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Adopting Bamboo as an Alternative Material in the Furniture Industry: A Systematic Literature Review (SLR) on Awareness and Readiness of Adoption

Noor Aslinda Abu Seman^{1*}, Siti Fatimah Ibrahim², Juliana Abdul Halip³, Nurazwa Ahmad², Arifha Mohamad⁴, Umi Kartini Rashid¹, Mohd Khairun

Anwar Uyup⁵

¹Johor Business School, Universiti Tun Hussein Onn Malaysia, Batu Pahat, Johor, Malaysia, ²Faculty of Technology Management and Business, Universiti Tun Hussein Onn Malaysia, Batu Pahat, Johor, Malaysia, ³Faculty of Engineering Technology, Universiti Tun Hussein Onn Malaysia, Hab Pendidikan Tinggi Pagoh, Panchor, Johor, Malaysia, ⁴Faculty of Business, Economics and Social Development, Universiti Malaysia Terengganu, Kuala Terengganu, ⁵Forest Products Division, Forest Research Institute Malaysia, Kepong, Selangor, Malaysia. *Corresponding Author's Email: naslinda@ccmcs.net

Abstract

This systematic literature review (SLR) of bamboo investigates its functions as an environmentally friendly substitute for traditional wood-based products alongside its operational characteristics, environmental advantages, and economic benefits in the furniture sector. Bamboo has captured the market's interest because sustainable material demand increases due to its durable quality, renewability features, and cost-effectiveness. However, adoption remains limited due to industry-specific barriers and a need for more awareness. Using the PRISMA methodology, this review analysed 31 studies from Scopus, which were selected based on relevance to bamboo adoption, readiness, and understanding within industry contexts. The findings reveal five critical dimensions impacting bamboo adoption: material properties, environmental impact, economic feasibility, barriers to adoption, and industry readiness. This study further integrates the aspects into a conceptual framework delineating the stages of industries, from profiling to evaluating readiness for adoption. Despite being a helpful guide, this approach has many drawbacks, such as possible bias in the breadth of the reviewed literature and a need for actual data on current technical developments in bamboo processing. The research ends with suggested further studies that must verify this framework's universal applicability and conduct empirical examinations on bamboo's economic impact and environmental consequences as an alternative material.

Keywords: Alternative Material, Awareness, Bamboo, Furniture Industry, PRISMA Approach, Readiness.

Introduction

The global bamboo furniture market is expanding rapidly focus because people now on environmental sustainability and seeks ecofriendly materials. The bamboo furniture market started at USD 12.52 billion in 2023 before it is predicted to grow to USD 18.54 billion by 2029, with an annual growth rate of 6.82% (1). Bamboo's fast regenerative nature and its negligible environmental footprint draw customers to select it instead of regular wood products for their purchase decisions. The market receives support from government-backed sustainability programs and improved bamboo processing methods, which focus on treatment improvements to extend the lifespan of bamboo products (1, 2). The commercial sector, including hotels and offices,

demonstrates the fastest projected CAGR of 7.1% because businesses choose bamboo furniture because of its durable quality, lightweight design, and attractive appearance (2). The bamboo furniture market achieves its most extensive production level in the Asia-Pacific region, which controls more than 60% of global output because China and India combine their industry capacities (1, 2). The North American bamboo furniture industry is growing, driven by increasing consumer awareness and government support for environmentally friendly purchasing patterns (2). The European market shows potential growth at a 6.4% CAGR because people are becoming wealthier and more interested in environmental issues (3). Various markets face two significant

