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Challenges in Wood Industries and Contributions of Technological Promotion to Quality Timber Processing in Selected Cities of Ethiopia

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Abstract

The study investigates the challenges and advantages of technological training in the adoption of advanced methods of timber processing in selected Ethiopian cities, including Addis Ababa, Adama, Hawassa, and Jimma. It examines the impact these technologies have had on the timber industry, identifies the constraints that hamper the full application of the technologies, and describes the prevailing conditions. It applied a mixed-methods approach, where both qualitative and quantitative research were combined. This included interviews with industry experts and site visits to timber processing plants for direct observation. The results indicate that modern technologies have improved the industry in some ways, but a number of drawbacks still exist. These challenges include incorrect or very outdated machinery, absence of professional workers, lack of access to modern technology, and poor infrastructure. The industry also suffers from limited production space and sales areas. In any case, the popularization of new technologies has increased awareness and enhanced the labor skills, especially of producing high-quality lumber in a number of cities. The study also emphasizes technology as a transformative force in Ethiopia's timber industry, and strategic efforts toward resolving current challenges should be embraced on the fronts of technology adoption, training in the workforce, and infrastructure improvement. These are likely to have positive impacts on increasing long-term productivity and economic gains and ensuring environmental sustainability within the industry.

1. Introduction

Ethiopia, a country endowed with a rich variety of natural resources, has experienced notable growth across several sectors, particularly in manufacturing and construction (Tamirat & Tadele, 2023). The timber processing sector in Ethiopia, despite its long-standing history and experience, remains underdeveloped in terms of its competitiveness in the global market. The sector faces a variety of internal and external challenges that have hindered its full potential (Birhan, 2014; Tolera, 2022). Timber processing technologies, which play a pivotal role in transforming raw timber into valuable, market-ready products, are critical for supporting Ethiopia's economy, urban development, and sustainable resource use (Picchi et al., 2022).

In recent years, selected cities in Ethiopia have been at the forefront of adopting advanced timber processing technologies, aiming to enhance efficiency, product quality, and sustainability in the timber industry. The adoption of modern timber processing technologies offers numerous benefits (Kunickaya et al., 2022). Improved processing techniques can lead to higher productivity, better utilization of raw materials, and reduced waste, which are critical for the sustainability of the industry (Kaba et al., 2024).Furthermore, the production of high-quality timber products supports the growing demand in both domestic and international markets (Sori et al., 2023), fostering economic growth and creating employment opportunities in urban centers (Arce, 2019) Cities like Addis Ababa, Hawassa, and Bahir Dar are notable for their progressive steps towards integrating these advanced technologies, reflecting their commitment to industrial modernization and economic development.

The cities at the forefront of this modernization, such as Addis Ababa, Jima, Hawassa, and Bahir Dar, serve as key examples of how the integration of cutting-edge technologies can drive industrial development and foster urban economic growth. However, the successful integration of these modern timber processing technologies has been met with a number of challenges. The sector is constrained by both internal factors, such as outdated machinery, a shortage of skilled labor, and limited access to financing, and external issues like insufficient infrastructure and complex regulatory environments (Ayana, 2021; Kaba et al., 2024). Additionally, issues related to sustainable forest management and environmental impacts of timber harvesting pose significant concerns (Ayana, 2021). To fully realize the potential benefits of modern timber processing technologies, it is imperative to address these barriers through strategic interventions. Identifying and resolving key challenges will maximize the sector's contributions to Ethiopia's economy while promoting the sustainable management of its natural resources (Sori et al., 2023).

This study seeks to explore the contributions and challenges associated with the promotion of modern timber processing technologies in selected cities of Ethiopia. It examines the current level of technology adoption in the timber processing sector, identifies the main barriers to the successful integration of these technologies, and evaluates the impact of technological improvements on the quality and efficiency of timber processing. By offering insights into these key areas, this research provides a comprehensive understanding of how the timber processing industry can better contribute to Ethiopia's national economy and ensure its sustainability in the face of both local and global challenges

2. Methodology

2.1 Research Design and Approach

This study employs a mixed research approach, incorporating both qualitative and quantitative research designs, to comprehensively understand the wood industry in Ethiopia. Key informant interviews are utilized to gather in-depth insights. The qualitative approach is chosen to explore the nuanced experiences, perceptions, and knowledge of various stakeholders involved in the industry, whereas the quantitative research approach is used to analyze numerical data and identify some trends and patterns within the industry.

