# DIGITALIZATION OF KEY PROCESSES IN THE WOOD PROCESSING COMPANIES

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**Abstract**

*The wood processing industry is not immune to the ripple effects of information technology's constant and rapid growth. Companies from that industry are under more pressure than ever to use digital innovation to adapt to rapidly shifting markets, lead the charge in the energy transition, and speed up the implementation of Industry 4.0. The paper presents research on the digitalization of key processes in the wood processing companies that are members of the "Herzegovina" wood cluster. Questionnaires and interviews are used to obtain research data. According to the research findings, there is a difference in the degree of digitalization between the interior planning and design process, which has the highest level of digitalization, and the cutting, hauling, and transportation of lumber, which has the lowest level of digitalization. The findings show that, regardless of the process in issue, the formal environment for digitalization must be established by declaring digitalization as a strategic goal, redefining roles and responsibilities, and ensuring a constant financial flow.*

**Keywords:** digitalization, wood processing industry, processes

**JEL:** L86, L23

## 1. Introduction

Digitalization is already altering existing work practices and will continue to do so in the future, allowing and compelling firms to reinvent their business processes. The issue is that many firms still lack the knowledge of digital technologies and the ability to choose which technologies to implement to improve their business operations (Denner *et al*., 2018). However, digitalization has offered numerous business prospects, attracting a diverse group of academics. An increasing body of literature indicates that it is causing significant disruption to business models in the manufacturing sector (Arumugam *et al*., 2022; Molinaro & Orzes, 2022; Radke *et al*., 2022; Landscheidt & Kans, 2019; Beier *et al*., 2017; Lerch & Gotsch, 2015).

Businesses must begin a comprehensive socio-technical change to meet the demands of the digital age (Culot *et al*., 2020). According to Singh & Hess (2017), this necessitates adopting an all-encompassing digital strategy that considers the benefits and dangers of digital technology and encourages the production of values and revenues based on digital assets.

Digitalization varies greatly across economic sectors, with notable disparities between nations and company sizes (Jaumotte *et al*., 2023). For example, innovative digital technologies are used by 83% of enterprises in the European Union (EU) machinery and transport equipment industry, significantly more than in the building sector (52%). Different levels of digitalization can be explained by the fact that other businesses generate various goods and that only specific jobs can be accomplished by utilizing advanced digital technologies. There is also a significant association between the usage of modern technology and digital uptake throughout the pandemic in all industries (Brunori *et al*., 2023).

The wood processing industry appears to have tremendous potential for digitalization. From forest to factory, throughout the wood supply chain process, vast amounts of data are generated that can give valuable insights that could enhance the management of the whole process (Gharaibeh *et al*., 2022; Müeller *et al*., 2019; Scholz *et al*., 2018). Likewise, the latest technological tools can create a cyber-physical

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setting for designing and producing wood goods, allowing process optimization (Chang & Chen, 2017). Several studies have investigated the essential aspects, adoption, and benefits of digitalization in the wood sector (Molinaro & Orzes, 2022; Kropivšek & Grošelj, 2020; Cheta *et al*., 2020; Ercanli, 2020; de Geus *et al*., 2020; Proto *et al*., 2020; Zheng *et al*., 2018).

However, the wood processing industry struggles with digitalization, establishing production systems, and applying smart manufacturing (Landscheidt & Kans, 2016; Salim & Johansson, 2016). Here, the wood processing industry, which comprises, among others, the business sectors of furniture and interior products manufacturing, the production of floors, and cabinetry and joinery (Landscheidt & Kans, 2019), continues to rely on inefficient and primarily manual labor-intensive production processes. Although the industry's enormous potential for digitalization and sophisticated manufacturing systems is recognized (Kortüm *et al*., 2016), the process of updating production systems has only just begun. The workforce's poor level of digital literacy, a lack of consistent supply of high-quality raw materials, and a conventional view of manufacturing principles are all reasons for this (Vestin *et al*., 2018).

When compared to other industries, the wood processing sector is relatively slow to adopt cutting-edge digital technologies like industrial robots and computer-controlled systems like computer-aided design (CAD) and computer-integrated manufacturing (CAM) (Vestin *et al*., 2018).

There is still a shortage of real-time data, data integration, and traceability issues in the wood sector (Santos *et al*., 2019). That sector is estimated to be 20-30 years behind others, such as the automobile or electronics sectors (Landscheidt & Kans, 2016).

Several theoretical recommendations exist (Vestin *et al*., 2018; Kortüm *et al*., 2016) regarding how wood processing companies should adopt digitalization and smart manufacturing concepts to maximize their development potential. However, those recommendations are not widely used in practice (Landscheidt & Kans, 2019).