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barriers because processing expenses remain high, and some consumers lack awareness. The future of this industry looks bright based on market predictions, which expect USD 21.60 billion by 2031, even while facing existing obstacles (4). As sustainability concerns grow worldwide, the furniture industry redefines its manufacturing practices. Due to rapid growth, renewability, and mechanical peculiarity that rivals conventional materials like wood and steel (5, 6), bamboo is one of the alternative materials rising in popularity. Bamboo has many excellent attributes that make it suitable for furniture, flooring, and building applications because of unusual properties, like a deficient nitrogen and sulfur content (7, 8). In addition, these unique properties of bamboo, like extremely high tensile strength and lightweight and biodegradable nature perfectly render bamboo a good candidate for sustainable furniture purposes (9-11). Flexible materiality enables the enterprise to develop various products, including laminated bamboo timber and bio composites, which can be applied to furniture and construction (11, 12). As the furniture industry wrestles with the cries to go sustainable, bamboo is the plausible material that harmonizes with eco-friendly tenets while meeting eco-environmental aims and market demands (13, 14). Despite these promising attributes, bamboo has encountered challenges in establishing itself in the furniture sector. Current literature states that one way to manufacture bamboo products is in laminated lumber and scrimber form. Traditional bamboo products struggle with poor bamboo biomass usage rates while also containing excessive adhesive content (15, 16). The present deficiencies call for new solutions to enhance bamboo products' manufacturing efficiency while building sustainability standards in furniture production. The evaluation of bamboo versus other sustainable materials through comparison shows its strategic advantages or constraints. The market shift toward eco-friendly furniture drives companies to discover multiple sustainable materials that meet environmental innovation criteria (9, 17). Research for innovative design plans that use sustainable resources and reduce waste has increased the necessity for frameworks which compare bamboo performance against upcycled materials and bio composites (18, 19). Investigating bamboo ergonomics combined with

functional properties against other sustainable materials through studies provides marketers and designers with user perception findings to develop strategic approaches (20). Sustainable progress for furniture production demands a complete evaluation that unites the assessment of bamboo sustainability benefits with competitor materials support producer decision-making and to consumer choice decisions (21). Researchers must study how stakeholders from the furniture industry view bamboo as a material alternative compared to traditional materials. Even though abundant literature affirms the properties of bamboo-based composites, the understanding of manufacturers' perspectives regarding challenges and readiness to transition to using bambooconstruction substances remains limited (22, 23). According to a recent study, bamboo adoption in the furniture sector could be sped up by a concerted drive toward public awareness regarding bamboo material benefits (9). Multiple operational barriers prevent manufacturers from switching from traditional wood to bamboo despite low interest in new materials and supply chain disorganization (24). The assessment of industry opinions about using bamboo as a new manufacturing material requires a more profound understanding of their current recognition of its potential and willingness to adopt it. The study of industry readiness to adopt bamboo as a furniture replacement requires a detailed evaluation of regulatory challenges alongside market opportunities and policy effects. Implementing bamboo into standard furniture production depends heavily on existing legislative guidelines alongside governmental support mechanisms for its use, either encouraging or preventing. The adoption of supportive policy mechanisms together with incentives helps enhance bamboo perception, leading to beneficial resource behavioral changes in individuals and industry groups because it advances bamboo-friendly policy direction (25). The bamboo sector gains economic strength and environmental advantages when national policy mechanisms support them (26). The bamboo industry faces challenges stakeholders lack awareness and because insufficient funding, making it difficult to invest in sustainability (24). Market incentives through economic drivers become increasingly important in driving bamboo adoption since the market

demand for sustainable materials continues to expand. According to research, bamboo stands out because its swift life cycle offers economic advantages and matches sustainable development targets, considering its strength and adaptability in furniture construction (20). By providing tax reductions for sustainable material usage, the market interest would increase, boosting bamboo furniture acceptance and thus promoting producer behaviour change (9). Bamboo adoption faces crucial regulatory barriers that slow its quick acceptance by potential markets. Manufacturers encounter difficulties because harsh certification regulations and trade limitations produce complex regulatory circumstances (27). The construction industry encounters obstacles in classifying bamboo under existing building codes because it conventional materials prefers associated historically with underdevelopment (28). The inadequate standard regulations for bamboo furniture manufacturing create market uncertainty, discouraging investment despite the benefits of selecting bamboo materials. The adoption of bamboo in furniture production requires immediate solutions for policy, market and regulatory issues to maximise economic returns and environmental benefits. In addition, bamboo still faces barriers to entry into the furniture industry. A significant research problem exists because researchers need to study how manufacturing businesses are prepared to accept bamboo as their base material. Research investigating bamboo composites' mechanical properties and processing techniques (29, 30) fails to examine the social and economic factors determining stakeholder acceptance of this material. Most current studies about bamboo materials focus on their technical properties, although they fail to explore the barriers to adoption created by socio-economic factors (31, 32). Research indicates that bamboo benefits are insufficient to overcome the barriers manufacturers face when adopting bamboo-based products (8, 30, 33). The current research centers on bamboo materials without considering essential market factors about supply chains and consumer education that might obstruct its widespread production utilization (12, 18, 34). Knowledge about these market dynamics supports the broader adoption of bamboo in the furniture industry because it guides strategies for breaking