Data were gathered through semi-structured interviews with key informants, comprising 21 individuals from wood industries, 4 experts, 2 researchers, and 1 technology provider or trainer, a total of 28 informants were interviewed from the cities of Addis Ababa, Adama, Hawassa, and Jimma. These cities were intentionally selected based on their previous participation in technological promotion training programs. Key informants were randomly chosen from among the training participants in each city. Additionally, field visits and observations were conducted at selected timber processing enterprises to record their operations, technology usage, and workplace conditions. These observations provided practical insights and complemented the information collected from key informant interviews.

2.2 Data Analysis

The data collected from the interviews and observations were transcribed and analyzed using content analysis, transcription, synthesis, and thematic presentation. These methods used to systematically to analyze the content of communication, to convert spoken language into written text, to combine information from different sources or data points to generate new insights and to identify common themes and patterns related to the challenges and contributions of technological promotion in the timber processing industry. This involves: Recording interviews and reading through the record's multiple times; Coding the data to identify significant themes and patterns; Grouping similar codes into themes that capture key aspects of the wood industry.

A comparative analysis is conducted to identify similarities and differences across the different cities. This involves: Comparing themes and patterns identified in Addis Ababa, Adama, Hawassa, and Jima; Analyzing how location-specific factors (e.g., infrastructure, local policies, market conditions) influence the wood industry in each city; Drawing conclusions about the overall state of the industry and identifying city-specific challenges and opportunities.

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3. Results and Discussion

3.1 Lack of Modern Machineries and Equipment

One of the most significant challenges identified in Ethiopia's timber processing industry is the pervasive use of outdated machinery and equipment (fig1). As observed in many sawmills and wood processing enterprises are currently operating with technology that is both obsolete and inefficient. As stated by respondents, the reliance on old equipment results in several detrimental effects, including reduced productivity, increased levels of waste, and subpar quality of the final products. Consequently, this hampers the industry's capacity to produce high-quality timber products that can compete effectively in both local and international markets. Respondents stated that, the use of outdated machinery not only limits operational efficiency but also contributes to higher operational costs due to increased maintenance needs and energy consumption. Furthermore, the lower quality of output associated with these outdated systems can tarnish or decrease the reputation of Ethiopian timber products, making it challenging to establish a strong presence in competitive markets. This issue is not unique to Ethiopia; similar challenges have been documented in other countries with developing wood industries. For instance, a study conducted in Cameroon by (Ngaba et al., 2023) and by (Muthike & Githiomi, 2017) in Kenya highlighted how outdated machinery significantly impairs the productivity and competitiveness of the timber sector there.

3.2 Shortage of Skilled Labor and Training Gaps

A shortage of skilled labor was identified by informants in all the cities as a critical challenge facing the wood industry in Ethiopia. Skilled labor is needed in most of the important processes, including logging, sawmilling, and furniture production. However, there is a total absence of workers with adequate training to meet these demands. The absence of institutions that formally train in working with wood and its related products exacerbates the problem. As a result, most workers enter the industry poorly skilled and rely heavily on informal, on-the-job learning. The skills gap negatively impacts the industry's overall efficiency, resulting in higher operational costs and reduced product quality. It also stifles innovation and limits the adoption of modern technologies, which require workers proficient in advanced machinery and techniques. Additionally, the lack of skilled labor undermines the industry's ability to meet international standards and compete in global markets (Ortiz & McGuinness, 2015). This training need requires an integrated approach. All the respondents highlighted establishing vocational training in collaboration with technical institutes and NGOs, where proper training in both basic and high-value woodworking is undertaken. One respondent from Addis Ababa also added that the "government should establish close coordination between industry participants and education/training institutions so that trained personnel are indeed prepared to meet constantly evolving industry demands.".

