly. You could pay with several options and small goods were offered to customers. We also did not notice any negative reactions from employees when we postponed the purchase of the intended product, explaining that we would reconsider this decision.

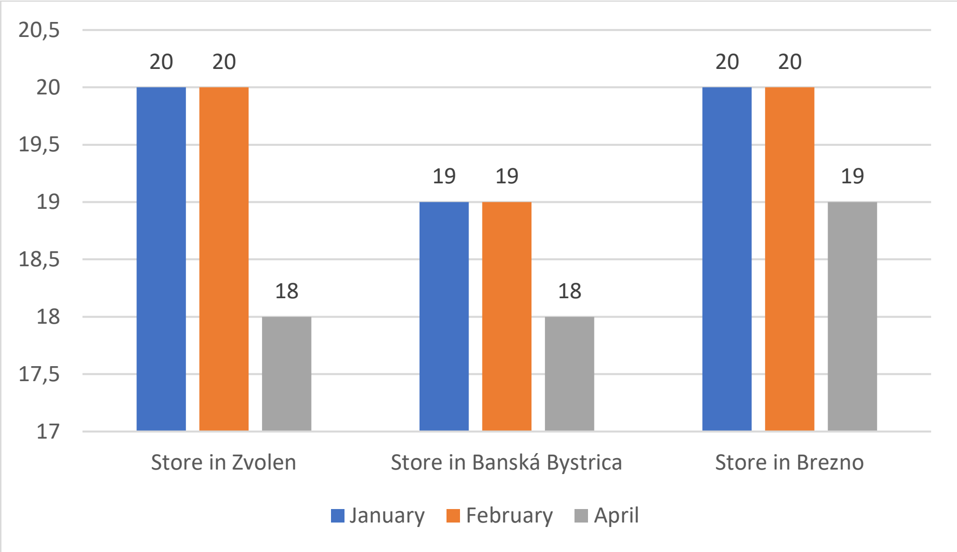

Figure 4. Evaluation of employees´ behaviour when leaving the store
Source: Own processing

The overall assessment of mystery shopping shows that the store in Brezno performed best during all visits, and although the differences in mystery shopping ratings for individual visits are not so significant, employees in the stores in Zvolen and Banská Bystrica should be available to store visitors to help them at the moment they demand it.

We carried out mystery shopping in the local branches of a well-known international furniture retailer, which has set up a number of operations not only in Slovakia but also in other countries around the world. It is possible to find a number of products for homes, offices, or exteriors in its stores. We evaluate the overall offer as positive, but the negative associated with it is the effort to have enough products in a limited space, which can be negatively reflected in the clarity of the offer. This negative can also result in a worsened transition in the store areas, especially if there are more customers at a given time.

Another shortcoming identified for two of the three monitored stores is the need to seek the assistance of a seller who should be close to the customers if they need to provide information in relation to the intended goods. However, in the case of several of our visits, we had to make this effort and spend time looking for an employee, and this fact does not create a positive impression of a visit to the store. However, this shortcoming is balanced by the employee's willingness to devote time to our issues as well as his expertise.

4. CONCLUSION

Customers and their satisfaction should be the meaning of each business, and this also applies to the furniture sector. Companies are looking for a way to reach as many customers as possible, but it is much more important to keep them. For this reason, it is essential to pay attention to the quality of services, in all possible areas that have a direct or indirect impact on overall customer satisfaction. Mystery shopping is one of the ways to monitor the level of quality of provided services which is mentioned in this article. It can quickly and easily detect areas of deficiencies that should be reduced. Finally, it leads to a satisfied customers who show their satisfaction in repeated store visits and their purchases.

ACKNOWLEDGEMENTS
The authors would like to thank the Scientific Grant Agency of the Ministry of Education, Science, Research and Sport of the Slovak Republic and the Slovak Academy of Sciences, grant number 1/0475/22 "Environmental Consumer and Environmental Citizen", grant number 1/0495/22, "Sustainability of Value Supply Chains and its Impact on the Competitiveness of Companies in the Forest and Forest-Based Sectors" and grant number 1/0494/22 " Comparative Advantages of the Wood Based Sector under the Growing Influence of the Green Economy Principles".

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ECONOMIC PRINCIPLES AND POSSIBILITIES OF USING RECYCLED MATERIAL BASED ON WOOD – PLASTIC – RUBBER

Mária Osvaldová, Marek Potkány

Abstract: The circular economy is a model of production and consumption reusing existing materials and products in the shortest possible time. This model prolongs the product life cycle and creates opportunities for innovative products The current economic system operating on the principle of linear economy, goods are produced, used, and discarded, so the material flow has a defined beginning and end. But the circular economy works differently. Products and services in the circular economy are designed in a way that allows them to be reused, thus increasing their economic efficiency and economy. Our paper shows how circular economy principles can be used to produce innovative products using wood waste along with plastic or rubber, as well as pointing out their economic benefits.

Keywords: circular economy, composite material, plastic, rubber, wood

1. INTRODUCTION

The concept of circular economy is contained in theories questioning the linear economic system that assumes infinite resources (Mativenga, 2017). Natural resources play a significant role in the efficiency and continuity of the economy and production (Nikolaou et al, 2021). In light of limited world resources and a predicted demographic development, the linear economic model does not appear economical or sustainable (Goovaerts, 2018). There has been pressure on the European polymers market for several months. A lack of raw materials and price increases negatively impact the production of plastic products in the EU. Many European plastic manufacturers report difficulty obtaining raw materials and alarmingly low stocks (European Plastics Converters, 2021). There are several initiatives that can be taken under current conditions to reduce or even eliminate the consumption the use of natural resources and close materials loops (Nikolaou et al, 2021). The paper presents an application of the principles of the CE to a specific sector of the Wood Working Industry (WWI), specifically on production of products containing waste materials such as wood, plastic, and rubber. The paper analyzed available electronic and print sources of the issue and synthesised and compared them to draw conclusions and identify opportunities.

2. PRINCIPLES OF THE CIRCULAR ECONOMY

Modern industry is characterized primarily by a linear economy, take-make-dispose. The model is based on the extraction and collection of raw materials for producing products, which are thrown away by consumers after they have served their purpose (Getsmarter, 2021). In other words, it means raw materials obtained by a demanding process and their renewable will take decades, after use they will simply be thrown away and will decompose for several hundred years (Inštitút cirkulárnej ekonomiky, 2017). In the CE waste is reduced to a minimum in the first place (Ellen MacArthur Foundation, 2013). The principle of a CE is the separation of economic growth from the consumption of raw materials, and therefore the economy is not stopped by a lack of raw materials. Depending on the circumstances, the transition to a CE can support economic growth (Ghadimi, 2022) by increasing revenue from new circular activities and creating more functionality from the same number of materials and production. The development, production and repair of circular products require a specialized workforce and this will increase jobs opportunities. Meanwhile, the number of less specialized jobs will decline due to the reduced demand for the extraction and processing of raw materials. The value of labor will increase and this is good for employment and GNP (WE Forum, 2017). The expansion of the circular system has environmental benefits by reducing emissions and resource consumption, as well as reducing global ecosystem degradation (Rizos et al, 2016). The circular model leads to greater sustainability and benefits for companies willing to take on risk (Shevchenko, 2022). It is essential for companies to understand the benefits of circular-economy business models before they adopt them (Getsmarter, 2021). CE is a model of production and consumption focusing on sharing, leasing, reusing, repairing, renovating, and recycling existing materials and products for as long as possible. In this way, the product life cycle is extended (European Parliament, 2022). Slovakia is one of the few EU countries that must first solve the problem of landfilled waste as a first step toward CE. The landfilling of waste is still the most common waste disposal method in Slovakia. The country faces major environmental challenge associated to improve waste management. Priority should be placed on waste prevention, sorting, and increased recycling and recovery as a replacement for landfilling (Inštitút cirkulárnej ekonomiky, 2017). Small and medium-sized enterprises (SMEs) are increasingly aware of the benefits of closing loops and improving resource efficiency, such as saving material costs, creating competitive advantages and accessing new markets. CE has been a challenge for SMEs from the beginning, they face various barriers in their transition to CE. Barriers such as lack of financial resources and lack of technical skills. In most cases, SMEs point to lack of supply and demand support and lack of capital as barriers to greening. The first barrier indicates that SMEs normally operate as small players within wider value chains, so they are dependent upon the quality of bigger green actors. The second barrier shows that SMEs do not often have the financial capacity to manage costly transition to a circular business model (Rizos et al, 2016).

3. RESULTS

3.1. Current Use of Recycled Plastic and Rubber in Products

The automotive industry in Slovakia makes the highest contribution to GDP (Yearbook of Industry of the SR 2020, 2020). The automotive industry has struggled with the problem of accumulating end-of-life vehicles waste in recent years. In the automotive industry, the challenge is to use waste plastics, rubber, and other parts from end-of-life vehicles (Cardamone, 2022). The number of vehicles that end their lives in Europe each year is approximately six million. EU directive about end-of-life vehicles waste is the Directive on End-of Life Vehicle 2000/53/EC and It also requires a 85% minimum reuse and recycling rate and a 95% minimum reuse and recovery rate for the total vehicle weight (Cardamone, 2022). There are 3 ways to process end-of-life vehicles: selective disassembly, it is a process of reusing of the components from vehicles, complete disassembly, separate the car parts and recycle them or use the shredding process and then separate the material (Gejdoš, Sobotová, 2012). The use of plastics in the automotive industry began to rise rapidly in the second half of the 20th century. This was directly related to requirements for passive safety and economy in cars. Polymer-based materials begun replacing metals. Besides the required higher security, the other reason for using plastic in car manufacture is the possibility of recycling polymers and meeting environmental regulations (Novák, Žigo, 2018). Over the last decade, the use of these materials has changed dramatically (Aimplas, 2016). Despite the fact that rubber waste disposal has become a global problem, current rubber waste management are considered insufficient (Chittella et al, 2021). According to Sermaraj et al (2021) the world automobile industries recycles 7 % of waste rubber tyres on-site, while 77 % are sent to landfills or dumped illegally (Sermaraj et al, 2021). Tires that are no longer usable and end up as waste are a global problem and increase the risk to the environment. Tire waste can be incinerated as a simple, cheap, but least environmentally friendly method of disposal. However, the use of waste tires as a secondary raw material is more environmentally friendly than using them as fuel. As a raw material, waste tires offer excellent potential for processing and use. Products from waste rubber can be used, for example, in transport construction, agriculture, coastal construction, retaining walls, etc. (Svoboda et al, 2018). There are already partial solutions for using recycle material in new products, e.g., using rubber granulate in companies AVE SK odpadové hospodárstvo s.r.o., (rubber paving, rubber curbs, rubber speed retarders, rubber ballistic panels, etc.) or Dron Industries s.r.o. (coke and gas fuel, liquefied gas, steel cords), or other producers like OPlast, a.s., AYYA SALMET s.r.o., NEXTWOOD s.r.o. (wood-plastic boards, fence parts, paving, etc.). Waste plastic currently finds a wide range of applications in various areas of industry. Construction materials, furniture production, electrical components, packaging production, secondary fuel textiles, and other areas are among the most common uses of waste plastic. Reuse and recycling are relatively low but significantly practiced for composite materials. It is necessary to promote reuse and identify new waste prevention strategies. (Mativenga, 2017). Recent years have seen a rapid growth in the manufacturing of wood-plastic composites. North America and China are the top two largest producers and Europe is in third place. Sectors with the most share in wood composites are decking, automotive, tiling, and fencing. The European Union is working towards more efficient waste management to conserve natural resources. One way to improve CE could be to use various waste materials and side fractions as part of wood-plastic composites (Keskisaari, Kärki, 2018). In the circular economy, wood can serve as an ideal material since it is a natural resource that is available in large quantities. The purpose of CE is to reduce waste and promote recycling of products. Low-quality wood that cannot be sold, but can be repurposed, could be an interesting option. Low grade wood can be used to produce fibers or chips that can be glued together to produce higher quality materials, such as woodplastic or woodrubber (Pichelin, 2018). The promotion of sustainable raw material management and increasing recycling of waste plastic, wood, and rubber provide opportunities for new technologies and innovations. They offer an environmentally friendly alternative to traditional products.These products improve carbon sequestration and could replace less environmentally friendly materials. Specifically, this refers to the storage of carbon emissions in production processes and the use of raw materials (www.woodrub.com).

4 POTENTIAL USE OF WOOD IN INNOVATIVE PRODUCTS

Wood-plastic composite (WPC) is one of the key wood products widely used in landscaping, transport, urban engineering and building construction. Over time, WPCs are being used in place of traditional wood-based composites (Xu et al, 2021). Profiles made of wood-plastic composites are commonly used to construct outdoor terraces. WPCs injection molded parts are currently being used in a variety of industries including packaging, everyday needs, and construction (Gardner et al, 2015). WPCs offer significant potential in the construction industry. Using WPC tiles, ceilings, windows, and floors offers environmental protection and sustainable development benefits. As a result, wood-based products can be effectively integrated into green construction (Xu et al, 2021). Among the woodplastic composite products which are commercially available are molded sheets for the automobile industry, furniture industry, injected parts in the electrical industry and injected molded parts for toys and musical instruments, etc. (Gardner et al, 2015). According to industry estimates by Mordor Intelligence, the European woodplastic composite (WPC) market reached over 450 kilotons in 2021 and is expected to register a CAGR of over 8% from 2022-2027. Unfortunately, the pandemic period was severely disrupted by this plan. In light of growing construction activities, this forecast should gradually be fulfilled. We assume that woodrubber composites (WRC) could have a similar potential. Currently, several products are being offered on the market that involve the use of recycled rubber in various fractions. Rubber granulate offers a variety of product shapes as a benefit. Some of the most frequently produced products are anti-vibration boards and mats intended primarily for traffic constructions, side panels for rails, or rubber curbs. Rubber anti-vibration mats and sidewalls reduce track vibration. With rubber granulate as the foundation, they are among the most widely used construction products. They serve as a barrier between vibrations and surrounding. The rubber granulate can also be used as a sound-absorbing layer in noise barriers and curtains or as a playground surface for children. (Bret, 2018).

Figure 1. rubber paving (AVE SK) , woodplastic paving (NEXTWOOD)
Source (avesk.sk, nextwood.cz)

Figure 2. Woodrubber board (rubber ratio 10%) a Woodplastic board (pomer plastu lastic ration 15%)
Source (Own proccesing)

5. CONCLUSION

Dissertation will develop more circular business models elements, as well as describe the principles of CE in innovative products that use wood waste. The concept of circular economy has become an important idea in a sustainable economy. The objective of the CE is to use less raw materials, design products with a long life and recyclability, and share, reuse, and repair products before they are recycled or disposed of. An economic analysis of the innovative products will be conducted through the development of business plans based on time value of investment and operating costs with a defined life cycle and using dynamic and complementary evaluation methods. The following methods use the time value of money: net present value (NPV), profitability index (PI), internal rate of return (IRR), discounted payback period (DPP), sensitivity analysis, and Break Even Analysis. Business plans specifications will also include physical properties of composite materials (density: STN EN 323, swelling in thickness: STN EN 317) and mechanical properties of composite materials (elasticity in bending and of bending strength: STN EN 310, tensile strength perpendicular to the plane of the board: STN EN 319) for innovative products with European standards. The future of composite materials is an extremely promising one, with composite materials. Market forecasts indicate that composite materials containing rubber or plastic recycled materials are being used significantly more in several industries, such as furniture or construction. As a result, the industries are likely to switch from traditional materials such as wood, plastic, rubber, steel, and iron to more advanced and environmentally friendly composite materials.

Acknowledgements: This article is a part of the work on the project UNIVNET "University Research Association for Waste Recovery, especially from the Automotive Industry" funded by the Ministry of Education, Science, Research and Sport of the Slovak Republic and project KEGA 005TU Z-4/2020.
This research was supported by projects APVV-18-0520 "Innovative Methods for Analyzing the Performance of Wood and Forestry Complex Using the Principles of Green Growth".

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WOMEN IN THE FOREST-BASED SECTOR: KEY INSIGHTS INTO CURRENT SITUATION IN THE CZECH REPUBLIC

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Abstract: Presented paper deals with gender-reflected issue of human resources in the forest-based sector in the Czech Republic. The article is largely devoted to the evaluation of activities, that were part of the ongoing project Interreg Danube Transnational Programme „Fem4Forest“ (2020-2022). Activities conducted in 2021 are presented in a specific national context and include qualitative research based on round tables, role models interview analysis and analysis of guided interviews. The target groups/stakeholders were not only female forest owners, female workers in forestry and related sectors at different working positions (including managerial positions) but also stakeholders from the forest-based value chain and gender-oriented organizations. Due to the same methodology used in the process of data collection in all 10 project partner countries in Danube Region, it is possible to conclude common findings, that are presented at the end of the article. Results from the above-mentioned activities are important input information for further development of the forest-based sector in relation to the design of appropriate human resource practices in companies in the Czech Republic and for designing the new attitudes in forestry.
Keywords: gender, Fem4Forest, labour market, skills and competences, interviews, Danube region

1. INTRODUCTION

Gender issue is a contemporary topic. Various surveys deal with the (in)equality between men and women at the national and international levels. In the Czech Republic, the topic of equality is primarily based on the Constitution of Fundamental Rights and Freedoms, the current strategic material is the Government Strategy 2021+, and inequality in remuneration is addressed, for example, by Equal Remuneration initiative (NAP, 2022). The role of women and their more active representation in forestry, which is traditionally considered a male-dominated sector, is addressed by the Interreg Danube Transnational Programme project *Forests in Women's Hands (Fem4Forest)*. The project is led by the Slovenian Forestry Institute and involves a total of 14 project partners from 10 countries in Europe. Faculty of Forestry and Wood Sciences of the Czech University of Life Sciences in Prague is the only partner from the Czech Republic. The project aims to *„strengthen the forest sector at local, regional and interregional level trough increased involvement and ability of women actors by supporting their equal presence and competences at the market in Danube Region*" (Interreg DTP, 2022). Due to the stakeholders´ engagement the project overlaps also to the wood-processing sector. The paper pays attention to the results of qualitative surveys from 2021.

2. MATERIAL AND METHODS

The source data for this paper are based on information obtained through conducted interviews and round tables, which took place in connection with the activities of project work packages T1 (*Analysis of stakeholder demand*) and T2 (*Demand - driven action plan to increase the competence of women in forestry sector*) in the Czech Republic in the period from April to November 2021. Data collection is based on the methodology of the Fem4Forest project entitled *Methodology for identification of needs and interests of women in the forest sector*, which was adopted in April 2021 and is implemented by project partners. The task of each country/project partner was to ensure the collection, analysis, and interpretation of information in each country. In the Czech Republic, 2 round tables, guided interviews with female workforce and female forest owners and guided interviews with female role models from the forestry sector were conducted. The Czech university of Life Sciences (CZU) – Faculty of Forestry and Wood Sciences (FFWS) was responsible for data collection in the Czech Republic. The project determined the minimum numbers for participants in each category - 12 guided interviews, 3 guided interviews with role models and at least 10 participants at each round table. Guided interviews were conducted in cooperation with an external company, role model interviews and round tables were then fully directed by FFWS CZU. Due to the measures taken to decrease the spread of coronavirus, some activities were carried out only online or in a hybrid form (on-site + online). The uniform approach used by all project partners then allows the comparison of findings between the countries.

3. RESULTS

3.1. Guided interviews

A total of 12 women of various ages took part in the interviews on the voluntary basis (the youngest respondent was 21 years old, the oldest was 60 years old). The following identification data were collected: age, place of residence, experience in forestry, job position and brief information about the employer of the employee. The job positions held by the respondents were different, as was the length of their experience (1 year at minimum, maximum 40 years). The information obtained dealt with the following areas:

1. Forest ownership (forest possession and related benefits)
2. Women and forestry (connection and perception between women and forestry)
3. Careers of women in forestry (experience, opinions about (un)suitable job positions for women, opinion on low representation of women at managerial positions)
4. Career and education (necessity of career building, benefits of specific education and suggestions for improvement of female positions in forestry)

In the end, the respondents were presented with three pictures, which showed women working in forestry and they had to choose the one that seemed to them the most suitable for the positions of women. These represented A) silvicultural operations, B) logging operations and work with technology and C) administrative, managerial positions – see *Table 1*.

Table 1. Selected results from the guided interviews (Czech Republic)

Brief information on company represented by the respondent	**Perceived role of women in forestry**	**Suggestions for improvement of role of women in forestry**
Private company dealing with complex timber processing	Logging (B)	Projects that would allow trying different job positions

Forest cooperative	Silvicultural operations (A) Logging (B)	Present that forestry is not only for men, but also for women
Company providing advisory and other services for Ministry of Agriculture	Logging (B)	Creating more suitable working conditions
Private company that follows operation in forestry (services)	Management and administration (C)	Equal salary for men and women at the same job positions
High school of forestry	Silvicultural operations (A) Management and administration (C)	Be respectful for women´s specifics and use their benefits
Company providing services in forestry	Logging (B)	To ensure that women can return to the same positions after maternity leave
Private company – planting	Silvicultural operations (A)	Respect from males
Public administration company (forestry)	Silvicultural operations (A) Logging (B) Management and administration (C)	Acceptance of women in forestry
Private forests	Logging (B)	Acceptance from men
Organizational unit of the state acting as a professional organization for the Ministry of Agriculture for forestry and hunting	Silvicultural operations (A) Management and administration (C)	Providing background at home (family care)
State forestry company	Silvicultural operations (A)	Role models presentation
Private company dealing with logging and timber trade	Silvicultural operations (A)	Presenting that forestry is not only for men, but also for women

Source: data from the guided interviews gathered by project activities in the Czech Republic, 2021

The results confirmed that women are not frequent forest owners. There were only 2 women among the respondents, and they own very small plots of land (0.7 hectare and 6 hectares, respectively). The respondents agreed that it would be appropriate - in addition to a greater acceptance of women by men - to ensure presentation of women's abilities leading to the acceptance of women as workers in the forestry sector. The responses regarding the opinion of the most common positions of women in forestry confirm that women do not tend to choose one specific job position but see the role of women in different job positions. Respondents often chose more than 1 option (4 answers). Option A, which referred to silvicultural operations, was chosen most often.

3.2. Role models

The identification of role models in the Czech Republic was based on previous project activities and on meeting the requirements of the interviewed for experience in forestry and holding a managerial position. All three role models have a university education in forestry, two of the respondents have a tertiary university degree (doctoral); all have more than 10 years of experience. Their opinions are summarized in *Table 2*. Due to the limitations associated with the coronavirus pandemic, online interviews were conducted, and their summaries are also used as project promotional materials.

The interviews were structured and dealt with education, women's careers, and their views on women in forestry, including key messages for women at the beginning of their careers. One area was also reflecting on what these women experience as the key for improving the position of women in the forestry sector. All three women agreed that one of the key areas is reconciling work and family life.

Table 2: Role models (Czech Republic)

Brief information on respondent position and company	**Length of experience**	**What should be done for better integration of women in forestry sector?**
State forestry company – head of subsidies department	19 years	Offers for career growth (increasing competences), kindergartens, flexible working hours.
High school of forestry – principal	11 years	Courses that would help women to be prepared for managerial positions, better job descriptions and promotion of forestry.
Private forestry company – head of property-legal agenda and marketing	25 years	No integration as such is needed, but there is a need to better reconcile work and family, e.g., by flexible working hours.

Source: data from the role models interviews gathered by project activities in the Czech Republic, 2021

3.3. Round tables

Two round tables were organized in the Czech Republic - the first in May 2021, the second in November 2021. The first round table was attended by a total of 12 external participants (women), who represented entities operating in the forestry sector (representatives of state forestry companies, state administration, private forestry companies etc.). The results of project activities, including a quantitative analysis of forest ownership in the Czech Republic, certification and gender in forestry were presented. During the feedback and discussion, it was stated that:

- it is good that there is an initiative that addresses the role of women in a male-dominated environment

- there are also female forest owners in the Czech Republic, but mostly own small properties (corresponds to the findings of the guided interviews)
- an active role/discussion with relevant stakeholders is important, which will lead to greater awareness of the situation of women in forestry

The second round table was attended by a total of 20 participants (men and women). Thanks to the lowering of covid measures, the event was organized as a hybrid event and, in addition to representatives of the forestry-wood sector, representatives of gender-oriented institutions in the Czech Republic also participated. Within the feedback and discussion, it was stated that the role of women (especially role models) and their active participation in the development of young women and their further career development should be interesting and more communicated between interest groups. The second round table also helped to raise awareness of the project's activities at the university level, where a gender equality plan was adopted at the end of 2021.

In 2021, all qualitative surveys were supplemented by the results of quantitative surveys in the form of questionnaires among women who own a forest and women who work in the forest sector; the second survey then focused on women who are at the beginning of their careers. For the first questionnaire, a total number of almost nine hundred responses (out of which 104 from the Czech Republic) was gathered, the second questionnaire reached more than 400 responses.

4. DISCUSSION AND CONCLUSIONS

Guided interviews were conducted among a total of 106 respondents across the project partnership countries (93 female respondents, 12 in the Czech Republic). Guided interviews with role models identified a total of 24 women. These women work in various job positions (e.g. heads of state administration bodies, national parks, academic staff, managers in the forestry-wood sector). In the Czech Republic there were 3 interviews with women with a considerable experience and forestry education. As shown by the results of a quantitative questionnaire survey in the Czech Republic, respondents are not really aware of role models in forestry – "*I do not know*" or "*No*" answer was chosen by more than 75 % of respondents (Böhling, 2022) and that is why sharing experience and knowledge from role models is very important.The organization of round tables was affected by restrictions because of covid-19 pandemic. Nevertheless, project partners managed to organize all meetings (20 round tables) with a total of more than 350 participants. The first round table took place in March 2021 in Ukraine (organized by project partner *FORZA*), that also had the most participants at both round tables (70 and 41, respectively). In the Czech Republic, 2 round tables with 32 external participants across all target groups (local and national public authority, sectoral agency, interest groups including NGOs, higher education and research, education / training centre and school, enterprise, SMEs, business support organizations, general public from both forestry and wood sectors) joined the event. Summary of information related to these activities is available in the report entitled *Collected needs of women and wider gender perspectives in forestry,* project deliverable: D.T1.1.2, published on the Interreg Danube Transnational Programme website.

On the one hand, Czech Republic belongs to the European countries where inequality between men and women persist. The development in the recent years has shown a change, however there is still a considerable gender pay gap (IoSCAoS, 2020). The problem is also at managerial and leading positions where women are under-represented. According to the data (GOV, 2021), the Czech Republic reached worst results in representation of women in leading positions and in education. On the other hand, the project results indicate that for example equal treatment at work is perceived really as "equal" – confirmed by 60 % of the respondents. Higher number of acceptances with this statement was indicated only by respondents from Ukraine and Romania (Böhling, 2022). Key messages from the questionnaire among forest professionals say that women need to utilize their strong skills (communication, patience, feeling for nature) and would appreciate more practice and soft skills improvement. This was generally confirmed also in other countries. Gender issue is a matter of interest by various initiatives, on the institutional level as well – CZU adopted a Gender Equality Plan at the end of 2021 (GEP, 2021). This plan is also a prerequisite for CZU to participate in project proposals at the European level (e.g., Horizon projects). Findings from Fem4Forest project could be helpful in designing new approaches and measures related to the improvement of situation of women in the forestry-wood sector.

Acknowledgements: We wish to thank project partners from the Interreg DTP3-500-1.2 Fem4Forest project and to all participants who joined the project activities in the Czech Republic.

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EVALUATION OF FOREST-BASED SECTOR FOR THE NATIONAL ECONOMY IN THE BIOECONOMY CONTEXT

Ján Parobek, Alena Rokonalová, Katarína Slašťanová

Abstract: Terms such as the green economy, the blue economy and the bioeconomy are now often used, and they represent areas that should contribute to sustainable development and at the same time reduce the impact of human activity and industrial production on the environment. The aim of the paper is to evaluate the contribution of the forest-based sector to the Slovak economy on the basis of comparison with selected countries in the bioeconomy context. The contribution of the forest-based sector as a part of the bioeconomy were compared within the Slovak Republic, the Czech Republic and Finland. The following indicators were analyzed: forest cover, share of the woodworking industry in total GDP, number of enterprises in the woodworking industry, employment in the woodworking industry.
Keywords: bioeconomy, forest-based sector, wood processing industry

1. INTRODUCTION

The concept of the bioeconomy has become increasingly popular in the last decade. The current literature deals to a large extent with the issues of reducing the use of fossil resources. In this context, two narratives of the bioeconomy concept have been developed. Hausknost et al. (2017) recognise a "biotechnology-centred" narrative and a "bioresource-centred" narrative. "Biotechnology-centred" narrative highlights the development of new molecular biotechnologies, while a "bioresource-centred" narrative emphasize the importance of developing industries and value chains based on the use of renewable natural resources. The concept is based on the premise that natural resources are limited and therefore need to be used efficiently. It has its roots in the discourse of ecological modernization, which argues that economic growth and development can be reconciled with environmental protection (Kleinschmit et al., 2014).

The concept of bioeconomy should be built on the foundations of sustainable development and a green economy and should provide goods and services that are (Wolfslehner, 2019):

1. environmentally friendly,
2. have a positive impact on citizens' health,
3. ensure a sustainable supply of natural resources.

The bioeconomy is a comprehensive, cross-sectoral concept covering all sectors and systems that rely on biomass. The aim of the concept is to produce new biologically sustainable products and also to replace fossil raw materials (not just fuels) within individual industries and thus to mitigate climate change. The main components of the bioeconomy should be: agriculture, forestry, food, fisheries, chemistry, energy (Iring, 2016). The forest-related bioeconomy debates that are emerging in Europe are strongly influenced by the bio-resource narrative. The key role of trees as carbon sinks in the biological resource narrative also leads to a special emphasis on the role of productive forests in mitigating climate change (Pülzl, Kleinschmit, and Arts 2014). The whole forest-based value chain is very much linked to a bioeconomy. It does not only concern the primary production of forest resources, but also the use of wood and non-wood material, the provision of forest ecosystem services, as well as energy production and material use during recycling processes (Wolfslehner 2019, Štefko et al. 2021). According to above mentions information, woodworking industry represents one of the most important players to support principles of bioeconomy and utilisation of renewable resources. This paper focuses on the evaluation of the woodworking industry as part of the bioeconomy in the economies of selected countries from the national economy point of view.

2. METHODOLOGY

The aim is to evaluate the contribution of the forest-based sector to the Slovak economy on the basis of comparison with selected countries in the bioeconomy context. The paper focuses on the woodworking industry and its share in the selected macroeconomics indicators, namely, gross domestic product and employees of the following selected countries: Slovak republic, Czech Republic, Republic of Finland. The EU woodworking industries include the production of sawn wood, wood-based panels, and wooden construction materials and products. About 70% of the wood in the EU is used in construction and furnishings (Eurostat, 2022). In the context of the bioeconomy, countries emphasize the following aspects and challenges within the forest-based sector (Wolfslehner, 2019):

4. economic indicators of the wood processing industry,
5. employment in the wood processing industry,
6. carbon sequestration in wood products,
7. sustainability and legality of wood processing,
8. availability of wood.

For the needs of the paper, forest-based bioeconomy indicators were identified, through which it is possible to determine the contribution of the bioeconomy to the economy of the country. The following indicators are assessed and compared:

9. forest cover,
10. GDP of the woodworking industry and its share in total GDP,
11. number of employees in the woodworking industry.

Using the comparative method, the contribution of the woodworking industry to national economies of selected countries is compared. Comparative analysis can generally be defined as the process of searching for common and different features of two or more objects (selected indicators of forest resources and economic indicators) in order to acquire new information and knowledge. The indicators will be assessed within the individual countries for the period from 2010 to 2018. Common and different features through a comparison of selected indicators are analysed.

3. RESULTS

In connection with the analysis of the contribution of the bioeconomy to the economy of the evaluated countries, one sector within the bioeconomy is analysed, namely the woodworking industry. In the analysis of its contribution in the economy of the three selected countries, the forest cover the share of gross domestic product generated by the woodworking industry to the total gross domestic product of a given country are compared.

In terms of available wood, the woodworking industry is partly dependent on the forest cover of the country. In Slovakia, forests cover an area of approximately 2 million ha, which represents 41% of the total land. In terms of forest categorization, commercial forests represent 1.404 million ha, which is 72.1%. The forest cover of the Czech Republic is 34.1% (2.692 million ha).Similarly, commercial forests represent 74.2% (Ministerstvo zemědělství, 2021).

Of the total area of the Republic of Finland (30.4 million hectares), forest land represents 22.8 million hectares, which means that forests together make up 73% of the total area. Finnish forests thus represent 10% of the forest area in Europe (LUKE, 2018). According to the Finnish Institute of Natural Resources, the total wood supply has increased by more than 40% since 1971. The increase in forest area is also recorded in Slovakia. Since 1990, the area of forest stands has increased by 1.36%.

Figure 1 shows the share of the woodworking industry in total GDP within the period 2010 to 2018. The share of the woodworking industry in total GDP in the Czech Republic is at the level of 1.3 to 1.6%, which is comparable to the Slovak Republic. In the Czech Republic, the share of the gross domestic product of the woodworking industry in the total gross domestic product of the country stagnated in the given period. In the Slovak Republic, the share of gross domestic product of the woodworking industry in the total gross domestic product of the country in the years 2014 and 2015 slightly grew, but subsequently stagnated in the following period with a slight decline. In Finland, the share of the woodworking industry in country's total gross domestic product has slight increasing trend. Throughout the observed period, the share of the wood processing industry in Finland's total GDP increased from 2.1% in 2010 to 2.4% in 2018.

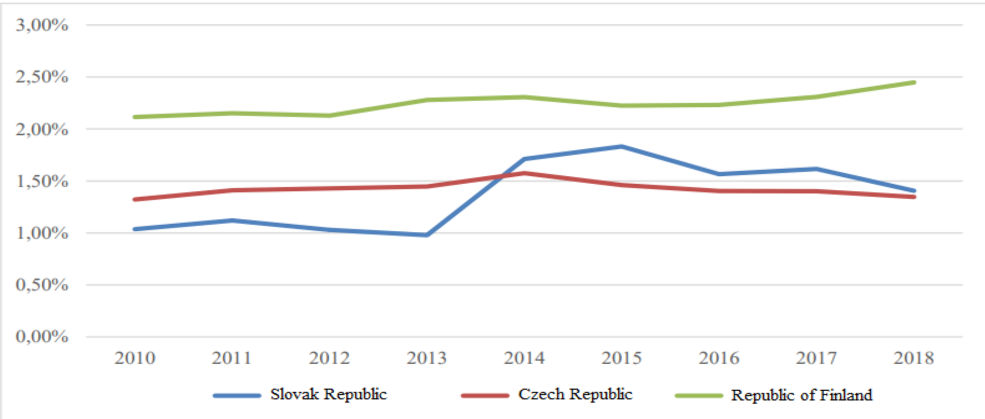

Figure 1. The share of the woodworking industry in the total GDP of the country

The largest number of employees in the woodworking industry is in the Czech Republic, while in the Slovak Republic and Finland this number is approximately the same and only after 2016 the number of employees working in the selected industry in Finland reached a higher number than the number of employees in the Slovak Republic.

4. DISCUSSION

According to Gasova and Stofkova (2017) the process of globalisation creates higher demand on the adoption of highly flexible innovative solutions. Piplani and Smith-Hall (2021) emphasise that the forest-based bioeconomy is much more than minimising waste, substituting resources or biotechnological innovation, it can also contribute to achieve goals like poverty reduction, biodiversity conservation, and sustainable consumption. The main part of Finland's bioeconomy consists of the forest industry. Historically, the Finnish wood processing industry began with sawmilling. Nowadays the most important products of Finnish forest industry are pulp, paper, paperboard, packaging materials and sawn wood. Paperboard has become the most important product in forest industries in Finland (LUKE,2021). These facts are also reflected in the amount of labour force in the selected industry.

Hájek et al. (2021) point to the current state of the bioeconomy in Czech Republic. Policy of bioeconomy is not very coordinated, differently understood and suitable strategy for bioeconomy has not yet been adopted. The trends is similar in other eastern European countries. However, public awareness of bioeconomy is increasing. Finland, on the other hand, is seen as leading actor in the sustainable forest-based bioeconomy, a country with plentiful wood resources, extensive knowledge in forest utilization and government support. However, there are challenges in targeting and ensuring the availability of wood-based biomass for different purposes (Näyhä, 2019).

In the Czech and Slovak Republics, the situation persists when wood raw material is exported directly without further sophisticated added value and has long been one of the largest exporters of raw wood in relation to domestic logging in the world. Kupčák (2017) point out the negatives of wood exports as follows:

12. the raw material is exported without further processing and the added value is created abroad,
13. the export of wood reduces the possibility of job creation,
14. the state loses tax revenue.

Hajdúchová et al. (2016) investigates the impact of the global economy on the forest-based sector in Slovakia. The analysis suggests that Slovakia should focus particularly on higher value-added products, which could be achieved by the complex utilization of wood raw materials. This effort would improve the contributions of the forestry and timber industries to regional development. In addition, woodworking should strive to increase its competitiveness by implementing modern management methods, using new technologies, or concentrating production on a larger scale. Parobek and Slašťanová (2020) analysed the competitiveness of the Slovak Republic in the sawmill sector and wood base panels production and came to the conclusion that positive forest industry contribution for the development of the national economy of the Slovak Republic lie the effective collaboration between other industrial sectors in an effort to maximize added value. Wood base buildings is one of the most important sector for forest industry from the increasing efficiency point of view. From an industry perspective, Finland is largely self-sufficient. Most of the wood raw material comes from domestic sources and in many cases the technology of domestic origin is also used.

5. CONCLUSSION

The bioeconomy is expected to be a leading paradigm in the forest-based sector in the coming years. Bioeconomy has been defined in various ways and, in the context of forestry, can be applied as utilizing forests to help economies to replace fossil materials. In this context, forests provide a wide range of environmental, social and economic benefits. The forest-based industry offers environmentally sustainable products that are made from renewable raw materials and provide alternatives to emission-intensive materials such as steel, cement and oil. Therefore, for a comprehensive knowledge of the impact of a different materials or its part on the environment, it is necessary to process an LCA analysis in scientifically recognized programs (Buryova Sedlak, 2021).

In Finland, the wood processing industry is one of the largest industries and a major contributor to economic prosperity. However, the woodworking industry does not play a major role in contributing to the economy. We can also observe a growing awareness of the bioeconomy in the Czech and Slovak Republics. According to our research, the problems come from the low domestic consumption of wood and the increasing export of wood. Both countries should focus in particular on the comprehensive use of wood raw materials, which would contribute to increasing added value and thus to the GDP growth. The forestry and timber sectors of the Czech and Slovak Republics have great potential for further development of value-added products and services for growing demand based on renewable natural resources.

Acknowledgements: The authors are grateful for the support of the Scientific Grant Agency of the Ministry of Education, Science, Research, and Sport of the Slovak Republic, Grant No. 1/0494/22 Comparative advantages of the wood based sector under the growing influence of the green economy principles and Grant No. 1/0495/22 Sustainability of Value Supply Chains and its Impact on the Competitiveness of Companies in the Forest and Forest-Based Sectors.