entry barriers and increasing the potential of bamboo products in the market (35). Future studies must examine manufacturing companies' acceptance levels, preparedness, and buying customers to utilize bamboo materials during product development and production. Previous studies examine how manufacturers encounter two significant obstacles: uncertain bamboo product market demand and poorly organized supply chains that affect production logistics (32, 36). Increasing public knowledge about bamboo sustainability benefits would facilitate faster market entry of bamboo products into the furniture industry (37). Some studies combining material science findings with economic factors aim to create comprehensive bamboo knowledge for sustainable furniture manufacturing strategies that enhance market potential and demand for bamboo products (13, 38). This paper presents a systematic review of research on bamboo adoption readiness by the furniture industry due to the stated considerations. The review highlights current research understanding, unmet literary needs, and research components to propel sustainable furniture production knowledge forward. The review summarizes major elements while presenting a conceptual sequence for industrial bamboo adoption with different stages. The proposed framework guides businesses and stakeholders involved in bamboo adoption by explaining how they should achieve industry profiling, awareness-building, and barrier identification before the readiness assessment step. The study presents crucial findings regarding bamboo's applicability as a sustainable alternative product in the furniture industry through a systematic assessment process that matters to industry stakeholders, policymakers, and researchers alike. The following review paper will organize its sections into Methodology, followed by Analysis and Discussion segments before concluding the study.

Systematic Literature Review (SLR) Process

The study used a systematic literature review (SLR) methodology, which adheres to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines set in past researches (39, 40). Researchers chose this methodology to guarantee research integrity while offering a transparent description of research

activities to enable replication. The initial stage employed appropriate keywords within a primary academic search platform to collect every relevant source. Next, we implemented inclusion and exclusion criteria based on peer-reviewed scholarly material that supported the core research questions while removing irrelevant multiple or incomplete records. A complete evaluation sequence started with title abstract checks to eliminate unsuitable sources before moving on to full-text reviews of the remaining articles. The systematic review gathered studies that met all established selection criteria to become foundation research for following analysis and finding synthesis. The study permitted researchers to choose articles without limits on time between 1999 and 2023 to achieve an extensive investigation of subject evolution. Most key studies originating from this research topic appeared between 1999 and 2023, and these studies demonstrate that academic and industrial interest in bamboo as a substitute material has grown extensively. The analysis reveals the promising attributes and obstacles that emerged through bamboo material adoption during the past twenty years. The research methodology relied heavily on quality evaluation and risk assessment of biases. The evaluation process of each selected study depended on a standardized assessment framework which analyzed elements like study design, sample size, data collection methods, and statistical analysis techniques. The final set of studies included those that passed quality standards for retention, while methodological weaknesses were analyzed, which affected the presentation of the overall results. The SLR approach demonstrates robustness, vet researchers should recognize several specific constraints. Using Scopus as the primary database led the research to exclude possible relevant studies from other databases while focusing on peer-reviewed literature, which created potential biases because studies without significant findings have a lower chance of getting published. English as the primary language restriction in the review potentially eliminated vital studies from non-English speaking research organizations. The potential for selection bias through subjective screening decisions remains a weakness even though multiple reviewers conducted the screening process. The paper discusses these constraints to facilitate contextual understanding of the collected data and direct future research directions.

Search Strategy

The literature search depended on Scopus because of its extensive collection of indexed peerreviewed articles, which followed stringent standards. A detailed search string enabled the retrieval of all important research about bamboo wood alternatives for particleboard production, chipboard production, and furniture manufacturing. Supplementary research using different keywords produced 642 results, which needed further examination, as presented in Table 1.