3.3 Limited Access to Modern Technology

Respondents identified that there were significant barriers to accessing modern technology due to the high costs and limited awareness. A representative of a small-scale timber processor revealed that the high cost of improved technology has been a limiting factor in being able to produce quality products. There is also overall general knowledge about the availability of appropriate modern technological solutions. Other important issues involve the mismatch between the labor force's skills and those needed by advanced machinery operation and maintenance. The lack of proper training programs further exacerbates the situation of using new technologies

3.4 Lack of Convenient Production and Sales Places

Ethiopian wood industries face challenges in both production and sales, which negatively affect efficiency, the quality of the products, and their competitiveness in the market. The use of substandard production facilities and inappropriate production areas is the main reason, as stated by respondents, affecting the quality of the products being produced. Moreover, the absence of specific sales areas forces producers to rely on custom orders, consequently limiting their potential to respect production schedules and assure quality standards. Insufficient space to put their training into practice was also underlined by all surveyed cities' respondents, whether it involves storing the wood for seasoning or the absence of a showroom in which to present their products, which undermines visibility in the market. The research team observed these operational limitations firsthand and underscored the urgent need for government support. This involves the creation of improved production environments and infrastructure enhancement to raise the capacity in manufacturing. Independent sales platforms for industry stakeholders might also create further flexibility and adaptability to market demands. Holistic attention to these issues will go a long way toward developing a more robust and competitive wood industry for Ethiopia.

3.5 Supply Chain Challenges

Most of the respondents mentioned this as a very important problem. It upsets the production schedules due to frequent work stoppages; productivity is reduced, and there are problems with meeting deadlines and fulfilling orders. This unpredictable supply of wood makes adequate planning and smooth operations hard to undertake.
The high costs related to transportation of raw materials and finished products are another major obstacle coupled with poor infrastructure. The deplorable state of roads and the length between forests and processing facilities make transportation expensive, thereby increasing the cost of production. In addition, the electricity and water supplies are unreliable; this further disrupts activities and creates inefficiency in daily activities at processing facilities. Issues raised in this respect were confirmed through visits of the research team to selected processing enterprises, which underlined the urgent need for government intervention. Among the priorities should be investment in infrastructural development: provision of a good road network and ensuring dependable utility services. Developing a structured and reliable raw material supply chain is equally critical to enable businesses to plan effectively and improve efficiency. Addressing these supply chain challenges holistically is central to realizing full potential for the wood processing industry in Ethiopia and enhancing its competitiveness both domestically and globally

3.6 Another Challenge

Other miscellaneous problems affecting the wood industry in Ethiopia, as identified by respondents from different cities, are regulatory barriers, limited market connections, and financial constraints. Stakeholders stress that a more enabling regulatory framework will facilitate smoother operations that stimulate growth in the industry. Many complained about the complexity of prevailing regulations, which often get in the way of efficient business practices and expansion efforts. The other important concern which was raised was about market connectivity in all cities. This refers to the lack of organized platforms for showcasing and selling their products. For instance, two respondents from Adama recommended that bazaars organized by the government could increase visibility and direct linkage with buyers to stimulate demand for domestic producers. Such would provide opportunities for networking and strengthen the position of the domestic producer in the market. Financial constraint was one crucial challenge cited consistently. Many also emphasized that a lack of sufficient access to credit facilities negatively affects the level of investment in, and growth of, the wood industry. Technology providers and researchers also identified this issue as problematic, which effectively restricts upgrading equipment, modernization of technologies, and enterprise scaling. Some also criticized the current taxation policy for being too burdensome with regard to the real needs of the wood processing industry. One respondent lamented those high taxes eroded profit margins and discouraged investment, further stifling the growth of processing enterprises.