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IMPROVING ENERGY EFFICIENCY THROUGH ENERGY MANAGEMENT SYSTEMS IMPLEMENTATION - A CLUSTER ANALYSIS OF ISO 50001

Alena Pauliková, Jana Chovancová

Abstract: In the context of rising energy prices and the increasingly evident impacts of climate change, organizations are looking for ways to reduce energy consumption and improve their energy efficiency. One of the tools facilitating this effort is the newly revised ISO 50001 standard focusing on Energy Management. The present paper provides a comprehensive overview of the requirements of this standard using cluster analysis. The study's outputs can facilitate an organization's planning, implementation, and maintenance of energy management. The practical implication of this system to the wood processing industry highlights the opportunities for using renewable energy sources (e.g., biomass) and increases the circularity potential of this industry. We created a cluster containing the ISO 50001 standard for detailed analysis based on a harmonized structure. It includes mandatory requirements that define the obligation to document information and instructions for proper use. The cluster represents a comprehensive holistic model for energy management systems. While it is not limited to this one standard, it also allows adding other relevant energy or integrable standards such as ISO 9001, ISO 14001, and ISO 20121.
Keywords: cluster, energy, efficiency, EnMS, management systems, implementation.

1. INTRODUCTION

Energy in all its forms is a significant cost item for any organisation, including heating/climate, transporting goods and people, and manufacturing processes. It is also embedded in the costs of all procured products and services. Most of this energy originates in fossil fuels. However, several issues arise in relation to these energy sources. One is the rapid depletion of non-renewable resources, which is contrary to the principles of sustainable development. Another problem for organisations is the steadily rising energy cost, significantly affecting their competitiveness. Finally, there is the issue of the aggravating effects of climate change, which is driven by fossil fuel combustion in energy production.

Not surprisingly, many organisations are taking steps to reduce their dependence on fossil fuels, either by increasing their energy efficiency or replacing fossil fuels with renewable energy sources such as solar energy, hydro-energy, biomass, etc.

To help such organisations on their journey towards energy sustainability, the International Organisation for Standardisation promulgated “ISO 50001 Energy management systems – Requirements with guidelines for use” in 2011, amended in 2018. This standard enables organizations, regardless of size, sector, and/or geographic location, to improve their environmental performance through making better use of its energy-intensive assets and thus reduce both energy consumption and costs [15].

The present paper builds on the requirements of ISO 50001 and transforms them into a framework that allows managers to implement this management system easily and progressively, as well as to control and plan actions to improve the energy performance of the organisation.

For this purpose, analytical and visualization tools are used, including content analysis, cluster modeling and a Touch graph navigator. The outputs aim to contribute to more efficient implementation and auditing of the energy management system.

2. LITERATURE BACKGROUND

Many researchers ' focal points are energy production and consumption and their relation to climate change. Many studies show a positive relationship between energy consumption and the increasing amount of greenhouse gases - the main trigger of climate change [1]–[10] and propose policy measures for its mitigation.

However, all parts of society, from households to public institutions to the private sector, have an indispensable role in implementing these measures and achieving global climate protection goals (e.g., enshrined in the UN´s Agenda 2030 and Paris Agreement). Several studies have mapped the opportunities for organisations to improve their energy performance. Many focus on using ISO 50001 as a comprehensive tool to effectively implement an organization's energy management system (EnMS).

For example, McKane et al. [7] predict the impact of the introduction of ISO 50001 on climate change. According to their methodology, a scenario with 50% of projected global industrial and service sector energy consumption under ISO 50001 management by 2030 would generate cumulative primary energy savings of approximately 105 EJ and avoids emitting 6500 million metric tons (Mt) of CO_2 emissions.

Many studies deal with the application of ISO 50001 in different sectors. The industry sector is addressed in the study of Jovanović and Filipović [6], who propose a maturity model for energy management system based on the PDCA model and requirements of ISO 50001.

Using a case study of the implementation of EnMS in a cement company, Pelser et al. [10] demonstrate the benefits that this system has brought, with up to 25% savings in energy costs being one of the most significant.

The importance of introducing energy efficiency elements at the regional and municipal level is demonstrated in the study by Chovancová [3], highlighting the multiple social, environmental and economic benefits.

Several studies also map the benefits/benefits and barriers associated with EnMS implementation. Notable is a recent study by Fuchs et al. [5], who conducted a content analysis of 72 case studies of ISO 50001 implementation. The most frequently reported benefits were energy-related cost savings, productivity, and operational improvements. On the other hand, the primary barrier is lacking an energy management culture.

Despite numerous studies focusing on implementing EnMS, there is not yet a coherent and managerially effective overview of the requirements and documented information of the ISO 50001 standard in the literature. For this reason, the present article aims to analyse ISO 50001 requirements and provide their comprehensive visualisation to facilitate efficient and smooth implementation of ISO 50001 in an organization.

3. BUILDING OF CLUSTER FOR ISO 50001

The base is to table the summary for the management systems according to the ISO 5001: 2018 standard. Table 1 was derived from a detailed analysis of energy efficiency management systems. It depicts the PDCA cycle adapted to individual chapters of EnMS. The table, considered a summary table, allows for feedback control while compiling the visualization cluster.

Table 1. The PDCA cycle adapted to the main chapters of EnMS. (Source: [15] & Authors)

<table>
<tr><th rowspan="2">Phase of PDCA Cycle</th><th colspan="2">Standard ISO 50001:2018 EnMS</th></tr>
<tr><th>Chapters</th><th>Subchapters</th></tr>
<tr><td rowspan="15"></td><td rowspan="5">0 Introduction</td><td>0.1 General</td></tr>
<tr><td>0.2 Energy performance approach</td></tr>
<tr><td>0.3 Plan-Do-Check-Act (PDCA) cycle</td></tr>
<tr><td>0.4 Compatibility with other management system standards</td></tr>
<tr><td>0.5 Benefits of this document</td></tr>
<tr><td colspan="2">1 Scope</td></tr>
<tr><td colspan="2">2 Normative references</td></tr>
<tr><td rowspan="5">3 Terms and definitions</td><td>3.1 Terms related to organization (3.1.1 ÷ 3.1.5)</td></tr>
<tr><td>3.2 Terms related to management system (3.2.1 ÷ 3.2.5)</td></tr>
<tr><td>3.3 Terms related to requirement (3.3.1 ÷ 3.3.9)</td></tr>
<tr><td>3.4 Terms related to performance (3.4.1 ÷ 3.4.16)</td></tr>
<tr><td>3.5 Terms related to energy (3.5.1 ÷ 3.5.6)</td></tr>
<tr><td rowspan="2">4 Context of the organization</td><td>4.1 Understanding the organization and its context</td></tr>
<tr><td>4.2 Understanding the needs and expectations of interested parties</td></tr>
<tr><td colspan="2" style="display:none"></td></tr>
<tr><td>PLAN-></td><td rowspan="2">4 Context of the organization</td><td>4.3 Determining the scope of the energy management system</td></tr>
<tr><td>DO-></td><td>4.4 Energy management system</td></tr>
<tr><td></td><td>5 Leadership</td><td>5.1 Leadership and commitment</td></tr>
<tr><td>PLAN-></td><td>5 Leadership</td><td>5.2 Energy policy</td></tr>
<tr><td>DO-></td><td>5 Leadership</td><td>5.3 Organizational roles, responsibilities and authorities</td></tr>
<tr><td rowspan="6">PLAN</td><td rowspan="6">6 Planning</td><td>6.1 Actions to address risks and opportunities (6.1.1 ÷ 6.1.2)</td></tr>
<tr><td>6.2 Objectives, energy targets and planning to achieve them (6.2.1 ÷ 6.2.3)</td></tr>
<tr><td>6.3 Energy review</td></tr>
<tr><td>6.4 Energy performance indicators</td></tr>
<tr><td>6.5 Energy baseline</td></tr>
<tr><td>6.6 Planning for collection of energy data</td></tr>
<tr><td rowspan="8">DO</td><td rowspan="5">7 Support</td><td>7.1 Resources</td></tr>
<tr><td>7.2 Competence</td></tr>
<tr><td>7.3 Awareness</td></tr>
<tr><td>7.4 Communication</td></tr>
<tr><td>7.5 Documented information (7.5.1 ÷ 7.5.3)</td></tr>
<tr><td rowspan="3">8 Operation</td><td>8.1 Operational planning and control</td></tr>
<tr><td>8.2 Design</td></tr>
<tr><td>8.3 Procurement</td></tr>
</table>

CHECK	9 Performance evaluation	*9.1 Monitoring, measurement, analysis and evaluation of energy performance and the EnMS (9.1.1 ÷ 9.1.2)*
		9.2 Internal audit (9.2.1 ÷ 9.2.2)
		9.3 Management review (9.3.1 ÷ 9.3.4)
ACT	10 Improvement	*10.1 Nonconformity and corrective action*
		10.2 Continual improvement

3.1. Description of processual phases

The initial phase in the process is to build a central circle/unit of EnM standard. The second phase covers the cluster units according to the main chapters (see Table 1) of EnMS, (see Figure.) with 1st degree of separation (°sep). EnMS's standard chapters present the central part of the visualised cluster.

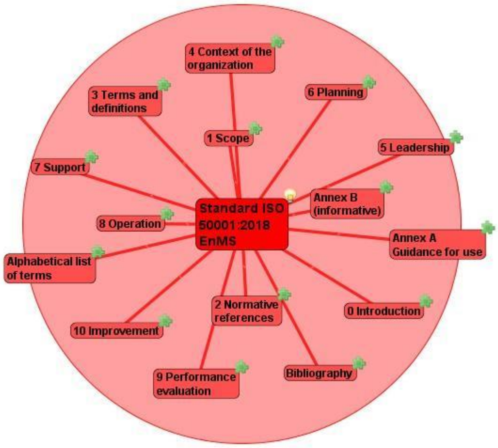

Figure 1. The central unit with ten essential chapters, two Annexes, A & B, a bibliography and an Alphabetical list of terms (Source: Authors)

Standard presented this way contains a set of ten chapters and two Annexes, A and B. The ISO 50001 and its parts, including chapters and subchapters (up to the third level of structuring), are linked by employing relations that differ in their thickness of lines, patterns, and colour.

The PDCA cycles are visualized through the orange diamond units: "PLAN, DO, CHECK and ACT" with the 2nd °sep. These units are connected according to their representation within the structure of EnMS, with an emphasis placed on the PDCA cycle. The unit PLAN is related to chapters 4, 5 and 6, the unit DO relates to chapters 4, 5, 7 and 8, the node CHECK is linked with chapter 9, and, finally, the node ACT is linked with Chapter 10. The subchapters of EnMS are shown, and then the sub(2) branches are activated in the 3rd °sep. [9].

If the organization plans to apply the EnMS, it must elaborate a list of all items needed for the required presentation of correct implementation [4]. These requirements are not highlighted in the document of standards. Implementers must search carefully for them in the text. The requirements are indicated by using the verbal form "shall".

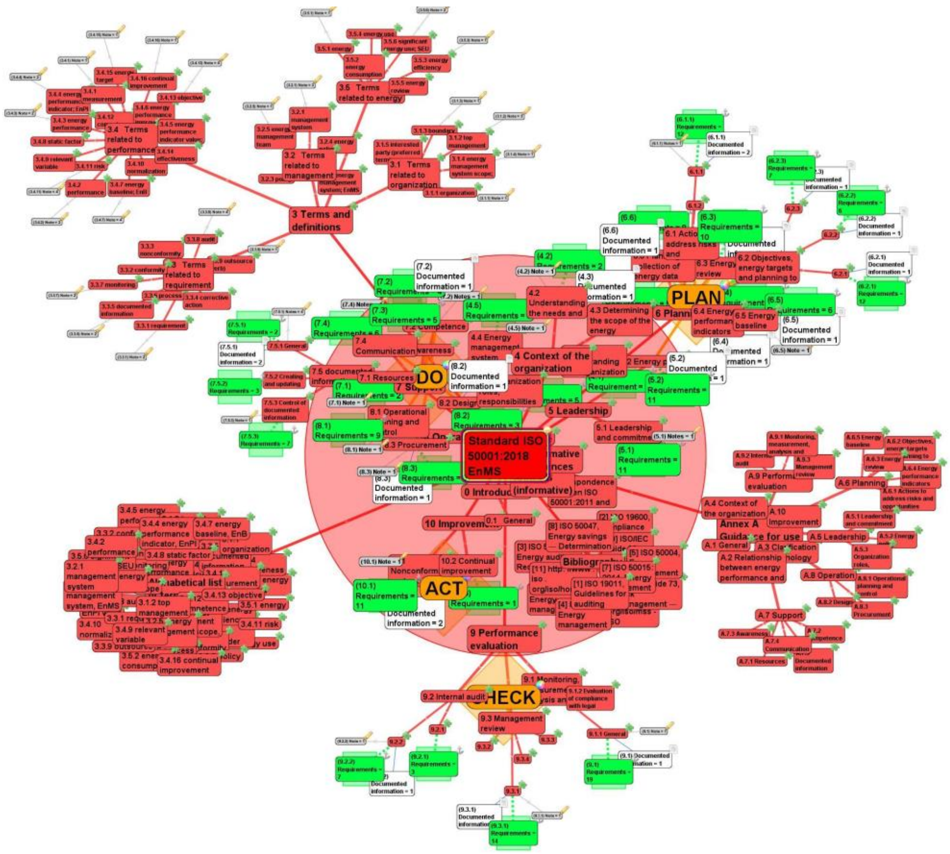

Figure 2. Visualised cluster EnMS with their requirements, and documented information (Source: Authors)

3.2 Requirements of ISO 50001:2018

The requirements illustrated in such a manner remain a core for managerial decision-making. During the building of the cluster, it is suitable to determine the "health condition" of the enterprise and the potential unconformities when performing Chapter 9 Performance evaluation and the Subchapter 9.3 Management review of ISO 50001:2018. The company determines which EnMS requirement is mandatory, and which is marginal. In the submitted visualization, all the requirements of EnMS are considered; see Figure 2 (neon green rounded square with the halo effect, anchor tags). These requirements will be selected for a particular organization regardless of its operational type (national or international) [8].

3.3 Documented Information of ISO 50001:2018

Additional requirement for the effective implementation of the EnMS is the submission of evidence in the form of "Documented information". For this reason, we considered it appropriate to include "Documented information" in the overall requirements. They are presented in Fig. 2 as rounded white squares with the text and number of the required information. As with the requirements, a set number of documented information is mandatory. If no evidence is submitted, according to the EnMS rules, the given fact is not meaningful, i.e., as if it did not exist.

One of the benefits of a visualized cluster is the possibility of rational insight into its structure. MSS implementers can, in a short time and quickly find out how many requirements they need to comply with during the audit process. It leads to less time spent on the implementation process and financial savings [8].

4.CONCLUSION

From the insight of visual management, it is noticeable that it is beneficial to study clusters and obtain an intelligent view of the EnMS structure. From this standpoint, it is further possible to create a newly expanded cluster, management systems standards groupings in the form of singlet, duplet twin, triplet, etc. These the management systems that have great potential to be visualized together with ISO 50001 are:

- EMS, Environmental management systems — Requirements with guidance for use according to ISO 14001:2015, recommended for the environmental protectors [9],
- QMS, Quality management systems — Requirements according to ISO 9001:2015, recommended for the producer of various industry sectors [2, 13].

Using suitable software, the final EnMS cluster offers more effective navigation through all chapters, subchapters, and sub(2)chapters, including related mandatory requirements and documented information. This ultimately shortens the implementation time since the requirements must be addressed only once during the process. By clicking on different visualisation areas, the cluster becomes more compendious and shows significant interactions in individual characteristics of the EnMS.

Acknowledgements: This article was written with the support of project No. KEGA 031STU-4/2020 “Network visualization of common and specific elements and documented in-formation of integrated management systems with respect to relevant ISO standards”.

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PRODUCTION OF ANTIQUE WOODEN FLOORS BASED ON THE PRINCIPLES OF CIRCULAR ECONOMY

Slavica Petrović

Abstract: At a time when there is extremely high pressure on all kinds of resources on Earth, the issue of product lifetime is becoming increasingly important. That is why the linear economy, which is based on the concept of using the product, and throwing it away, has long since begun to give way to the circular economy. The circular economy is not a new concept of business in the production of wooden floors. For many years, wooden floors have been made from antique wood, i.e. over a hundred years old wood. Antique wood originating from dilapidated housing facilities, barns, warehouses, military barracks is most often used for the production of floors. In addition, thanks to its technical characteristics, wood flooring can be repaired several times, which prolongs its lifetime. Being in accordance with the principles of the circular economy and raising the awareness of the population about environmental protection, antique wood floorings are nowadays better positioned on the market.
Keywords: antique wood flooring, reclaimed wood flooring, repaired wood flooring, circular economy

1. INTRODUCTION

The linear economy, which is based on the concept “take – make – waste” long ago began to give way to the circular economy, which is based on stopping waste generation (Ellen MacArthur Foundation, 2022). “In a world with growing pressures on resources and the environment, the EU has no choice but to go for the transition to a resource-efficient and ultimately regenerative circular economy” (European Commission, 2012). In the past decade, there has been a view that the circular economy is based on seven schools of thought, namely: industrial ecology, biomimicry, natural capitalism, regenerative design, cradle-to-cradle, blue economy and performance economy (Ellen MacArthur Foundation, 2022). The circular economy developed at the School of Industrial Ecology promoted generation of a minimum amount of waste in the production process and its use as a raw material for the production of new products. It also promoted the use of energy from renewable sources in the production process, and the lowest possible use of fossil fuels. Recent research (Saidani et al. 2020) raises a question of whether the circular economy and industrial ecology are separate concepts, or entities without clear boundaries and standardized definitions. Today, the circular economy is based on three basic principles, namely: designing out waste and pollution, keeping products and materials in use, and regenerating the natural system (Ellen MacArthur Foundation, 2022). This means that circular economy today is primarily committed to preventing the generation of waste in the production process and maximizing the utilization of raw materials. Therefore, circular design “whose main goal is to create long-lasting and quality products whose lifetime is fully controlled”, has a very important role in the process of raw material processing (Matić, 2019). According to the second principle of the circular economy, materials must be kept in use, and for wood products, this is achieved through the technical cycle. It means that the products are repaired, re-produced and only finally recycled. The position of the World Economic Forum (2022) is that, “in a properly built circular economy, one should rather focus on avoiding the recycling stage at all costs. It may sound straightforward, but preventing waste from being created in the first place is the only realistic strategy".

At a time when the effects of climate change are maximally expressed environmental protection and pollution reduction are humanity's survival issues. Therefore, one of the roles of the circular economy is to raise public awareness of the importance of ecology and environmental protection. Wood is a natural renewable material that has a special significance and advantages over other types of raw materials used in flooring production. Wooden floors are subject to various European environmental certification schemes, such as the German "Blue Angel", the Nordic "Swan" and the Austrian "UZ 37" (Petrović, 2016).

The extent to which the circular economy is important for today's business is shown by the fact that the British Institute for Standardization developed the first standard for the circular economy marked BS8001:2017- Framework for Implementing the Principles of the Circular Economy in Organizations – Guide. The standard is applicable to any organization, regardless of its location, size, sector and type (BSI 2022). "It does not contain requirements that must be met, which means that it is not possible to claim compliance to the standard or undertake some form of certification to it" (Pailiuk, 2018).

2. MATERIALS AND METHODS

The collection of information and data analysis in this paper were performed by conducting an office research of the global wood flooring market. The methods used for the purposes of this research are general scientific methods, such as the historical method, induction and deduction, synthesis and generalization and the content analysis method. The subject of research in this paper are antique wood floors. In accordance with the principles of the circular economy, the research was conducted with the aim of raising the awareness of the population of the possibility of prolonging the lifetime of old wooden floors.

3. RESULTS OF RESEARCH

"Wood that is a minimum 100 years old is considered "antique." Once this antique wood is salvaged and applied to a new use, it is referred to as "reclaimed" wood (Log&Timber Home Living, 2022). Antique, i.e. reclaimed floors are made of wood whose original purpose was changed, by turning it into floors. The raw material for the production of such floors are wooden beans from roofs or other constructions from old and dilapidated residential buildings, barns, warehouses, military barracks, doors from such buildings and even old wine barrels (Log&Timber Home Living; Tennessee Wood Flooring 2022). The most important phase in the process of an antique wooden floor production is finding the raw material. Further, manual inspection and manual removal of nails and other metal parts from the raw material is the next phase in the production process of antique wooden floor. The raw material is then stacked, separating each plank of wood with smaller blocks of wood to alleviate moisture and create air for the materials to breathe, and then prepare it for the kiln (Real Antique Wood, 2022). The raw material is then dried in the kiln in order to achieve optimal moisture in the wood for floor production and eliminate insects in case they are present in the wood. The raw material is then processed with special attention paid to the treatment of the upper wear surface of the floor, in order to preserve its authenticity and traces of time. Nail holes, cracks, insect damage, discoloration, various dents as traces of use, together with the patina present on the antique wood give the floor a rustic appearance (Figure 1). As the manufacturers themselves say, every piece of the antique wooden floor produced in this way brings a part of history into the building. The surface treatment is also very important in maintaining the rustic look of the floor. Therefore, certain manufacturers apply air-drying of organic oiled finishes that takes up to 12 hrs between two coatings (Reclaimed Flooring CO, 2022). In this way, the oil penetrates deeper into the wood making it, more resistant. In addition, manufacturers avoid UV drying of hard wax oils because the top surface of the floor then becomes too shiny making the floor resemble a laminate floor.

In Europe, antique floors are most often made from oak, beech, pitch pine, maple, ash, elm, exotic tree species, and in North America also from cypress and chestnut (Ted Todd; Olde Wood Limited; Country Wood; Carlisle Wide Plank Floors 2022). The use of exotic tree species is of special importance, if it is known that some of them are on the list of the ten most endangered tree species in the world, the felling of which is prohibited today. Panga-Panga, Muhuhu, Mninga, Keruing, Iroko, Jarrah, Knotty Pine, Merbau, Ghanian Mahogany are some of the exotic tree species that are used for the production of antique floors (Antique Wooden Floor 2022). Since the amount of raw material on the market of a country is limited, it is also the subject of international trade (The British Wood Flooring Company, 2022). Maple is imported to Europe from Canada, oak, pitch pine and Douglas Fir from North America, Jarrah from Australia, Iroko, Sapele and Wenge from Africa (Ted Todd, 2022). Websites of some manufacturers of antique floors state the origin of the wood they use in production (the name of the palace or city where the wood they use in production comes from, as well as its age) (Reclaimed Flooring CO, 2022). Since the amount of available raw material is a limiting factor, manufacturers usually do a small number of projects per year to produce and install antique floors (Antique Wooden Floors, Countrywood 2022). Raw materials of various shapes are used for the production of antique wooden floors, which is the reason why floor elements do not have standardized dimensions. Therefore, the lengths and widths of elements within a single wooden floor can be different (Real Antique Wood, 2022) (Figure 1). The price of an antique floor depends on the dimensions of the elements, wood species, the type of surface treatment, as well as the age of the wood. Manufacturers do not specify the prices of antique wooden floors on their website, but they are available upon request. There are no official data on the annual production of this type of wooden floors on the world market.

The use of antique wood for the production of floors does not only have a sentimental value, but also reduces the volume of felling in the world. In addition, wood that has been in

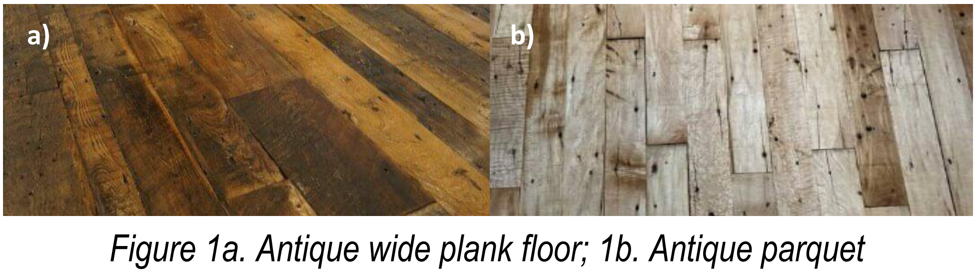

Figure 1a. Antique wide plank floor; 1b. Antique parquet
(Source: Real Antique Wood, 2022; https://realantiquewood.com/reclaimed-wood-flooring/)

use for years or centuries reacts less to changes in humidity and is therefore more stable. Some manufacturers in Europe believe that it is necessary to use at least two centuries old wood for the production of antique floors, because it is a long enough period of exposure of wood to changes in humidity and temperature, after which it becomes stable (Reclaimed Flooring 2022). “Reclaimed woods have a tight grain due to years of use. This makes reclaimed flooring extremely hardwearing and durable“(Ted Todd 2022).

Engineered floors are also manufactured from antique wood, in a way that the wood is attached to the plywood board. The upper wear layer of the engineered floors is manufactured from antique wood, and can be from 4 mm to 7 mm thick, while the plywood board has 5 to 9 layers of veneer. In this particular case, the engineered floors are produced of 7 mm thick wood and 12 mm thick birch plywood (Countrywood 2022). Engineered floors are manufactured as wide planks or parquet stacked according to a certain pattern, or mosaic parquet when the parquet elements are stacked in panels (Figure 2).

One should be careful when buying antique wood flooring and antique engineered flooring, because manufacturers also use the word “antique” for a floor that is not produced of old wood. When used in a different sense, the word “antique” denotes the floor grade which only resembles the floor produced of old wood (UK Wood Floors 2022). Manufacturers achieve this by surface treatment, artificially creating a patina on the wood. In addition, these floor elements are intentionally mechanically damaged after production to make the wood look as if it was already in use (Armony Floor 2022). “Hand scraping and distressing produce marks one might have found on a floor crafted by artisans many years ago” (Rustic Hardwood Flooring 2022). For this purpose, a special machine with serrated rollers is used, under which the floor elements are passed. Depressions are formed on the wood due to the direct contact of the dented rollers and the floor elements. The lack of such intentional damage is the regular distribution of indentations on the floor elements, based on which it is easy to recognize that they were made by machinery.

Repairing of wooden floors is not a procedure that has been in use since recently, but the development of the circular economy has stimulated the demand for such floors and increased

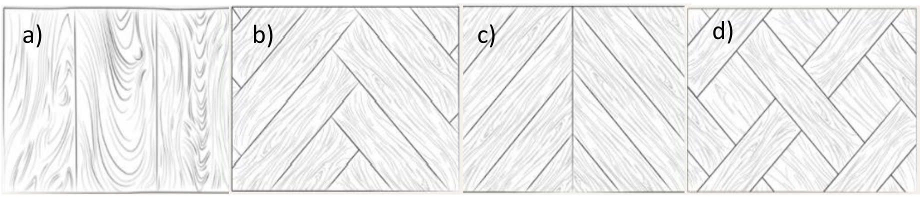

Figure 2. Antique engineered wood flooring: a) planks; b) parquet “Herringbone” pattern; c) parquet “Chevron” pattern; d) mosaic panel
(Source: Reclaimed Flooring CO. 2022 - https://www.reclaimedflooringco.com/product/18th-19th-

their value for customers. Antique repaired wood floors are products that have always had the same purpose during their lifetime. As a rule, if they are antique it means that they are older than a hundred years. If the buildings where antique wooden floors are installed have lost their function, the floors are removed, repaired and resold on the market. Thanks to that, a wooden floor from the 18th, 19th or 20th century can be bought on the world market today. Figures 3 a, 3 b, 3 c and 3 d show an antique repaired mosaic parquet dating from the 18th century. Figure 3 a shows a parquet from the Bohemia Palace, made of oak and spruce wood, with mosaic boards' dimensions of 58x58x2.5 cm. Figure 3 b shows a mosaic parquet originating from a palace in southern Bavaria, Germany. The mosaic board is made of oak and maple, and its dimensions are 63x63x3 cm. Figure 3 c shows a mosaic parquet originating from Piedmont in Italy. The mosaic board is made of walnut. Figure 3 d shows oak Versailles parquet, originating from Strasbourg, in France. The boards are available in dimensions 110x110x4 cm, 96x96x3 cm and 94x94x3.5 cm (Souce: Antique parquet, 2022).

4. CONCLUSION

At a time when a lot of pressure is put on all types of raw materials, in accordance with the principles of the circular economy, we are striving for extended lifetime of a product. Wooden floors are a true example of a product to which the above can be applied, and that can be done in two ways. The first mode is the production of antique wooden floors, while the second one is concerned with the repairs of old wooden floors. Antique floors are made of wood, which is over a hundred years old and comes from roofs or other constructions in old and dilapidated residential buildings, barns, warehouses and military barracks. In addition to antique floors, another type of floors made from antique wood are engineered antique floors. Thanks to its technical characteristics, an old wooden floor that was once in use can be repaired i.e. planed and re-treated, and then re-used in the same way for a long time. Owing to that, today we can buy a wooden floor produced in the 18th, 19th or 20th century.

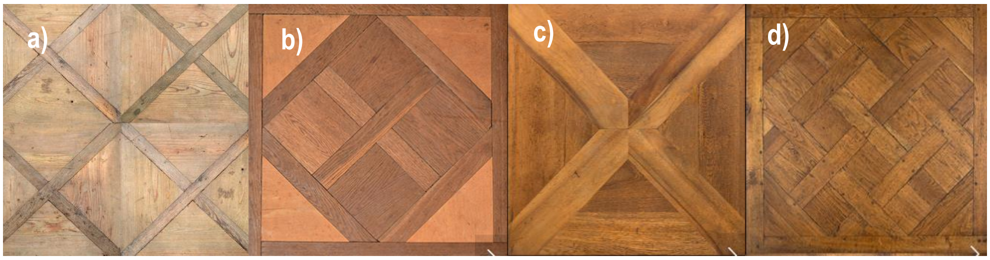

Figure 3. Antique repaired mosaic parquet (Source: Antique Parquet, 2022; https://antique-parquet.com/18-century)

Acknowledgements: This paper represents part of an ongoing research project supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia – Agreement on financing the scientific research work in SRO 2022, registration number 451-03-68/2022-14/2000169 dated 17.01.2022.

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INVESTMENT IN HUMAN CAPITAL AS A GUARANTEE OF THE COUNTRY'S ECONOMIC DEVELOPMENT IN WOODWORKING INDUSTRY

Olena Plaksiuk, Renata Nováková, Eva Habiňáková

Abstract: People endowed with knowledge, education, skills and experience are the guarantee to the development of economic and technological potential of the economy and society as a whole. The competitiveness of modern production and the national economy in general depends on the efficient use of available human capital. The knowledge, skills and information that a person possesses are used repeatedly and do not wear out over time, but only become of great value due to experience and strengthened entrepreneurial potential. The modern economy, based on knowledge, already has a scientific basis for comprehensive research of human capital and knowledge management, taking into account the methodology of effective investment decisions. The role of human capital will only grow in the future, so the issue of investing in human capital as the main source of development of the national economy, quality of work and life of the population remains particularly relevant. The purpose of the article is to study the relationship between investing in human capital and the efficiency of the economic system.
Keywords: enterprise; human capital; human resources; investment in human capital, costs, effectiveness, national economy, education.

1. INTRODUCTION AND METHODS

Economic and political crises, depletion of natural resources and other negative effects in the country force entrepreneurs to look for production reserves, rational use of material resources and production capacities, apply innovations and increase the share of human labour in the products produced. As a result, scientists are paying increasingly more attention to the study of human capital, its formation, development, reproduction, preservation and implementation. Therefore, the decisive factor for the effective functioning of any company is human capital, which is its wealth, one of the highest values, the key to leadership, competitiveness and progressiveness. The issue of the formation and use of human capital has received a great deal of attention among scientists in the long term. Karl Marx's scientific contributions reflect the nature and role of capital, its impact on human life, and the relationship between hired labour and capital. The representative of neoclassical theory of capital A. Marshall claims that "human capital is defined as the part of its wealth allocated for income in the form of money" [8] and adds that "intangible benefits of people are divided into two groups. One of them is its own qualities – business skills, professional skills, etc. All these benefits are inside the man himself and therefore called interior. The second group includes benefits called external as they include relationships positive both for an individual and many people. Examples of such relationships should be look for in the reputation and business relations of businessmen and independent workers"[8].

In their judgments, scientists have come very close to concepts such as "human and social capital." Significant contributions to the study of human capital formation present famous scientists such as J. Coulman[5], T. Schultz [15], J. Minzer [13], G. Becker [1], P. Bourdieu [3], L. Thurow [17], S. Fischer [9], O. Zacharova [20]. In particular, Schultz believes that in countries seeking development, economic growth is achieved not only through technology transfer, investment in physical capital and the accumulation of knowledge. Economic growth depends on human capital in another sense: on improving people's health, reducing crime, appropriate social climate and institutions and education [4].This definition can be interpreted from two positions, i.e., income and investment. From the perpective of income L. Thurou states that "human capital is the ability of people to produce objects and services" and Fischer's interpretation says that "human capital is a measure of a person's ability to generate income."

According to the System of national accounts [6] of the Ministry of Economy and Social Affairs of the United Nations it is set that the investment into human capital is identical to the investment into basic capital as it increases human productive potential and thus it is a source of economic benefit.

We believe G. Becker's approach is more productive. In his works he sticks to investment position: "Human capital is created by investment into people including education, professional training, health care costs, migration, search for information about prices and incomes"[2]. In general, the combination of these two positions provides the basis for modelling the analytical approach to the human capital assessment. Following the research by O. Zakharova [19], the process of such assessment should be continuous and consist of progression of mutually related phases where each of them has its own specific implementation. At the same time, in the absence of sophisticated tools and appropriate methods for determining the evaluation of investment in human capital, as well as insufficient level of information support, such a procedure is relatively time consuming and complicated and the results obtained have a low level of information, which significantly reduces the employer's economic interest in continuous professional development and health of workers and consequently leads to a gradual reduction in investment in human capital [19].Under such conditions, it is important to assess the impact of investing in human capital on the economic development of business and the country as a whole.

2. RESULTS AND DISCUSSION

The development of a country's economy directly depends on the formation of quality national human capital. Only experienced professionals can be the driving force behind positive change both in the company and throughout the country. Recognition of a person as an object of economic activity provides an opportunity to assess investments in human capital in terms of profitability and efficiency of investing in human resources on the macro level. Therefore, we agree with the opinion of scientist S. Dyatlov that human capital is a supply and flow of knowledge, skills, experience, culture, motivation, which are used productively, bring income to man, enterprise and society as a whole [7].

The formation of human capital is the process of creating a person's productive abilities by investing in specific processes of his life. In this case, the investment is made in two ways: as an investment of funds and resources and as a waste of time and effort, i.e., as certain types of human activity [18]. O. Martsinkovska [11] proposes to classify the cost of human capital first, natural (all costs necessary for physical formation and human development) and intangible (accumulated costs on education and training, part of the cost on health and labour mobility); second, to expressed in humans and not expressed. "There is a deep internal dependence and interaction between human capital and production, tangible and intangible: production determines the need for specialists at various levels from workers and engineers to managers, and these specialists implement their knowledge and skills in the process of productionand transform them into real human capital "[6].

The need for human resources can be assessed in accordance with the economic activity of the employees involved in the work.

Table 1. Working people according to economic activities in Slovakia between 2016 - 2020

Year	2016	2017	2018	2019	2020	2020/ 2016
Working people according to economic activities, in thousands of people						%
Economy in total	2 492,1	2 530,7	2 566,7	2 583,7	2 531,3	1,57
A Agriculture, forestry and fishing	72,0	68,6	58,9	72,0	65,3	-9,31
B Mining and quarrying	11,0	12,6	12,0	8,8	7,6	-30,91
C Industrial production	610,3	623,6	629,4	635,9	633,9	3,87
D Supply of power, gas and cold air	29,7	32,3	30,9	29,4	30,9	4,04
E Water supply, wastewater treatment and disposal	28,2	27,8	24,7	22,6	23,6	-16,31
F Civil engineering	229,4	244,2	240,5	235,9	229,1	-0,13
G Wholesale and retail, repair of motor vehicles and motorcycles	310,5	294,5	312,8	306,5	307,2	-1,06
H Transport and storage	163,6	161,4	175,0	174,3	161,0	-1,59
I Accomodation and food services	113,9	105,4	110,7	107,9	94,6	-16,94
J Information and communication	67,0	66,8	67,6	76,6	92,9	38,66
K Financial and insurance activities	46,8	51,9	51,2	54,7	54,5	16,45
L Real estate activities	16,2	16,1	16,4	15,1	16,0	-1,23
M Professional, scientific and technical activities	79,0	87,8	78,8	90,7	83,8	6,08
N Administration and support services	59,9	64,5	63,2	59,9	55,6	-7,18

O Public administration and defence, compulsory social security scheme	222,4	224,3	229,4	216,8	219,1	-1,48
P Education	177,0	184,1	186,9	200,0	193,6	9,38
Q Health service and social help	181,5	191,6	201,0	198,1	191,5	5,51
R Art, entertainment menie and relax	34,1	36,5	36,8	36,7	34,1	0,00
S Other activities	36,5	34,5	36,3	37,7	32,9	-9,86

[source: http://datacube.statistics.sk/]

In Slovakia, the employment situation is rapidly deteriorating in areas of economic activity such as: mining and quarrying (-30%), agriculture, forestry and fishing (-9.31), accommodation and food services (-16.94%), water supply, wastewater treatment and disposal (-16.31).Instead, the share of human resources in the highly innovative Information and Communication sector grew rapidly (+ 38.66%).There are obvious structural imbalances in the labour market, conditions for productive employment are lacking in almost all sectors of the national economy, a high share of non-professional jobs is maintained and most people are engaged in the simplest jobs. Forestry plays an important role in the country's economy. According to statistical studies, this industry is a profit for the country, although it has been on a declining trend over the last five years (Chart 2).

Table 2. Main indexes of economic activities in forest industry

Efficiency index	Unit of measure	2016	2017	2018	2019	2020	2020/ 2016, %
Sales and revenues	mil. EUR	508,26	532,71	1105,05	968,07	865,81	70,35
Wood sales	mil. EUR	433,15	440,84	487,27	425,20	332,79	-23,17
Other sales and revenues	mil. EUR	75,10	91,87	617,78	542,87	533,02	609,75
Total production costs	mil. EUR	463,53	488,26	1064,43	939,45	840,30	81,28
Economic result (profit, loss)	mil. EUR	44,59	44,45	40,62	28,62	25,51	-42,79
Total state aid	mil. EUR	24,38	51,55	38,40	36,80	39,44	61,77
State aid for forestry activity	mil. EUR	1,31	2,08	5,80	5,96	4,49	242,75
State aid for investments	mil. EUR	4,69	36,24	19,72	8,79	7,87	67,80
Write-off	mil. EUR	27,33	37,26	48,96	53,23	50,97	86,50

Total personal costs	mil. EUR	124,53	131,02	219,12	226,12	153,75	23,46
Labour costs	mil. EUR	85,72	87,19	149,20	150,73	96,11	12,12
Investments in total	mil. EUR	60,64	39,60	48,14	60,87	39,16	-35,42
Investments – building part	mil. EUR	32,54	21,67	21,03	24,68	6,89	-78,83
Investments– machines and equipment	mil. EUR	26,12	10,53	24,25	33,18	24,88	-4,75
Average monthly wage	EUR	1 004,0	1 032,0	980,0	1 084,0	1 022,0	1,79
Workers together– recalculated state	persons	7 139	7 041	17 966	17 868	16 810	135,47
Workers – recalculated state	persons	2 696	2 826	12 698	13 434	13 084	385,31

Forestry faced not only the problem of physical depreciation of fixed assets (depreciation - +86.5), but also the problem of obsolescence of production facilities and equipment in general. Over the last five years, investment in tools and equipment has fallen by 35.4%. In general, the industry is supported by the government because it is quite expensive and requires large investments in maintenance and development. Human resources play a relatively important role in industry. The number of people involved in forestry has increased by more than 100 percent due to a significant increase in the number of workers. The average wage for the period was increased by 1.79%, which exceeds the increase in profit. In this case, it is appropriate to pay attention to labour productivity, which decreased in 2020 (1517.55 euros) compared to 2016 (6245.97 euros) by 75%. For the efficient functioning of industry, it is necessary to keep the trend of increasing labour productivity above the growth of average wages. However, it would be wrong to say that there is only a direct link between investment in human capital and productivity, which leads to some increase in corporate profits and average wages. The level of productivity and profitability is also affected by other factors, which include: the presence of certain innate and acquired skills, employee loyalty to their own development and entrepreneurship, corporate culture, the formation and validity of social motives to achieve goals, prestigious jobs, prestige professions, higher wages and others. The quantitative impact of each of these factors is difficult in most cases, so in order to minimize the cost of determining this impact, indicators should be chosen to fully assess the level of quality and productivity of a particular employee, which occurred directly as a result of investing in human capital.