While digitalization has many potential uses in the wood processing industry, little effort has been taken in the past to examine and synthesize the existing body of knowledge on these topics. Previous evaluations lack systematization and give only piecemeal coverage of the subject by focusing on isolated technologies (such as blockchain, IoT, and Big Data) and/or isolated processes in the wood supply chain (Gharaibeh *et al*., 2022; Bout & Heeks, 2018; Bohlin *et al*., 2017; Siipilehto *et al*., 2016; Manner *et al*., 2016).

Recent literature has argued that the technological advancement of enterprises working in the wood sector is relatively limited. According to Landscheidt & Kans (2019), many manual operations still characterize manufacturing processes, and enterprises are not entirely aware of the prospects of automation in this sector. A thorough examination of the subject can help confirm or disprove this assertion and identify the primary application areas of digitalization and future uses that may be worth considering, thereby promoting technical growth in the industry (Molinaro & Orzes, 2022).

There is limited study on digitalization in the wood processing industry in Bosnia and Herzegovina (Gašpar *et al*., 2023). That was the incentive for investigating the digitalization of key processes in companies that are members of the "Herzegovina" wood cluster.

The presented research uses data collected for the EU4Business project "Boosting Competitiveness of the Wood Processing Sector in Herzegovina," which is jointly funded by the EU and the Federal Republic of Germany.

Research questions (RQ) are as follows:

RQ1: Is there a difference in understanding the importance of digitalization and willingness to invest in it regarding the different business processes in the analyzed wood processing companies?

RQ2: Do the key challenges in digitalization, recognized at the analyzed wood processing company level, also apply to specific key processes?

RQ3: Do the key priorities in digitalization, recognized at the analyzed wood processing company level, also apply to specific business processes?

RQ4: Is there a difference in the assessment of the level of digitalization among different business processes in the analyzed wood processing companies?

The paper is organized as follows: the methodology follows the introduction, followed by the results and discussion. A conclusion and suggestions for further study round out the paper.

## 2. Methodology

Empirical research was conducted between 29 November 2021 and 22 January 2022 in Bosnia and Herzegovina. The target group included the companies operating in the wood industry, specifically the wood cluster "Herzegovina" (Hercegovina Wood Cluster, 2022), which contains 27 companies.

Ten enterprises from the "Herzegovina" wood cluster agreed to participate in the study after being invited to do so; as a result, the sample consisted solely of those ten organizations (return rate is 37%).
The data was gathered by a questionnaire consisting of three sections organized according to the following topics:

1) The importance of digitalization and the preparedness to invest in it
2) Barriers to the company's digital transformation;
3) Digitalization priorities.

In addition to these questions, the respondents were asked about the company in general (year of establishment, number of employees, annual income, key business procedures). Each respondent estimated the current state of digitalization for primary business processes and the company as a whole.

The collected data/answers were grouped, coded, summarized and the results were expressed as absolute frequencies. In addition, for the level of digitalization (percentage of digitalization of business processes according to the free assessment of respondents), the selected descriptive indicators are presented.

- *Companies' characteristics - sample*

The participating companies have operated for roughly 25 years (M=25; SD=4). Seven of them, the majority, were established before the year 2000. Three enterprises employ fewer than ten people, six employ between ten and fifty, and one employs more than fifty people.

The following was revealed by examining the realized annual revenue: Four enterprises earn more than BAM one million annually, while three generate between BAM 100,000 and 500,000, or between BAM 500,000 and 1,000,000.

The analysis of the respondents' job positions showed that the answers were given by seven CEOs (Chief Executive Officers) and three COOs (Chief Operating Officers).

Multiple responses were given by the respondents to the question about the researched organizations' key business procedures.

Table 1 shows the results.

Table 1. *Number of the analyzed wood processing companies by their primary business processes*

| **Primary business processes** | **Number of companies** |
|---|---|
| Furniture production | 6 |
| Interior planning/design | 4 |
| Panel processing (Folding, cutting, pressing, CNC processing, etc.) | 4 |
| Cutting, hauling, and transporting timber | 3 |

Source: Authors' preparation

## 3. Results

The first part of the research findings presented the answers to questions from individual thematic blocks for each primary business process in the analyzed wood processing companies (Table 1). The obtained results are shown in Table 2.