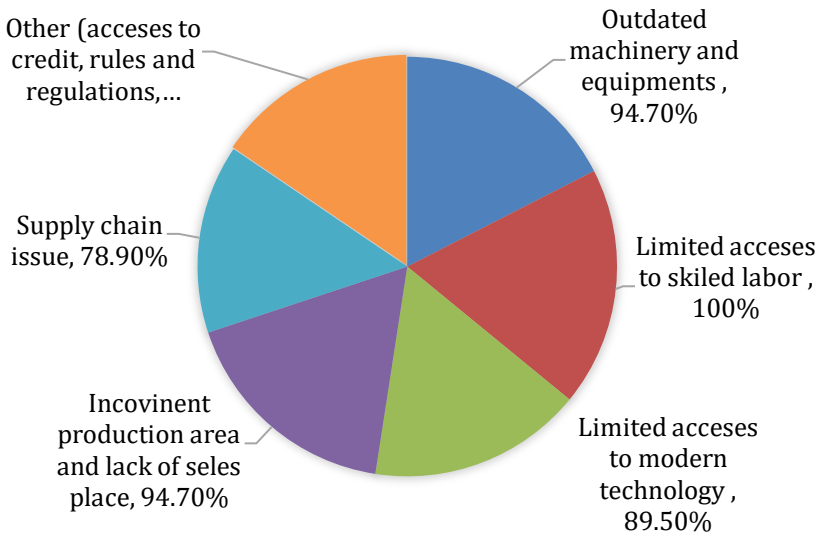

Fig. 1 *Key challenges in wood industries*

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3.7 Contributions of Technological Promotion

The study gathered valuable feedback from participants who had undergone technological training in timber processing, offering insights into its practical benefits and transformative impact on their operations. Their responses highlight key areas where the training influenced knowledge, practices, and industry collaboration, ultimately contributing to improved quality standards and productivity across the sector. The participants provided feedback in several key areas, as outlined below:

- **Positive Views on Lumber Seasoning:** A unanimous majority 100% acknowledged the importance of training on proper lumber seasoning and handling. The participants pointed out that the techniques used in seasoning enhanced the lumber's structural and durability features, thus ensuring good quality for construction and other intended uses. Participants believed that knowing the critical role of moisture control and seasoning in defect limitation, such as warping and cracking, would aid them in producing premium-grade timber suitable for both local and international markets.
- **Solutions to Lumber Distortions:** Besides, the training introduced practical solutions to common problems in the field, such as those concerning lumber defects and degradation. Participants were satisfied with being introduced to new ways to minimize problems, which are common during production and storage, like warping, splitting, and other forms of distortions. Methods were considered valuable in helping the trainees maintain quality standards from processing through storage and up to minimal loss and satisfied customers.
- **Improved Collaboration Among Stakeholders:** The training seminars have encouraged more interaction and cooperation between interested parties in the wood sector. Indeed, participants confirmed that shared experiences and best practices during the sessions assisted in developing relationships and networks among the players involved in the sector. This improved collaboration is viewed as a step in the right direction to addressing their shared challenges and developing collective strategies for improving the industry.
- **Alternative Materials through Diversified Use of Timber**: A full 96.4% of the respondents mentioned a trend of gradual increase in the use of lesser-known timber species, such as eucalyptus. According to them, the diversification of timber resources has lessened dependency on traditional species and imported wood products. This transition not only encourages the sustainable use of available resources but also opens up new market avenues for underutilized timber varieties that have gone unnoticed until now.
- **Greater Efficiency and Productivity:** Of the participants, most (92.9%) stated they were able to record remarkable changes in production efficiency after undergoing the training. Indeed, they pointed out that adopting current techniques enabled them to optimize the available timber resources and minimize waste. More significantly, improved efficiency resulted in reduced production costs and improved profitability, making their operations more feasible and competitive.
- **Better Resource Utilization and Time Management**: About 75% of the respondents highlighted those modern methods of sawing, like chain sawing, minimize resource wastage and optimize time use. This is because such methods reduce the time used for repetitive activities, such as frequent loading and unloading, allowing for smoother operations and improving the productivity of resources.
- **Greater Emphasis on Quality Lumber Production**: An overwhelming majority of 85.7% showed a renewed interest in quality lumber production. To them, proper sawing methods, followed by effective seasoning, are crucial for high-quality finished goods. Therefore, with the increased level of awareness, they are determined to ensure that quality does not remain compromised at any phase, which will further help in acquiring trust among customers and enable them to increase more shares in the market.