The wood processing industry is also an important part of the integration of the national economy into global areas of added value. The presence of significant raw material potential and relatively cheap skilled labour creates a competitive advantage for Slovakia on the foreign market of wood products. Slovakia is the eighteenth largest exporter of wood products in Europe and Central Asia. At the beginning of 2020, the volume of Slovak wood products, according to the World Bank, was close to the average (2.84). Slovakia overtook world exporters such as China (1.7), United States (2.24), Germany (2.51), France (2.11), Spain (2.36) and Bulgaria (2.44) and was slightly lower than the Russian Federation (3.05). Slovakia has a strong raw material potential for the development of the wood processing industry. However, it is not fully used due to the existence of a number of barriers associated with the imperfection of the competitive business environment, which is reflected in particular in the absence of a strategic vision for the development of the wood processing industry. As a result, the practice of achieving maximum effect in the short term and the reluctance of producers to introduce innovations into the production process have become established in the domestic market for wood processing products. In connection with the specifics of wood processing companies and the production of wood products, we propose to identify the following key ways to increase the efficiency of the economic activity of timber companies:

1. optimization of the use of the company's work resources due to high specialization and lack of qualified personnel in production,
2. optimizing the use of tool and objects of work in the company's prodsuction, financial and investment activities via creating a data system to provide control in the complex process of wood processing which includes the use of indicators characterizing working time and the amount of simultaneously used tools, taking into account employees remuneration.

Due to this, effective communication between the government, science and business must be a prerequisite for the creation of state strategic programmes for the development of the wood processing industry in Slovakia. In this context, the definition of key areas for the development of promising wood processing industries should be based on thorough analytical studies of existing trends in this segment of the domestic manufacturing industry, as well as scientific justification of ways and methods to maximize available raw materials and labour potential.

The experience from the economically developed countries of the world shows that investing in human capital, even in small amounts, makes it possible to obtain a much higher economic return in the long run than substantial investment in the technical development of companies. The achieved level of economic development of the country is largely determined and formed by ensuring the expected rate of economic return from all available investment costs in the innovative development of production. The key component of such costs is investment in human capital, the implementation of which should, in the long term, contribute to the sustainable provision of a highly skilled, experienced and motivated labour force for enterprises. Reaching a high level of innovative development can be achieved by ensuring a long-term continuous and intensive process of accumulation, increase and retention of human capital in the form of professional knowledge, skills, abilities and health of employees. At the same time, the rational use of investment costs focused on the professional development of employees can be ensured by planning and justifying economically feasible types and volumes of investments in human capital, taking into account the specifics of the investment process.

3. CONCLUSION

The country can achieve a high level of economic and innovative development, provided that it ensures a continuous and intensive process of accumulation, increase and retention of human capital in the form of professional knowledge, skills, abilities and health of workers. Rational use of investment costs focused on professional development of employees can also be ensured by planning and justifying economically feasible types and volumes of investment in human capital, taking into account the specifics of the investment process. Investments in the professional development of employees should be made on a long-term basis and to a sufficient extent, which will create a basis for highly effective activities in the near future and contribute to the rapid implementation of strategic objectives. Moreover, the condition must be met that the professional level of each employee of a company increases at the same time with the changes in market demands, employment or technological requirements of the production for a qualification of a person holding certain position or working in a certain workplace. At the same time, an uncontrolled and economically unjustified process of investing in the professional development of employees can reduce the expected positive results of the investment return in human capital and even significantly reduce the level of employee motivation. It is appropriate to perform a more thorough critical analysis of the selection of economically acceptable types of investment in human capital and the implementation of measures to optimize investment flows that direct the state or the company to the professional and personal development of people. In addition, techniques that are successfully used in the conditions of western companies cannot always be fully transferred and used in Slovakia.It is therefore necessary to study in more details the nature of any existing model for evaluation of investment in human capital in order to determine the appropriate scope for its practical application in enterprises, government agencies and educational institutions, taking into account social, economic and industrial activities.

Acknowledgements: We wish to thank project KEGA č. 012UCM-4/2020 – System applications of foresight processes in the new study programme Safety Engineering

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INFLUENCE OF THE DOMESTIC MARKET ON THE ECONOMIC RESULTS OF THE FURNITURE ENTERPRISES IN BULGARIA

Radostina Popova – Terziyska, Elena Stefanova

Abstract Markets are one of the classic localization factors, whose importance will grow due to the rapid development of transport and communication systems and the growing opportunity for furniture manufacturers around the world to offer their products through their own stores, through specialized retail chains or in the form of individual orders. Bulgarian furniture companies are in a favorable position on the domestic market due to the lack of significant transport costs, good knowledge of needs and the ability to work on an individual basis. A significant part of the furniture manufacturing enterprises in Bulgaria are small and their presentation on the international markets is more complex and expensive than their positioning on the domestic market. This gives reason to expect that the state of the internal market could be a significant factor in the economic results achieved. In this article are selected and substantiated indicators for assessing the state of the domestic market by district and the country as a whole, as well as the economic results achieved by furniture manufacturers. For a period of nine years (2012-2020), the dynamics of the indicators characterizing the potential opportunities on the market have been studied. The strength of the connection between the considered factors and the achieved result of the enterprises by districts is studied. Summaries and conclusions have been made about the possibilities for optimizing the market strategy of enterprises to achieve better economic results.
Keywords: internal market, furniture production, regional features, localization

1. INTRODUCTION

The globalization of the world economy has opened new perspectives for furniture manufacturers in Bulgaria. High standards in the European Union countries significantly increased the requirements for serialization and competitiveness and not every company can meet them. The furniture manufacturing companies in Bulgaria are of predominantly small and medium size therefore they face serious challenges when they have to enter the foreign markets. Therefore, in the accumulation of experience and capital needed to expand production to the necessary threshold, the internal market remains of top priority. The local manufacturers tend to know the national traditions, have local raw materials at their disposal, which are relatively cheaper than the imported raw materials due to low transport costs. They can produce unique furniture, take individual orders and then assemble and maintain this furniture. They can also easily present their products to local fairs and exhibitions. These considerations give them certain advantage in the domestic market over foreign furniture companies. This gives us a good reason to pay attention to the characteristics of the market and to determine the extent to which the Bulgarian furniture manufacturers benefit from these objective advantages.

The purpose of this study is to identify how strong is the link between the state of the internal market and the economic performance of furniture manufacturers. The obtained results can be used in production and marketing strategies, as well as to meet the requirements for sustainable regional development.

2. THEORETICAL FOUNDATIONS OF THE STUDY

The markets have been mentioned as a factor in the localization of industrial production in the distant past. "As early as 1900, a study of 12 industrial centers in the United States identified seven factors that determine the location of production: proximity to raw materials; proximity to markets; the possibility of using hydropower; climate; availability of labor force; availability of capital; influence of the productions already located in the given point" (Pchelintsev,1996 and 8. Tonkova, 2002). Proximity to the markets was crucial due to the relatively poor development of the transport systems.

Today, proximity to the marketplace continues to be an advantage, although not that important, especially in cases where the product is compact, uniform and highly transportable, which cannot be said for much of the furniture. Considering the evolution in the development of the Regional Economy science, D. Konakchiev points out that “Two other remarkable contributions of R. Toman and William Miller should be noted. Toman mainly works on the problems of the territorial location of production facilities. (Konakchiev, 2003)

To the classic factors for localization - capital, land, labor and management - he adds the volume, state and trends in market development, transport factors and government policy. "In their publication Andreev, A.V., L.M. Borisova and Z.V. Pluchevskaya emphasize the connection between the absorption capacity of the market and the efficiency of economic activity in the region. (Andreev, Borisova and Pluchevskaya, 2008) Rather they refer to the opposite, i.e. the increase in the purchasing power of the population due to the existence of efficient enterprises in the region. In order to clarify the range of factors and factor dependencies in the localization process, Professor L. Georgiev (Geneshki, Georgiev, 1995) refers to the classification of Prof. M. Geneshki, which includes the territorial factors and the sale of finished products (consumption and related transport costs). The author adds four new factors to this classification, including "local demand - formed by the demand for non-transportable products of a given production activity within the localization environment."

The transportation of furniture differs from transportation of other wood products such as parquet, doors, windows, etc., but the production, for example, of custom-made kitchen furniture is closely related to the needs of the area located nearby the furniture company. Tsv. Stoencheva also pays attention to the absorptive capacity of the market, emphasizing that "it is determined by the number and age structure of the population, its purchasing power and the type of settlement." (Stoencheva, 2010)

3. RESEARCH METHODOLOGY

Graphical representation of the dynamics of some factors influencing the absorption capacity of the internal market and correlation analysis in statistics have been used, assessing the direction and strength of the relationship between factors and economic results achieved by furniture manufacturers (revenue of enterprises, gross operating surplus and operating income). Pearson's correlation coefficient (Radilov, 2017) have been used for this purpose, due to its more universal nature. Exhaustive NSI data were used. To assess the factor conditionality of the achieved economic results of furniture manufacturing companies, information for one initial year and for several years at the end of the period 2012-2020 have been used to reveal the evolution of the relationship, if any, and mainly in the last years of the period. Graphic images and computational procedures are implemented using automated algorithms or built-in functions in Excel.

4. RESEARCH RESULTS

Figures one to four show some factors that largely shape the absorption capacity of the domestic market in Bulgaria in the period 2012-2020. The figures were developed by the authors based on data from the official NSI website. The stable macroeconomic environment, the currency board and the membership of our country in the European Union apparently create preconditions for a systematic increase in the absorption capacity of the internal market.

Purchasing power is not evenly distributed across different social groups, but national traditions of people living in close kinship and helping each other throughout life suggest that new furniture can be bought not only by high-income employees but also by their closest relatives. In addition, significant amount of money is received from people working abroad. The graphs clearly show that GDP per capita has been growing steadily over the period under review.

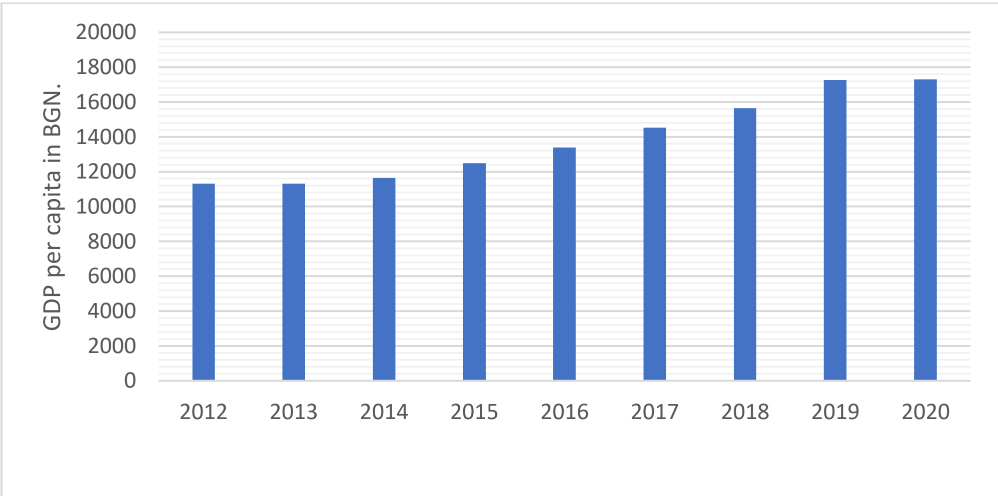

Figure 1. Dynamics of GDP per capita for the country in the period 2012 - 2020 according to NSI data

The number of newly built homes is also growing steadily. The total number of dwellings in the territorial aspect is also related to the need for furniture for renovation and refurnishment, but their dynamics is not presented, as their large number changes insignificantly as a result of new construction within a year.

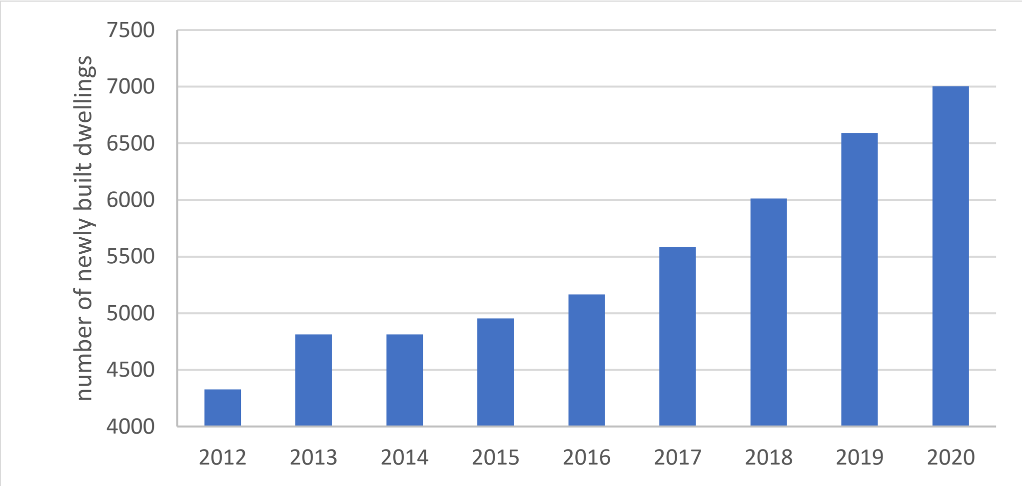

Figure 2. Dynamics of the number of newly built dwellings in Bulgaria in the period 2012 - 2020 according to NSI data

There has been some decline in the number of employees at the end of the period, but this can be attributed to the travel restrictions related to the impending Covid 19 pandemic and the closure of some of the world's leading economies, which led to a shortage of key raw materials for production which also affected Bulgaria.

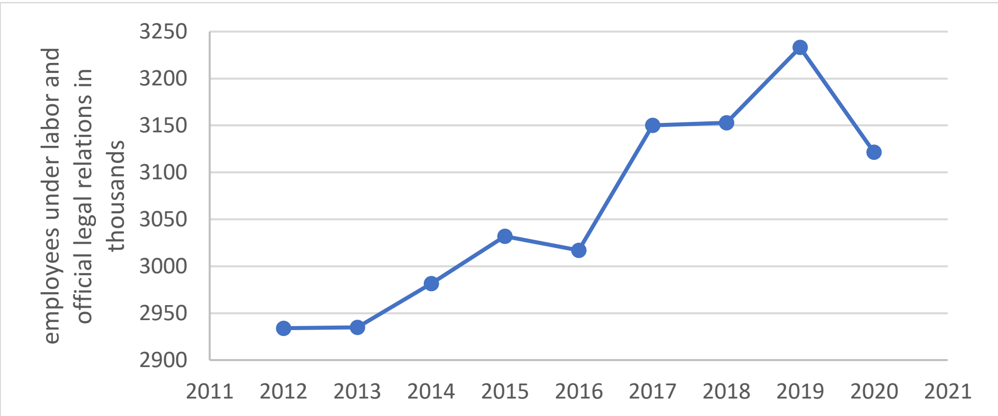

Figure 3. Dynamics of the number of employees by labor and official legal relations in Bulgaria in the period 2012 - 2020 according to NSI data

The average wage is steadily rising, which in the conditions of low inflation is a prerequisite for improving the living standards of the population.

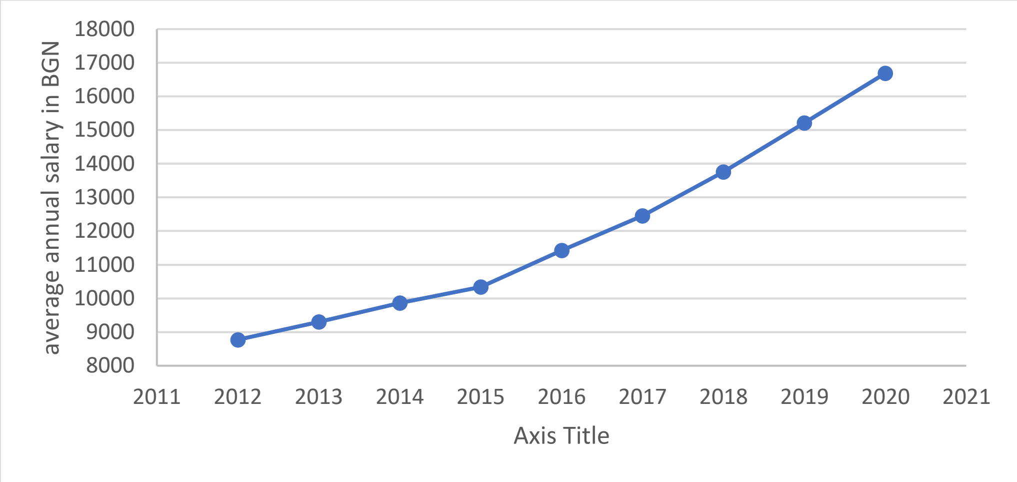

Figure 4. Dynamics of the average annual salary of employees during the period 2012 - 2020 according to NSI data

The economic results of furniture manufacturing enterprises are not only realized in the domestic market, but the predominant number of small enterprises gives us a reason to believe that the internal market is essential. For example, according to our calculations made with the help of NSI data, the average number of employees in a furniture manufacturing company in Bulgaria in 2020 was 8, with the highest average number for the districts of Ruse - 21, Gabrovo - 18 , Yambol - 16, and the smallest for the districts: Smolyan city - 2, Pernik city and Pleven city - 3, Burgas city, Varna city and Razgrad city - 4, etc.

Correlation coefficients were calculated between the revenue of furniture manufacturing enterprises, the gross operating surplus and the income from operating activities by districts and the respective factors, and the following results were obtained, presented in Table 1:

Table 1. Correlation coefficients between the revenue realized by the furniture manufacturing enterprises in Bulgaria, the gross operating surplus and the revenues from operating activity and some indicators characterizing the absorption capacity of the domestic market.

Result value thousand BGN	*Year*	*Size factor*				
		GDP per capita, BGN	*Total number of dwelling*	*Number of newly built dwellings .*	*Employees by labor and official legal relationship.*	*Average annual salary per employee, BGN*
Revenue of enterprises	2012	0,095	0,047	0,060	-0,008	0,048
	2018	0,367	0,299	0,136	0,294	0,372

	2019	0,382	0,297	0,253	0,282	0,378
	2020	**0,391**	0,345	0,347	0,305	0,364
Gross operating surplus	2012	0,106	0,035	0,081	-0,035	0,086
	2018	0,165	0,110	0,147	0,064	0,198
	2019	0,227	0,171	0,203	0,139	0,219
	2020	**0,235**	0,183	0,232	0,146	0,213
Revenues from operating activities	2012	0,096	0,040	0,056	-0,011	0,050
	2018	0,359	0,288	0,140	0,280	0,369
	2019	0,380	0,296	0,257	0,280	0,376
	2020	**0,389**	0,344	0,347	0,302	0,364

Source: Own calculations

The set of indicators characterizing the state of the domestic / regional / market is formed according to the idea to reflect the fertility of the local economy, household welfare, housing saturation, working status of the employed population and wages as prerequisites for active participation in the furniture market.

The obtained results show an increasing sensitivity of the achieved economic results to the characteristics of the territory in terms of welfare, which is a prerequisite for the purchase of furniture. In general, the relationship in the best years is moderate, but it is better seen in the factors "GDP per capita" and "average wage per employee". From the characteristics of the economic result achieved by enterprises, they better respond to the studied factors - revenue of enterprises and revenues from operating activities. The gross operating surplus depends on the economic strategy of enterprises and cannot respond adequately to the territorial factors shaping the state of the internal market in the territory. The strongest positive relationship was achieved at the end of the study period between the factor "GDP but per capita" and the revenue realized by furniture companies. It is obvious that not only the business activity of the population and its purchasing opportunities, but above all the overall economic prosperity of the region have a positive impact on the economic results achieved by furniture manufacturers. The growing importance of the local market for the economic results achieved by furniture manufacturers can be considered a positive fact, which means that the role of localization is growing.

CONCLUSION

From the study it can be concluded that for the period under review the influence of the potential of the domestic market on the results achieved by furniture manufacturing companies is growing significantly. This requires a careful and systematic research of local population’s needs for new furniture. Without underestimating the opportunities for specialization and entering foreign markets, the local market is increasingly oriented towards transactions involving rich customers who are willing to furnish their homes in a modern way if they are offered a good alternative, advice on selection, quick production and delivery, and reliable warranty and post-warranty service. In this sense, the role of localization choice is growing, which with the right approach could bring additional benefits without additional capital investment.

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THE ROLE OF THE FORESTRY AND WOOD PROCESSING COSTS IN THE WOOD VALUE CHAIN

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Abstract: Forestry, wood processing and furniture production are activities linked in the value chain and are an example of the circular economy as a strategic determinant of European Union policies. Value added is the sum of labor costs, depreciation and profit. According to the Strategy for the Development of Wood Processing and Furniture Production of the Republic of Croatia 2017-2020 with the Action Plan for Implementation 2017-2020, the expected growth of value added in wood processing is 20%, while in furniture production it is 50%. In order to monitor costs and create a competitive advantage in the market through product differentiation the value chain divides the company into strategically important activities. The cost price shows the total costs required to produce a unit of product. Within this study the costs of production of roundwood will be analyzed, as well as the average sales prices of assortments (beech, fir and spruce) used by the company for the production of pellets and sawn timber. Based on example of sawmill and pellet production, the types of costs and their distribution by work units will be determined. Additionally, as wood material participate as the largest share of production costs, the average sales prices of forest assortments in the state forest company "Croatian Forest Ltd., which is the main supplier of raw materials for the wood processing company, will be shown.
Keywords: wood processing, roundwood, cost prices, value-chain, market risk

1. INTRODUCTION

If a company knows its cost function, a decision must be made, how much will be produced to achieve its formal goals, such as profit or return on investment. Profitable companies are well aware of the fact that costs exist wherever production and that every ammount of unnecessary costs reduces the company's profits. The most effective cost management is reflected through business process management. Due to today's dynamic market, knowing how to manage costs in a proper and quality way is a complex process that requires the application of modern methods. Cost management has long been carried out using traditional methods and scheduling keys. However, due to strong changes in the market, companies need to develop new methods whose cost allocation keys would be more adequate and precise than the keys of traditional methods.

Labor costs have a significant share in the cost of the product. Products have a significant impact on competitiveness, because of that it is important to calculate the price cost correctly. Managers often fail to recognize growing indirect costs and tend to focus almost exclusively on direct costs. Profitable companies are very aware of the simple fact that costs exist wherever there is production, and that every monetary unit of unnecessary costs reduces just as much a company's profits (Samuelson, 1995).

Cost Management is a special way of managing a company and running a business that gives the greatest importance in achieving organizational goals to optimize costs (Cingula, Klačmer, 2003). For this purpose, methods and procedures have been developed, ie numerous models, which provide the organization's management with a critical mass of information necessary for decision-making in order to optimize costs, based on facts (Hele, 2003). Each organization must develop a costs calculation model based on the nature of its products, operations, and the manner in which it intends to use the information obtained. Wrong cost analysis leads to wrong decision.

The price structure is determined by the supply, the place of the supply, the needs and the purchasing power of the consumer. Therefore, different price structures are distinguished: production price (cost price and average profit), supply price (amount for which the seller is willing to sell goods) and demand price or purchase price (amount that the buyer is willing to pay). The price structure is not only a calculation procedure for calculating the share of individual elements in the price of goods, but it reflects the technical relationship and the relationship between labor and capital.

The company's development strategy should be directed towards the supply of products or services, which differ from the supply of competitors. A successful strategy indicates the managerial ability to make moves that make the company recognizable, and thus give customers a motive to prefer products or services, and generate a competitive advantage over competitors. (Thompson, Jr., A. et al., 2008).

Value chain refers to the way a business process is viewed as a chain of activities that converts inputs into outputs as value to the customer. (Buble, M., 2005).

The contribution margin represents the ability of an enterprise to earn above the sum of variable costs. As long as the contribution margin appears, there may be interest in maintaining the product or production center, because in that case the contribution margin participates in covering fixed costs. (Belak, V., 1996). It is used for the purpose of making business decisions related to determining the most profitable project, break-even point, what to produce or what to buy, production volume, planning, etc.

In order to further increase and maintain competitiveness, increased investment in technology is needed to reduce costs per unit. The optimal technology should also be determined with regard to the quality, quantity and type of wood. However, higher investments result in better technological equipment, and thus higher production per employee, better working conditions and greater safety at work (Liker et al., 2015). Additionaly, Šegotić et al. (2009) showed that in Croatian wood industry companies' income per employee, percentage of export in total income, and percentage of presence of university educated employees in company are very important parametres in achieving business success.

2. MATERIAL AND METHOD

2.1. Research area

The Forest Administration of the Delnice branch manages forests in the southwestern part of Croatia. The forests under this Administration stretch from the Adriatic Sea to 1500 m above sea level. The most common tree species are conifers and beech. Fir makes up about 88% of the coniferous wood supply, and beech about 85% of the deciduous wood supply. The total forest area is 97749 ha. Of that, 78,897 ha are commercial forests, 15,263 ha are protective forests and 1,185 ha are special purpose forests. Growing stock is 27,383,093 m3 or 287 m3 / ha. The increment is 519,766 m3, and the annual cut is 457,613 m3. The forests of UŠP Delnice are located in the Primorje-Gorski Kotar County. The forests are managed in compliance with environmental, economic and social standards, which is confirmed by obtaining the international FSC certificate.

Research polygon A is divided into six departments (work units): preparation of raw materials, sawmill, planning mill, finishing, finals and pellet mills, which employ 86 workers. In accounting, the plant is divided into two work units: Sawmill and Pellet Plant.
It produces sawn fir and beech timber, fir elements for pallets, pallets, elements for parquets and boards, various wall coverings and floors (paneling, floor boards and rustic floor) and pellets. In the production process, 90% of fir and 10% of beech raw materials are processed. The raw material comes in three classes of technical roundwood and three thickness classes. The production program is based on fir raw materials of the second and third class of technical roundwood, while the first class produces wall coverings and floors and carpentry. Beech raw material is delivered mainly in the third class of technical roundwood and is used for making cubes for pallets.
The research site has FSC, ISO 9001 and ISO 18001 certificates, and process traceability is monitored and available on a daily basis. The company's management employs eight workers and a special maintenance department.

2.2. Method

Calculation methods have the task of determining the cost price or the average cost of economic effects. In this paper, the cost price will be calculated using the full cost price, ie using the additional calculation and the calculation of related products. Since the existing methods cannot be used to track how much each product contributes to covering fixed costs, the cost price will also be calculated using the direct cost method. For the needs of work, based on available data, the contribution margin per unit of product will be calculated, on the example of a wood processing plant that produces sawn timber and pellets as the final product.
This calculation is important when choosing an assortment. If we have to eliminate certain products from the product mix (for example, due to lack of capacity), the first selection criterion will be products with a lower contribution margin. Namely, products with a higher contribution margin contribute more to covering fixed costs, ie they have higher earning power.
Total income is the amount of collected capital of a certain business entity in a certain period of time. Total revenue is the multiplication of the quantity produced and sold of a given product and its selling price.
The calculation made of the coverage of variable costs enables the calculation of the cost price, which represents the ratio of total costs and the amount of produced effects. The cost price is actually the cost per unit of performance and below it the company operates at a loss.
Raw material for the sawmill production is procured from the company Croatian Forests Ltd., Forest Administration Delnice. After taking over, the raw material is stored in the sawmill area, and enters the primary and secondary processing. From the assortment of fir, wall coverings, floors and carpentry are produced. Pellets are mostly made from beech assortments. The prices of forest assortments according to the state forest company Price list of main forest products are for round timber technical roundwood = 33.07 EUR/m^3 FCO forest road. While for beech timber the technical roundwood is 3rd class = 30,66 EUR/m^3, FCO forest road. Contracts with raw material suppliers are made on an annual basis, and represent the main cost of production.
According to Porter's value chain model, the company's activities are divided into primary and secondary. Primary activities relate to the production or delivery of services and include

physical product creation, marketing, customer transfer and after-sales activities. Primary activities are divided into: inbound logistics, operations, outbound logistics, marketing, sales and servicing. Secondary or supporting activities create the environment needed to carry out the primary activities of the value chain. Secondary activities are divided into enterprise infrastructure, human resource management, technology development and procurement (Porter, 2008).

3. RESULTS

The value chain divides the company into strategically important activities, in order to understand the dynamics of costs, existing and potential sources of differentiation. Competitive advantage is achieved if a company performs strategically important activities cheaper or better than its competitors. However, achieving and maintaining a competitive advantage depends not only on the company's value chain, but also on the way the company fits into the overall value chain (Porter, 2008).

Table 1 shows the data on the production of sawn timber and pellets, wood processing plants in the area of Forest administration Delnice for 2020.

Table 1: Distribution and share of main costs in production of sawmill and pellets

Cost types	Costs in EUR	**Costs allocated per working units**			
		Sawmill costs	Share in total costs	Pellets production costs	Share in total costs
raw material	2 284 820,44	1 878 348,19	39%	406 472,25	9%
other materials	319 172,96	189 120,5	4%	130 052,46	3%
el. energy	316 511,23	129 920,23	3%	186 591	4%
services	641 085,25	496 060,92	10%	145 024,33	3%
depreciation	155 982,19	74 935,13	2%	81 047,06	2%
intangible costs	140 024,62	107 864,24	2%	32 160,38	1%
salaries	881 824,14	668 335,87	14%	213 488,27	4%
Total costs in production	4 739 420,82	3 544 585,08	74.15%	1 194 835,73	25%
other business expenses	41 085,03				
Total Costs	**4 780 505,85**				

Total income in sawmill production is 3 097 720,21 EUR, and 1 111 875,17 EUR for pellets production. Basic fixed and variable costs are presented in table 1. Total amount of processed raw materials in the sawmill is 19,189 m^3 / year, and the total production costs are 4,780,505.85 EUR. The total amount of pellets produced is 7,329.84 t / year.
For variable costs, raw material costs, employee salaries, and other raw material costs were taken into account.

The average price of assortments in the sawmill is obtained by dividing the total income of the sawmill and production and is: 3 097 720 EUR/19 189 m^3 = 161,43 EUR/m^3
The average price of pellet production is obtained by dividing the total revenue of the pellet plant with the amount of pellets produced and is: 1 111 875,17 EUR / 7,329.84 t = 151,69 EUR/ tons
The cost price of the product in the sawmill is 184.72 €/m3. The cost price of the products in pellets production is 163 EUR/tons.

The contribution margin in pellet production is total income minus variable costs:
Km=UP-V= 1 111 875,17 EUR -750 012,97=361 862,19 EUR/ 7 329,84 t = 49,37 kn/tons
The contribution margin in sawmill production is:
Km=UP-V= 3 097 720,21 – 2 735 764,56=361 955,66 kn / 19 189 m^3 = 18,86 EUR/m^3

4. CONCLUSION

The paper analyzes the types of costs in the production of fir and beech products. The distribution of costs by work units, ie by stages of processing, was also analyzed. In order to show revenues and costs in the processing chain from the forest to the final product, a marginal cost approach was used, in order to separate variable costs and other revenues in the form of contribution margins. The average contribution margin rate in the production of fir timber is 18,86 EUR/m^3, and in the production of pellets 49,37 EUR / t.
Looking at the production and the ratio of total costs of the company a significant share of costs in the sawmill depend on raw materials (39%) and wages of workers (14%).
The calculation of the contribution margin indicated higher added value in the production of pellets, ie products with a higher degree of processing. Also, the paper used data for year 2020, when there was a significant impact of the pandemic on the market in which supply chains were disrupted. Currently, raw material prices are rising, but the demand of renewable energy sources such as pellets has increased even more significantly. Existing approaches to the development of wood processing often neglect the ways in which the value chain and opportunities for clustering are created. It is necessary to connect the local dimensions of the problem with the trends in the global environment, in order for the company to remain competitive and strengthen its position in the market.

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THREATS TO THE AGRICULTURAL AND FORESTRY SECTOR OF THE WORLD ECONOMY THROUGH THE PRISM OF WAR IN UKRAINE

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Abstract: The article is devoted to the analysis of threats to the agro-industrial and forestry sector on a global scale through the prism of the war in Ukraine. The aim of the article is to identify threats to the economic security of the world (primarily food and environmental) and individual countries caused by the military conflict in Ukraine. The goal is achieved by performing the following tasks: analysis of the current state of major producers and suppliers of agricultural and forestry products of the Ukrainian economy, identification of priority types and main export flows of agricultural and forestry enterprises of Ukraine, the reduction of which threatens global economic security. Given the important place and leading role of Ukraine in the world food market, it should be borne in mind that the military conflict on its territory will exacerbate the problem of food security around the world. The largest consumers of agricultural products of Ukrainian enterprises in the pre-war period were Asian countries, in particular China, in second place – European countries, and in third place - America. Ukraine's forests perform mainly water protection, protection, health, recreational functions and are a source for meeting the needs of society in forest resources. Destruction of forests due to hostilities on Ukrainian territory threatens the environmental security not only of Ukraine but also of European countries.
Keywords: threat, world economic security, agricultural sector, forestry sector, food security, ecological safety

1. INTRODUCTION

The Ukrainian and world scientific community has recognized the extremely important role of the forestry and agricultural sectors for the economic, social and environmental stability of the state and the world.

The functioning of the forestry sector in the modern economy is associated with the conservation, increase and efficient use of forests and forest resources, ensuring environmental security. Forests play an important role in shaping the carbon balance of the atmosphere, in preserving biodiversity, perform water protection, protection, health, recreational functions, are a source of meeting the needs of society in forest resources [1]. The forestry sector is an important link in the system of sustainable development of society. The agricultural sector of the modern economy primarily meets the needs of human society in food, as well as resource (raw material) needs of many areas of human life. The agricultural sector is at the forefront of achieving the global Millennium Development Goals (UNDP 2030), such as tackling hunger and eradicating poverty (by increasing food security) and improving public health through production of quality, nutritious, organic food, for a healthy lifestyle), development of renewable energy (by meeting the energy and heating needs of biomass produced of various kinds), responsible consumption (due to the latest efficient agricultural technologies and supply chains that do not harm the environment) , conservation of marine and terrestrial ecosystems (by increasing the alternatives to meet the food needs of mankind through the use of such an important economic resource as agriculture) [2]. The global challenges facing humanity today, including climate change and mass natural disasters, the pandemic spread of new viral diseases, the demographic problems of overpopulation in some parts of the world and desertification in others, the growing scale of military conflicts, negatively affect food and environmental security of mankind.

The purpose of the report is to study and analyze the threats to the economic security of the world (primarily food and environmental) and individual countries caused by the military conflict in Ukraine. The realization of this goal was achieved by performing the following tasks: analysis of the current state of the agricultural and forestry sectors of the Ukrainian economy, identification of priority types and main export flows of agricultural and forestry enterprises of Ukraine, reducing which threatens global economic security.

2. FORESTRY SECTOR OF UKRAINE

2.1. General characteristics of the pre-war state of the forestry sector of Ukraine's economy and its role in the economy of the European region

According to the State Agency of Forest Resources of Ukraine, the total area of forest areas belonging to the forest fund of Ukraine is 10.4 million hectares, including 9.6 million hectares covered with forest vegetation. Forest cover of Ukraine (in relation to the area of forests to the total territory of the state) is 15.9%. Ukraine ranks 9th in Europe in terms of forest area and 7th in terms of timber reserves [3; 4]. Conditions for forestry in Ukraine are extremely heterogeneous: the level of forest cover varies from 0-4.9% in the Steppe zone (in Mykolaiv, Kherson and Zaporizhia regions) to 30-60% in Polissya (Volyn, Rivne and Zhytomyr regions) and the Ukrainian Carpathians (Ivano-Frankivsk and Zakarpattia regions) [5, p. 21].

More than half of the country's forests are man-made and in need of intensive care. The age structure is dominated by medieval plantations (47.5%), the share of young is 16.9%, the rest are mature plantations, as well as mature and overripe plantations (35.6%). The Ukrainian forest is gradually aging, and the average age of forests is now over 60 years (which has a negative impact on their sanitary condition). The stock of wood in forests is estimated at 2.3 billion cubic meters. The average annual growth of wood in the forests of Ukraine is 35 million cubic meters (ie 3.9 cubic meters per 1 hectare) [4].

Over the past three years, the Ukrainian forestry sector has seen a trend of declining total forest production: in 2020, new forests and reforestation are 25% less than in 2017, and compared to 2010 the area of new forests is 12 times smaller. It should be added that the total volume of reforestation in 2020 amounted to only 10.3% of the total area of deforestation (wood) in 2019 [5, p.37].

The dynamics of the volume and structure of timber harvest by the main types of forestry products of Ukraine in the period 2013-2020 are presented in table 1 [6].

Products of the forestry sector represent a rather insignificant share in the total volume of Ukraine's foreign trade (share in exports in 2020 - 2.7% and in imports - 0.5%), but trade in wood, timber and key wood products provides a stable trade surplus, which in 2020 amounted to more than 1 billion dollars USA [5, p. 62]. The dynamics of exports of lumber, furniture and other wood products are presented in the table 2 [7].

Table 1. Timber harvesting by types of forest products

Indexes	2013	2014	2015	2016	2017	2018	2019	2020
million cubic meters								
Total harvested wood	20.3	20.7	21.9	22.6	21.9	22.5	20.9	17.8
All kinds of round wood, of them:	18.0	18.3	19.3	19.6	18.9	19.7	17.9	16.8
Business round wood	8.1	8.2	8.3	8.3	7.3	9.0	9.3	9.0
Fuel wood	9.9	10.2	11.0	11.3	11.6	10.7	8.6	7.8
Illiquid wood	2.3	2.3	2.7	3.0	3.0	2.8	3.0	1.1
percent								
Total harvested wood	100	100	100	100	100	100	100	100
All kinds of round wood, of them:	89	88	88	87	86	88	86	94
Business round wood	40	39	38	37	33	40	45	50
Fuel wood	49	49	50	50	53	48	41	44
Illiquid wood	11	12	12	13	14	13	14	6

According to the State Statistics Service of Ukraine, more than half of Ukraine's exports of timber, timber and key timber products in 2020 fell to countries such as Poland (227 million dollars USA or 17%), China (124 million or 9%), and Romania (97 million (or 7%), Germany (86 million or 6%), Hungary (72 million or 5%) and Italy (68 million dollars USA or 5%) [6].

Table 2. Exports of wood, wood products and furniture, million dollars USA

Indexes	2013	2014	2015	2016	2017	2018	2019	2020
Raw timber	237	254	173	106	-	-	-	-
Fuel wood	107	112	100	102	114	147	112	101
Lumber	273	356	361	394	460	586	515	515
Furniture made of wood and wood materials	162	140	92	77	112	148	180	210
Other wood products	526	540	473	529	630	762	773	795
Total	1305	1402	1199	1208	1316	1643	1580	1621

In general, the role of the forestry complex of Ukraine, the share of economic indicators of its products in the world economy and the European economy is insignificant. Ukraine's forests perform mainly water protection, protection, health and recreational functions.