Table 2. *Number of answers in three thematic blocks according to primary business activities*

| **A section topic**<br>• Answers | **Number of answers*** | | | |
|---|---|---|---|---|
| | FPP | IP/DP | PPP | CHTTP |
| **Digitalization significance and the preparedness to invest in it.** | | | | |
| • Digitalization brings advantages, but it is not yet a high investment priority. | 2 | 0 | 1 | 2 |
| • For the company to maintain its competitive advantage, digitalization is required, but the investment must be economically justifiable. | 5 | 4 | 4 | 1 |
| • Digitalization is essential for improving productivity, but it must be financially justified. | 4 | 4 | 3 | 1 |
| • Although digitalization is vital, the company lacks the capital to do so right now. | 1 | 1 | 1 | 0 |
| • There is currently no strategy for digitalization and investment within the organization. | 6 | 4 | 4 | 3 |
| **Barriers to the digitalization of the furniture production** | | | | |
| • Employees have a limited understanding of digitalization. | 5 | 1 | 3 | 3 |
| • Employee turnover is high. | 3 | 2 | 2 | 2 |
| • Lower-level management and staff are opposed to digitalization. | 1 | 1 | 1 | 3 |
| • Financial constraints. | 1 | 1 | 1 | 0 |
| • A small production volume. | 3 | 0 | 3 | 3 |
| **Digitalization priorities in furniture production** | | | | |
| • Providing more training to staff to improve their proficiency with digital tools. | 4 | 1 | 3 | 3 |
| • Integrating the company data by bringing together information from different digital devices and software applications utilized in other of the company's business processes. | 5 | 4 | 4 | 3 |
| • Upgrades and new purchases of digital equipment. | 6 | 4 | 4 | 3 |

* Multiple answers
FPP - The furniture production process; IP/DP - Interior planning/design process;
PPP - Panels processing process; CHTTP - Cutting, hauling, and transporting timber process

Source: Authors' preparation

- *Results of the wood processing companies whose primary business process is furniture production*

All companies that stated this is one of their primary business processes answered that they lack a systematic approach to digitalization and investment. Most recognized the necessity of digitalization in retaining competitive advantages and increasing productivity, but only in cases where the investment is financially justified.

One company stated that the lack of funds prevents it from the digitalization of this process. When it comes to the challenges of digitalizing the furniture production process, most companies recognized their employees' low level of digital literacy as a challenge. H

alf of the companies saw a challenge in high employee turnover and a small volume of production, which economically does not justify significant investments in digitalization. Most companies believe that digitalization priorities recognized at the entire company level are also priorities for this business process.

- *Results of the wood processing companies whose primary business process is interior planning/design*

All companies stated that currently, there is no systematic approach to digitalization and investment regarding this business process. Regarding the interior planning/design process, all companies stated that digitalization is necessary for retaining competitive advantages and increasing productivity, with financial justification being considered. Not a single company stated that the digitalization of this process is not a priority regarding investment. Only one company stated that the lack of funds prevents it from the digitalization of this process.

The answers related to the digitalization challenges associated with this business process are not harmonized as in the case of the furniture production process. For most of the offered statements, one answer was recorded.

As multiple answers were possible, it was not easy to assess whether a different company stood behind each answer or whether the answers referred to only one company. Harmonization is complete regarding priorities related to data integration and upgrades and new purchases of digital equipment. Increasing the digital literacy of employees was not recognized as a priority by most companies. That may be because the employees in this business process are mostly highly educated (engineers and/or architects).

- *Results of the wood processing companies whose primary business process is panel processing*

The results of this business process are quite similar to those related to furniture manufacturing. There was a difference in the priority related to increasing employees' digital literacy. Namely, for this business process, this priority was chosen by half of the companies, in contrast to the furniture production process, where most companies chose it.

- *Results of the wood processing companies whose primary business process is cutting, hauling, and transporting timber.*

Most companies stated that digitalization has advantages, but it is not yet their top priority regarding investment. The reason for this attitude probably lies in the business process itself.

Namely, replacing mechanical machines with the digital ones in this process requires significant financial investments for which, given the volume of work, there is no

economic justification, which was cited as a challenge by all companies.

All companies stated that they lack a systematic approach to digitalization and investment regarding this process. The answers related to the digitalization challenges regarding this business process are highly harmonized.

Challenges are employees' low level of digital literacy, high employee turnover rate, resistance to changes, and, as already said, a small production volume. No company cited financial constraints as a potential challenge. All companies stated that digitalization priorities recognized at the entire company's level are also priorities for this business process.

The second part of the research results refers to the companies' self-assessment level of digitalization for each analyzed business process (Table 3).

Table 3. *Percentage of digitalization by primary processes (self-assessment) in the analyzed wood processing companies*

| **Primary business processes** | **R** | **M (SD)** | **D** |
|---|---|---|---|
| Furniture production | 5-60 | 26.7 (20.7) | - |
| Interior planning/ design | 65-85 | 77.5 (7.5) | 80 |
| Panel processing | 5-70 | 30 (24.7) | - |
| Cutting, hauling and transporting timber | 0-15 | 5 (7.1) | 0 |

R - range (min-max); M (SD) - mean (standard deviation); D - mode

Source: Authors' preparation

According to the presented self-assessment, the interior planning/design process has the highest level of digitalization, with the highest minimum (65%), maximum (85%), and average (77.5%). The process of cutting, hauling, and transporting timber has the lowest level of digitalization, with the lowest minimum (0%), maximum (15%), and average of only 5%.