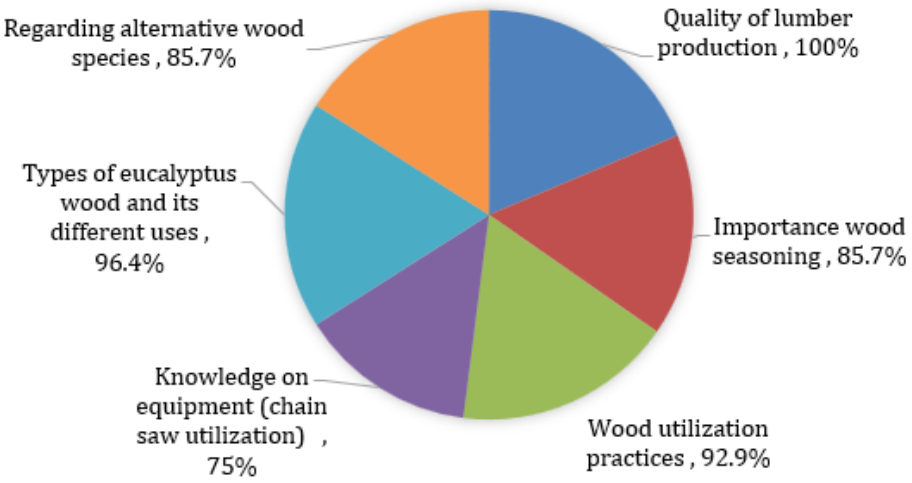

Fig. 2 *Contributions of technological promotion*

4. Conclusion

The critical challenges faced in the wood processing industry in Ethiopia include a number of drawbacks to the growth and competitiveness of this industry, both domestically and on the global stage. Outdated machinery, limited skilled labor, lack of modern technology, shortages of production facilities, and supply chain disruptions are major drawbacks. These challenges increase inefficiencies, raise production costs, and reduce product quality; thus, Ethiopian timber products cannot meet international standards. Besides, regulatory barriers add to the woes of the industry, along with limited market connectivity and financial constraints. Despite all these challenges, some positive developments have taken place regarding the adoption of newer techniques in lumber seasoning, improved resource utilization, and a move towards quality-oriented production. Some of the issues mentioned above have been adequately addressed through training programs, whereby industry players have managed to increase their efficiency, reduce wastage, and improve product quality. However, there is still an urgent need for a more integrated approach to dealing with the root causes of these problems and realizing the full potentials of the industry.

Based on the challenges identified in Ethiopia's wood-processing industry, a multifaceted approach is recommended to promote sustainable growth and competitiveness. First, investment in modern machinery and equipment is crucial, with government support through incentives or subsidies to help SMEs acquire updated technologies that improve productivity, minimize waste, and enhance product quality. Simultaneously, the development of vocational training programs, supported by collaborations between industry stakeholders and educational institutions, is essential to address the current skills gap, especially in machinery operation and maintenance. Improving infrastructure—including roads, electricity, and water supply—will further streamline production processes and reduce operational costs. To strengthen market access, the government should support organized sales platforms, such as trade fairs and bazaars, to connect producers with buyers and promote local timber products. Additionally, access to credit and regulatory reforms must be prioritized to facilitate business expansion and improve operational efficiency. Finally, the industry should be encouraged to adopt sustainable practices, including the use of lesser-known timber species like eucalyptus, to reduce reliance on traditional resources and diversify product offerings, thereby ensuring long-term environmental and economic sustainability.

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Author Contributions

*Gemechu Kaba led the **conceptualization and design of the study**. Omer Hinde contributed to **data collection and field coordination**. Hiwot Hailu was responsible for **data analysis and interpretation**. Azmera Belachew contributed to the **literature review and drafting of the manuscript**. Tesfanesh Ababu assisted in **refining the methodology and reviewing the final version of the paper**. All authors read and approved the final manuscript.*

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper

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