2.2 Threats to the environmental security of the European region due to hostilities in Ukraine

On the territory of Ukraine, where hostilities are taking place, the Russian occupation forces are destroying enterprises, infrastructure and logistics of various parts of the economy, including the forestry and agro-industrial sectors, creating dangerous living conditions for the local population.

In the context of the military conflict, there are threats to the existence of both the forest sector of Ukraine and the environmental security of the entire European region. The main threat, of course, is the threat to the lives of workers. Another threat is the physical destruction of forests and forest resources, local species of animals and plants, as well as environmental pollution. So far, since the start of the large-scale Russian invasion, the operational headquarters of the State Ecological Inspectorate of Ukraine has recorded 231 crimes against the environment: according to preliminary estimates, the damage is 201 billion UAH [8].

According to the State Agency of Forest Resources of Ukraine, the total area of forest fires compared to the same period in 2021 has increased 96 times (up to 5509.7 hectares of forest). Since the beginning of the year, 322 forest fires have been recorded, of which 40 are large. In the occupied Kherson region alone, the fire covered more than 1,587 hectares. In the Donetsk region, fires damaged more than 4,000 hectares of forest. The situation in the occupied territories is complicated by the fact that the Russian occupation forces are obstructing the work of firefighters. Extinguishing fires during hostilities takes much longer, in particular in the case of unexploded ordnance and mines left by invaders, a significant part of the forest areas located in the territories liberated after the temporary occupation, mined [9].

According to some estimates, almost 200 unique forest areas of Ukraine are under threat of destruction as a result of hostilities. As a result, reserves and national parks of Ukraine, which are an important part of protected areas in Europe, suffer significant losses. In the spring of 2022, Red Book plants and animals are under threat of existence in the zone of hostilities and "hot spots". It is likely that some of them will not be able to produce offspring [10].

The threat posed by the activities of the Russian military near Ukraine's nuclear facilities is unprecedented. Currently, our state is eliminating the consequences of the 35-day occupation of the Exclusion Zone and the Chernobyl nuclear power plant by the Russian military. According to satellite images from NASA and the European Space Agency, during the occupation of the Exclusion Zone, fires were recorded in natural complexes and abandoned areas with an area of almost 14 thousand hectares. As a result, aerosols have risen into the air, which are harmful and may contain radiation-contaminated parts. [11].

Threats to the environmental security of Ukraine and Europe also arise from the destruction of critical infrastructure. The destruction of gas and oil pipelines usually causes large-scale fires, which result in rising temperatures and additional risks to ecosystems. The destruction of water and electricity networks, the destruction of sewage systems makes it impossible to access safe drinking water and water supply in general. According to UNICEF, 1.4 million people remain without water in eastern war-torn Ukraine. Another 4.6 million people are left without sufficient access to safe water due to hostilities in Zaporizhia, Kyiv, Luhansk, Mykolaiv, Kharkiv, and Kherson oblasts [12]. Lack of water, problems with its quality in these areas threaten the outbreak of powerful and deadly epidemics.

3. AGRICULTURAL SECTOR OF UKRAINE

3.1 General characteristics of the pre-war state of the agricultural sector of Ukraine's economy and its role in the world economy

The agricultural sector occupies a rather important place in the Ukrainian economy. Such activities as agriculture, forestry and fisheries provide one tenth of the gross value added, almost one fifth (17.1%) of the total number of employees and almost half (45.0%) of the total exports of Ukraine's economy (Table 3) [6].

Table. 3. The share of the agricultural sector (type of economic activity "Agriculture, forestry and fisheries") in the main indicators of the economy of Ukraine, percent

Indexes	2013	2014	2015	2016	2017	2018	2019	2020
Gross value added	11.6	12.8	13.4	13.8	13.2	13.7	13.4	10.0
Employed population (aged 15-70)	17.6	17.1	17.5	17.6	17.7	18.0	18.2	17.1
Number of businesses	4.1	3.9	4.0	4.0	4.2	4.2	3.9	3.7
Volume of products (goods, services) of economic entities	7.6	9.9	12.1	11.3	9.8	9.9	9.1	9.3
Volume of sold products (goods, services) of business entities	3.8	4.8	6.5	6.0	5.5	5.3	5.3	5.5
Number of enterprises, including:	12.7	13.5	13.6	14.7	14.9	14.2	13.2	
large	4.1	5.6	6.9	5.2	4.5	5.2	6.6	7.0
medium	15.5	16.3	16.7	16.9	15.9	14.3	12.9	11.9
small	12.6	13.4	13.5	14.6	14.8	14.2	13.2	13.0
Capital investments of enterprises	8.7	10.4	14.0	17.9	17.8	14.1	11.4	10.9
Foreign trade in goods: exports	21.5	25.2	31.9	35.3	33.5	33.0	37.9	45.0
Foreign trade in goods: imports	6.3	6.4	5.1	5.5	4.8	4.8	5.2	12.0

Information on priority types of agricultural products and goods of the agricultural market of Ukraine can be obtained from the results of data analysis Table. 4 [6; 14] i Table. 5 [13; 14].

Table 4. Production of agricultural sector products, 1990 and 2020, million tons

The main types of products	1990	2020	Deviation growth rate, %	
			absolute (+, -), million tons	growth rate, %
Cereals and legumes, including:	51.1	64.9	13.80	127.01
corn	4.7	30.3	25.60	644.68
wheat	30.4	24.9	-5.50	81.91
barley	9.2	7.6	-1.60	82.61
other cereals and legumes	6.8	2.1	-4.70	30.88
Fruits and vegetables, including:	27.9	33.3	5.40	119.35
potato	16.7	20.8	4.10	124.55
vegetables	6.7	9.7	3.00	144.78
watermelons	0.8	0.5	-0.30	62.50
fruits and berries	2.9	2.0	-0.90	68.97
grape	0.8	0.3	-0.50	37.50
Technical crops, including:	47.1	27.6	-19.50	58.60
sugar beet	44.3	9.2	-35.10	20.77
sunflower	2.6	13.1	10.50	503.85
soy	0.1	2.8	2.70	2800.00
rapeseed	0.1	2.6	2.50	2600.00
Livestock products, including:	29.8	12.7	-17.10	42.62
milk	24.5	9.3	-15.20	37.96

meat (in slaughter mass)	4.4	2.5	-1.90	56.82
eggs (average weight of one egg - 55 g)	0.9	0.9	0.00	100.00
honey	0.1	0.1	0.00	100.00

According to the results of 2020, among the 10 most popular products of the agro-industrial sector of Ukraine, the first place is occupied by corn, the second - wheat, the third - vegetables. Other types of products in the top ten most popular agricultural products produced and supplied to the agricultural market by Ukrainian producers are arranged in the following order: barley, sunflower oil, soybeans, fruits and berries, rapeseed, poultry and honey. According to [13], the production of agricultural products as a percentage of GDP during the years of independence of Ukraine decreased by almost 2.5 times. Instead, exports of Ukrainian agricultural enterprises increased almost fivefold between 2000 and 2020 alone.

Table. 5. Top 10 positions of products of the agricultural sector of Ukraine, 2020

Products	Production, thousand tons	Rating by production volume	Exports, thousand tons	Export rating	The share of exports in production, %	Export revenue, million dollars USA	Export revenue rating	Income, USD per 1 ton of exported products	Income rating per 1 ton of exported products
Corn	30297	1	23800	1	78.6	4886	2	205	10

Wheat	25420	2	16851	2	66.3	3596	3	212	9
Vegetables	9653	3	528	7	5.5	167	9	317	7
Barley	7947	4	4139	4	52.1	878	5	312	8
Sunflower oil	5913	5	5275	3	89.2	5325	1	1009	4
Soy	3000	6	1466	6	48.9	692	6	427	5
Fruits and berries	2800	7	156	9	5.6	238	8	1525	2
Rapeseed	2750	8	2396	5	87.1	1008	4	421	6
Poultry meat	1405	9	431	8	30.7	561	7	1301	3
Honey	68	10	81	10	…	139	10	1718	1

Currently, Ukraine is a world leader in the export of oil (sunflower, safflower, cotton) and sunflower meal (first place in the world market), rapeseed (second place), barley, corn, and walnuts (third place), and is one of the Top- 10 for 18 more items of goods (rye, honey, sorghum, wheat, sunflower, pigs, oats, meal, poultry, soybean oil, soybeans, milk powder, butter, skimmed milk powder, livestock cattle, cheese, milk). The most popular exported Ukrainian goods were crop products, in second place in popularity - animal and vegetable oils, in third place - the goods of food processing enterprises (ready to use) [13].

As of 2020, the largest consumers of agricultural products exported by Ukraine were Asia, including China, followed by Europe and America. Ukraine was also one of the suppliers of wheat to the Middle East and Africa.

3.2 Threats to the world's food security through hostilities in Ukraine

According to the UN World Food Program, more than 1.7 billion people in the world may be at risk of poverty and hunger (the worst since World War II) as a result of food failures caused by Russia's full-scale war against Ukraine. As of 2021, Russia and Ukraine accounted for about a third of the total wheat and one-fifth of the world's corn, as well as three-quarters of the world's sunflower oil production. Both countries exported significant amounts of food. According to some estimates, the economic consequences of the war could affect countries that are particularly vulnerable to rising food prices (North Africa and the Middle East), as well as the poorest countries (Somalia, Chad, Madagascar and Bangladesh), where the majority of the population is already starving. [15]. Even in countries with developed economies, significant inflationary processes should be expected, which will provoke rising prices for food and agricultural resources. According to Forbes, the war, which involved two countries, led to a 21% increase in world grain prices in just 10 days (February 24 to March 3, 2022) [16].

Also, due to Russia's military actions in Ukraine, there is a trend of rising world prices for fertilizers (nitrogen, phosphorus and potassium, mineral and chemical). Russia has been one of the main suppliers of fertilizers to the world market for a long time. In the face of growing threats to food security, the Ukrainian government has banned the export of fertilizers from the country. Nutrien, the world's largest fertilizer producer, has planned to increase production by 20%, but fertilizer prices are expected to be so high that many farmers around the world will not be able to buy them.

The ability of Ukraine and the world to produce food will also be negatively affected by rising fuel prices and shortages. Before the war, most food produced in Ukraine was exported through Ukrainian ports in the Black Sea. Currently, all seaports in Ukraine are blocked and cannot provide food exports. According to some estimates, 22 million tons of grain are currently blocked in Odessa's seaport alone.

Russia's military conflict threatens Ukraine itself with famine: almost a third of the country's sown area has remained unsown due to hostilities; Russia has stolen about 400,000 tons of grain from the temporarily occupied territories of our state (Zaporizhia, Kherson, Donetsk and Luhansk regions), which is a third of all reserves in these regions [17]. As a result of the shelling of Kharkiv, in particular the territory and buildings of the Institute of Plant Breeding. V.Yu. Yuriev National Academy of Agrarian Sciences of Ukraine (Kharkiv) destroyed the only National Center for Plant Genetic Resources in Ukraine, which stored seeds of more than 160 thousand varieties and hybrids of cereals from around the world.

4. CONCLUSION

The new active phase of Russia's military aggression against Ukraine, which began in late February 2022, has been going on for almost three months. The factors and consequences of this war for Ukraine, Europe and the World will be studied and analyzed by many generations of researchers in the future. But even today, the world community must realize the vital need to unite to counter Russia's aggressive behavior and counter threats not only to food or environmental security, but to the very threat to human existence on Earth.

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QUALITY 4.0: NEW CONCEPT FOR QUALITY MANAGEMENT IN WOOD PROCESSING INDUSTRY

Patrik Richnák

Abstract: The current business environment dominated by Industry 4.0 also gives attention to quality management. It is the digitalisation and the impact of the ongoing industrial revolution that is bringing about the new development of quality management, thus creating Quality 4.0. This concept does not only impact the processes that take place in an enterprise, but includes processes from research and development through procurement, production, logistics and sales to service and after-sales activities. Quality 4.0 represents the effort for performance excellence in the current digital era and harmonises quality management with Industry 4.0 with the vision to enable increased efficiency, performance, innovation and business models of enterprises. The main objective of this paper was to identify Quality 4.0 in Slovak enterprises in the wood processing industry through literature analysis and survey. In the first part of the paper, the literature analysis of journals and studies regarding Quality 4.0 was conducted. In the next part of the paper, the results of the quantitative survey of 73 enterprises in Slovakia participating in the wood processing industry were interpreted.
Keywords: Quality 4.0, Industry 4.0, Quality revolution

1. INTRODUCTION

Modern trends are important for identifying new opportunities, bringing about changes in the business to achieve continuous improvement in the way an existing activity, function or process is performed (Čambalíková, 2021a). It can be said that the change in the economic and business environment has greatly affected the penetration of new trends into management practice, also in the wood processing industry (Čambalíková, 2021b).

Given the dominance of technology and the turbulent environment with unprecedented customer expectations, quality management is a very relevant trend in the Industry 4.0 era. Industry 4.0 is characterised by the merging of technologies that blur the boundaries between the physical, digital and biological spheres (Čambalíková, 2020). The Industry 4.0 trend brings changes in the form of automatisation, digitalisation, integration, robotics, artificial intelligence, big data analytics using business intelligence, internet of things, augmented reality, virtual reality, 3D printing, blockchain (Čambalíková, 2022).

With the industrial revolutions and changes in management philosophies, quality is also diversifying. The development of quality has developed in parallel with the industrial revolutions. In Industry 4.0, the quality criteria determined to evaluate the quality of an enterprise are also considered in the revolutionary development of quality (Baran & Korkusuz Polat, 2022).

Quality 4.0 is linked to the quality management system in the Industry 4.0 era. The main objectives of Quality 4.0 are digitalisation, automatisation, interconnection and analytics in the quality management system (Mansouri et al., 2022). Quality 4.0 is part of the Industry 4.0 strategy, which is associated with the process of digital transformation connected with new technologies. Quality 4.0 can be defined as the application of Industry 4.0 technologies to quality management methods and tools (Radziwill, 2018). Quality 4.0 represents the fourth wave of the quality movement. The first wave was statistical quality control, the second wave was total quality management, and the third wave was Six Sigma. Quality 4.0 defines the philosophy of quality that is built on the statistical and managerial foundations of the previous philosophies. It leverages industrial big data, the industrial internet of things, and artificial intelligence to solve a whole new range of intractable engineering problems (Escobar et al., 2021).

Bowers and Pickerel (2019) define Quality 4.0 as the application of Industry 4.0 technologies to quality. Quality 4.0 is a concept that refers to the increasing digitalisation of industry, which uses advanced technologies to improve the quality of production and services (Fonseca et al., 2021; Cugno et al., 2021). Quality 4.0 describes the path to new technologies that suppliers can take. It includes deep learning, statistical analysis, the Internet of Things, big data analytics and the cloud, and conventional quality control frameworks that are used to increase market efficiency and continue to improve it. Smarter practices and processes can help increase consistency in different ways through digital technologies (Klinc & Turk, 2019). Quality 4.0 integrates new technologies - artificial intelligence, mobile devices, smart sensor networks, big data, cloud computing and applications such as augmented reality and virtual reality (Bryndin, 2018; Gadre & Deoskar, 2020).

Salimova et al. (2020) define quality 4.0 as the adaptive ability of an object at all stages of the life cycle to meet the needs of a particular consumer on the basis of partnership with stakeholders and digital management of the value chain (data-driven value chain management). Nenadál (2020) says that Quality 4.0 does not replace traditional quality methods, but rather develops and improves them. This concept includes all the issues of advanced quality management in the digital era. Quality 4.0 involves the architecture and engineering of quality, quality monitoring and quality management. Quality 4.0 introduces quality into the design of goods and processes and anticipates future quality concerns before product development and distribution. The main role of quality monitoring includes applying prescribed procedures and products, maintaining operator and equipment. Quality 4.0 includes all quality assurance practises, planning, coordination, course and regulation (Javaid et al., 2021). The discipline of quality management has continuously evolved over time and the concept of Quality 4.0 represents the phase of development in which Industry 4.0 digital technologies are being applied in quality management (Emblemsvåg, 2020; Foidl & Felderer, 2016).

2. METHODOLOGY OF THE SURVEY

In the construction of the literature review of the studied issue, the analysis, synthesis, comparison of the conceptual framework from foreign scientific sources from recent years, which are in international databases, was used. Interpretation of the studied theme from the practical aspect was conducted on the basis of the evaluation of the questionnaire survey. The data collection was realised in the period from May 2021 to December 2021 by electronic standardised questionnaire. The questionnaire was distributed among the quality managers of the wood processing industry through e-mail addresses. The questionnaire was structured into several areas. The first area concentrated on the identification of the respondents and then other parts of the questionnaire were related to Quality 4.0.

The object of the survey were enterprises participating in the wood processing industry in the Slovak Republic. The relevant respondents whose answers were included in the analysis were 73. The enterprises were categorised according to size on the basis of the European Commission 2003/361/EC. Medium-sized enterprises in the wood processing industry participated in the survey with the largest share (53.42%). Large enterprises were represented with a share of 31.51%. With the least share (15.07%) the participation of small enterprises was recorded. For the purpose of the analysis conducted, it can be concluded that the represented sample of respondents from the wood processing industry is at a very good level as medium and large enterprises are dominant. Based on the summarisation of the results of the questionnaire survey, it follows that among the wood processing enterprises from Slovakia, the legal form of business was represented with a high share of 80.82% by limited liability company. The significantly smaller percentage with a share of 19.18% was represented by joint stock companies from wood processing enterprises. In identifying the research sample, the geographic location of enterprises in the wood processing industry was also included in the analysis. Based on the summary of the results from the questionnaire survey, we conclude that enterprises participating in the wood processing industry were dominant in the Nitra Region. The share of these enterprises was 27.40%. The high share of participation also had enterprises from the Banská Bystrica Region, where the share of participation was at the level of 20.55%. Next follow the Žilina Region (17.81%), the Prešov Region (10.96%), the Trnava Region (8.22%). The Bratislava Region and the Trenčín Region had an identical share of participation (5.48%) in the survey. The wood processing enterprises from Košice Region (4.11%) participated in the survey the least.

3. SURVEY RESULTS AND DISCUSSION

In the survey, we asked the analysed enterprises from the wood processing industry what is the level of implementation of Quality 4.0 in their enterprise. Based on the evaluated results, we conclude that 47.95% of enterprises from the wood processing industry have implemented Quality 4.0. Up to 30.14% of the surveyed enterprises plan to implement Quality 4.0. No initiatives regarding Quality 4.0 are planned to be implemented by 12.33% of the respondents. Completed implementation of Quality 4.0 and its continuous improvement is in progress in 9.59% of wood processing enterprises in Slovakia.

The use of Quality 4.0 in wood processing enterprises in Slovakia has also improved several selected quality indicators. Their visual form is shown in figure 1. The largest percentage share (23.29%) was obtained by data analysis. Visual control was evaluated with a share of 20.55%. Respondents rated the defect rate with a proportion of 17.81%. Wood processing enterprises in Slovakia perceived improvement in real-time data processing at 16.44%. Quality control costs gained 15.07%. The least (6.85%) analysed enterprises perceive an improvement in customer satisfaction.

The digital transformation of quality cannot do without the implementation of Quality 4.0 tools. In figure 2 we have evaluated selected Quality 4.0 tools by wood processing enterprises in Slovakia. Respondents consider enabling technologies as the most important tool. This tool reached 23.29%. The second most used quality 4.0 tool in wood processing enterprises is artificial intelligence (19.18%). Big data based on the evaluation reached 16.44%. Other tools were in the following order based on percentage: blockchain (12.33%), machine learning (10.96%), deep learning (9.59%). The least used quality 4.0 tool is data science at 8.22%.

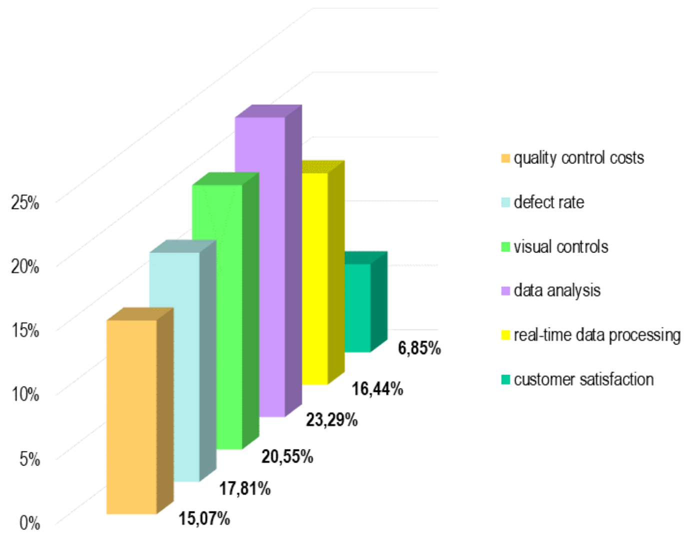

Figure 1. Improvement of selected quality indicators. Source: own research

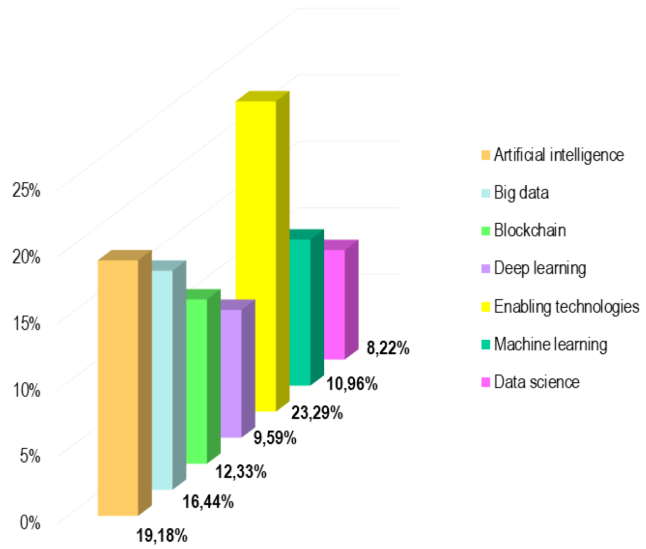

Figure 2. Using Quality 4.0 tools. Source: own research

4. CONCLUSION

The main objective of the paper was to identify quality 4.0 in Slovak enterprises in the wood processing industry through literature analysis and survey. In the first part of the paper, the literature analysis of journals and studies regarding Quality 4.0 was conducted. In the next part of the paper, the results of the quantitative survey of 73 enterprises in Slovakia participating in the woodworking industry were interpreted. Based on the summary of the results, we can conclude that the survey was conducted with the largest share of medium-sized enterprises from the wood processing industry. On the basis of the legal form of business, limited liability companies were represented with the high proportion. Enterprises operating in the wood processing industry were dominant in the Nitra Region. Almost half of the interviewed enterprises from the wood processing industry have implemented Quality 4.0. The wood processing enterprises mainly experienced an improvement in data analysis by implementing Quality 4.0. The most used Quality 4.0 tool in wood processing enterprises was enabling technologies.

The success of transformational change in the form of Quality 4.0 must be a multifaceted, cross-functional integrated approach. At the same time, it must address a range of strategic, cultural and technological issues. Enterprises that are prepared for Quality 4.0 and overcome the challenges associated with transformation will be rewarded with lower defect and failure rates and a competitive advantage in the form of greater customer satisfaction and operational efficiency (Antony et al., 2021).

Acknowledgements: The paper is a partial output of VEGA No. 1/0375/20 research project titled „New dimension in the development of production management and logistics under the influence of Industry 4.0 in enterprises in Slovakia“.

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QUALITY CONTROL OF TIMBERFRAME HOUSES IN RELATION TO HEATING ENERGY COSTS

Pavol Sedlák, Dominika Búryová, Rozália Vaňová, Stanislav Jochim

Abstract: Wood based houses, as other construction projects, are a balance between cost, time and quality. There are several aspects while assessing the quality of a building, and typical customers are mostly concerned about visible defect, which may have negligible effect to the entire process.
But, in relation to heating energy, integrity of building envelope is the key parameter that is often overlooked in design and construction process. The paper describes the building integrity assessment procedure by means of Blower Door (air tightness level) and Infrared (insulation level) in-situ testing, also with cost analysis for possible heating energy savings, as a result of immediate repairs during the testing procedure or later more complicated envelope corrections. If the air tightness testing is performed too late on fully finished building, it is usually impossible to make any improvements to the envelope, as main airtight layer is not accessible and therefore not repairable – which is very specific for timberframe buildings.
As quality has been defined as delivering a product without a defect being present, it is important that briefing documents set out clearly the product specifications that are required – and the building integrity specification is repeatedly missing in many contracts. In addition, the overall air tightness specification is not even stated in Slovak Technical Standards – in contrast to Czech, Austrian or German standards.
Keywords: building envelope, quality control, air tightness, heating energy, energy costs

1. INTRODUCTION

Well designed and constructed buildings should be output of today's construction industry, as the high quality achieved in building projects ensures future marketability and enhances the confidence of clients. If we accept that to a certain extent quality is subjective, there are a few other things which may be considered – especially by owners and users. In the construction industry, these can include things like:

1. aesthetics
2. absence of defects, durability (particularly important for wood facades [1])
3. flexibility in use
4. operational costs (maintenance, energy)

As part of official procedures generally accepted and applied worldwide in developed countries, listed essential quality aspects are usually ensured:

5. Structural stability and strength – guaranteed by architects and structural engineers in design of a building, together with verified construction process
6. Fire protection - guaranteed by fire protection specialists and the design
7. Health and safety – usually satisfied by the design and by use of certified materials
8. Sound protection – important mostly for semi-detached or row houses
9. Thermal protection and energy efficiency (heating, cooling) – affected mainly by architecture, insulation level and integrity of building envelope.

These aspects are often overlooked by clients, as they rely on professionals and procedures described in national standards, codes and law.

Timberframe houses production with wood processing industry holds a significant position within the industrial sector in Slovakia [3], as wood has been traditionally applied in different applications, mainly in construction [4], furniture production, etc. As timberframe houses are generally more complicated than their masonry counterparts, they also require highly skilled professionals and craftsmen. Consequently, risk of serious defects is significantly higher in timberframe structures, and quality control is essential for this type of buildings.

2. THERMAL PROTECTION AND ENERGY EFFICIENCY - HEATING ENERGY

The building sector accounts for 40% of the EU's energy requirements and offers the largest single potential for energy efficiency. Reducing the energy demand in heating (or cooling) is an important element of decarbonisation policy and is essential for reducing energy bills and increasing thermal comfort of occupants. Therefore, heating energy consumption is a key parameter of a building, as it forms most of the operational costs.

Apart from location, purpose, heating-ventilating-air conditioning (HVAC) systems and overall shape of a building, it is quality of building envelope and its integrity with highest impact on heating energy, because it is responsible for heat transfer between interior and exterior. The importance is more significant in houses using mechanical ventilation with heat recovery (MVHR), as minor degradation of building envelope performance excessively reduce overall MVHR efficiency.

The building envelope integrity can be basically verified by two methods, which are later described in detail:

10. Infrared testing for thermal insulation level examination and related defects
11. Blower door testing to check undesirable air leakages causing additional heat loss

3. INFRARED TESTING – THERMAL INSULATION LEVEL

The use of thermal infrared (IR) imaging is unique and valuable tool for inspecting and performing non-destructive testing of building elements, detecting where and how energy is leaking from a building envelope. Applications can include: detection of moisture and water infiltration, observing thermal bridges, voids, locating areas of heat loss and assessing the performance of insulation. It can be also used for clarifying the operating conditions of hard to reach HVAC installations under full-load operating conditions and for other purposes.

While there are certain recommended/required insulation levels stated in national standards by means of U-values, it is also important to make buildings without significant thermal bridges. If there are any weaknesses, they are usually visible in proposed design plans. Defects resulting from poor workmanship on site are unlikely, usually when doing alterations to the structure.

For further assessing of detected details (e.g. detail of window installation and similar) on building envelope, usually 2D or 3Dthermal modelling is required based on finite element method (FEM), to obtain results for standard conditions with precision app. 97%.

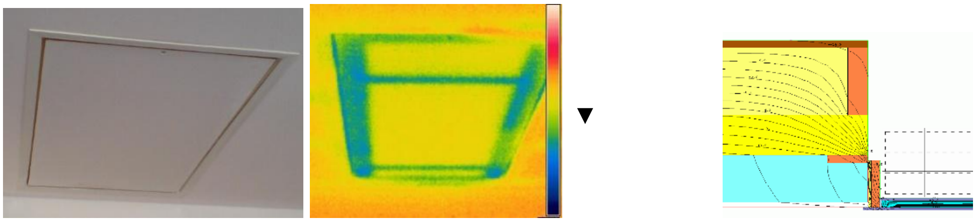

Figure 1. Infrared imaging and related 2D thermal modelling

4. BLOWER DOOR TESTING – AIR TIGHTNESS

Due to specific issues with natural ventilation [2] and in order to significantly reduce demand for building heat energy by using ventilation systems with heat recovery and therefore satisfy sustainable standards, air permeability of building envelope became an important issue. The key principle for planning the air tightness of a building is to create “continuous uninterrupted airtight building envelope”, that can be outlined using the “red pencil method” [5] – Fig. 2. Any unintentional air leaks directly cause additional heat loss by air infiltration and compromise effectivity of MVHR ventilation.

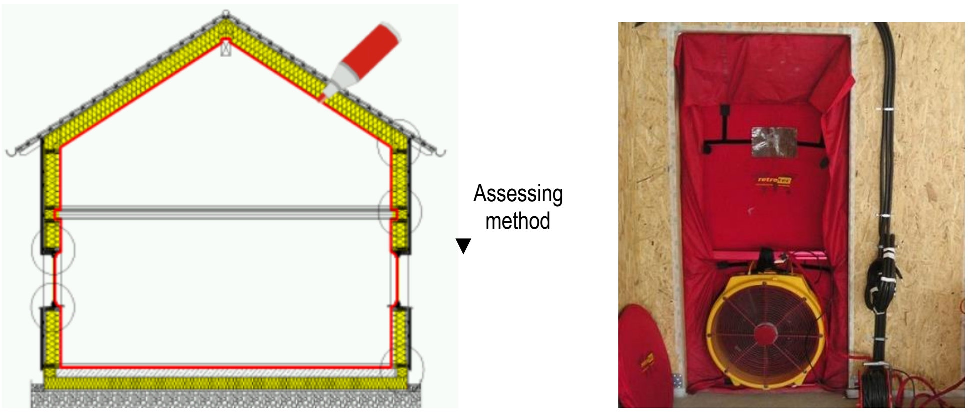

Figure 2. Red pencil method principle [5] and Blower Door Test being conducted on a house with OSB as main air barrier (accessible during the test)

In timber frame construction the airtight layer is formed by oriented strand boards (OSB), various foils or by cross laminated timber (CLT) – each material requires specific approach and provides unequal results. These materials are mostly hidden in the envelope structure – and therefore the airtight layer is not repairable on finished house, what is specific problem for timberframe structures. Additionally, vulnerable materials like foils or taped joints get easily damaged during construction. Therefore, it is necessary to check and repair the airtight layer when it is fully accessible, as improvements on finished house simply can not be made at reasonable costs.

A blower door test (Fig.2) is used on buildings in order to quantify the amount of air leakage through its enclosure. The main advantage of the test is quick setup of the portable apparatus, almost immediate results and possibility to detect air leakages by smoke pen or anemometer, or sometimes rapidly by infrared camera.

The air flow rate is described by power law relationship, where parameter C_{env} and $n_{(exp)}$ describe air tightness of the building. The purpose of this process is to determine parameters for power law relationship. Values of parameters are obtained by method of least squares, in order to calculate air flow rate through building envelope Q_{env50} at standard pressure difference of 50 Pa.

Overall result is expressed by n_{50} [1/h] - air change rate @ 50Pa, calculated from Q_{env50} [m_3/h] and volume [m_3] of a building [6]. It is desirable to obtain as low values as possible, to minimise thermal loss by air infiltration. Maximal permitted values are stated in national standards, though these limits are missing in Slovak Technical Standards (STN) - Tab.1.

Table 1. Permitted values n50 describing building air tightness, in selected countries

air change rate n_{50}	Germany (DIN 4108-7)	Austria (Önorm, OIB-R6)	Czech Republic (ČSN 73 0540-2)	Slovakia (STN 73-0540)
houses with natural ventilation	max. **3,0** h^{-1}	max. **3,0** h^{-1}	max. **4,5** h^{-1}	**not stated**
houses with MVHR	max. **1,5** h^{-1}	max. **1,5** h^{-1}	max. **1,0** h^{-1}	**not stated**
passive houses (with MVHR)	max. **0,6** h^{-1}	max. **0,6** h^{-1}	max. **0,6** h^{-1}	recom. **0,6** h^{-1}

5. IMPROVEMENTS BASED ON BLOWER DOOR TESTING - COST ANALYSIS

In order to show effect of building air tightness improvement, there were two case study timberframe houses selected. On both, initial blower door test was performed when the airtight layer was fully accessible, original n_{50} [1/h] results were calculated. Technicians then fixed all detected repairable air leakages, and second blower door test was done again with derived enhanced n_{50} [1/h] results. Heating energy consumption for electric heating was calculated according to Passive House Planning Package (PHPP), for all scenarios, and savings were calculated. Basic parameters are shown in Tab.2.

As seen form Fig.3, improved air tightness of buildings causes significant energy costs reduction, as much as app. 2.000 Euro over 25 years in these cases – though possible savings in other cases can vary significantly, depending on used material, design, workmanship and also on climate and HVAC systems. And, in addition, energy prices will likely to grow due to current geopolitical situation and inflation.

Table 2. Overview of case study houses parameters

		house No.1	house No.2
			
	floor area	98,6 m^2	144,2 m^2
	internal building volume	281,5 m^3	428,6 m^3
	simple description	OSB/foil as air barrier, plastic windows, regular design and work crew, place:Pezinok	OSB as air barrier, high quality wood windows, detailed design, motivated workmen, place:Zvolen
original envelope 1st BD test	n_{50} (airtightness)	**2,19 h^{-1}**	**0,95 h^{-1}**
	heating energy / year	3776 kW.h/a	3142 kW.h/a
	energy costs / year	**642 Eur/a**	**534 Eur/a**
improvements to the building envelope (based on detected air leakages during 1st BD test)		-repaired number of incorrectly taped joints and holes in foil vapour barrier -sealed joints of OSB boards (OSB-foil) -entrance door hinges set properly	-sealed cracks around ceiling joists -repaired pipe and wire penetrations through external walls -OSB board (the air barier) painted
improved envelope 2nd BD test	n_{50} (airtightness)	**1,18 h^{-1}**	**0,39 h^{-1}**
	heating energy / year	3261 kW.h/a	2693 kW.h/a
	energy costs / year	**554 Eur/a**	**458 Eur/a**
air leaks, that can not be fixed		-through hidden construction details -around sliding sash of terrace door -around window hinges and frame	-through complicated construction details

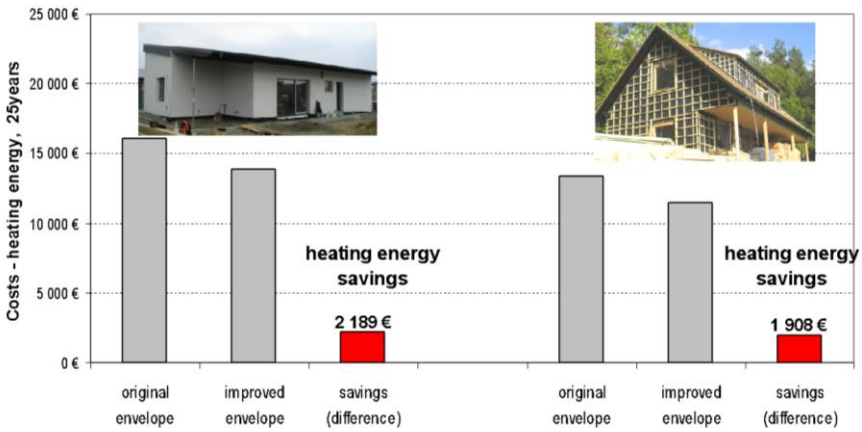

Figure 3. Energy savings for case study houses, over 25 years

6. CONCLUSION

Quality is an emotive issue. For clients, in particular, the intuitive conviction that all buildings should be designed and constructed to an acceptable standard of quality, is a difficult idea to shake, as is the belief that if something fails to perform in the way they expected, even if they didn't know what to expect, then blame can be laid.

It often falls to the Government to lead, which to a certain extent it has been doing with standards and the law, initiatives for improving quality of buildings – though there could be significant gaps in technical standards, as discussed earlier in building envelope air tightness requirements.

Timberframe structures are especially sensitive to air leakage defects caused by wrong design or workmanship during construction, due to nature of its external envelope. Apart from ventilation heat recovery efficiency, there is also high risk of water vapour condensation within the structure and related damages. It is therefore essential to focus on this crucial aspect of the building process and check for possible defects when the airtight layer is accessible and can be easily and inexpensively fixed – as there is only one chance to do it properly.

Acknowledgements: This paper was also supported by VEGA 1/0665/22

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WHAT ARE THE BENEFITS OF ENVIRONMENTAL PURCHASING FOR WOOD PROCESSING COMPANIES?

Nikola Slašťanová, Hubert Paluš

Abstract: Currently, the need for ecological and environmental performance of companies is the wood-based sector is often emphasised. In order for companies to implement environmental requirements into their business, they should also perceive the resulting benefits. The purpose of this research is to evaluate benefits the companies in wood-based sector have experienced after introducing environmental requirements into the purchasing process. The survey was conducted using an online questionnaire among the companies operating in wood processing sector in the Slovak Republic and was focused on defining the relationships between the green purchasing requirements focused on suppliers (environmental management systems, green image, certificates, etc.) as well as on inputs in the supply chains (environmental products, recycling, packaging, etc.) and the benefits that have resulted from the introduction of these requirements. Subsequently, the results were compared with a survey conducted among a group of companies that do not have environmental purchasing requirements in place, which made it possible to determine their potentially expected benefits.
Keywords: green purchasing, benefits, requirements,

1. INTRODUCTION

Green development has become one of the five development ideas consisting of innovative, coordinated, green, open, and inclusive development (Wang et al., 2019). Green (environmental) purchasing means basing all purchasing decisions and allocation of contracts on environmental criteria along with other criteria such as price and quality. Not only does green purchasing positively contribute to environmental protection at a local level, it also creates a powerful market demand for greening the production and serves as a model to influence the behaviour of companies, private institutions and households (Shao and Ünal, 2019). It is a way of contributing to the protection of the environment through green purchasing practices. Sustainable procurement remains a key objective for many businesses. Repeated purchasing of green products might induce consumers to pay a higher price because the consumers might now consider a store's green credentials when choosing where to shop (Tucker et al. 2012). Environmentally preferable criteria early in the procurement process improve the organizations' environmental performance, while addressing ethics, social regeneration and economic concerns. In addition to improved environmental performance, many 'green' products work as well or better than traditional products and can even save money. Green purchasing support common environmental decisions throughout the purchasing process, initial selection of the supplier, product design, process and through product disposal. Businesses that want to maintain a competitive advantage in the business world are putting it into practice. Purchasing should be considered in all supply chain management activities, and more specifically, re-used, recycled materials should be purchased in such a way as to reduce resource use as much as possible. Behaviour according to these principles is not mandatory, it is not defined by legal conditions, its implementation is based on voluntariness. However, business entities and companies have understood that it has many benefits for their future existence in the market.