The furniture production and panel processing processes had a similar level of estimated digitalization, with a minimum of 5% and a maximum of 60% and 70%, respectively.

## 4. Discussion

The first research question (RQ1) sought to find out whether there is a difference in understanding the importance of digitalization and the preparedness/willingness to invest in it regarding the different business processes in the analyzed wood processing companies.

The results in Table 2 show some differences regarding RQ1. In most companies where the key process is cutting, hauling, and transporting timber, the importance of digitalization is not recognized, and consequently, there is no willingness to invest in it.

Companies with other key processes underline their awareness of the advantages and importance of digitalization. However, a relatively conservative approach prevails regarding investment in digitalization, meaning that clear financial justification is necessary before investment.

Regardless of which key process is involved, all companies stated the lack of systematic approach to digitalization and investment. However, some researchers have found that flexible organizational structures with independent business units, agile organizational forms, and digital functional areas are especially well suited for digitalization (Culot *et al*., 2020; Singh & Hess, 2017).

Despite the clear benefits of digitalization to the businesses that adopt it, the investigated organizations failed to see the need to formally set the stage for digitalization by making it a strategic goal, reorganizing roles and responsibilities, and allocating sufficient resources.

The second research question (RQ2) sought to find out whether the key challenges in digitalization recognized at the analyzed wood processing company level also apply to specific key processes. The presented results show that, when it comes to digitalization, there are similar challenges at the level of key processes as at the level of the entire company.
Challenges like the low level of digital literacy of employees, high employee turnover rate, resistance to changes, and a small volume of production were recognized by most companies where key processes are furniture production, panel processing and cutting, hauling, and transporting timber. These results support previous research on challenges in the digitalization of wood processing companies (Molinaro & Orzes, 2022; Vestin *et al*., 2018; Landscheidt & Kans, 2016). The challenge regarding the high employee turnover rate is not theoretically approved, but that challenge exists in all industries in Bosnia and Herzegovina. The cause is a large outflow of labor from the country due to better wages and working conditions in other countries, especially Europe.

The third research question (RQ3) sought to find out whether the key priorities in digitalization recognized at the analyzed wood processing company level also apply to specific key processes. The results show that data integration and digital equipment procurement are the same priorities regardless of the key process in question. The difference between key processes exists only in relation to the priority of increasing employees' digital literacy through additional training. Increasing the digital literacy of employees is not recognized as a priority only in the process of interior planning/design. As already explained, this may be because the employees in this business process are mostly highly educated (engineers and/or architects).

The fourth research question (RQ4) sought to find out if there is a difference in assessing the level of digitalization among different business processes in the analyzed wood processing companies. The results in Table 3 show a large difference in digitalization in wood instruction, varying between the planning/interior design processes with the highest level of digitalization and the processes of felling, extracting, and transporting wood with the lowest level of digitalization.
For furniture production and panels processing, digitalization assessment is quite uneven. However, the obtained results follow previous research (Landscheidt & Kans, 2019; Santos *et al*., 2019; Vestin *et al*., 2018) that indicate a significant delay in the digitalization of the wood industry compared to other industries.

## 5. Conclusion

The research findings indicate a difference in digitalization on dependence on business processes within the company. However, there are also some differences between key processes regarding the low level of employee literacy as well as in understanding digitalization importance and willingness to invest in it.

The results reveal that no matter what process is in question, making digitalization a strategic priority, restructuring roles and duties, and providing a continual flow of finances are all essential to provide the formal backdrop for digitalization. The data also suggest that the digitalization of the cutting, hauling, and transportation of timber, as well as the production process, is the most difficult task due to the requirement for significant investments in digital equipment and employee training.

Although this research provides valuable information about the digitalization of key processes in the wood processing industry, it does have many drawbacks. First, because the analysis is based on a small sample of small and medium-sized companies from the "Herzegovina" wood cluster, the findings are limited in their applicability to other contexts.

In order to analyze the state and practices of digitalization of key processes in the wood processing industry in Bosnia and Herzegovina and its regions, future research should expand the sample, *i.e.*, include more wood processing companies from Bosnia and Herzegovina. Also, the research could be extended to the entire region, which would collect data for a comparative study. That will enable a more comprehensive understanding of the degree to which key processes and the wood processing companies in Bosnia and Herzegovina and beyond are digitalized.

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