Green purchasing has spread to several areas of industry. Great emphasis has begun to be placed on environmental requirements in the woodworking industry as well. Although the process brings some complications to companies associated with the introduction of green purchasing, after its implementation will bring some benefits to the company.

Green purchasing brings many economic, social and environmental benefits to businesses (Slašťanová et al., 2021). Several studies have found that benefits may come from better or unique resources or capabilities (Reuter et al., 2010), cost reductions through eco-efficiency, improvements in product quality, generation of new revenue in (niche) markets, and better image and reputation (Esfahbodi et al., 2017; Rao and Holt, 2005). Green purchasing helps to improve the ecological impact of the entire production process and contributes to increasing the environmental content of products and processes (Ferri and Pedrini, 2018). It can improve the image of a company, competitiveness and marketing exposure (Rao and Holt 2005; Lee, Kim, and Choi, 2012). There are also many benefits to wood certification (Polisar et al., 2017). Positive responses suggest that ecolabels are perceived as useful marketing tools and generally accepted symbols of environmentally sound consumer choices (Yokessa and Marette, 2019).

2. METHODOLOGY

The research was carried out using the questionnaire survey. The questionnaire was constructed as a part of broader research and for the purposes of this particular analyses it consisted of several parts - business data (respondents profile), status of implementation of environmental purchasing, implemented environmental purchasing requirements and the benefits following from their implementation. Questions were closed-ended and answers were recorded on a 4 point Likert scale (1 - total agreement and 4 – total disagreement.). The survey was conducted online in 2021 and 320 responses were collected and evaluated from the companies operating in wood processing sector in Slovakia.

Collected data allowed to split respondents into two groups. First group consisted of companies with implemented green purchasing. These companies also indicated which particular green purchasing requirements they use in supply chain management. Additionally, they identified benefits following from the implementation and use of green purchasing requirements. Second group of companies consisted of respondents not having implemented any green purchasing activities. Even without having any experiences in this area they were asked what potential benefits they would expect the green purchasing could bring. Data were processed in MS EXCEL and using the frequency analysis, the means of answers were calculated and used for further evaluation and description. This allowed for the identification of main benefits and comparison between the two groups of companies. Differences in experienced and potential benefits perceived by both groups were evaluated using the methods of semantic differential.

Furthermore, relationships between the selected company characteristics (ownership structure and customer market) and implementation of green purchasing were examined using a Mann–Whitney U test, where a 95% confidence level and at the level of significance alpha = 0.05 were applied. The Mann–Whitney U test statistic is nonparametric test of the null hypothesis that, for randomly selected values X and Y from two populations, the probability of X being greater than Y is equal to the probability of Y being greater than X. The data were processed and evaluated by the statistical software SPSS and the data obtained were incorporated into contingency tables.

3. RESULTS AND DISCUSSION

In the survey there were 320 respondents participating, the majority were businesses that have implemented green purchasing (51 %). This group of companies were asked question about the particular environmental requirements they use in purchasing process when acquiring products and services from their suppliers. The list of identified requirements together with their mean values is summarised in Table 1. Among the most important environmental requirements were the improvement of the products with reduced content of toxic substances ($\bar{x}$ = 1.64), purchase of environmentally friendly products ($\bar{x}$ = 1.78), implemented forest certification system by the supplier ($\bar{x}$ = 1.83) and recyclable packaging / product packaging ($\bar{x}$ = 1.87). Least perceived environmental requirements are e.g. green (ecological) product design ($\bar{x}$ = 2.51), green image of the supplier ($\bar{x}$ = 2,60) and introduction of ecological research and development activities (green innovation) by suppliers ($\bar{x}$ = 2,67).

Within environmental purchasing companies require ... *n = 163*	$\bar{x}$
products with reduced content of toxic substances	1.64
environmentally friendly products	1.78
forest certification system at the supplier	1.83
recyclable packaging / product packaging	1.87
recyclable products	2.02
use of environmentally friendly procedures, technologies and materials at the supplier	2.11
production of green products (recycling, environmentally friendly packaging) by suppliers	2.12
environmental labelling of products	2.15
pollution minimization and harmful waste	2.23
the supplier's ability to reduce material and energy consumption	2.26
the supplier's ability to support green solutions in supply chain management	2.32
supplier life cycle assessment of the supplier	2.40
established environmental management system at the supplier	2.43
green (ecological) product design	2.51
green image of the supplier	2.60
introduction of ecological research and development activities (green innovation) by suppliers	2.67

Table 1. Environmental requirements implemented by respondents
Consent scale: (1 - completely required; 2 - rather required; 3 - not required at all; 4 - not required at all)

Based on the results of U-test, statistically significant dependencies were found between the business characteristics and the environmental requirements for inputs and suppliers in the purchasing process. Businesses that have implemented green purchasing are more frequently companies with domestic ownership structure and foreign customer markets. Slovak owned enterprises in contrast to foreign owned companies have implemented environmental requirements for production inputs related specifically to environmentally friendly products (U = 1288,000, α <0.005), recyclable packaging / product packaging (U = 1283,500, α <0.001). Enterprises with foreign customer market prefer more environmental requirements for suppliers, specifically established forest certification systems at their suppliers (U = 1770,000, α <0.001) and green image of the supplier (U = 1621,500, α <0.001) than the enterprises selling dominantly to domestic market.

Table 2 summarises responses by both group of respondents – those having and not having implemented green purchasing requirements. Businesses that have implemented green purchasing have experienced benefits of improved image ($\bar{x}$ = 1.78), improved competitiveness ($\bar{x}$ = 1.88), providing green products and services ($\bar{x}$ = 1.94). Considered a less important benefit were saving energy, water and waste ($\bar{x}$ = 2.31) and environmental labelling of products ($\bar{x}$ = 2.20). Businesses without green purchasing that would implement green purchasing would expect the potential benefits such as saving energy, water and waste ($\bar{x}$ = 1.44), improved competitiveness ($\bar{x}$ = 1.45) and improved image ($\bar{x}$ = 1.63). They would not expect to gain better access to licenses and certificates ($\bar{x}$ = 2.40) and to provide environmental labelling of products ($\bar{x}$ = 2.20).

Benefits are…	Implemented green purchasing n=163	Not implemented green purchasing n=157
	$\bar{x}$	$\bar{x}$
greening of processes	2.16	1.82
providing green products and services	1.94	1.95
improved image	1.78	1.63
environmental labelling of products	2.20	2.20
easier to obtain licenses and certificates	2.05	2.40
saving energy, water, waste	2.31	1.44
extended market	2.10	1.75
increased market share	2.12	1.80
improving of competitiveness	1.88	1.45

Table 2. Experienced and potential benefits following from green purchasing

The results of individual responses in experienced and potential benefits were compared using a semantic differential (Figure1). The semantic differential shows that companies clearly agreed in the answers regarding environmental labelling of products and providing green products and services. They also agreed that they see improved image as an advantage. Opinions mostly differ on the benefits of saving energy, water, waste where companies without green purchasing perceived it as an advantage in contrast to the companies with implemented green purchasing.

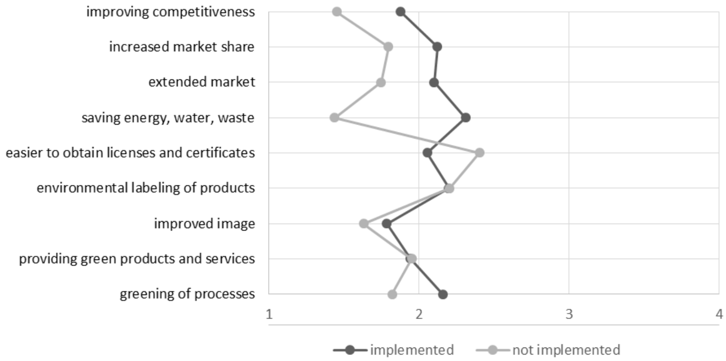

Figure 1. Differences between companies with and without implemented green purchasing

The results of the research identified the benefits of companies in the wood sector after the introduction of environmental requirements into the purchasing process, specifically in improved competitiveness, improved image, providing green products and services. As confirmed by other research such as Yang et al. (2021) trade is increasingly global, even for SMEs. Many large enterprises now require improved environmental performance throughout their supply chain. Green purchasing can help reduce overall costs for the short, medium and long term by introducing a life-cycle perspective. In sum green purchasing improves overall competitiveness. Environmentalism as a marketing factor has really grown in the past few decades. Not only will customers be looking for the best product, they'll also be looking for the product that is best for the environment (Wong et al., 2009).

5. CONCLUSION

The research identified benefits for businesses that have green purchasing and found out what benefits would motivate businesses to implement green purchasing. Businesses that do not have implemented green purchasing yet would expect advantages related to the business improved image, increased competitiveness and reduced water and energy costs. Businesses that have introduced green purchasing have experienced several advantages and benefits specifically in the increased image of the company and increased competitiveness. This can be considered as positive information for companies intending to introduce green purchasing procedures to their business in the near future.

Acknowledgements:
The authors are grateful for the support of the Scientific Grant Agency of the Ministry of Education, Science, Research, and Sport of the Slovak Republic, Grant No. 1/0494/22 Comparative Advantages of the Wood Based Sector under the Growing Influence of the Green Economy Principles and Grant No. 1/0495/22 Sustainability of Value Supply Chains and its Impact on the Competitiveness of Companies in the Forest and Forest-Based Sectors and Grant No. 1/0475/22 Environmental Consumer and Environmental Citizen.

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APPLICATION OF THE MODEL OF CIRCULAR ECONOMY BETWEEN THE FORESTRY AND AGRICULTURAL SECTOR

Gergana Slavova, Yoana Doneva

Abstract: Today, we live in a time when the protection of the environment is of the utmost importance. The pollution is affecting the air we breathe, the water we drink and the soil that helps in feeding us. Thus, pollution has a very negative impact on people's health and respectively their lives. Therefore, the application of the circular economy model focused on the utilization of waste products is needed. If we talk about the forestry sector and all its derivative activities, it creates a precondition to reduce to some extent the negative impact of consumption of one hundred billion tons of wood per year. These data are taken from the UN annual report on the circular economy. The use of low-carbon, natural and renewable materials such as wood, bark, and straw creates an opportunity for greater recyclability and application of regenerative materials. The forestry sector creates extremely good preconditions for the development and implementation of a circular model. For example, through the circular production, repeated use and recycling of wooden pallets, recyclable wood flooring, furniture, panels, decors, etc.
This article aims to explore the possibilities for integrating circular economy models, using the shared resources of forestry for the agricultural sector with the use of mulch wood, support equipment, wooden grills, recyclable pallets, wooden support pegs, production of wood pellets for heating greenhouses, etc. The study is built on secondary studies of similar cases presented by other authors and adds to this analysis several successful examples from some regions of Bulgaria. We will start with a study of the impact of forestry on the development of the agricultural sector and the related industries, and then propose solutions for further expansion of circular economy activities, based on current cooperation and integration of the forestry and agricultural sectors.
Keywords: circular economy, forestry sector, agricultural sector, recyclability, resources

1. THE CIRCULAR MODEL OF ECONOMY

The concept of a circular economy is not new. It has been growing for decades to reach its current definition and gain global importance. In recent years, architects, economists, environmentalists and other scientists have contributed to the development of this concept. In the 1960s, Professor Kenneth E. Boulding first developed the idea of a circular economy. (Boulding, K., 1966). He is considered the father of the model and a pioneer in ecological economics. In the following years, the topic of the circular economy model continued to interest people from academia and many reviews on the topic were formed by Pierce and Turner (1989), Tim Jackson (90“s), Walter Stachel (Ellen MacArthur, 2016), Robert Constanza (Gallucci, Dimitrova, 2018), Paul Anderson (2007), Patricia Giselini (Ghisellini, Cialani, 2016), Nancy Boken (Jesper M. etc., 2016) and many others. Great influence on designing the model had the theoretical developments related to circularity, the economics of productivity, regenerative design, industrial ecology, blue economy and others. Large global companies, as well as international structures, world governmental and non-governmental organizations, are interested in the model of the circular economy. Some of them are the Food and Agriculture Organization (FAO), the EU's Common Agricultural Policy, the North American Forestry and

Agriculture Sector which focus on preserving resources, improving nutrition, food security, etc. They can easily overlap with the main principles of the driven by design circular economy: eliminating waste and pollution, circulate products and materials at their highest values and regenerating nature.

2. INTEGRATION OF THE CIRCULAR ECONOMY MODEL BETWEEN THE AGRICULTURAL AND FORESTRY SECTOR

There are several opportunities to integrate the circular economy model between the agricultural and forestry sector. The waste from the forestry sector can help the agricultural one. Help, such as mulching paths between crops, the space between tree trunks, flower alleys, and strawberry plantations in order to prevent weeds, keep roots cooler and help retain the moisture in the soil. Often waste wood can also be used to create or produce wooden grills, wooden support pegs, wooden pellets for heating greenhouses, as well as production of wooden flooring and more. Forest and plant biomass can also be used for biotechnological processing to produce biogas, liquid biofuels, organic chemicals and bioplastics (Horvathova V and others,2021). For example, large wood processing companies produce big quantities of waste wood biomass, mainly from planing, milling, cutting wood for furniture, the creation of building materials and the production of various wooden household products (Magyar, 2020). With great success, this wood can be used in agriculture in the form of mulch. Many good practices in this direction are observed in many European countries such as Denmark, Sweden, Portugal, Germany, England, Italy, France, etc. (according to the personal observations of the authors). However, it is very important to know that not all types of wood can be used in agriculture. Some of them can be toxic. There's wood that contains natural but harmful to plants substances such as resins and poisonous chemicals. An example is yew wood (Magyar, 2020). It is not a good idea to use leftover sawdust from already painted wooden furniture or varnished ones. The reason is that the residual chemicals in them are highly toxic and instead of helping to retain moisture in the soil and protect plants from weeds, they will lead to soil and groundwater contamination with harmful, heavy and not easily degradable chemicals.

Therefore, the best way to mulch is to use waste sawdust from untreated wood. Some of the following types can be used: ash, fir, oak, beech, cedar, cherry, peach, apricot, prune, pear, apple, dogwood, quince, etc. It is very important to comply with the requirements and not use sawdust from a tree that has been pre-painted with oil paint. As is the case with some types of agricultural fruit trees, where the bark of the trees is painted or whitewashed in order to protect them from rodents. Another important condition for clean crops is not to apply sawdust from wood treated with fungicides and other chemical plant protection products. Chemically contaminated sawdust and wood must be disposed of safely and legally. It is contraindicated to use decontaminated wood obtained from old wooden beams in which highly toxic wood preservatives are used. Therefore, it should be borne in mind that mulching is not as easy a process as it seems. Some basic requirements must be met, such as the use of wood that has not been treated with chemicals, as well as one that does not contain natural harmful chemicals that inhibit the growth of different types of crops. Here we can point out several coniferous trees (including yew), which do not allow other crops to grow in the soil under them. Therefore, their wood, which contains a rich amount of resin, is unsuitable for mulching. An interesting fact is that mulching the soil changes its acidity and it becomes a little bit more acidic. It is good to know that such soils are preferred by certain types of plants, such as potatoes, carrots, tomatoes, cucumbers, blueberries, raspberries, blackberries, strawberries and goji berries. Also, some types of flowers, such as roses, azaleas, daffodils, hydrangeas, and rhododendrons, feel much better when applying mulch to enrich the soil (Waddington, 2000). Mulching not only improves and retains soil moisture but can also protect plants from freezing in winter and weeds in the spring. Another example of a positive effect of mulching can be observed in strawberries where mulching protects plants from rotting and soil contamination. When using sawdust for mulching it is important to know that it uses some of the nitrogen in the soil to decompose. For this reason, it is good to add a little more nitrogen fertilizer. Good practices for the application of wood mulch in Bulgaria can be identified in the parks and gardens in Bulgarian resorts such as "Albena", "Golden Sands", "Saint Constantine and Helena", "Elenite", "Bansko", "Pamporovo" and of course several private yards and gardens maintained by landscaping companies as "Erica", "Mimosa", "Art Garden", "Green Dream", "Elegance Gardens" and others. Sawdust can be used successfully as an insulator in wooden and plastic crates for longer preservation of fruits and some vegetables in winter. Sawdust can also be used for greenhouse heating, mushroom growing (Sheehan, 2020), and also as the main bedding for domestic animals. Apart from being soft, comfortable and convenient, they also can repel bedbugs and fleas. In addition, mulching with black walnut sawdust on paths and alleys where no cultivated plants are sown does not allow any grass to grow, which is a good tool as a natural herbicide (Magyar, 2020). In Bulgaria, sawdust and wood are widely used in the cultivation of oyster and shiitake mushrooms. Many mushroom farms in the country operate on this principle.

3. INNOVATIONS AND ADVANTAGES IN APPLYING THE CIRCULAR ECONOMY MODEL BETWEEN FORESTRY AND AGRICULTURAL SECTOR IN BULGARIA

4.

Another innovative approach in which we can use sawdust in agriculture is by mixing organic manure from birds or ruminants with it or making compost. As a good example in this direction, we can point out the pioneering work of a Bulgarian company, encouraged and financially supported by the European Environmental Protection Program, which produces active organic fertilizer obtained from the waste from the agricultural production and sawdust. It’s mixed with sawdust to obtain a reliable solid biological product. The company is called "Water Recycling Technologies BG Varna" Ltd. and is a Bulgarian engineering company that deals directly with the implementation and multiplication of new, innovative recycling technologies in the field of ecology and environmental protection. The application of circularity by the company is explained by the following main activities: treatment and recycling of wastewater from livestock farms with concomitant production of soil-forming mixtures and organic fertilizers. Processing and decontamination of the obtained liquid fertilizers, adding sawdust in order to obtain granular biofertilizer. The main goal of the company is to return the organic waste to nature in the form of granular or liquid biofertilizers. The full cycle of treatment and reprocessing of organic waste is carried out within two to three hours. The applied technology is waste-free and up to two to three times less energy-intensive than similar technologies. The processing is innovative and is based entirely on the use of waves. The method was not previously used in Bulgaria in this field. Physico-chemical processes such as dispersion, disintegration and ionization are combined under the influence of electromagnetic fields. Regarding this, in the processed substances, the physico-chemical reactions proceed immeasurably fast. Substances change at the intramolecular level. Some of the soil-forming processes occurring in nature are largely due to the vital activity of microorganisms that feed on organic and mineral components. The main raw materials for the production of the biofertilizer are the faeces of domestic animals (birds, sheep, cattle) and sawdust. The innovative technology used by the company "Water Recycling Technologies BG Varna" Ltd. allows decontaminating the organic waste from the plant and the animal biomass. For this purpose, a stationary installation for processing animal waste is used. The final products are organic fertilizer and soil-forming mixtures.

In addition, the company has mobile installation and equipment for wastewater treatment and sludge treatment. The main stages of processing are the creation of a conditionally sterile substance by disintegrator, followed by separation of liquids and solids by precipitator-separator and adding soil-forming microorganisms and components. It is very important to note that in order to prevent the creation of conditions for the rapid development of pathogens in the process of work immediately are added colonies of friendly soil-forming microorganisms that multiply rapidly, creating powerful colonies which prevent the development of pathogenic flora. The addition of sawdust to liquid substrates allows the formation of granular organic fertilizers which are very easy to apply and similar to chemically artificial mineral fertilizers. The difference is that they are developed entirely on a biological basis. This is allowing the production of ecologically clean food and the development of organic agriculture to spread not only through the country, but also in all countries applying soil improvers and granular organic fertilizers of the company "Water Recycling Technologies BG Varna" Ltd.

The main advantages of applying the circular economy model by the specific company are:

1. All waste products from the agricultural livestock sector are utilized.
2. Waste material from the forest sector (sawdust) is also put to use.
3. In the process of treatment, all the organo-mineral components are preserved in the new granular bio-fertilizer.
4. Emphasis is placed on joint efforts to use waste (from the forestry and agricultural sectors) as a resource.
5. The pathogenic microflora and weed seeds are completely destroyed.
6. Heavy metals are converted into safe compounds and removed if necessary.
7. Complex chemical reagents and GMOs are not used in the production process. Due to this, the obtained granular biofertilizer is ecologically clean for the soil biocenosis.
8. Depending on the type of soil in the production, different recipes are applied for the composition and processes of the technologies used. This is the reason why the two main products are liquid and granular fertilizer.
9. The installation can be integrated into the production schemes of the treatment plants and facilities of the agricultural companies.
10. The described treatment process fully complies with the Ordinance on the procedure and manner of utilization of sludge from treatment plants and wastewater treatment facilities for their use in agriculture.
11. Fresh animal manure is processed into organic manure, suitable for use in crop production.
12. Any waste from the agricultural sector of organic nature can also be processed.

The main positive effects of the application of the circular model between the agricultural and forestry sectors are:

13. No harmful emissions and secondary waste are released.
14. The construction and disposal in landfills for non-hazardous waste and sedimentation lagoons are becoming meaningless.

1. Helps sustainable development and environmental protection by utilizing renewable biological resources in the agricultural and forestry sectors.
2. Reduces the anthropogenic impact on the agroecosystems by reducing the share of conventional mineral nitrogen and phosphorus fertilizers used for the soil. This in turn leads to the protection of agricultural systems and the production of cleaner and healthier food throughout the production-consumer chain.

Wood from the forest sector can also be used in the packaging of bottles of wine and other food products (sawdust), as well as glass packaging with wooden lids and wooden packaging. (Marinova, V., Stoyanova, A., Kirechev, D., 2021). As successful examples from Bulgaria, we can point out “Burkani.bg”, “Unipack” JSC, “Propac”, “Beis” and others.

Other examples of companies which successfully applied the circular economy model in Northeastern Bulgaria are: “Perpetuum Mobile” JSC which belongs to the Holding Company of Albena. The company uses the waste materials from buffaloes, cereals, vegetables, oilseeds and fruits from the company "EcoAgro" JSC, again part of the holding company of "Albena" for the production of biogas. For this purpose, the company “Perpetuum Mobile” JSC has an installation for the utilisation of waste from the agricultural sector. It produces electricity and heat through the indirect use of biomass. Through the used plant and with the help of some wood pellets the company heats part of its greenhouses for vegetables.

In Bulgaria, many companies produce wooden garden furniture, toys, packaging, ornaments, accessories and structures. Their waste materials, such as cut wooden boards which are small or with irregular shapes, can be used to create garden wooden tools, small wooden swings, birdhouses, wooden wind vanes, sandpits, wooden support pegs and others. Examples of companies that produce garden furniture, gazebos, swings, wooden toys, children's wooden houses, wooden playgrounds and many others in Bulgaria from such materials are "Wooden Paradise", Dobrich, “OhoBoho's e-shop”, etc.

4. CONCLUSIONS

In conclusion, we can summarize that the application of wood waste in the agricultural sector is large and can be sought in a number of areas such as mulching, packaging, components of granular fertilizer, pellets for heating greenhouses, biogas production, growing different types of mushrooms, creating wooden houses for birds, dogs, cats, benches, building support structures and decorative wooden panels in parks and gardens.

Waste from the agricultural sector can also be used for mulching. Straw or mowed grass can be a resource instead of being agricultural residual material that is not used. They can be used to produce pellets for heating, but most importantly the two sectors can coexist and thrive together. This means that the forestry and agricultural sectors are excellent in creating conditions for the implementation of the circular economy model. The Ministry of Agriculture in North America has developed an agroforestry management system which can be used for the development of good practices around the world in the direction of combining and applying the model of the circular economy. It is clear that there is a connection between the sectors. The relations that can be sought in the future in this direction are significant.

Acknowledgements: We would like to thank the owners of "Water Recycling Technologies BG Varna" Ltd., who were so kind to provide us with the necessary information for our research on the joint application of a circular model in the forestry and the agricultural sectors. We would like to express our gratitude to the manager of the landscaping and garden equipment company "Erika", as well as to the owners of the company "Mimosa" and "Wooden Paradise". All of them were extremely well-meaning and dedicated, providing valuable advice and useful facts for the needs of our research.

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VALUE ENGINEERING IN PRODUCT QUALITY MANAGEMENT APPLIED IN THE ENERGY EFFICIENT WOOD CONSTRUCTION

Renata Stasiak - Betlejewska

Abstract: The aim of a paper is to present value engineering as a product quality management tool in theoretical and empirical terms. In the article, the analysis of the literature in the field of value engineering, the analysis of added value and the analysis of empirical data were adopted as the research methodology. The result of the conducted analyzes is an increase in the level of product quality in line with the proposed value engineering model. The innovation of the article is an attempt to build a project value engineering model, within which an analysis of the added value for the client was made.
Keywords: Value Engineering, product quality, management, wood construction

1. INTRODUCTION

Value engineering began at General Electric Co. during World War II. Because of the war, there were shortages of skilled labour, raw materials, and component parts. Lawrence Miles and Harry Erlicher at G.E. looked for acceptable substitutes. They noticed that these substitutions often reduced costs, improved the product, or both. What started out as an accident of necessity was turned into a systematic process. They called their technique “value analysis” [McGill University 2022].

Value engineering (VE) has been founded as methodology u U.S. Navy in 1954. Definition of American Society for Value Engineering SAVE says that value engineering is identified as systematic use of recognized methods, which identify the function of the product or service, they establish value of this feature and provide the necessary reliability of functions at the lowest cost total. The function should be realized at the lowest possible the cost of the product (service) life cycle consistent with the requirements: qualitative, maintenance, safety, aesthetics.

Value engineering is constitutive analysis a key element of target cost accounting - the stage at which it comes to developing proposals to improve the effectiveness of the project. Engineering in general value is defined as a structured analysis of all features functionalities created in the project value chain carried out in order achieving the target project cost while meeting the requirements customer [Łada, 2007].

Value engineering is identified as a systematic method to improve the "value" of goods and services by using an examination of function. Value, as defined, is the ratio of function to cost. According to assumption of VE methodology, value of the product or service can be increased by improvements within its functionality or cost reduction [McGill University 2022].

Value engineering became more popular as the part of teaching courses related to the project management or industrial engineering since the value of the project outputs can be optimized analysis of the function or the cost.

According to Document No. FHWA-2012-0046 Value Engineering (VE) is defined as a systematic process of project review and evaluation at the concept and design stage, carried out by an interdisciplinary team of people not related to the project, the purpose of which is to provide recommendations regarding:

- essential functions ensuring safety, reliability and efficiency at the lowest total cost,
- improving the quality and increasing the value of the project,
- reduce the duration of the project.

Value Engineering is related to the Value methodology that can be applied to a wide variety of applications, including industrial or consumer products, construction projects, manufacturing processes, business procedures, services and business plans.

The value methodology is commonly applied under the names Value Analysis (VA), Value Engineering (VE), and Value Management (VM). These terms can be used interchangeably with value methodology throughout the standard and this document. Other value improvement processes also qualify as value studies as long as they adhere to the Value Standard's Job Plan and perform Function Analysis as part of their total process. This Standard has been prepared by the SAVE International Standards and Resources Director, a member of the SAVE International's Vice President of Education's team. It seeks to state the minimum that clients and providers should expect when the value methodology is applied to a project. This Standard will assist managers, value program managers, practitioners, and trainers in applying value methodology in their organizations in a consistent, standard manner. It may also assist those who procure value methodology services to develop proposal requests that ensure they receive complete and useful value methodology services [Miles 1972].

In the literature qualitative value engineering approach has been identified as one of the methods of shaping quality in financial institutions and a program to improve the level of quality; in other words, a continuous process of streamlining operations and improving the level of services in a banking company - formulated as the sum of the guidelines of such precursors of quality management as William Edwards Deming, Joseph Juran, Armand Feigenbaum and Philip Crosby. A significant contribution to the development of this concept is also made by Leonard L. Berry, who stated that increasing the level of service quality may become an effective strategy of the company on the way to increasing profits [Roszkowski 2002, Delekta 2012].

The essence of qualitative value engineering can be summarized in four points [Grey and Harvey 1995]:

- The approach to costs takes place from the point of view of the identification of factors influencing the emergence of costs, and not on the reduction of individual components of these costs.
- The importance of organizational changes in financial institutions.
- Treating customer service only as part of the quality improvement program, not an end in itself.
- Orientation of qualitative value engineering to long-term effects.

2. VALUE ENGINEERING IN THE WOOD CONSTRUCTION EFFICIENCY ANALYSIS

Value Engineering as an ordered method application include: function identification, setting the price of the function, creating alternative ways to achieve the function without detriment to the desired quality (broadly understood).

According to the Handbook on Systems Engineering provides a multi-step process for VE presented in the following (Fig. 1).

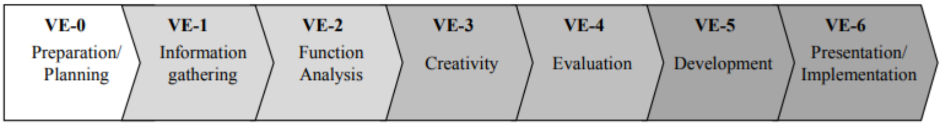

Figure 1. Process of value engineering.
Source: Haskins 2010.

In the construction, there are two different variants of the use of value engineering:
1. at the design stage - selection of the optimal solution material or design,
2. at the tender stage - selection of the best alternative.

According to the design stage, the construction is that field of material production, which is fosuced on meeting production and consumtion needs by manufacturing of the construction assets production and its maintaining in working order. The production processes are referred to appropriate methods of products/items manufacturing that are characterized by a specific set of features. Processes engineering is a system of knowledge, which consists of issues such as [Stasiak-Betlejewska 2013]:
- technological quality of production items, which requires the knowledge of the methodology for isolating and quantifying the characteristics of the objects produced in the process,
- ergonomics of the production processes - specifying the eligibility requirements,
- technical equipment of the production processes or knowledge of current conditions, opportunities and constraints of the process equipment, process automation,
- technology of the manufacturing processes or knowledge of selecting and shaping the production course, transportation, storage, inspection and maintenance of technical equipment necessary for the production processes of specific products,
- organization of the production processes, what means the principle of model development or model selection for the production of objects characterized with the certain technology quality,
- economy of the production processes, what means the development of criteria and methods for the selection of process models in the current socio – economic conditions.

An important issue is also the engineering process structure of building materials, which includes issues such as: construction materials use quality, ecology of materials, processing technology, materials changes course control and economy of creating and using materials.

In today wood construction efficiency the product quality is a set of features that meet specific market requirements as well as meet the specific needs of customers in the form of implementation of their specific functions related to following wood material quality: structural safety, fire safety, and security as well as protection against noise and energy savings.

It is important to underline that the building durability is the ability of a building to perform its function for a limited period of time and it may reduce its value in use. Value engineering methodology applied in the wood construction energy efficiency analysis enables analysis of the functions in the context of the civil engineering standards on the energy efficiency, customer requirements and its value in the production process planning.

The content of the value engineering analysis applied in the wood construction energy efficiency analysis in the context of the product quality was performed in model proposed in table 1.

Table 1. The content of the value engineering analysis in the context of wood construction energy efficiency – author's proposal.

Analysis of the product quality	**Product quality result in the production process**	**Nonconformities identified in the production process**
	quality level of applied materials	nonconformity
Analysis of the production process	operations	operation
	result of the operation	number of nonconformities
Required state of the product according to: ● **civil engineering on energy efficiency** ● **customers' needs**	● conditions of the wood construction with regards to the energy efficiency ● the house construction quality	required state of the production result

Table 1 shows the importance of the quality level analysis on the every stage of the manufacturing process with regard to applied materials, its quality level and clients requirements that should be met in the every result of the every operation on the production process. The analysis should be done with value engineering applying because the value of each production stage should be assessed in the context of the final result comparing with the production function required by the client.

In accordance to proposed model, the project construction application can be prepared (Figure 2).

Figure 2. Model of value engineering analysis in the construction project.

3. CONCLUSIONS

Value engineering is related to the the cost analysis that enables to compare different series of expenses by presenting them in terms of "present value". In this way, alternative solutions with different financial outlays at different time frames and select the most cost-effectiv version can be compared. Product life cycle elements concerns: the design lifetime of the facility, material life (material durability), annual maintenance costs, rehabilitation or reconstruction,discount rate and inflation and change of Terms of Use.

Combining elements of technique and economy by applying value engineering methodology allows spend money more rationally and make objective decisions on selection of technical solutions.

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GLOBAL INVESTMENTS MANAGEMENT DIRECTIONS IN TIMBER CONSTRUCTION

Renata Stasiak – Betlejewska, Emilia Grzegorzewska

Abstract: Mass timber will shape the future of low carbon construction and develop the bio-economy. Paper includes review of national and global policies on the timber construction development and its investments according to temporary conditions. Opportunities and recommendations for domestics timber construction markets are result of the analysis.
Keywords: investment, management, timber construction

1. INTRODUCTION

Timber construction sector is a large contributor to greenhouse gas emissions and consumes the vastest amount of natural resources. Widely considered a hard-to-decarbonise sector, improvements in buildings and construction are of fundamental importance for national and global targets to combat climate change. At material level, mitigation opportunities exist in terms of efficiency (using less of the same material) and substitution (using a different material) [D'Amico et al. 2021].

Timber for construction is one of the many forest products used around the world. It is used in buildings both large and small. While there are limitless possible designs, and construction is based in both engineering and cultural practice, timber has a high strength to weight ratio, and is used most efficiently in structures where it is carrying a lot of its own self-weight. Construction-grade timber and engineered forest products are some of the highest value products from trees. This suggests that structural use is important for economies that rely on forestry. Timber can have economic benefits for construction, as modern timber is largely factory prepared and brought to site for rapid assembly [Ramage et al. 2017].

According to reports, over the past 20 years, global timber consumption has increased by 1.1% per annum, driven by increasing urbanization and global housebuilding requirements. Over the next 30 years, Gresham House expects timber consumption to rise by 3.1% per annum. This will be driven by: urbanization, decarburization, increased housebuilding. Globally, the vast majority of countries have set significant targets to reduce carbon emissions towards net zero by 2050. Timber will play a critical part in this transformation. In result of the urbanisation and decarbonisation the growing statistics on low carbon intensity buildings being built from timber has been observed. It is forecasts a double timber consumption increase in the next 30 years as the supply demand imbalance that will result in increased timber prices over the medium to long term [Global Timber Outlook 2020].

Mass timber, which uses prefabricated solid wood panels for low- to mid-rise construction applications, is already becoming popular in Europe and shows increasing commercial potential worldwide. Substituting mass timber for concrete and steel can reduce greenhouse gas emissions in construction without compromising quality, though the net effect of mass timber on the climate also depends on its land use impacts. Ongoing research into these impacts, along with emerging efforts to integrate forest restoration projects into mass timber supply chains, could ultimately shed light on the potential value of mass timber for carbon removal [Beyreuther et al. 2017].

Mass timber is lighter weight than steel and concrete but it rivals or exceeds these traditional building materials on durability, seismic performance and fire resistance. The use of mass timber panels can bring significant cost savings for construction projects and reduce construction time by up to 25%. Mass timber is also less sensitive to temperature changes, making structures more energy efficient. Substituting mass timber for concrete and steel produced with traditional manufacturing processes reduces emissions from construction by 25-40%. Using mass timber for 90% of new urban buildings could prevent nearly 8bn tons of CO_2 emissions by 2050, equivalent to a 4% annual reduction in global emissions from manufacturing and construction as a whole [Churkina et al. 2020; Liang et al. 2019; Padilla-Rivera & Blanchet 2017; Pierobon et al. 2019]. However, assessments of the emissions benefits of mass timber do not include the effects of increased timber demand on forest land use and management, both of which affect mass timber's overall value for climate mitigation [Pierobon et al. 2019].

Until recently, massive timber construction required an alternative approval process under the International Building Code (IBC), which increased project costs and schedules. Changes made in 2021 remove this obstacle by allowing timber buildings up to 18 stories high. Building regulations in some European countries have already been adapted to allow even taller wooden buildings. Policymakers are also trying to accelerate massive timber construction through an incentive system. For example, legislation proposed by the U.S. Congress in 2020 would provide a tax break for buildings made of materials that reduce energy consumption and store carbon, including bulk timber. Recent design developments further emphasize the expanding possibilities of building wooden houses. For example, the Japanese Sumitomo Forestry Company proposed a 70-story wood and steel tower to commemorate its 350th anniversary in 2041. These policies have increased the use of timber in public housing, schools and other government buildings.

The biggest new idea in sustainable building is also one of the oldest construction materials around: timber. But this isn't ordinary wood. Cross-laminated timber, as it's known, is arguably the first major structural innovation since the invention of reinforced concrete more than 150 years ago. Cross-laminated timber itself has been in use for decades, particularly in Austria and Germany. Interest in the material is surging along with concern about the greenhouse-gas emissions associated with concrete and steel. The production of construction materials such as steel, cement and glass accounts for 10% of global energy-related CO2 emissions, according to a United Nations report [Henry 2021].

2. GLOBAL STATUS OF THE CONSTRUCTION AS THE IMPACT OF COVID-19

According to Global Status Report for building and construction (2021) and International Labour Organization, the year 2020 marked a consequential year for buildings and construction. The COVID-19 pandemic greatly impacted the construction of buildings, resulting in a historic drop in new building, and also led to a change in the way that existing buildings were used. During the 18 months following the onset of the COVID-19 crisis, the global buildings and construction sector saw the depths of what a pandemic can affect, from construction sites being left empty for months during lockdowns, to the financing of construction being disrupted, to the way supply chains for materials reacted to sudden drops and surges in demand [International Labour Organization 2021]. In 2020, the average annual growth rate in buildings and construction worldwide dropped an estimated 4% from 2019 levels [OECD 2021]. This decline in market growth was due primarily to the pandemic's profound impacts on construction activities, including the effects of lockdowns on the labour supply, the limited demand for new buildings, the slowdown in public and private procurement, and the disruptions in the supply chain. The impacts of COVID-19 on the output value of the construction industry varied widely globally. Some European economies suffered considerable construction impacts, with the output value in real terms dropping an estimated 13.2% in France and 14% in the United Kingdom from 2019 levels [GlobalData 2021a; GlobalData 2021b; GlobalData 2021c]. Germany experienced only a 1.8% reduction in construction value in real terms in 2020 and it show a 2.8% increase in the growth rate of construction for the year [GlobalData 2021d].

It was also observed that implications of the pandemic and associated measures to control the spread of COVID-19 have had wide-ranging impacts on the building construction supply chain and the costs of materials [ILO 2021].

3. SUSTAINABLE BUILDINGS AND CONSTRUCTION POLICY

Energy efficiency and energy codes in buildings are the second most frequently cited actions within all Nationally Determined Contributions. Countries increasingly recognize that building energy codes are essential.

Achieving the Paris Agreement goal of limiting global warming to well below 2 °C requires a rapid decarbonisation of the economy, which, according to most climate-economic models, can only be done with the use of costly carbon-removal technologies. The decarbonisation of industry and material production, in particular, requires technological and organizational change and large investments into new energy infrastructure and factories. The median remaining lifetime of existing production facilities for cement and steel stretches to 2045, causing substantial lock-ins that impede decarbonisation efforts in this sector. Decarbonizing material production requires further technological development and will compete with other applications of low carbon energy, including electric transportation and low-temperature heat. Governments are hence assessing or implementing policy frameworks to reduce material demand, variously referred to as material efficiency (ME), resource efficiency, a sound material-cycle society, sustainable material management, or the circular economy. Material efficiency strategies in fabrication and waste management aim at prolonging the technical lifetime of engineering materials; they are also termed value-retention strategies and form the core of the circular-economy vision [Hertwich et al. 2019, Pauliuk et al. 2021].

According to EU Environment Programme (2021) overall investment in energy efficiency increased significantly in 2020, primarily through targeted government support in Europe. However, this relative increase occurred as most economies slowed and as the buildings and construction sector faced unprecedented challenges in demand, delivery and supplies. The need to meet the global lack of housing alongside the need to decarbonize the building sector means that more investment in improving existing buildings and in constructing buildings that are net zero emission is needed from all actors in the finance and investment sector. Efficiency investment is driven in part by the activity of the construction industry and its delivery of new buildings that are rated as low energy or sustainable, with their efficiency exceeding required codes. The second driver is investment in the renovation and refurbishment of existing buildings to have more efficient systems, which occurs either through direct investments by building owners, or through government policies using incentives and programmes [United Nations Environment Programme 2021].

4. INVESTMENTS DIRECTIONS

The industry's global annual labour productivity growth over the past 20 years was less than 1%, which is significantly less than the productivity growth of the global economy, approximately 2.8% a year. Construction-related spending accounts for 13 percent of global GDP.

Construction market characteristics have shaped an industry response with unfavourable outcomes that have been presented in the figure 1.

As it results from Figure 2, the lagging performance of the construction industry is a direct result of the fundamental rules and characteristics of the construction market and the industry dynamics that occur in response to them.

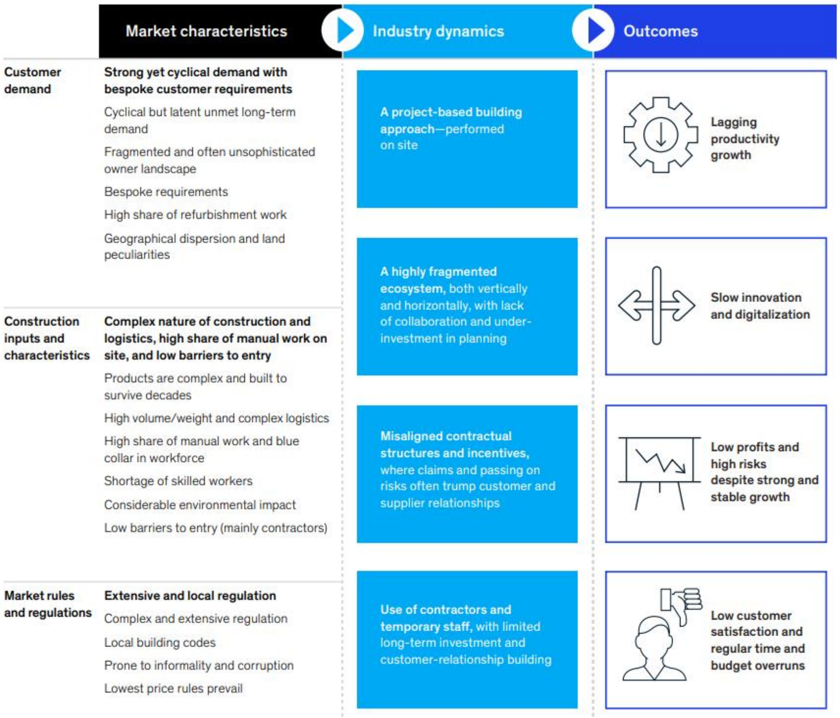

Figure 1. Construction market characteristics that have shaped an industry response with unfavourable outcomes [IHS Global Insight; ISSA – Infrastructure Stock & Spend Analyzer; World Bank; McKinsey Global Institute analysis]

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STRATEGY FOR SUSTAINABLE CONSUMPTION OF SOLID FUELS FROM WOODEN BIOMASS IN BULGARIA

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Abstract: The study analyzes the role of solid biomass fuels in ensuring sustainability in the consumption of heating fuels, the challenges facing industry to reduce their environmental impact and business opportunities as a part of sustainable development strategies. Emphasis is placed on the policies for ensuring the sustainability of the realized biomass fuels and their footprint in the production of pellets and eco-briquettes in the role of fuels from renewable sources. The economic, social and environmental contribution to the production and consumption of solid fuels from biomass in the context of sustainable development in Bulgaria is studied. As a result of the analysis, conclusions are drawn on: the importance of solid biomass fuels in Bulgaria will continue to influence the sustainability of the economy; the requirements for ensuring their environmental contribution are increasing; the solid biomass fuels market is dynamically developing; the importance of the forestry sector and the wood processing industry is increasing.
Keywords: sustainable consumption, sustainable development, renewable energy, wooden biomass

1. INTRODUCTION

The heating sector consumes nearly 50% of the EU's energy, with 75% of the energy consumed based on fossil fuels (European Commission, 2016). The lack of an EU-wide strategy is a prerequisite for the fragmentation of local markets and, together with the increasing uncertainty of the investment process as well as the difficulty to choose fuel sources based on their preferences, are the basis to look for common solutions.

Achieving economic growth, protecting the environment and improving the quality of life in Bulgaria's development policy implies the application of criteria for the use of renewable energy sources. The implementation of policies on the utilisation of alternative fuels is an opportunity to adapt to local conditions in the most cost-effective way. The EU's adopted policy on the promotion of the use of energy from renewable sources (DIRECTIVE (EU) 2018/2001, 2018) is aimed at fulfilling the Union's commitments under the 2015 Paris Agreement on climate change, improving security of energy supply, improving efficiency of energy use, reducing pressure from resource use, etc. An ambitious EU target in this respect is to achieve a 32% share of renewable energy in 2030, considering the importance of biomass in providing gaseous and solid fuels for transport and heating.

The requirements of the EU legislation are aimed at strengthening the existing EU sustainability criteria for biomass energy production. New points in the regulatory framework are the introduction of risk-based criteria for the sustainability of forestry biomass extraction from forestry, ensuring adequate consideration of the carbon impacts of using forestry biomass for energy generation. The greenhouse gas emission reduction requirement is increased to 70% for new installations and an 80% emission reduction requirement is applied for biomass-based installations for heating or electricity generation. A common methodology with defined greenhouse gas accounting values for solid biomass fuels used for heat and electricity is adopted.

The growing importance of energy as a political and economic challenge and its close interconnection with such areas of energy policy as security of energy supply, climate change, the intra-European market, and economic and business development determine the relevance and topicality of the issues at hand. The subject of this paper is the place of solid biomass fuel consumption (briquettes and pellets) in the national energy system and its sustainable development in Bulgaria. The aim of the paper is to analyse the role of solid biomass fuels in ensuring sustainability in the consumption of heating fuels, the challenges faced by the industry in reducing their environmental impact and the opportunities for business as part of sustainable development strategies.

2. WOODEN BIOMASS AND RENEWABLE ENERGY

Solid biomass fuels are part of the group of secondary fuel sources because they are derived from biomass from forestry and agricultural production and can be a serious alternative to current traditional fossil fuels. Forestry and related sectors are key actors for the implementation of alternative energy strategies.

When used as a fuel, wooden biomass energy has some environmental advantages over fossil fuels - it is a renewable resource, the amount of carbon dioxide emitted when it is burned is much less, wooden fuel contains minimal amounts of sulfur and heavy metals, and does not pose a threat to acid rain, suggesting the use of lighter and cheaper means of combustion. This allows, if sustainably produced and used, wooden biomass to become a significant source of renewable energy. Furthermore, wooden biomass can be stored easily without wasting energy. Currently, the main biomass energy sources are considered to be: logs, trees and timber; wood chips; wood bark; fuel pellets and wood briquettes, etc. When considering specific forms of wooden biomass for energy or as fuel, it is important to ensure that the quality and characteristics of the wood fuels are suitable for the appliances chosen.

As the costs of fossil fuels such as coal, natural gas and fuel oil continue to rise, the use of a wood fuel heating system will become increasingly attractive if wooden biomass fuel is easily supplied or the cost comes down. Increasing concern for the environment (by reducing the use of fossil fuels) will increase interest in the use of wood as a sustainable, low carbon renewable alternative. Wooden biomass is expected to become an increasingly important alternative source of energy, providing people with a source of renewable thermal energy.

2.1. Wooden biomass in the scope of Sustainable Development Strategies in EU

Biomass is seen as organic matter that can be used for energy production or other purposes. In many cases biomass is a waste, which increases its importance in a circular economy. Wooden biomass is organic matter obtained directly from forests and the wood processing industry. The environmental benefits of wooden biomass are associated with zero carbon emissions for its cultivation and relatively low emissions for its processing and transportation, which ensures a relatively high percentage in the reduction of greenhouse gases when used as solid fuel (Annex IV, (DIRECTIVE (EU) 2018/2001, 2018)). In this sense, expanding the use of wooden biomass can be very successfully included in the EU targets aimed at reducing greenhouse gas emissions by at least 40% compared to 1990; increasing energy efficiency to at least 32.5% and achieving 32% use of renewable energy by 2030. To achieve these sustainability criteria, it is necessary to improve the environment and implement requirements for national and international schemes to set standards for the production of biomass products.

EU Member States are expected to provide sufficient flexibility in the period up to 2030 to develop appropriate support mechanisms in line with renewables, technology maturity and technology-specific risk profiles and characteristics. In its opinion, the EU Standing Forestry Committee, the initiator of legislative action in the field of forestry, supports the option of introducing risk-based sustainability criteria for forestry biomass.

The implementation of strategic actions in the field of biomass utilisation can be traced back to market dynamics in the world and the EU. This increases the contribution of wood pellets as a sustainable solution to EU energy and climate goals. According to Bioenergy Europe (Bioenergy Europe, 2020), in the EU 59% of the energy consumed from renewable sources is generated from bioenergy, with 70% of this coming from solid biomass. Wood chips and pellets are increasingly used for renewable energy and heat production. Globally, pellet production is growing at around 5% per year and EU production growth is around 4% per year. The EU is becoming one of the largest producers of wood pellets in the world with a production of about 18.5 thousand Mt in 2020, recently overtaken by China and followed by Canada. According to The European Biomass Association (AEBIOM), production doubled in 2020 compared to 2011. Over the same period, there was an increase in imports from 3.1 thousand Mt in 2011 to 12.5 thousand Mt in 2020 the EU is defined as the largest market for wood pellets in the world with a consumption of 30.8 thousand Mt in 2020. While the EU produces almost 30% of world production, EU demand represents almost 50% of the world market. The main users of wood pellets are the United Kingdom, Italy, Denmark, Germany, Sweden, France, Belgium, the Netherlands and Austria. For the period 2011-2022 the demand for wood pellets is determined mainly for residential needs (39-55%), and industrial use (more than 5 MW) is about 45-61%, and in recent years the share of industrial use is growing. Consumption for housing purposes is determined by winter temperatures, fossil fuel prices and subsidies or tax breaks (in some countries Sweden, Germany, Austria, France, Spain, the Czech Republic). The largest market for wood pellets for domestic use is Italy, followed by Germany and France. Industrial demand for wood pellets dominates in the United Kingdom, Belgium, and the Netherlands, where demand for housing is low and used in small power plants that rely mainly on raw material imports. The use of wooden biomass for electricity generation in Central Europe is also growing. In the context of the COVID-19 crisis, the demand for wood pellets was less affected than other biofuels, as most of the consumption is in the housing and public heating sector.

Production capacity in the EU for the production of wood pellets is growing by about 4-5% per year, growing from 15 thousand Mt in 2011 to 25 thousand Mt in 2020. The business sector is mainly represented by small and medium enterprises, such as their number increases from about 500 in 2012 to 720 in 2018. The largest producer of wood pellets in the EU in 2019 is Germany with about 2.8 thousand Mt, followed by Sweden, Latvia, France, Austria, Estonia, Poland. Most of these countries have a significant domestic market for residential heating pellets. The main producers are small and medium enterprises, and the main raw material for pellets is traditionally sawdust, with increased interest in the processing of wood waste and agricultural raw materials. According to the USDA (USDA, 2020), the production of wood pellets in the EU is not expected to keep pace with growing demand from both the domestic heating market and electricity generation.

Demand for pellets in the EU has significantly outpaced domestic production in the last ten years. The largest importer of wood pellets in 2019 is the United Kingdom (8.7 thousand Mt), followed by Denmark (3.1 thousand Mt) and Italy (1.8 thousand Mt). The main exporters to the EU are the United States (6.8 thousand Mt - mainly for the United Kingdom), Russia (1.7 thousand Mt) and Canada (1.6 thousand Mt). In response to the demand for industrial pellets in the EU, supply capacity is expanding, but imports from third countries may be affected by the implementation of sustainability requirements by the EU government, which increases opportunities for internal trade within the Union.

2.2. Wooden biomass in Bulgaria

Bulgaria has a developed forest sector and potential for the production of wooden biomass products. According to national statistics (NSI), the production of wooden biomass products in Bulgaria (mainly pellets and briquettes) shows a continuous increase - from 84 thousand Mt in 2012, to 126 thousand. Mt in 2016 and 215 thousand Mt in 2020, and this increase is mainly due to an increase in pellet production - from 66 thousand Mt in 2012, to 111 thousand Mt in 2016 and 204 thousand. Mt in 2020 The growth in pellet production in Bulgaria is a consequence of increased demand in the EU and rising domestic demand for heating. Consumption of wooden biomass is mainly for residential heating, to a lesser extent for energy production. In Bulgaria, the share of households using wood for heating remains high at around 1.8 million households (around 60%), with 1.2 million (40%) heating on wood alone. Rising firewood prices in recent years have predisposed more households to replace firewood with wood pellets and briquettes. In addition, an increasing number of public sector (municipalities, schools, hospitals, hotels, etc.) have implemented pellet heating projects. During the same period, the import and export of wooden biomass increased significantly. Imported quantities reach 80 thousand Mt (98% pellets), and exported quantities increase to 196 thousand Mt - mainly for the EU (Greece) and Turkey. Domestic consumption increased from 63 thousand Mt to almost 100 thousand Mt. in 2020. In recent years, both the production and consumption of pellets and wood chips have increased. Despite rising pellet prices, these products are becoming increasingly popular for both domestic consumption and export. The pellet sector in Bulgaria also showed great resilience to COVID-19, as it did not significantly affect the activity of wood processing.

The increase in the importance of wooden biomass is also confirmed by the data of national statistics related to the management of wood processing waste. In the period 2016-2020 there is an increase in the generated wood waste from 265 thousand Mt in 2016 to 483 thousand Mt in 2020, as the recovered wood waste increased from 247 thousand Mt in 2016 306 thousand Mt in 2020 Mt. This is strong evidence of the growing role of the sector in the circular economy.

The improvement and optimization of the production and consumption of wooden biomass products in Bulgaria implies the provision of legal, financial, organizational and other regulations to encourage more efficient use of wooden biomass for heat and energy production.

2.3. Bulgarian legislation and strategies in the field of wooden biomass

The national policy and legislation in the Republic of Bulgaria regulating the management of wooden biomass in the last decade has evolved in response to changes in European legislation and changing market and political conditions. In response to Directive 2009/28/EC of the European Parliament and of the Council (replaced in 2018 by DIRECTIVE (EU) 2018/2001), a National Renewable Energy Action Plan was adopted in 2012, which set out specific measures to promote the use of biomass - including plans to increase the production of processed biomass heating and improve energy use by replacing conventional boilers with higher efficiency wooden pellet chambers.

In the context of European legislation on climate change mitigation and the promotion of renewable energy at the expense of fossil fuels, an Integrated Energy and Climate Plan for the Republic of Bulgaria 2021-2030 was adopted in 2020. The main objectives of the plan are to stimulate low-carbon development of the economy; competitive and secure energy. The main dimensions of the plan are towards decarbonisation, increasing energy efficiency, achieving energy security, improving the domestic market and stimulating research and innovation. The plan attaches increasing importance to the use of plant and wooden biomass for energy production.

The National Action Plan for Forest Biomass Energy 2018-2027, adopted in 2018, is a framework for policy action in the field of wooden biomass. The objectives of the plan are aimed at creating preconditions and ensuring conditions for a coherent and coordinated policy on the use of forest biomass. The main priorities of the plan focus on: sustainable biomass production; efficient biomass energy production; reducing air pollution; strengthening the legal framework, improving scientific capacity and ensuring user awareness. Efforts in this direction should ensure that the growing demand for wooden biomass does not conflict with the sustainable production and consumption of wood from the forestry sector.

The environmental policies of the Ministry of Environment and Water, including in the waste management sector, are aimed at successfully implementing the transition to a circular economy so that the value of products and materials is preserved for as long as possible and waste generation is minimised. In order to promote the use of waste as a resource, Directive 2008/98/EC on waste has been harmonised in the Waste Management Act (WMA) and allows certain production waste to be defined as a 'by-product' and certain waste that has gone through a recovery process to cease to be waste.

After 2020, Bulgaria is expected to make the transition from the use of primitive biomass to the use of modern biofuels from it, enabling combustion in high-tech appliances and heating facilities. Studies have shown that the possible EU obligation to include alternative fuels would be a very effective measure to increase the consumption of sustainably produced fuels - eco-briquettes and pellets. The public consultation on sustainable biomass energy production at EU level also reports a divergence of views on the benefits and risks of biomass energy, as well as on the need for a new EU policy (PricewaterhouseCoopers EU Services EESV's consortium, 2017). The results confirm that the policy needs to stick to the main objective, namely the sustainability of the economy with the use of biomass and climate mitigation.

3. CONCLUSION

The recent rise in energy and gas prices has raised the question of the EU's dependence on natural gas. This has posed economic challenges for the population to pay high prices for energy and for industry to reduce its competitiveness. In this context, biomass energy has a huge potential to provide efficiency and at the same time to contribute to decarbonisation. Wooden biomass has maintained a relatively constant price and has been relatively little affected by the pandemic, providing new opportunities for the sector. Forest biomass is an important source of bioenergy and accounts for more than 2/3 of EU bioenergy consumption. For both environmental and economic reasons, 74% of primary material for pellets and 62% of primary material for wood for energy purposes are by-products of the forest and wood processing sector.

In conclusion, the following conclusions and generalizations can be drawn: 1) In the coming years, solid biomass fuels will continue to effectively influence the sustainability of the EU and Bulgarian economy in the context of waste and by-product recovery from different sectors of the economy. Solid wooden biomass will continue to be seen as a widely used renewable source of heat and energy in the country, with wide availability and social acceptability for the population. 2) The requirements for ensuring their environmental contribution in biofuel production and consumption are being increased towards quantifying carbon emissions to meet these challenges. 3) The pellet market is dynamic and Bulgarian producers can take advantage of the favourable opportunities they have to produce at lower costs in line with the principles of subsidisation in implementation of the adopted policies. 4) The environmental benefits of using solid biomass fuels are great and they fit very well with the current EU policy for developing a sustainable and low carbon economy.

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COMPARATIVE ANALYSIS OF THE TAX BURDEN OF WOOD PROCESSING ENTERPRISES IN THE CZECH REPUBLIC

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Abstract: Wood processing enterprises (CZ-NACE 16) in the Czech Republic contributed with their production 0.46 – 0.72% to the total gross value added of the national economy in 2010 – 2019, with the lowest share at the peak of the bark beetle calamity. In Austria, for example this trend was reversed. The share of these enterprises in the gross value added of the national economy of the Federal Republic of Austria over the same period was 0.73 to 0.86%, with the peak at the height of the Central European bark beetle disaster.
The content and aim of this paper is to analyse the tax burden of enterprises in CZ-NACE 16 according to the revenue collection of individual types of taxes and to compare them with enterprises in the same sector in selected countries of Central or Western Europe. The results of the analysis will be available to the industry, public and political authorities to address the development of wood processing in the Czech Republic and the search for an optimal arrangement of the wood processing structure, taking into account the current limitations of raw wood resources and possibilities of processing with additional added value.
Keywords: enterprises, wood processing, CZ-NACE 16, tax burden, analysis, Czech Republic

1. INTRODUCTION

There are many definitions of the term 'tax' in literature, both domestic and foreign. They all say that a tax is a compulsory and non-refundable contribution to public finances stipulated by law (see Bailey 2004; Vančurová, Láchová, 2018, for example). In the Czech legal system, a tax is also defined by the Tax Code (Act No. 280/2009 Coll.). In the Czech Republic, the obligation to pay taxes is stipulated in the Charter of Fundamental Rights (Constitutional Act No. 2/1993 Coll.).

In each country, the tax system is set out by the relevant legislation; hence taxes in the individual countries can differ significantly (see the European Union, 2015). The tax system of a particular country always reflects its specific economic conditions. It is no coincidence that tax legislation is one of the most frequently amended ones in all countries in the world. Impacts of economic strategies on the tax burden of undertakings were studied, for example, by Dang, Hang, He (2019), or Delgado et al. (2019) in the EU.

The Member states of the European Union also lay down their rules for defining tax types, tax bases, and tax rates, including tax rebates (Barrions, d'Andria, Gesualdo, 2020). Within a tax system, taxes are usually structured into direct and indirect taxes; states seek an optimum ratio of the two parts to make taxation effective. The theory of optimal taxation was addressed by Saez (2004) and Boadway (2013), for example.

Company taxation is another area where EU countries decide on their own tax rules (European Union, 2015). The fragmented European tax system burdens groups of undertakings active in various EU countries and hence are subject to various national tax systems (Martens-Weiner, 2006; Barrions, d'Andria, Gesualdo, 2020). Therefore, the EU seeks to harmonise the tax systems. McLure (2008) and Delgado et al. (2019) examined the issues of harmonisation in the EU and its impacts.

Assessing the overall tax burden in the individual countries and sectors is a very complex process. International comparisons and analyses are made using Tax-to-GDP ratios, particularly the overall Tax-to-GDP ratio (see, e.g. Szarowská, 2010). Institutions that regularly publish the tax burden in individual countries include Eurostat and Organisation for Economic Co-operation and Development (OECD).

This article brings a comparative analysis of the tax burden imposed on wood-processing undertakings. According to the Classification of Economic Activities, such undertakings are categorised within CZ-NACE 16 – Timber processing; production of wooden, cork, wicker, and straw product, excluding furniture. This sector is a downstream sector to CZ-NACE 02 – Forestry and timber harvesting, on which it depends. Consequently, it is evident that the wood-processing sector is also affected by the massive depletion of coniferous, predominantly production forests in Central Europe (e.g. in Austria, Germany, Slovakia, Poland, and, above all, the Czech Republic) that has been occurring over the last decades due to climate changes and spread of insect pests (see e.g. Grodzki, Jabłoński et al. 2019; Bárta, Lukeš, Homolová, 2021).

The article aims to analyse the tax burden of undertakings classified within CZ-NACE 16 based on the collection of the selected tax types and compare it with the tax burden of undertakings of the same sector in the selected countries of Central and Western Europe. The results of the analysis will be available to the industry as well as public and political bodies; they can be used to address the development of wood processing in the Czech Republic and to find the optimal structure of wood processing with respect to the current limitations in raw wood sources and opportunities for processing with added value.

2. MATERIAL AND METHODOLOGY

The research method was divided into two phases. The materials needed to have inputs for the first phase were obtained through desk research from a review of available literature and statistical data from Czech databases or databases of other European organisations and companies. Primarily, the Czech Statistical Office (CSO) and the European Statistical Office (Eurostat) databases were used. Czech tax legislation and specifics of the Czech tax system were analysed to establish the structure of the Czech tax system, the set tax rates, and the calculation methods used.

The tax burden in the individual EU member states is compared using the Eurostat method of the overall tax-to-GDP ratio, the so-called compound tax quota. Data are collected by Eurostat on the basis of the European system of national and regional accounts. Compound tax quota is calculated as follows (Szarowská, 2010):

$$Compound\ tax\ quota = \frac{tax\ revenues + quasi\ taxes}{GDP} \times 100\ [\%]$$

The second phase involved obtaining detailed economic information and indicators of the CZ-NACE 16 undertakings in the Czech Republic so that their tax burden could be calculated. The data was obtained from the paid database of the Czech Statistical Office and the interactive browser of economic indicators in the processing industry – Panorama of the Manufacturing

Industry – run by the Ministry of Industry and Trade of the Czech Republic (Ministry of Industry and Trade, 2022). Two indicators selected on the principle of effective and adequate tax rate were chosen for the analysis of the tax burden:

$$Share\ of\ taxes\ in\ revenue = \frac{tax}{revenue} \times 100\ [\%]$$

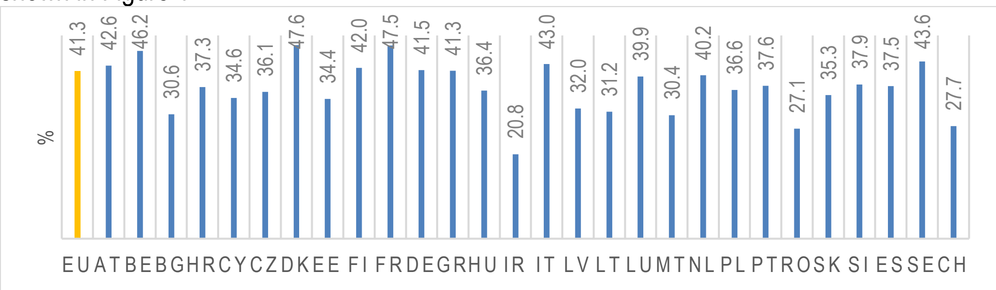
$$Share\ of\ taxes\ on\ EAT = \frac{tax}{EAT} \times 100[\%]$$

where: EAT…earning after taxes, tax…all taxes paid within the CZ-NACE in the Czech Republic (income tax will be included in the calculations in this paper)

For the conversion of Czech crowns to euros, the exchange rate tickets of the Czech National Bank (CNB) for the period 2010 - 2020 were used (Czech National Bank, 2022).

3. RESULTS AND DISCUSSION

According to the Eurostat Database (2022), the overall tax-to-GDP ratio stood at 41.3% in EU in 2020. The biggest tax burden in 2020 was in Denmark (the overall tax-to-GPD ratio was 47.6%), followed by France (47.5%) and Belgium (46.2%). The Czech Republic was somewhere in the middle with 36.1%, while the lowest value of the tax-to-GDP ratio was found in Ireland (20.8%). Since 2010, the tax burden in the EU has been continuously increasing, which is confirmed by the EU statistics (Eurostat, 2022). The tax burden in EU countries is shown in Figure 1.



Source: Eurostat, 2022

Figure 1. The tax burden in EU countries

The sources of tax revenue in the EU can be divided into three parts: labour, capital, and consumption. Tax revenues from labour account for the biggest part, specifically about a half of all tax revenues; tax revenues from consumption and capital amount to approximately 30% and 20%, respectively (European Union, 2015).

Enterprises in the CZ-NACE 16 wood processing sector contributed with their production 0.46 - 0.72% to the total gross value added of the national economy in 2010 - 2019, with the lowest share at the peak of the bark beetle calamity. In Austria, for example, this trend was reversed. The share of these enterprises in the gross value added of the national economy of the Federal Republic of Austria over the same period was 0.73 to 0.86%, with the peak at the height of the Central European bark beetle disaster. (Šafařík et al., 2021)

The table 1 shows selected performances of CZ-NACE 02 and 16 in the period before and in the peak of the bark beetle disaster.

Table 1. Selected CZ-NACE 02 and 16 outputs in the period before and at the peak of the bark beetle disaster

The beginning of the bark beetle disaster	Forest products production (in mil. €)				Manufacture of articles of wood and of wood products and cord, except furniture (CZ-NACE 16) on gross value added at basic prices 2015	
	in total		round timber			
	CZ	AT	CZ	AT	CZ	AT
2010	1,424	2,094	560	874	0.712%	0.736%
2016	1,928	2,104	697	855	0.534%	0.780%
2017	2,073	2,183	762	903	0.548%	0.780%
2018	2,003	2,242	831	953	0.505%	0.842%
2019	1,868	1,967	846	796	0.460%	0.855%

The table 2 shows the basic economic characteristics of business undertakings within the CZ-NACE 16 sector and the calculation of the tax burden of these subjects.

Table 2. Selected economic characteristics and calculation of the tax burden on enterprises

Values (€ million)	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Total sales	3,291	3,515	3,354	3,244	3,245	3,397	3,487	3,688	3,936	3,868	3,674
Total costs	3,285	3,505	3,334	3,220	3,129	3,264	3,337	3,544	3,678	3,614	3,464
Profit for the current period (EAT)	181	195	177	181	240	267	301	320	439	479	426
Profit before tax	195	217	194	207	262	289	348	366	492	542	502
Income tax	14	22	17	26	22	21	47	46	53	63	75
Total revenue	3,480	3,722	3,528	3,428	3,392	3,553	3,685	3,910	4,171	4,156	3,965
Income tax/ revenue*100	0.40%	0.60%	0.48%	0.77%	0.65%	0.60%	1.27%	1.18%	1.28%	1.52%	1.90%
Income tax/sales*100	0.43%	0.63%	0.51%	0.82%	0.68%	0.63%	1.34%	1.25%	1.35%	1.63%	2.06%
Income tax/EAT*100	7.73%	11.37%	9.65%	14.61%	9.19%	7.97%	15.58%	14.42%	12.13%	13.16%	17.71%
Net turnover for the accounting period	3,466	3,700	3,511	3,401	3,370	3,531	3,638	3,864	4,117	4,093	3,890
ROA (%)	8.10%	8.96%	8.51%	9.50%	12.17%	13.15%	14.82%	14.59%	18.37%	18.10%	17.17%
CNB exchange rate (CZK/€)	25.29	24.59	25.14	25.97	27.53	27.28	27.03	26.33	25.64	25.67	26.44
Active business entities	28,848	29,495	29,405	27,849	27,553	27,672	27,474	28,650	29,135	27,188	25,369

Source: Ministry of the Industry and Trade, 2022; CSO, 2022a; calculations

Table 3 provides an overview of the aggregate revenue collection of selected tax types for business entities in the CZ-NACE 16 sector.

Table 3. Overview of the aggregate collection on selected types of taxes (CZ-NACE 16)

Year	Collection of value added tax (in millions of €)	Collection of corporate income tax (in mil. €)	Collection of personal income tax (self-employed persons in mil. €)

2010	-34.163	10.969	-1.823
2016	-56.883	22.255	-1.022
2017	-67.604	22.952	-0.473
2018	-55.844	30.253	-0.570
2019	-39.856	52.595	-0.058

Source: CSO, 2022b; calculations

4. CONCLUSION

Climate changes, associated draught, and the calamity situation in Czech forests pose a considerable problem for forestry and the downstream sectors.

The results of the analysis will be available to the industry, public and political authorities to address the development of wood processing in the Czech Republic and the search for an optimal arrangement of the wood processing structure, taking into account the current limitations of raw wood resources and possibilities of processing with additional added value.

The tax burden on enterprises in the wood processing sector (CZ-NACE 16) in the Czech Republic consists mainly in the collection of corporate income tax. On the contrary, the collection of value added tax was consistently negative in the period 2010-2019. In the period of the bark beetle calamity and the subsequent period when the price of the input raw material - saw logs is rising extremely, this situation must be described as negative, which may reduce the economic performance and viability of wood processing enterprises. This may also reduce the share of wood processing enterprises in the economic performance of the forestry and wood complex in the Czech Republic.

Acknowledgements: We wish to thank project INTERREG AT/CZ AT251 FORRISK.

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BIOMASS POTENTIAL IN THE BIOECONOMY STRATEGY

Mikuláš Šupín, Erika Loučanová, Mária Šupínová and Miriam Olšiaková

Abstract: The main objective of the paper is to describe, analyse and forecast the potential biomass in bioeconomy strategy. Global problems such as climate change, ecosystem degradation, limited resources represent challenges that urge us to find new ways of producing, consuming, and innovating while respecting the ecological limits of our planet. At the same time, it is necessary to achieve sustainability, which presents a strong incentive to modernize and innovate industries as well as the way of using wood as source of bioenergy. This also applies to the biomass. In the future, we can expect the trend of increasing demand for biomass. Biomass as biofuel can provide answers to current global energy and economic crises as a sustainable energy source. It also creates opportunities for new bio-products and bring ways how to use underutilized waste streams or to achieve value from supply chains through a sustainable bio-economy strategy.
Key words: sustainability, bioeconomy, bioenergy, biomass, EU.

1. INTRODUCTION

The current global economic model which relies on fossil raw materials is not sustainable in the long term. This is especially due to the fact that megatrends of demographic growth and climate change continue. This situation makes it necessary to explore alternative models that minimise the overall consumption of energy and material and maximise the share of renewable resources in the economic system. The bioeconomy is such an alternative model. It offers both opportunities and challenges for Europe's forest resources. Forests are Europe's biggest renewable natural resource in terms of energy and material supply. At the same time, they provide much more than only biomass. Forests directly benefit people both globally and locally. Forests present an important contribution to the global carbon cycle. They support a rich portfolio of other ecosystem services that range from protective functions to cultural services, and they also provide products (e.g. mushrooms). Forests are critical to mitigate the problem of climate change. This situation offers great opportunities for a holistic forest-based bioeconomy through the intelligent use of biomass as well as through developing innovations relating to the entire spectrum of forest ecosystem services.

Biomass as biofuel can provide answers to current global energy and economic crises - both as a sustainable energy source. Dependence on non-renewable fossil fuels as well as environmental concerns related to air pollution and greenhouse gas effects contributing to global warming and climate change have stimulated interests of policy makers and industry to promote bioenergy as part of energy security and climate change mitigation strategies (Souza et al., 2015). Bioenergy can contribute to achieving several policy objectives such as agricultural and rural development, climate change mitigation and energy security. But it is the manner in which bioenergy development is supported and regulated that determines whether or not bioenergy will be sustainable. However, an increased use of renewable biological resources needs to consider sustainability boundaries, e.g., by taking care of biodiversity and climate change mitigation. Trade-offs between biofuels and environmental resources are inevitable. The mitigation of climate change via reducing GHG emissions through a transition to low carbon energy systems such as selected biofuels offers a logical trade-off, as long as the design of expanded biofuel production avoids areas of special biodiversity concerns or embeds new production areas within a sustainable matrix of natural and transformed ecosystems (FAO 2022; Šupín et al., 2020; Kaputa, V.; Paluš, H.; Vlosky, R. P., 2016; Loučanová et al., 2020; Parobek et al., 2016; Gasova, Stofkova, 2010). Therefore, the aim of this paper is to describe, analyse and forecast the development of the potential biomass and wood industry.

2. METHODOLOGY

The analytical-synthetic method is the principled approach to processing the issue of potential biomass in bioeconomy strategy. Through the analysis of the investigated phenomena and processes, the issue is solved in individual parts, various case studies. The research and descriptive method are used to analyse the interrelationships. The result of the research is partial theoretical and research findings and conclusions, which are combined through a synthesis into a unified set of issues characterise the biomass potential in bioeconomy strategy.

3. POTENTIAL BIOMASS IN BIOECONOMY STRATEGY

As it is stated by Proskurina et al. (2019), the United Kingdom, Denmark, and Italy were the biggest importers of wood pellets in the EU. Italy uses wood pellets mostly for residential heating, whereas in the United Kingdom and Denmark, wood pellets are used almost exclusively for large-scale industrial operations, i.e. electricity and heat production. The Baltic countries accounted for 35 % of all European wood pellet exports. Baltic countries have excellent potential for future wood-pellet industry development because they have abundant forests and low costs and they are in close proximity to naval ports. Portugal also has potential for further development of wood pellet exports due to abundant forest resources, relatively low production costs, and limited local consumption. In addition, global oil prices have grown, which may lead to an increase in demand for biomass.

The EU is the main leader in biomass utilization and the main importer of most biomass products. Divergent policy regulation and large price differentials have led to complex wood pellet trade streams within the EU. Many different factors influence current biomass trade streams, such as historical bioenergy development, availability of biomass resources, policy regulations, and sustainability certification.

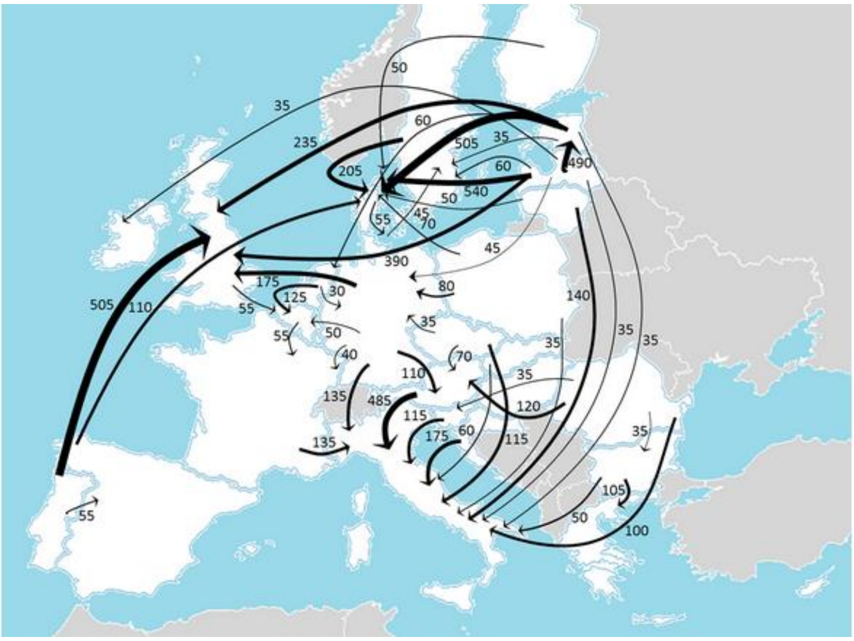

Figure 1. Net wood pellets trade streams within the EU
Source: Proskurina et al., 2019

The large trade in wood pellets can be explained by increased demand in the heating and industrial sectors. In both sectors, global wood pellet markets have increased significantly in the past decade. In the EU, the high wood-pellet consumption and significant imports can be explained by historical reasons – the use of wood pellets started in Sweden – by renewable energy development trends, and by policy support and environmental issues. Different scenarios suggest that European wood pellet markets will continue to grow.

In the long term, new trade streams of biomass for energy can emerge. Different scenarios indicate that total torrefied biomass demand might reach 10–18 Mt by 2030 (Proskurina et al., 2019, Loučanová et al, 2021).

Kraxner et al. (2017) present that future forest biomass availability is likely to be affected by climate change. A review of climate change impacts on productivity suggests that productivity may increase in the northern part of Europe and that there are mixed projections for other parts of Europe. In addition to climate change, a key issue for forest biomass availability is whether private forest owners can be activated to bring their wood to the market. However, it is unclear if private forest owners are interested in mobilising more wood as they might have very different objectives for their forests. This may include the use of mixed-species forests to increase the productivity of stands, or the intensification in selected parts of the landscape to facilitate a higher level of habitat retention in the forest matrix. Using the wood resource more efficiently may also contribute to reducing the biomass removal or the area that is affected by harvesting.

Most bioeconomy strategies offer different understandings of what a bioeconomy is. What goals should be prioritised and how these can be achieved is largely dependent on the different prerequisites and complexity of the forest-based sectors in each country. Hence, bioeconomy strategies of different geographical regions and the EU do not prioritise the same aspects concerning the forest-based bioeconomy (Ramcilovic-Suominen & Pülzl, 2018; Kraxner et al., 2017). Despite the radical business model changes that have occurred in recent years, the sector is still rooted in tradition. Forest stakeholders generally accept the bioeconomy concept, as it is open enough to satisfy the varying needs and constraints of those employing it. Although forest stakeholders consider themselves an important pillar of the bioeconomy, few national strategies have actually consulted or involved forest stakeholders in drafting national strategies. The only exceptions are forest-rich countries. Bioeconomy strategies primarily focus on economic goals. Environmental and societal goals are in the background.

As it is mentioned by Bauhus et al. (2017), current forest harvesting, measured as the proportion of annual increment that is harvested, represents about 70 % across Europe. Towards a sustainable European forest (regarding the forest biodiversity) there is the overall pressure that a forest-based bioeconomy imposes on forest ecosystems. Recent analyses of biomass production potentials in European forests have pointed out that there are theoretical opportunities to increase biomass production from the current levels. However, the scenarios indicated that taking technical, environmental, and social aspects into consideration reduces the theoretical potential supply in 2030 considerably while still remaining above the current harvest levels for the EU. This indicates that strong intensification of biomass extraction from forests is likely to be in conflict with high environmental standards for forest management. Various European countries are in different positions and high variability. In any case, it is evident that the goal to conserve forest biodiversity may substantially reduce theoretical harvesting potentials. This does not consider the possibly enormous and still largely untapped potential to increase biomass.

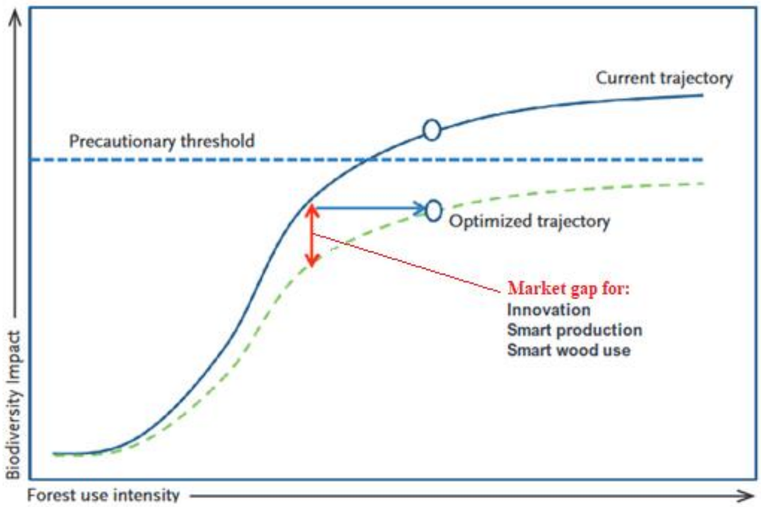

Figure 2 GAP analysis - Hypothetical relationship between forest use intensity and its influence on biodiversity
Source: Bauhus et al., 2017, adjusted by authors

Hypothetical relationship between forest use intensity and its influence on biodiversity is reflected in Figure 2. At high level of forest use intensity, characterised by high removals of biomass, substantial cultivation of non-native tree species, use of fertilisers etc., the impact may exceed a threshold that defines undesirable effects such as loss of species, weakening of populations, or reduction in ecosystem functions. To avoid exceeding this threshold, alternative, smart forms of forest management may be applied. This can include the use of mixed-species forests to increase the productivity of stands, or the intensification in selected parts of the landscape to facilitate a higher level of habitat retention in the forest matrix. Using the wood resource more efficiently may also contribute to reducing the biomass removal or the area that is affected by harvesting (Bauhus et al., 2017).

Market gap provides opportunities for new bio-products, uses to underutilized waste streams, and ways to extract value from supply chains that will stimulate and sustain the forest industry for future generations. A sustainable forest-based bioeconomy which capitalises on the entire spectrum of forest ecosystem services can play a central role in the sustainability transformation (Wolfslehner et al., 2017; Parobek et al., 2016).

4. CONCLUSION

The wood processing sector is similarly to the agricultural sector, dependent on forest ecosystems and their goods and services and it is a major contributor to forest biodiversity loss. In the future we can await that trend of the demand for biomass will continue to increase. Wood energy can replace fossil-intense products in other sectors, creating place for bioeconomic. The biomass is an essential component of GHG reduction technologies displaying a critical role for environmental security and climate change mitigation. The potential biomass is related to the region, actives, and time horizon. Policy makers must decide on the optimal mix of options, adapted to local circumstances. The aims should improve understanding of the benefits and relations solving the areas how to use the wood products to mitigate climate change and the capacity to deliver broader human development. It is advisable to think opportunities for new bio-products, using the underutilized waste streams, and ways to extract value from supply chains that will stimulate and sustain the forest industry for future generations. Sustainable production methods in forests will keep the harvest intensity within the forests´ regrowth potential.

ACKNOWLEDGEMENTS

The authors would like to thank the Scientific Grant Agency of the Ministry of Education, Science, Research and Sport of the Slovak Republic and the Slovak Academy of Sciences, grant number 1/0475/22 "Environmental Consumer and Environmental Citizen", grant number 1/0495/22, "Sustainability of Value Supply Chains and its Impact on the Competitiveness of Companies in the Forest and Forest-Based Sectors" and grant number 1/0494/22 "Comparative Advantages of the Wood Based Sector under the Growing Influence of the Green Economy Principles".

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POSITIVE EFFECTS OF THE FOREST ON THE HUMAN ORGANISM

Mária Šupínová, Erika Loučanová, Mikuláš Šupín and Miriam Olšiaková

Abstract Forest therapy may play an important role in health promotion and disease prevention. Forests produce and release biologically active substances into their surroundings, which can have a beneficial effect on humans. Therefore, this article is focused on the positive effects of the forest on the human body from the point of view of ecological innovation and medicine. The article analyses case studies examining the participants exposed to the forest environment compared to the urban intervention group intervention period. The results show that active forms of movement in the forest reduce the risk of various diseases of civilization. They also represent a potential trend for innovative models aimed at "forest bathing to improve physiological and mental health of healthy and weaken individuals."
Key words: effects of the forest, case studies, nursing, innovation.

1. INTRODUCTION

In general, wood raw materials are the main product of the forest. However, the forest also has other products, such as berries, wicker, resin and others. Various parts of trees and plants such as bark, roots, leaves are used in remedies or medicinal products production. Forests also produce and excrete biologically active substances into their surroundings, the so-called Phytoncides that can have a beneficial effect on humans and negatively on germs because they support - inhibit the growth of bacteria and protozoa. The hygienic impact of forests is also conditioned by the healing of the air and the impact on other physical factors favourable to humans. Any forests generally affect the movement of air in their surroundings and thus also affect the movement of impurities. Solid pollutants (dust, ash, etc.) sediment by damping the air flow and are trapped on vegetation organs. Aerosol and gaseous impurities are partially absorbed by vegetation or raised by turbulence into the upper layers of the atmosphere, where their concentration decreases or is completely eliminated. Forests create strong absorbing barriers that convert noise into kinetic energy by resonance of thin plant parts. In addition to the above, the forest also has the positive effects of the forest on the human body. These advantages are the main topic of this paper.

2. LITERATURE REVIEW

In recent years, from the point of view of management, a great attention is paid to innovations and their ecological variants with respect to the various segmentation models. Lešková (2009) presents that ecological innovations reduce the demands on materials, use closed material flows and create or use new materials. At the same time, they focus on reducing energy intensity and create or alternative energy sources. They also reduce overall emissions or existing environmental burdens and health risks, while supporting the whole idea of a healthy lifestyle and sustainable consumption (Kollár, Brokeš, 2005; Loučanová, Olšiaková, 2020; Zuraidah, et al. 2012; Loučanová, Nosáľová, 2020; Loučanová, Olšiaková, 2020). In 2010, Harvard Business Press organization when monitoring ecological consumers over the last twenty years, has found that companies can classify consumers into four groups:

- “Resource Conservators“ hate waste.
- “Animal Lovers“ are probably vegetarians or vegans, they belong to the group of People for the Ethical Treatment of Animals (PETA).
- “Health Fanatics“ they are afraid of excessive sun exposure, they are afraid of pesticide residues on the products, and they prefer organic food and safe products.
- “Outdoor Enthusiasts“ they spend their free time camping, climbing, skiing and hiking.
- These groups people try to minimize the impact of their activities to environment and looking for recreation in nature.

There is a growing interest in the health benefits associated with individuals undertaking outdoor activities in a natural environment (Bowler et al., 2010). Forests and other natural environments are recognized as fundamental health resources and may play a role in disease prevention (Prüss-Üstün et al., 2016). Since the development of the concept of nature as a therapy, exposure to “forests”, or “forest therapy”, researches was conducted in a very specific natural context.

While the theory of forest therapy believes that taking time out in nature, specifically in a forest area, most health professionals do not recommend or integrate such therapy in the management or prevention of disease during their medical consultations. As yet, there are no evidence-based clinical practice guidelines for the use of such therapy for healthcare professionals (Oh et al., 2017; Li, 2018). This is the reason why we analysed studies to evaluate the current evidence of spending time in forest, and natural green environment.

3. METHODOLOGIES

The analytical-synthetic method presents the principled approach to analyse the issue of positive effects of the forest on the human organism. The issue is analysed in individual parts through the analysis of the investigated phenomena and processes. Various case studies, researches, descriptive method are used to analyse the interrelationships. The gained knowledge describes the biodiversity hypothesis - the loss of biodiversity in urban areas may be associated with increased morbidity. They are described from several points of view, while the basic causality and connections are determined. Partial theoretical and research findings and conclusions are the result of the research, which are combined through a synthesis into a unified set of issues of positive effects of the forest on the human organism.

4. POSITIVE EFFECTS OF THE FOREST ON THE HUMAN ORGANISM

While the findings do not include all the answers, they support the idea that altering environmental microbes can relatively easily affect an already established microbiome in people and give their immunity a helping hand. The biodiversity hypothesis has been known for many years.

The results of these studies support the biodiversity hypothesis. Low biodiversity in the urban environment can lead to a weakened immune system.

First study

The study examined 10 different kindergartens including 75 children aged 3 to 5 years. Some kindergartens had standard courtyards of concrete and gravel, others took children everyday into the nature, and four had landscaped courtyards with grass and undergrowth.

Roslund et al. (2020) analysed "the levels of cytokines in plasma samples, and the frequency of Treg cells in blood samples by flow cytometry. They searched for associations between changes in plasma cytokine levels or total Treg cell frequencies and changes in bacterial diversity and abundance with linear mixed-effects models and with nonmetric multidimensional scaling. In addition, they performed a before-after comparison of the cytokine levels and their ratios. These comparisons demonstrated that the ratio increased among intervention children, but not among children in nature day-cares" (Table 1).

Table 1. Ratio before and after the 28-day intervention period

Kindergartens	Mean before	Mean after	Difference
Standard courtyards	0.86	1.15	0.29
Children every day in nature	0.93	1.04	0.11
Courtyards with grass and undergrowth	1.22	0.96	-0.26

Source: Roslund, M. I. et al., 2020

Before and after the experiment, the researchers examined their immunity. It was found that children in nurseries who played in the forest five times a week had a better immune system during the month. Microbes on the skin and intestines have gained in diversity, a feature associated with a better immune system. The children that the educators took into nature had very similar results.

Researchers write that their findings support the assumption that contact with nature prevents immune system disorders such as autoimmune diseases and allergies (Roslund et al., 2020).

Second study

Across the study of Oh et al. (2017), "the total number of participants was 323. Age of participants ranged from 20 to 79 years. Study population varied from young healthy university students to elderly with chronic disease. The duration of forest therapy interventions varied across the studies, ranging from 1 day to 11 weeks. Outcome measures varied across the study using different instruments to measure the effect of forest therapy on physical health and psychological outcomes. No adverse events were reported."

Table 2. Recorded positive effects of the forest environment on selected parameters

Parameters		The participants exposed to the forest environment compared to the urban intervention group
Physiological response	Blood pressure	Showed a significant reduction in blood pressure, the values of biomarkers (endothelin, homocysteine, angiotensinogen, angiotensin)
	Immune function	Significant decreases in the expression of perforin (natural killer cells) and granzyme b expressions which were associated with the pathogenesis of chronic obstructive pulmonary disease
	Inflammation	Favorable changes of pro-inflammatory cytokines and c-creactive protein
	Oxidative stress and antioxidant	The positive significant differences in malondialdehyde
	Cardiac and pulmonary function	The positive significant differences in changes of cardio-ankle vascular index
	Stress and stress hormone	The cortisol levels were significantly lower
Psychological outcomes	Anxiety and depression	The significant improvement of anxiety and depression
	Mood	Significantly lower scores in the negative subscales (tension-anxiety, depression, anger-hostility, fatigue, and confusion) and increased vigor

Source: OH, Byeongsang, et al., 2017

Study reported the positive impact of forest therapy on hypertension, cardiac and pulmonary function, immune function, inflammation, oxidative stress, stress, stress hormone, anxiety, depression, emotional response and etc. Forest therapy may play an important role in health promotion and disease prevention.

Summary

The subjects also had increased numbers of intracellular antitumor proteins, and there were lower levels of stress-related adrenaline and noradrenaline in their urine.
Half an hour in the forest:

2. increases innate immunity,
3. reduces the level of stress hormones,
4. lowers blood pressure, slows the pulse,
5. has an antidepressant effect, reduces anxiety,
6. charges with energy.

Other studies have found that rural children have fewer cases of asthma or allergies. Some studies also speak of better mental health for such children and proper brain development.

As studies mention, trees decrease the anxiety, anger, fatigue, and confusion scores and they increase the mental energy score. According to experts, this indicates the preventive

effect of the forest bath not only against civilization diseases caused mainly by stress, but also against depression.
This presented review points to the positive therapeutic effects of forest exposure on several physical and psychological conditions. These data show a consistent trend in a broad range of health outcomes, suggesting potential for forest bathing to improve physiological and psychological health in healthy and health-weakened individuals. The included studies only reported pre and post intervention differences within each group, and even though they found significant improvements within the forest therapy group, they failed to report whether there was any difference between groups, thus not testing the significance of between-group differences (Oh, Byeongsang, et al., 2017, Roslund et al., 2020, Paľovčíková, 2017, Loučanová et al., 2017, Loučanová et al., 2021, Stofkova et al., 2016, 2017; Stofko, Stofkova, 2014).

CONCLUSION

The objective of this article was to evaluate positive effects of the forest on the human organism. The results of the studies show the benefits of forest environment on health and well-being as well as the study by Oh, Byeongsang et al. (2017) "The exposure to a forest environment may provide benefits”. These data show a consistent trend in a broad range of health outcomes, suggesting potential for forest bathing to improve physiological and psychological health in healthy and health-weakened individuals."

Acknowledgements: The authors would like to thank the Scientific Grant Agency of the Ministry of Education, Science, Research and Sport of the Slovak Republic and the Slovak Academy of Sciences, grant number 1/0475/22 “Environmental Consumer and Environmental Citizen”, grant number 1/0495/22, “Sustainability of Value Supply Chains and its Impact on the Competitiveness of Companies in the Forest and Forest-Based Sectors" and grant number 1/0494/22 “ Comparative Advantages of the Wood Based Sector under the Growing Influence of the Green Economy Principles”.

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ATTITUDES, PRIORITIES AND OPPORTUNITIES FOR MANAGERIAL DEVELOPMENT OF FEMALE FOREST PROFESSIONALS AND FEMALE FOREST OWNERS IN BULGARIA

Daniela Ventsislavova Georgieva

Abstract: The current strategic goals and proposed initiatives regarding the labor force challenges in the forestry sector in Bulgaria are covering the overall development of human capacity without separately focusing on female managerial opportunities and participation in the sector. Researches in the field are indicative of the low level of employment of women with a tendency for becoming even lower during the upcoming years. However, women are an important factor in the labor market of the current modern society. The main goal of the paper is to study the attractiveness of forestry in Bulgaria by outlining the attitudes, priorities, and opportunities of women (1) to develop in their careers at the public and private forestry sectors and (2) to manage their forests as an alternative form for entrepreneurial development and increasing the competitiveness of the sector. Primary data is presented from the Fem4Forest project with information from in-depth interviews among the target groups, a round table with stakeholders and decision-makers, and results from online questionnaires.
Keywords: Female forest professionals, female forest owners, questionnaire, round table, in-deep interviews

1. INTRODUCTION

The main challenge for the development of the forestry sector in Bulgaria is the loss of competitiveness, leading to some negative consequences such as slowing down the economic growth and inefficient use of timber in the country (Chobanova, 2016, p.61). According to the strategic goals and priorities of the European Union (EU), the achievement of inclusive economic growth should be based on increasing the level of employment of women, as well as by raising the qualification of the workforce in the EU Member States. Greater gender equality can improve competitiveness and economic productivity, which is a prerequisite for achieving greater economic growth (Cuberes and Teignier, 2011; Revenga and Shetty, 2012, p. 40-43). Active participation of female in the labor market is seen as a factor counteracting the negative consequences of the declining working-age population (Labour force participation of women, 2015, p.3). In 2019, less than 1/5 of those employed in the "forestry and forest-based industry" in Bulgaria are women. Female participation in the forest labor market can be influenced by financial, social, and legislative factors (Georgieva and Chobanova, 2017; Georgieva, 2017), and to whether women are employed in the public or private forest sector, or own and manage a forest (Georgieva et all, 2021). However, there is a small number of female employees in the forest sector in the EU Member States in the Danube region. The measures currently taken to motivate their participation don't yield significant results because they are mainly focused on training, which, however, does not reflect the real reasons for the lack of interest of women to be employed in the sector (Georgieva, 2021). Compared to the forest industry, forestry is not attractive to female and this must be taken into account when determining the impact of employment on labor productivity and the competitiveness of the sector. The **main goal** of the paper is to study the attractiveness of forestry as an opportunity for career development for women. An additional goal is to outline the attitudes, priorities, and opportunities of women to manage their forests, as an alternative form of entrepreneurial development and to increase the competitiveness of the sector. **The object of the study** is women employed in the public and private forest sector, as well as those who own a forest in Bulgaria. The **adopted research methods** are logical, deductive, and comparative methods. Data from in-depth interviews among the target groups, a round table with stakeholders and decision-makers, and results from online questionnaires are presented. They are compared to data from 10 countries (Austria, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Germany (Bavaria), Romania, Serbia, Slovenia, Ukraine) in the Danube region as primary results of the Fem4Forest project.

2. ONLINE SURVEY RESULTS

To determine the needs of women in forestry in Bulgaria, an online survey was conducted using The Lime Survey tool. The survey was carried out during 22 March – 15 April 2021 based on snowball sampling. The target groups are female forest professionals and female forest owners. The questionnaire has 5 main sections, 3 of which contain the same type of questions for the two target groups. The other two sections contain specific questions for outlining the respondents' views regarding 1. Forest management and ownership and 2. The professional perspectives for the career development of forestry workers. A limitation of the study is the small sample size of n=45, which is reason to argue that the study is not representative. However, it creates further insights into the situation and position of women in forestry. From a socio-demographic point of view around 82% of the respondents live in cities while 18% - in villages. Around 42% are in the age group between 42 and 56 years old, while 34% are over 56 years of age. 20% indicate that they own a forest, while the rest are employed in forestry. The majority (44.44%) of the respondents state that women's participation in forestry is not satisfactory. For almost 58%, forestry (and even the forest sector as a whole) is male-dominated, and for 64% of respondents, forest management is often left to male, regardless of who is the owner. All women respondents who own a forest agree that it is not their main source of income, as they have acquired it as an inheritance from their relatives. However, they have a contract with a forest entity for timber harvesting, which they plan to continue as a way of managing their forests. Only 1/3 of the female plan some nature preservation activities. In terms of effective and efficient forest management, 22% of the forest owners would resort to training and specialized literature, while 33% rely on male relatives to make decisions about their forest. It is noteworthy that no woman who owns a forest uses social media, NGOs, and industry organizations to help them in making managerial decisions. 33% point out that there is gender discrimination against women who own forests. Female professionals are motivated to work in the forest sector. They find their work meaningful and enjoy being in the forest. In this respect, for 22% of the women working in forestry who filled in the questionnaires, the main motive for choosing such a career development is the fact that the work is interesting and diverse, while for 14% - because they like to be in the forest. For 11% this is a stable job, and 8% see working in the forest administration as a meaningful position. The lowest percentage of respondents believe that the combination of professional and personal commitments (6%), as well as the fact that they feel happy at work (3%), motivate them to work in forestry. Only 6% of the surveyed women state that in their work there is specialized training, sexually targeted to female. For 31%, women and men are not treated equally in their work environment. In a comparative aspect with the results, from the other countries - object of analysis in the project (n=835, without the results from Bulgaria), no significant differences are reported. However, it seems that almost every fifth female forest owner in the whole project survey lives from her forest in terms of harvesting. It represents more than 50% of their income. Such a trend has not been reported in Bulgaria. It is also noteworthy that the age of the respondents from Bulgaria is higher than in the other Danube countries. The Bulgarian respondents do not turn to non-governmental organizations, the state, or experts when making decisions for effective forest management while the data for the other surveyed countries show that female forest owners (46,5%) seek support from people to help them with manual labor and government funding. Information, know-how (training, literature) (49,2%), forest contractors (30,8%), and experts (25,4%) are needed as well when managing a forest. The above can’t be considered as a prerequisite to claim that professional development in forestry is unattractive to young women in Bulgaria, but is indicative of their perspective of female in forestry.

3. RESULTS OF IN-DEPTH INTERVIEWS WITH WOMEN FROM FORESTRY IN BULGARIA

The in-depth interviews were conducted during the period 30.04.-30.06.2021, aiming to gain in-depth insights about female forest ownership and career paths of women in the forest sector. Twelve women were interviewed, 6 of which are forest owners and the rest are forest professionals. All interviewees who own a forest have acquired it as an inheritance from their relatives, and the size of their forests is between 10 and 20 ha. None of them uses their forest for tourism, picking herbs and fruits, research, or training. A significant limitation of the study is that among the interviewed forest owners, no one works in the sector. For this reason, no comparative analysis can be made regarding the management of forests between women with and without forestry education and experience. The interviewees rarely visit their forests, mainly because they live in another place, as well as due to their age (between 60 and 80 years). Half of the interviewees have signed a contract with a private entity for timber harvesting, while the rest have left the forest unattended. They, as well as their relatives, are not interested in turning their forest management into a family business. Although the majority share their concern that private companies may deceive and fraud them, they see no other alternative of what to do with their forests. The interviewees did not show interest in participating in specialized training, nor did they turn to experts, non-governmental organizations, and state institutions for advice. They admit willingness to trust neighbors and family members when making decisions for managing the forests. Priority, they rely on the state for nature preservation purposes. In addition, „managing a forest requires teamwork so it is not a job for one woman alone“. Another issue regarding the private forests is that there are many heirs, so people (not only women) sometimes prefer not to waste time on filling papers, arguing with relatives, dealing with private firms, controlling the process of cutting the trees, etc. All female forest professionals who participated in the interviewees agreed that there is a lack of interest by young girls to be engaged in forestry, even though there are many vacant job positions. They attribute this fact to the desire of girls for a high salary, which they cannot receive in forestry. Additionally, fieldwork requires women to travel frequently or to live near the forest. However, women chose forestry as a career precisely because of their desire to be in nature and in the woods. Still, the majority of women choose to work in the state forest administration. The main reasons stated by the interviewees are: (1) the administrative work in state forest institutions seems to be more secure, (2) it is easier for women to combine professional and social commitments, especially if they have to take care of a child or a sick relative, (3) some of the forestry duties on the field are more suitable for male. For example for the management of forest roads and control of timber transportation by a forester, internet access is required, which can't be found everywhere in the forest. The forester needs to look for a spot with internet access, which sometimes takes time. This can lead to tensions with the truck drivers and even clashes. In these situations, male foresters instill more respect. In addition, sometimes foresters are being attacked. Even though it is not common, it can negatively affect the motivation of women to work in the field. Despite this, the interviewees state that they are "always ready to replace high heeled shoes with rubber boots". However, there is currently a negative public attitude towards foresters. „Unfortunately, society sees foresters as people who only cut trees, without understanding that trees are cut when needed (for example when sick or old). There is a regulated cut off the trees but because of misunderstanding, people get the impression that foresters are doing something bad to the nature and in this respect, foresters are seen as violating the law". This additionally has a negative effect on the choice of women to become foresters. Interviewees do not consider the renewal of machinery and other assets (like the use of drones or tablets) as something that will stimulate the participation of women in the sector. Also, they do not believe that digitalization will significantly change the type of the forester's working tasks. The forest professionals do not consider that there is gender discrimination in terms of the remuneration they receive at work, because it is linked to the position they hold, not to their gender. However, the forest sector is predominantly male-dominated, and more time is needed for female to prove themselves. This leads men to be often hired as decision-makers in the higher levels of management. „It is so because people think that in terms of forestry men are more reliable and have a stronger will". Still, many women are more active, disciplined, and better professionals than men. Another problem is that „because of fewer people working in the sector employees are required to do multitasks which is stressful". This can make a woman give up and look for another job. "To be a female forester it requires women deeply to love their job."

4. ROUND TABLE RESULTS

The round table was held online at the end of March 2021 and the total time duration of it was 2 hours. It was attended by 13 women from the target groups - local public authority, NGOs, higher education and research institutions, SME. A questionnaire was prepared for two main sessions. The first one aimed at identifying if the profession is prestigious, what is the situation of the women working in forestry, and what are their specific needs and interests? The second session aimed at collecting data for gender equality, motivation of women to study forestry, and needed skills and training for women based on their needs. During the round table, all participants express the common vision that forestry is prestigious work and they would recommend this career choice to all their female relatives. They said that all women working in the field love their jobs and work with passion. Still, representatives from the government and an NGO of women in forestry, express the view that Bulgarian forestry is too "conservative" and "closed". They find it as a way to "preserve" the sector due to harmful media influences referring to cutting trees, corruption, and frauds in forestry. The participants shared many good examples and stories of promoting forestry in the society, which however is not shown by the media, and even some of them are secrets. „There is a need for forestry to be more related to the social life of people from their early stages of life until their death". Some of the participants shared their fear that the forester as a profession is going to disappear and the current COVID-19 situation is not helping, because the forestry tasks can't be done at the home office. When it comes to maternity leave even though in Bulgaria it's 2 years, the participants don't see it as an obstacle. A forester expresses the view that the main problem is not the fieldwork but the fact that the jobs in the sector are not secure and if a woman losses her job it is very hard for her to find another one. This is one of the reasons women to look for an administrative job even if it is low-paid. The participants think that during the COVID-19 situation the administrative jobs in the sector will be even more attractive for women rather than jobs in the field. A representative from a government institution stated that in such institutions the assets are old and with no possibility to be changed soon. However, she thinks that technological renewal will not attract more women to forestry. The participants agreed that forests in Bulgaria are fragmented which in a way is an issue as well. There are not many private forests. Private forests are primarily hereditary. If there is a woman owner of the forest then she is more likely to rent it out than to manage it. „Currently, young people are more attracted to easy jobs, which do not require a long period of absence". However, "forester is not a male or female profession but it is a universal one, which requires love and passion. Still, women are more innovative and open-minded than men".

5. CONCLUSIONS

The results from the online questionnaire, interview findings, and the feedback collected from the stakeholders and decision-makers during the roundtable, provide an overview of the situation and position of women in forestry in Bulgaria. In this respect, female forest ownership could be seen as a family tradition, given the fact that all interviewed women inherited their forests. This as well is a common conclusion to the survey results from the other Danube countries covered by the project. In Bulgaria main purpose for which the forests are used by the female owners is timber harvesting for sale. Nature conservation purposes and recreation however are not a major priority for the interviewee when it comes to taking actual actions for achieving it. On the contrary, closeness to nature and achieving resilient forests are major motivations in forest management as it is concluded from all the project survey results from the other countries. In Bulgaria, however, female forest owners rarely spend time in their forests and they rely on private companies to take care for the woods. The overall project results show that women are aware of the many things that need to be done to actively manage forests and feel comfortable doing so, but face physical limitations. Even though female forest owners in Bulgaria do not feel secure signing contracts with private forest entities, when making decisions they ask advices from relatives and neighbors, but not from government institutions, NGO's and forestry experts. Unfortunately, Bulgarian data show that the interviewees do not have the needed knowledge to manage their forests and they are not willing to participate in any courses to gain it. It is so because of their age and the fact that they and their families do not see the benefits of forest management. In terms of female forest professionals, the Bulgarian results confirm the overall project data that women are intrinsically motivated to work in the forestry sector - but not because it offers attractive and well-paid careers. The main motives are their love for forestry and the fact that they find their job interesting and meaningful. However, the majority prefer and work at the government administration. This data confirms the information from the other countries under the project scope. Maternity leaves and social life responsibilities are not seen as a barrier to the Bulgarian female forest professionals, however, they state that it is a male-dominated sector and women must work harder to be recognized as experts. They think that there is gender equality in terms of payment because it is related to the job position. However, when it comes to high-level positions men are primarily hired. The collected and analyzed data confirms that female professionals are highly engaged, well educated, committed, organized, and meticulous when working in and for forests/forestry. Demotivating for the female is the negative social and media view of foresters. Because of that, the beauty of forestry is not sufficiently represented among the public and stakeholders, and the majority of women struggle with roles and stereotypes.

Acknowledgements: This paper is supported by funds allocated to Fem4Forest project (DTP3-500-1.2 Fem4Forest), co-funded by European Union funds (ERDF), and do not necessarily reflect the official opinion of the European Union/Danube Transnational Programme.

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COMPETITIVE SITUATION OF LISTED COMPANIES IN THE WOOD-BASED SECTOR IN CRISIS CONDITIONS - THE CASE OF WARSAW STOCK EXCHANGE IN POLAND

Leszek Wanat, Łukasz Sarniak

Abstract: The paper discusses the competitive situation of the wood-based sector on the example of companies listed on the Warsaw Stock Exchange in Poland. Secondary data from stock exchange reports and public statistics were analysed. Comparative and descriptive analysis was also applied. Finally, conclusions and recommendations were formulated for capital market policy in the sector perspective - the wood-based sector in Poland.
Keywords: wood-based sector, wood industry companies, Warsaw Stock Exchange, Poland.

1. INTRODUCTION

A time of uncertainty, first a pandemic, then a war, has caused various financial problems for wood industry companies. Constraints on the functioning of the market economy contributed to supply chain disruption and inability to pay in the wood-based sector. Major dilemmas included downsizing and even curtailing production activities. The alternative became debt and trying to survive a difficult period or even a crisis [1,5].

In 2022, with hopes of an end to the pandemic, traders believed the market would recover. Unfortunately, new threats emerged. Even Poland's economic growth failed to offset rising inflation. In addition, the prices of roundwood and wood materials increased significantly. This phenomenon was further exacerbated by international trade restrictions as a result of the Russian aggression against Ukraine, as well as economic sanctions introduced by the European Union. Consequently, instead of dynamic growth, the wood-based market is experiencing disturbing phenomena, asymmetry, slowdown and even signs of recession. These can also be identified in the equity stock market.

2. MATERIAL AND METHODS

The aim of the study was an attempt to identify the competitive situation of the wood-based sector on the example of companies listed on the Warsaw Stock Exchange in Poland. The temporal scope analyzed primarily the period of economic uncertainty. The time of the pandemic from 2020 until the war conducted by the Russian Federation against Ukraine in 2022 was taken into consideration. In terms of subject matter, the situation in the Polish wood market was analyzed against the background of the international market based on wood.

The study used primarily secondary statistical data, publicly available in publications of the Central Statistical Office in Poland [9], in the sector reports [7, 8] and in open databases available on the Internet [6]. Secondary data from stock exchange reports and public statistics were analysed. Data were aggregated, benchmarked and discussed in the form of descriptive analysis. The study was carried out against the background of the state of the art, in the perspective of selected scientific and professional publications relevant to the wood-based sector.

3. RESULTS AND DISCUSSIONS

In times of crisis, the ability to raise financial capital is a key problem for companies. It supports current operations and provides an opportunity for growth. The most popular source of financial capital are bank loans. Unfortunately, a significant increase in inflation has contributed to an increase in interest rates of the National Bank of Poland (NBP). Only from January 2021 to April 2022, a period of 14 months, inflation in Poland rose to 12.4 percent (a fourfold increase) [9]. In addition, the average loan interest rate (calculated as WIBOR 6M + 2 percentage points margin) increased nearly threefold (Table 1).

Table 1. Selected economic measures influencing the creditworthiness 2021-2022 in Poland

Period (month / year)	Inflation [%]	NBP reference rate [%]	Average credit rate [%]
I 2021	2,6	0,5	2,25
II 2021	2,4	0,5	2,25
III 2021	3,2	0,5	2,25
IV 2021	4,3	0,5	2,24
V 2021	4,7	0,5	2,25
VI 2021	4,4	0,5	2,25
VII 2021	5,0	0,5	2,25
VIII 2021	5,5	0,5	2,26
IX 2021	5,9	0,5	2,31
X 2021	6,8	0,5	2,96
XI 2021	7,8	1,25	4,38
XII 2021	8,6	1,75	4,84
I 2022	9,4	2,25	5,47
II 2022	8,5	2,75	6,02
III 2022	10,9	2,75	7,05
IV 2022	12,4	4,5	8,25

Source: Own elaboration based on [https://stat.gov.pl/, accessed 03.05.2021] [9].

As a result, many woodworking companies have lost their ability to obtain financial capital from the banking sector. How to solve this problem? By evaluating available secondary data and analyzing the state of the art, alternatives were reviewed [3, 4, 5]. Financial capital can also be attempted by issuing shares and listing them on a stock exchange. The three doubts formulated are answered in the study.

ISSUE ONE. Is it possible for a wood processing company to conduct a public offering or private placement and raise capital by issuing shares during a financial crisis? Of course it is. It is inefficient to use low-interest bank deposits (high inflation), so capital must be invested.

ISSUE TWO. Why would investors in times of crisis be willing to take up shares in, for example, a Polish sawmill? Firstly, because of the sanctions imposed by the European Union, the demand for wood and wood-based products is increasing. Secondly, stock market investors like to diversify their risk. This is why they invest in companies from different sectors. The wood industry is not very well represented on the Warsaw Stock Exchange. The appearance of companies from the wood industry should generate a lot of interest from potential investors.

ISSUE THREE. As relatively small companies, do sawmills have the opportunity to be listed on the Warsaw Stock Exchange? In Poland there are no sawmills whose assets amount to several billion PLN. Rather, there are medium-sized and small companies. For such entities a special market NewConnect was created in 2007. Currently 381 companies are listed on it with total capitalization of about 17 billion PLN (about 4 billion USD). As a rule, innovative companies from the technology sector with high growth potential were to be listed on it. Currently on NewConnect we have companies from virtually every industry. However, only two sawmills are listed on this particular capital market (Klon SA and Standrew SA). Considering the size of sawmill industry companies in Poland, this market seems to be the optimal solution.

Figure 1 shows the IPOs (initial public offering) on NewConnect 2012-2021 [8]. The analysis of the market situation shows that this is an opportunity and a place for the wood industry.

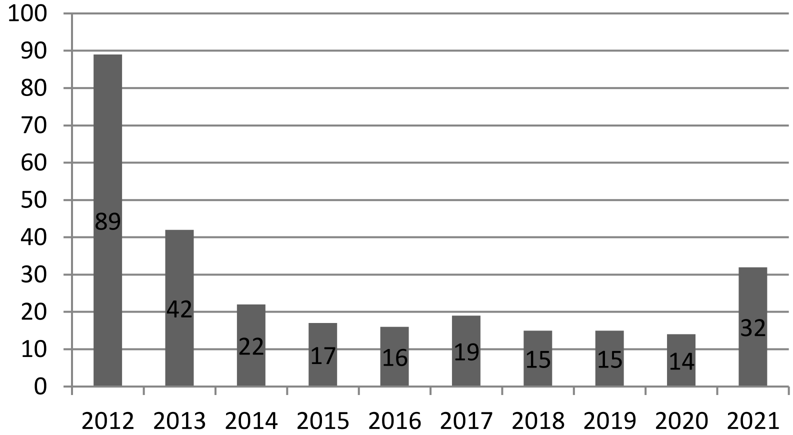

Figure 1. The number of IPOs on NewConnect in Poland (2012-2021, Warsaw)
Source: Own elaboration based on [https://newconnect.pl/, accessed on 13.05.2022]

It was noted that a potential initial public offering realized on the NewConnect market represents an opportunity for the Polish industry under conditions of economic uncertainty [2].

4. CONCLUSIONS

Based on the comparative analysis of prices and market trends, the following conclusions were formulated: (1) improving the competitive position of Polish woodworking enterprises is possible even under conditions of economic uncertainty, and (2) an opportunity to overcome the barrier of inability to finance development is participation in the capital market, for example, an individual public offering on the NewConnect market.

Of course, conducting a public or private offering of stock on a stock exchange or parallel market has advantages and disadvantages. The main advantage is the ability to raise financial capital. Generally, it is non-refundable and can finance business development. The company does not have to give it away. New shareholders become co-owners of the company. Of course, the purpose must be indicated in the terms of the share issue. However, companies have so much flexibility. Another advantage is to increase the prestige of companies listed on the capital exchange. This is a value to current and future customers. This often results in an increase in orders. These companies become leaders in local markets. Moreover, it is an advantage that the credibility of listed companies in the market increases. Public companies operate transparently. They are obliged to publish periodical reports and current announcements concerning the most important issues connected with running the company.

Issuing stock in a company also entails certain disadvantages. Firstly, obtaining the status of a public company also entails fulfilling information obligations (current and periodic reports). Moreover, by issuing shares, a company allows new entities (natural or legal persons) to co-determine the company's operations. In order to maintain control over the company, it is therefore necessary to have a controlling stake. A share issue is therefore a kind of change in the company's business model [2, 5].

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WOOD MATERIALS MARKET IN POLAND - SELECTED DEVELOPMENT DILEMMAS IN CONDITIONS OF ECONOMIC UNCERTAINTY

Leszek Wanat, Marek Wieruszewski, Władysław Kusiak

Abstract: The paper discusses the competitiveness and market development of wood-based materials in Poland. In conditions of economic uncertainty, first resulting from a pandemic and then from war, the market operates in an irregular situation. The most important criteria shaping the structure of the wood market were analysed, based on secondary data from public statistics and industry data. A comparative and descriptive analysis has been applied. Finally, conclusions and recommendations for sector policy in the wood-based sector in Poland were formulated.
Keywords: wood market, wood materials, forest-based economics, economic uncertainty, Poland

1. INTRODUCTION

Wood is the material of the future, natural, renewable, human-friendly. Furthermore, wood is a unique material from the functional, environmental, and aesthetic point of view. It is a renewable resource and can be reused and recycled in certain applications. It can also be a source of energy [1]. At the same time, wood and wood-based semi-finished materials are used in numerous final products. The forest-wood value chain, which further strengthens the value of wood-based products, is informed by the increasingly popular certification [7].

In 2020, the economy, including the wood-based sector, found itself in an emergency situation of economic uncertainty. In 2022, when the pandemic was not yet over, a war of the scale of the Second World War returned to Europe. Meanwhile, the drama and crisis has become an opportunity to activate various factors of symbiosis and solidarity: economic, ecological, industrial, as well as social, behavioural [3, 4]. So, is there a compromise that would allow the coexistence of many market participants in the model of integral economy [2, 8], even under conditions of uncertainty? What role can wood-based market play in times of crisis?

In 2021, the main customer for Scandinavian and German sawn spruce products was the USA. This was due to the continued huge demand for sawnwood in the USA during the pandemic period. Prices reached the limit barrier of growth in the months of May and June 2021 (they exceeded the level of more than USD 620/m^3), and from October 2021 they relatively stabilised on the world markets. Unfortunately, at the beginning of 2022, prices started to rise again [19].

2. MATERIAL AND METHODS

The aim of the study was to attempt to identify selected key trends in the Polish wood market under conditions of economic uncertainty. The temporal scope analyzed primarily the period of economic uncertainty. The time of the pandemic from 2020 until the war conducted by the Russian Federation against Ukraine in 2022 was taken into consideration. In terms of subject matter, the situation in the Polish wood market was analyzed against the background of the international market based on wood [13].

The study used primarily secondary statistical data, publicly available in publications of the Central Statistical Office in Poland [20, 21], Eurostat [19], in the sector reports [15, 16] and in open databases available on the Internet [17, 18]. Data were aggregated, benchmarked and discussed in the form of descriptive analysis. The study was carried out against the background of the state of the art, in the perspective of selected scientific and professional publications relevant to the wood-based sector.

3. RESULTS AND DISCUSSION

When evaluating general data, it was found that the situation on the European and world markets indirectly contributed to the increase in wood prices in Poland [6, 16]. In the second half of 2021, round pine wood (symbol WC0) was purchased for as much as ca. 700-800 PLN/m^3 (average price ca. 461 PLN/m^3). At the beginning of 2021, it was at PLN 250-320 per cubic meter. Medium-sized coniferous wood (symbol S2B), which cost an average of ca. PLN 120/m^3, in the second half of 2021 was priced at PLN 280/m^3. The new rules for the sale of roundwood (raw wood) for 2022 proposed by National Forest Holding - State Forests (Państwowe Gospodarstwo Leśne “Lasy Państwowe”) are likely to further increase the average prices of roundwood and its products on the domestic market [9, 15, 16].

The state of strong demand for structural sawnwood in the USA and the increase in roundwood imports have been taken advantage of by European sawnwood producers. Businesses in Germany, Sweden, Finland, and Austria opened new markets. This change caused some companies to limit their previously planned deliveries of sawnwood to the European market, including Poland. The prices have increased. Long-term contracts had to be realized at a loss or renegotiated. Conversely, some companies decided to terminate their supply contracts at the risk of incurring contractual penalties because the new orders guaranteed higher selling prices [5].

Changes in domestic market demand for sawnwood were analysed based on production trends. The dominant sawnwood producers in Europe were taken into account (Figure 1) [16, 19]. The highest increase in construction timber sales in the first half of 2021 (compared to the first half of 2020) was as high as 20.1%. At the same time, the export-sawnwood sales in the first half of 2021 increased by 12.7% on average (also compared to the first half of 2020) [11, 14, 19]. It proves higher demand for sawnwood on the Polish market. At the same time high demand for other imported sawn materials was found from Poland's neighbouring countries (Belarus, Lithuania, Estonia or Ukraine and Slovakia) [20, 21]. Unfortunately, in 2022, due to the war, the import from Belarus collapsed and from Ukraine was strongly limited. However, the demand for construction timber is still high, and as a result the price is also high.

The instability of supplies in case of other distributors of structural timber assortments caused an increase in the level of structural sawnwood production from domestic coniferous material. These activities concern companies realizing increased production of softwood and implementing the procedure of machine strength sorting of constructional pine sawnwood (Figure 2) [16, 20, 21].

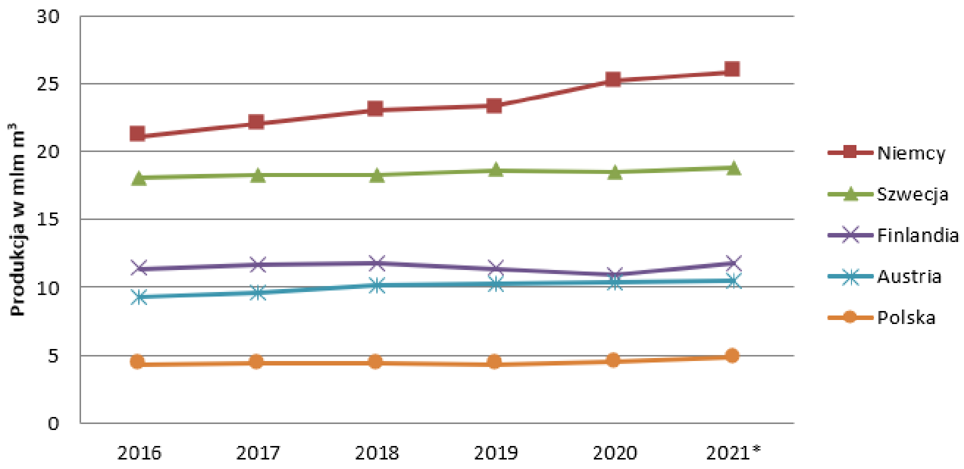

Figure 1. Coniferous sawnwood production in Poland [million m³] in comparison with selected European countries 2016-2021 from top: Germany, Sweden, Finland, Austria, Poland) Source: Own elaboration based on [https://ec.europa.eu/eurostat/, accessed on 13.05.2022]

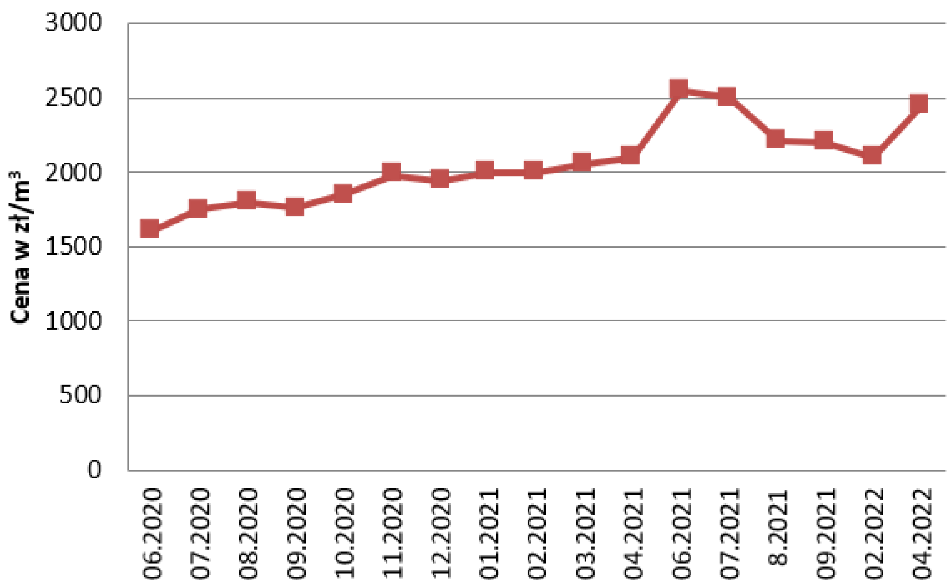

Figure 2. The price changes [PLN/m³] of constructional pine sawnwood in Poland 2020-2022. Source: Own elaboration based on [https://stat.gov.pl/, accessed on 13.05.2022].

From October 2021 we find a trend of gradual regulation of the supply market (Figure 1). With a concurrent domestic production volume plan of about 5 million m³, processed wood prices were projected to stabilize or decrease slightly. However, the economic situation, uncertainty, war, caused an increase in prices, to the level of 2450 PLN/ m^3 and more (Figure 2) [20 ,21].

Sawnwood production at Polish sawmills in March 2022 was 6% lower than a year earlier at 275 thousand m^3. According to the Statistical Office in Warsaw, February 2022 production was stable (237 thousand m^3), following a 5% decline in January (221 thousand m^3). The trend continues [16, 19].

For the first three months of 2022, sawnwood production was 3% lower than at the same time last year at 733,000 m^3. This reflects the trend of the past two years. In the first quarter of 2019, production reached an all-time high of 758 thousand m^3. After a decline in the first quarter of 2020 (-8% to 696 thousand m^3), the following year (2021) saw an increase of 9% to 756 thousand m^3. Full year 2021 sawnwood production of 4.9 million m^3 was 6% higher than a year earlier [15, 16].

4. CONCLUSIONS

Based on the comparative analysis of prices and market trends, the following conclusions were formulated:

1) The market for supply of sawnwood and wood materials in Poland, despite economic uncertainty, maintains relative stability. However, this trend is threatened by shortages on the roundwood (raw wood material) market. There is an increase in exports on this market and a decrease in supply on the domestic market, with a simultaneous increase in prices.

2) The prices of the most popular wood-based construction materials (sawn timber) on the Polish wood market increased significantly, catching up with the prices on international markets (including the USA). This trend is a threat to the development of the wood construction market, housing market, but also the furniture industry in Poland.

3) The economic uncertainty, the war in Ukraine and other factors related to the social situation cause that the Polish wood market will experience asymmetry and imbalance in the short and medium term.

4) The consequence of the identified situation and possible threats should be a constant evaluation of changes in the roundwood market. On the common European market, it may be necessary to intervene to strengthen the internal markets of EU member states, to limit the export of wood raw material. As a consequence, it may be necessary to support the wood industry to promote sales of wood-based final products, and to limit free sales of roundwood.

The competitive situation of the wood-based sector during the period of uncertainty seems to be influenced by the global situation, as well as by the institutional and sectoral policies of the national government. Still, as in the pandemic period, the attempt to build a network of cooperation between forestry and wood industry proves to be effective [11, 13]. Despite war, inflation and other asymmetric factors, cooperation is one of the strongest factors in shaping the competitive potential of the wood-based sector and the wood market in Poland.

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ASYMMETRY ON THE CONIFEROUS SAWNWOOD MARKET AND ITS CONSEQUENCES FOR THE WOOD PROCESSING INDUSTRY - THE CASE OF POLAND

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Abstract: The study discusses the consequences of the asymmetric situation on the coniferous sawnwood market in Poland. Selected factors of industry competitiveness, market structure, changes in supply, demand and prices were analysed. Descriptive statistical methods were applied, based on documents and industry reports. Finally, conclusions and recommendations for mesoeconomic policy in forestry and the wood-based sector in Poland were formulated.
Keywords: coniferous sawnwood, wood industry, wood-based market, export, Poland, Ukraine.

1. INTRODUCTION

Even in the times of crisis or economic uncertainty, striving for balance on the market of wood materials and wood-based products is a naturally occurring trend. This also applies to the coniferous sawnwood market, which is the segment of the Polish sector market that is of particular importance to the wood industry. On the one hand, the timber industry in Poland is currently achieving relatively high sales revenues. On the other hand, the costs of purchasing roundwood, energy and salaries are increasing [6]. Financial liabilities in the wood-based sector are also increasing.

Uncontrolled roundwood export to foreign markets is a controversial issue [8,10]. At the same time, a certain concern for entrepreneurs arises from new European Union legal regulations related to legal acts counteracting deforestation and limiting timber harvesting, also in Polish forests [1]. European sanctions against trading with Russia and Belarus are also a new problem for the wood industry.

Although understandable, these sanctions are causing serious disruption to supply chains for roundwood and wood materials, including coniferous sawnwood. Finally, a serious problem is the global economic situation, including record levels of inflation and ever-increasing interest rates. In this perspective, the asymmetry in the coniferous sawn timber market and its potential consequences for the timber industry were analysed, on the case of Poland.

2. MATERIAL AND METHODS

The aim of the study was an attempt to assess the situation on the coniferous sawnwood market in Poland and its potential consequences for the wood industry. In time scope, first of all, the period of economic uncertainty was analysed, leading from the pandemic of 2020, until the war conducted by the Russian Federation against Ukraine in 2022. In subject scope, the production and prices of coniferous sawnwood were analysed, against the background of other products of the wood-based sector.

The study used primarily secondary statistical data, openly available in publications of the Central Statistical Office in Poland and in sectoral reports [16, 18, 19, 20]. The data were aggregated, benchmarked and discussed - in the descriptive analysis model. The evaluation was carried out against the background of the state of the art, in the perspective of selected scientific and sector publications on the wood market in Poland.

3. RESULTS AND DISCUSSION

The starting point was to assess the situation on the Polish wood market, in particular on the coniferous sawnwood market, from the perspective of changes in pine sawnwood sales prices [13, 15]. The result of the comparative analysis is shown in Figure 1, indicating the price changes in Polish zloty (PLN/m^3) for particular thicknesses of pine sawnwood materials (in millimetres).

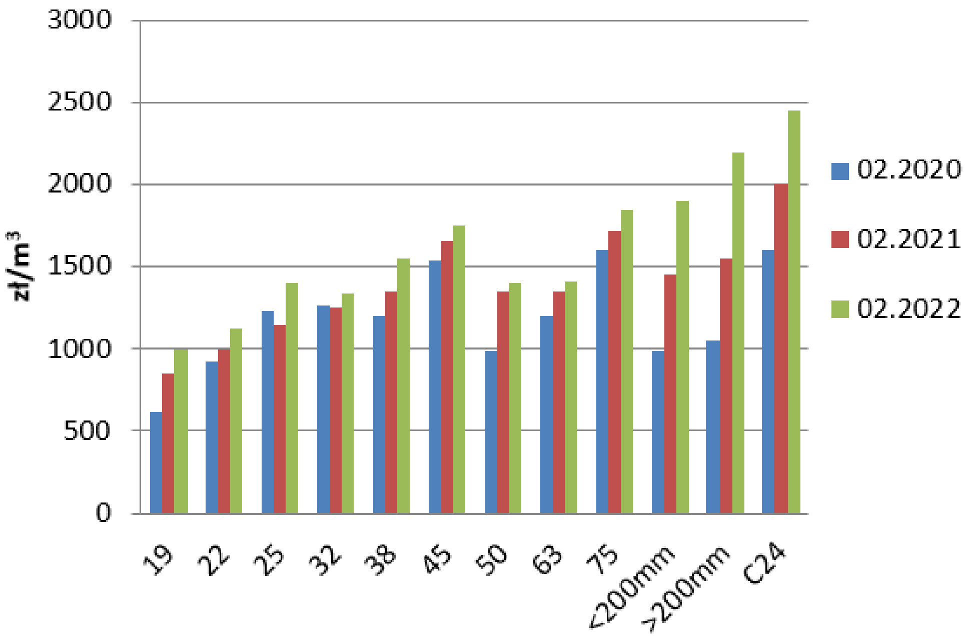

Figure 1. The price changes of pine sawnwood assortments in Poland 2020-2022. Source: Own elaboration based on [https://www.buligl.pl/, accessed on 03.05.2022] [17, 20].

The change in pine sawnwood prices shows a steady upward trend over the assessed period (Figure 1). The analysis also covered a longer time period. It was noticed that from the end of 2020 (Q4) to the middle of 2021 (July) in particular assortment groups there was an increase in conifer sawnwood prices by about 15-20%.

At the same time, the price of oak sawnwood increased from 20-22%, the price of pine glulam from 50 up to 77%, and the price of oak glulam by 20-24%. As a result, the prices of construction sawn timber (including the so-called wooden joinery, especially wood materials for windows - the average price in May 2022 is about 3800 PLN/m³) have also increased.

Aware of the price situation, the Polish woodworking industry is taking steps to ensure that domestic coniferous sawnwood is processed by local entrepreneurs, in Poland [4, 5]. However, it has turned out that the war in Ukraine has significantly restricted the access of the wood and furniture industries to coniferous sawnwood. Imports of wood and wood-based materials from Russia and Belarus stopped and imports of the same materials from Ukraine slowed down considerably.

Ukraine, mainly the western part, supplied on average up to 25% of sawn materials and wood-based boards to Poland. The methods of selling coniferous roundwood have also become an important factor - no export restrictions and selling a larger volume at open auctions. This way of organising the market also influences the increase in wood prices (supply market). At the same time, despite inflation, the demand for wood products and furniture remains high.

For example, imports of sawmill materials from Belarus, Ukraine and Russia accounted for approximately 10 percent of the total supply to the wood-based panel sector in Poland. The value of these imports to Poland in 2021 was respectively EUR 156 million from Belarus, EUR 44 million from Russia (together about 17 percent of Polish imports) and EUR 67 million from Ukraine (about 6 percent of imports).

Table 1 lists the volume of coniferous sawnwood exports from Ukraine to selected European countries in 2020-2021, annually in cubic metres [m³] and the percentage change in volume. The level of exports (in value and quantity) changed significantly during the war, of course.

Table 1. The volume of coniferous sawnwood exports from Ukraine in 2020-2021.

Country in Europe (recipient)	2020 [m³]	2021 [m³]	Change [%]
Hungary	323 474	308 814	-4,5
Italy	181 630	183 517	1,0
Germany	119 000	136 176	14,4
Romania	206 258	104 284	-49,4
Poland	75 245	72 254	-4,0
Other countries	190 246	308 900	162,0
Total	1 095 853	1 113 945	1,7

Source: Own elaboration based on [https://www.buligl.pl/, accessed 03.05.2022] [17].

The wood shortage has recently become a permanent phenomenon in the producer market. In the case of the coniferous sawnwood, the shortage of exports from Ukraine seems to be easier to compensate. In 2021, Ukraine exported 1.114 million m³ of coniferous sawnwood to Europe. This is 1.7% more than in 2020 (1.096 million m³). Hungary was the main customer (309,000 m³), followed by Italy (184,000 m³) and Germany (136,000 m³), Poland imported just over 72,000 m³.

However, the situation on the sawnwood market is deteriorating. Until now, Russia and Belarus have been the most important exporters of coniferous sawnwood to Europe. 30% was supplied to manufacturers of wood-based products [12]. In addition, 60 percent of imported firewood also came from Poland's neighbouring countries. The total blockade of imports from Russia and Belarus will translate into a short-term decrease in the supply of wood-based panels and coniferous sawnwood on the Polish market by at least 10-15 percent.

The identified asymmetry in the wood market, especially in the coniferous sawnwood market, is also due to the shortage of wood raw material (roundwood). Poland has liberal roundwood sales regulations, open to export. In 2021, more than 4.4 million m^3 of unprocessed wood was exported from Poland, including a significant amount of sawn logs. This amounted to over 2.5 million m^3 of logs (roundwood) in 2021. With a relatively constant level of wood harvest (16-18 million m^3 per year), this export share accounts for almost 15 percent.

In addition, disrupted supply chains will have an impact on the forestry and wood-based sector, and this factor strongly influences the increase in wood and wood material prices. In line with inflation in the economy, the indicated asymmetric elements in the supply and demand market, as well as in foreign trade of coniferous wood, are the factors that will shape the Polish wood-based market in 2022 and future years.

4. CONCLUSIONS

Based on the analysis of statistical data, comparative analysis of prices and market trends, the following conclusions were formulated:

1) Asymmetry in the coniferous sawnwood market has been identified, resulting from extraordinary changes in the structure of supply and demand, as well as economic uncertainty.

2) Increasing the supply of wood raw material to the Polish wood-based industry may eliminate the general deficit of sawnwood on the market, but it is unlikely that this will result in a decrease in prices.

3) A possible restriction of exports of wood raw material from Poland may not be very effective due to secondary trade, i.e. exports of partly processed wood by companies from the wood industry.

4) An increase in coniferous sawnwood prices as well as an increase in production costs may result in a reduction of wood-based production in the long term and, ultimately, in a decrease in demand for wood raw material.

In the context of threats and economic uncertainty, intra- and inter-sectoral cooperation [12, 14] remains an important factor for the development of the wood-based sector in Poland [7, 9]. The impact of the cooperation factor [2, 3] sometimes proves to be stronger than the availability of resources and their price, especially in crisis conditions.

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TIMBER PASSIVE HOUSE IN THE LIGHT OF NEW EUROPEAN BAUHAUS – AN ANSWER TO CRISIS MANAGEMENT AND SAFETY FORESIGHT IN FOREST-BASED SECTOR

Martina Zbašnik-Senegačnik, Ljudmila Koprivec

Abstract: In the light of NEB, greater energy efficiency of the building stock in Europe is expected. Passive house standard significantly reduces the operational energy of buildings (heating, ventilation, appliances, machinery) for already 30 years. The measurements of the building envelope led to greater use of embodied energy (thermal insulation, better windows and doors, additional components). Beside lower operational energy we can expect lower embodied energy in passive timber houses, as wood is a low-energy material. However, there are some challenges for the timber industry where lower embodied energy is expected.
Keywords: timber passive house, operational energy, embodied energy

1. INTRODUCTION

Walter Gropius and his associates founded the Bauhaus School in Weimar in 1919, which quickly became an international architectural, artistic and design movement. By combining art and practicality, the avant-garde Bauhaus influenced the industrial society of the 20th century. One hundred years later, the world is facing new challenges. Unlimited economic growth is destroying the environment to such an extent that it is necessary to introduce changes in the way of life and living. Buildings are in addition to industry and transport main consumers of energy and main source of emissions. They are contributing around 40% of total energy consumption and 36% of EU greenhouse gases (COM, 2020). Today a new plan is needed to ease the burden of the planet. European Commission therefore launched the New European Bauhaus NEB (NEB, 2021) initiative in January 2021 which aims to create a new way of life at the crossroads of art, culture, social inclusion, science, and technology. It defines lifestyle that combines aesthetic, sustainable and inclusive components and will inspire the future of the EU. One of the starting points is the commitment to make EU the first climate-neutral continent by 2050. All 27 EU Member States have joined the NEB initiative and committed themselves to reduce emissions by at least 55% by 2030 compared to 1990.

2. ENERGY IN BUILDINGS

The built environment represents a great potential in reducing the use of primary energy and, CO_2 emissions. The largest shares of total energy use in the life cycle of a building are operational energy (energy for heating, cooling and ventilation of premises, heating of sanitary water) and embodied energy (energy to produce materials and components for building construction). Numerous studies show that poorly insulated buildings the main part of the total energy consumption is operational energy, while in energy efficient buildings the need for operational energy is significantly lower than in conventional buildings. Key measures to achieve energy efficient building and reduction of the operational energy include improved thermal envelope insulation and airtightness, efficient windows, and heat recovery from exhaust air ventilation. Therefore, larger amounts of materials and additional components which increase embodied energy are needed (Su et al., 2020). Primary energy consumption may be even higher in energy efficient buildings with a higher share of embodied energy than in conventional, poorly insulated buildings with higher operational energy (Feist, 1996).

The design of a sustainable building should not end with low energy consumption for heating. Measures must be continued in the selection of materials of the building envelope. Brick, concrete, metals and wood are mainly used as a construction material in the developed world. It is possible to achieve the highest energy-efficient standards with these technologies. These materials differ in their environmental footprint – embodied energy and embodied carbon. Cabeza et al. (2021) summarize the numerical results of several studies from the world's relevant literature and conclude that general timber frequently used embodied energy of 3 MJ/kg. The embodied energy for the primary production of dimensional softwoods from spruce is approximately 10.5–11.6 MJ/kg. Embodied energy of concrete is 3.1 MJ/kg and structural steel is approximately 25.2–27.8 MJ/kg.

Steel and concrete are the high carbon intensive materials, in steel embodied carbon varies between 2.53–2.71 $kgCO_2/kg$ and in reinforced concrete between 0.19 and 0.24 $kgCO_2/kg$. On the other hand, wood has very low values of embodied carbon. According to the interpretation of the European standard EN-ISO 14067: 2018 (CEN, 2018), carbon stored in wood during the growing period can be considered as a negative value – timber soft wood air dried -1.66 $kgCO_2/kg$ and timber soft wood kiln dried -1.64 – -1.34 $kgCO_2/kg$ (Cabeza et al., 2021). Fig. 1 represents buildings built of brick, wood, and steel. In timber energy efficient buildings, the operational impact is still twice as high as the embodied impact, while in energy efficient brick buildings the embodied impact exceeds the operational impact, while in steel buildings they are almost equal.

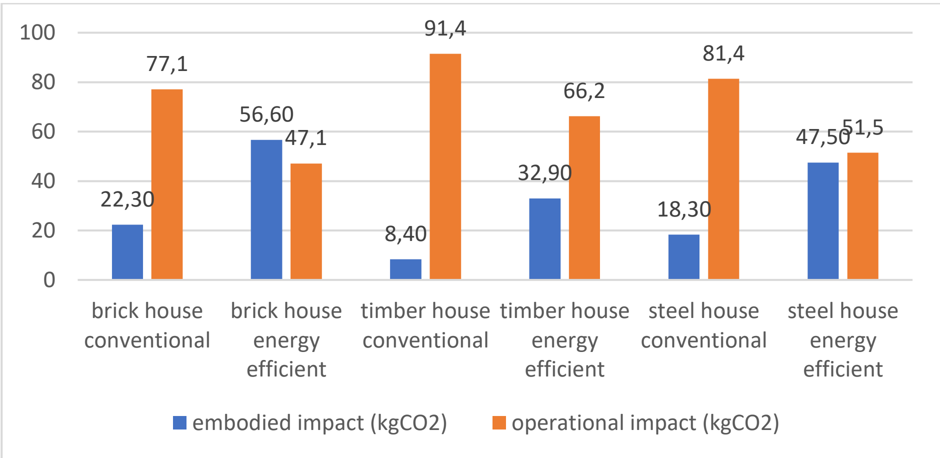


Figure 1. Proportional distribution of embodied and operational impact across the building's lifecycle

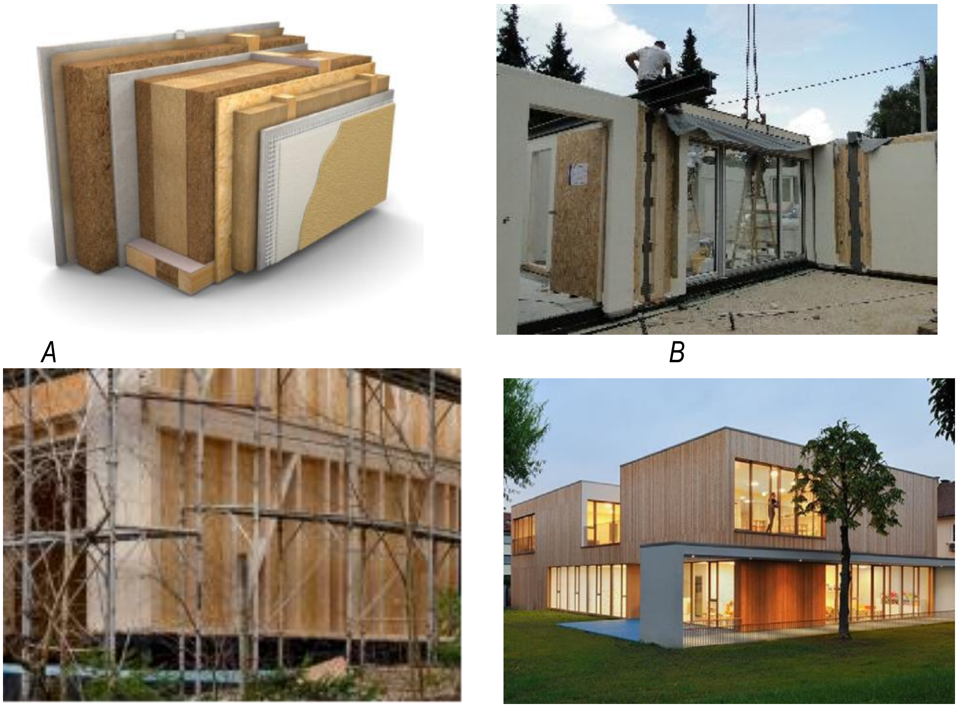
Ecologically optimized building is a building that does not require large amounts of energy throughout its life cycle, which reduces CO_2 emissions (Kovacic et al., 2018). In this paper, we focus on a passive timber house that meets these requirements and coincides with the ideas of NEB.

3. PASSIVE HOUSE – OPTIMAL ENERGY EFFICIENT BUILDING

Improving energy efficiency and introducing renewable energy sources into the building sector are key strategies for the coming decades. For almost three decades, there has been a passive house standard that fully meets NEB's expectations. A passive house has an annual heat requirement of no more than 15 kWh/(m^{2}a) (Feist, 1998). It has an extremely high-quality thermal envelope (overall heat transfer coefficient of walls and roof: $U \leq 0.1–0.15$ W/(m^{2}K), heat transfer coefficient of built-in windows and doors: $U \leq 0.85$ W/(m^{2}K)), which eliminates thermal bridges ($\psi \leq 0.01$ W/(mK)) and is airtight (n50 ≤ 0.6 h-1)). This means that transmission heat losses through the envelope are greatly reduced. A passive house has a ventilation system with heat recovery which reduces ventilation heat losses – which in traditional houses represent up to 30 % of all heat losses. The passive house is currently an optimal energy efficient building. It represents the optimal ratio between the construction costs and energy savings to achieve thermal comfort. Higher investment in greater energy savings for heating and cooling wouldn't contribute to the proportional economic and environmental impact (Feist, 1996).

3.1. Timber passive houses

Passive houses can be made of solid wood as well as wooden composites. Post and beams construction, timber frames, balloon frame system, constructions made of solid wood, load-bearing elements made of timber frames, etc. are mostly used in construction. Between the load-bearing timber structure thermal insulation of various materials is applied. Natural thermal insulation (e.g. thermal insulation from wood fibers and cellulose flakes) complements the sustainable note of the timber structure (Fig. 2A). Light timber constructions can be made in the workshop in the form of wall elements (Fig. 2B), or they can be made entirely assembled on the construction site (Fig. 2C). In the passive house standard, buildings of various purposes are built – single-family and multi-apartment houses, schools, kindergartens (Fig. 2D), office buildings, churches, prisons, museums, shops...



A *B* *C* *D*

Figure 2: A) wall element made of wood with thermal insulation of wood fibers (Photo: Marles hiše Maribor d.o.o.); B) construction of a passive house from prefabricated elements (Photo: Lumar IG d.o.o.); C) timber *post and beam construction of a passive house (Photo: Miran Kambič, Bauta d.o.o.); D) kindergarten built in passive house standard (Photo: Rihter d.o.o.)*

3.1.1. Case study – operational energy in passive house in Ljubljana

The timber passive house in Ljubljana is in a climate-unfavourable zone due to frequent winter fog. 190 m^2 of conditioned surfaces are heated by an underfloor heating system (Fig. 3). The heat is provided by an air-to-air heat pump. In the transition seasons, the rooms are heated by the heat of the sun, the heating system is turned on only when it is cloudy and when the sun goes down. Heating costs are very low. Electricity cost includes several consumers – ventilation and heating system, lighting, hot water, all appliances in a four-member household (refrigerator, freezer, washing machine, dishwasher, household appliances, stove for regular cooking, frequent use of oven, TV, daily use of computers…).

Figure 3: Timber passive house in Ljubljana

The cost of electricity consumption depends on the time of year and on the available solar energy. Tab. 1 shows electricity consumption in 2021. In the winter months (January, February, December) with less sunny weather (high fog and low clouds) and low temperatures, the average monthly electricity consumption was approx. 660 kWh (approx. 110 EUR). In other months, monthly consumption ranged between 300 kWh and 400 kWh (45-55 EUR). In sunny weather, regardless of the time of year and outside temperatures, the heat pump operated rarely. Throughout the year, four people live in the house and consume electricity for living more or less in the same way. The difference between annual and winter electricity consumption is heating energy. In the coldest month (January) with cloudy weather, the cost of heating 190 m^2 of surfaces was about 60 EUR in 2021.

Table 1. Operational energy in timber passive house in 2021

Month	*Duration of solar radiation (h)	*Average air temperature at 2 m (° C)	Monthly electricity consumption (kWh)
January	42.5	1.2	**723**
February	122	5.9	**605**
March	231.2	6.7	358
April	196	9.1	405
May	196.7	13.5	347
June	352.5	23.1	300
July	310.9	23.3	255
August	269.2	21	290
Septembe r	239.3	17.5	275
October	119.2	9.8	275
November	47.7	5.9	430
December	17.8	1.3	**647**

*Source: ARSO

The investment in a passive house lived paid off not only due to low operational energy and costs, but also due to the level of living comfort. The ventilation device constantly provides fresh and warm air. Large glass surfaces as additional heat source, in addition to heat, also let in large amount of daylight. Due to the well-insulated walls, the air temperature is same throughout the building.

3.2. Passive houses in Slovenia

Passive houses have been built in Slovenia since 2008. The construction experts became acquainted with the principles of planning and building a passive house. The market for passive house components at affordable prices were established. The decision to build (or renovate) was also encouraged state grants for buildings built in the passive house standard through the Eco Fund j.s.

From 2008 to April 2022, the Eco Fund j.s. awarded grants for (Eco Fund):
- 1300 single-family buildings
- 105 public buildings (schools, kindergartens, gyms)
- 115 dwellings in multi-apartment passive houses
- 15 office buildings

Passive houses are built from different materials, as energy efficiency does not dictate the construction technology. Among the buildings that received state grants, 55% of passive houses are made of wood (Eco Fund). In conventional construction, the ratio between solid and timber houses is different – only about 25% of houses are built of wood.

The best manufacturers of timber passive houses are members of the Passive House Consortium. In the last year companies (Lumar, Marles, Rihtar, Bauta) built 141 single-family passive houses in Slovenia. Between 2016-2021, 631 were built. During the same period, the same manufacturers also built 9 public facilities (kindergartens, schools, health center, sports center). Slovenian manufacturers of passive houses are becoming recognized abroad.

Due to state grants, the share of timber passive houses among newly built buildings in Slovenia is increasing among private single-family houses. The share of passive houses is also increasing among public buildings. The state must handle taxpayers' money economically and therefore build low-energy buildings throughout its life cycle. This is a good basis for implementing the NEB initiative.

4. NEW EUROPEAN BAUHAUS –INCENTIVE FOR THE FORESTRY SECTOR

The growing number of passive houses around the world has ensured that the passive house standard is an effective way to reduce energy consumption, which is what the members of the NEB initiative are committed to. However, limiting operational energy is not enough. The choice of materials affects the embodied energy of the building. Wood is a natural material, but the production from the raw material to the final building product, deteriorates greatly its energy balance. In addition to the use of energy for drying, part of the environmental footprint is energy for cutting and surface treatment. A lot of energy is also needed for transport, as these are specialized production processes that are highly globally centralized.

Demands for greater energy efficiency in the building sector are shifting from the architectural construction to the forestry and wood-production sectors. They face key challenges – how to ensure enough timber construction elements to take an active part in a new reality of the NEB.

Some challenges to reduce embodied energy:
- Savings in transport – energy for transport depends on the location of raw material extraction, production of individual components of semi-finished wood products and production of structural elements as well as the final location of the building. Due to the complexity of individual products, production is often centralized, which increases transport routes.
- Savings in processing – a large part of the energy for wood treatment and processing is intended for drying and production of adhesives (Ramage et al., 2017). Part of this energy can be avoided by using smaller cross-sections of the elements and by using traditional wood bonds without adhesives. If round wood is used, which is comparable to the natural shape of the trunk, gnarls are not as big a problem as with sawn wood, as the tree around gnarls already formed natural reinforcements.
- Use of wood from difunctional buildings – European Parliament (Bartolozzi, 2012) proposed a cascade use principle for wood, which includes the handling of wood waste in the following order (Ramage et al., 2017):

a) wood-based products – use wood for structures with a life service of at least 30 years (or more)
b) re-use – the priority is to reuse the structural wood in the new structure after removing the building at the end of its life
c) recycling – recycle timber structural waste into composite panels (chipboard, fibre…)
d) incineration – waste elements made of wood that are not contaminated with harmful substances and that cannot be re-incorporated into new building are used for fuel. Wood contaminated with paints, light, fungicides, etc. may be used for energy production only in special incinerators with appropriate combustion devices
e) disposal – landfill is the least favoured end-of-life scenario. Timber waste becomes a cost (costs of landfilling, waste taxation, prohibition of waste disposal). The goal is not only to reduce landfilling, but to include wood into the circular construction with the aim to reduce the need for a new wood.

5. CONCLUSION

Optimizing improvements in the thermal envelope is becoming key concept that determines the energy performance of a buildings. However, reduced energy consumption must be reflected in lower energy consumption throughout the building’s life cycle – lower operational energy can be reflected in higher embodied energy. The decision of the architect for using wood in the thermal envelope of a passive house is the first step towards fulfilling the NEB initiative. Due to low energy consumption throughout the building's life cycle a significantly lower environmental footprint of the building is evident compared to some other materials. An additional environmental advantage is the possibility of reusing timber elements after the demolition of the building. According to Kibert (2008), 50% of all waste generated by the construction industry worldwide is the result of the disposal of obsolete buildings, i.e. demolition. Until recently, most building components ended up in mixed waste, too often in illegal landfill. The awareness that some materials can be dismantled, processed and then reused or recycled is rising. The possibility of processing construction waste and returning it to the construction processes depends on the type of the material used in a construction, on the responsibility and environmental awareness of the investor and designers and on the commitment of contractors.

Wood has great potential in circular construction. Modern timber construction elements with proper installation methods and maintenance can withstand intact for decades and are suitable for use even after the demolition of the building and not only as a fuel. The greater problem is the complexity of demolition of the building, as the elements must not be damaged, as well as chemical substances for wood protection, which can be problematic when returning the material to the raw materials. In the future, the key strategy is how to treat wood in all phases of its life cycle – from chopping a tree, wood treatment, installation, demolition, and finally re-using it a new building. This is no longer just a task for architects and builders, but also for the forestry and wood-processing profession. The New European Bauhaus can be an incentive for the professions to connect with each other and co-create a built environment that will provide optimal living comfort while ensuring low dependence on energy and raw materials.

Acknowledgements: This research was funded by Slovenian Research Agency, by Research Program “Sustainable planning for the quality living space” (P5-0068).

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PLENARY LECTURE 1
HOLZHACKERS IN MALÉ KARPATY

Dušan Dobrovodský

Dušan Dobrovodský is a descendant of the so-called holzhackers, who came to the territory of Slovakia to the forests of the Lesser Carpathians at the invitation of the noble Pálffy family in the 18th century as experts in growing and processing wood. It is believed that their original home was Tyrol and Bavaria. They brought with them their culture, traditions and customs, which they still maintain today. They lived for almost 300 years in mountain houses as an ethnically closed group of people with their own culture, customs, dialect and Catholic religion. The lecture of Mr. Dušan Dobrovodský presented a probe into the management of forests and forestry in the past and brought us closer to the lives of people who dedicated their entire lives to preserving this important wealth for future generations.

Fig. 1: Mr. Dobrovodský lectures about the Holzhackers

PLENARY LECTURE 2
KYJATIC WOODEN TOYS AS CULTURAL HERITAGE OF THE SLOVAK REPUBLIC

Kristína Hedvigiová

Kristína Hedvigiová is the daughter of Mr. Ladislav Hedvigi, a manufacturer of unique wooden toys, who deserved that this wonderful tradition of making folk toys, which has been here for more than 150 years, has not disappeared. The wooden figurines are made of beech wood and are richly decorated with a typical circular or elliptical ornament, which is engraved using a special compass. Toys used to be of various shapes, e.g. horse, faucet, cots, cradles, etc. They have been assigned the GEMER – Malohont regional product trademark. The toys were also exhibited at EXPE in Dubai in 2022 as a cultural heritage of the Slovak Republic.

Fig.1: Samples of the Kyjatic toys

PLENARY LECTURE 3
WATER QUALITY

Mr. Matúšek

The lecture was enriched with a visual demonstration of the impact of reckless felling of wood and forest stands in the immediate vicinity of watercourses. Mr. Matúšek showed how floods can occur, which are currently plaguing us quite often, how groundwater is lost if the forest agglomeration is not sufficiently managed. Water quality is a topic that will resonate more and more in the future. For example, even global warming can be partially solved by cooling through reasonable manipulation of rainwater and groundwater. Life is not possible without water. We should not waste water unnecessarily. Very stimulating thoughts and topics were heard in this plenary lecture.

Fig.1: Mr. Matúšek and his collegue demonstrate the rainwater model

Conference Photos

Fig.1: Group photo after conference

Fig.2: Group photo in centre of Trnava

Publisher:
International Association for Economics, Management, Marketing, Quality and Human Resources in Forestry and Forest Based Industry – WoodEMA, i. a., Zagreb, Croatia
Slovak Association for Quality, n.o. Trnava, Slovakia

Print:
KON-PRESS,
Pekárska 29, Trnava, Slovakia
eko@kon-press.sk

Edition: 100 copies

ISBN 978-953-8446-00-9

ISBN 978-953-8446-00-9