Search Strategy	Scopus	-
Readiness OR awareness AND (Bamboo OR "wood alternative" OR	642	
"wood substitute") OR (particleboard OR chipboard OR furniture)	042	

Inclusion and Exclusion Criteria

Table 1: Search Strategy

The research selection process focused on welldefined criteria both for admission and exclusion of materials. Research articles were considered suitable for inclusion if they appeared in English peer-reviewed publications and analysed bamboo wood substitute materials or examined technological, economic, or data-based aspects within their specified manufacturing applications. The investigation excluded non-peer-reviewed materials such as conference abstracts, editorials, non-academic reports, and studies that failed to analyse bamboo wood alternatives' technological or economic elements or lacked sufficient methodological information for assessment. The inclusion and exclusion criteria were defined in Table 2 to scope only relevant materials applicable to the research objective.

Table 2: Inclusion and	Exclusion Criteria
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Exclusion/	Criteria	Description		
Inclusion				
Exclusion	Duplicate (DP)	Duplicates of the same material or very similar ideas.		
	Language	The full context of the research papers is not in English, excluding		
	compatibility (LC)	the title, abstract, and keywords.		
	No full text (NF)	Not accessible in full text.		
	Non-related (NR)	NR1: The research paper is a non-reviewed academic article		
		NR2: The research paper is unrelated to awareness or		
		readiness to adopt bamboo or other wood substitutes.		
	Casually applies	The research paper discusses bamboo or other wood substitute		
	(CA)	within other scopes (i.e. health benefits, food, etc.)		
Inclusion	Partially related	The research paper discusses the awareness or readiness to adopt		
	(PR)	bamboo or other wood substitutes, but not in the particleboard,		
		chipboard, or furniture manufacturing industry.		
	Closely related (CR)	The research paper discusses the awareness or readiness to adopt		
		bamboo or other wood substitutes in the particleboard,		
		chipboard, or furniture manufacturing industry.		

PRISMA Approach

The included studies underwent a thorough twostep evaluation process, resulting in their selection. We first inspected titles and abstracts to determine their relevance according to predefined parameters. The initial passing studies at the title and abstract screening progressed to more comprehensive full-text reviews for final analysis inclusion. We utilized PRISMA flow diagrams to ensure full transparency of their screening procedures. Following the PRISMA approach in Figure 1, we added the extracted materials to Mendeley Reference Manager for better organization and clarity.



Figure 1: PRISMA Approach

This PRISMA flow diagram in Figure 1 illustrates the selection process for a systematic literature review on the readiness and awareness of adopting bamboo as a wood alternative. An initial search using keywords related to bamboo, wood substitutes, particleboard, and furniture yielded 642 articles. The study continued with 635 remaining articles after discarding seven duplicate or unconnected sources. The review eliminated 604 studies through title, keyword and abstract screening because 511 articles lacked relevance, and 93 articles faced context-related issues. The research team executed an extensive analysis that caused 31 studies to make the final inclusion list. Thirty of the reviewed articles satisfied the main relevance criteria, and we introduced one more study, given its contextual value. The research method allowed researchers to choose suitable studies that evaluated bamboo's sustainability as a wood replacement. After reading the selected materials thoroughly and critically, we discussed data extraction and analysis in Section 3: Findings. We analysed the existing awareness and readiness frameworks deployed across the papers to reach the research objective. We extracted relevant variables and established several aspects to fit the context of the research objective: Bamboo as an alternative material.

Discussion

Research on 31 studies leads to identifying separate thematic areas that explain the adoption patterns of bamboo as a wood substitute. This part combines findings from research investigations on material properties, environmental impact, economic viability and the barriers to adoption and industry readiness, which are represented in Table 3. These themes highlight the multidimensional considerations influencing the shift toward sustainable wood alternatives, notably bamboo.

Aspect	Specific Focus	Number of	References
		Studies	
Material	Strength and	6	Seseni and Mbohwa (41); Ratnasingam <i>et</i>
Properties	Durability		al.,(42); Ab Latib et al.,(43); Mandila and
			Namaswa (44); Yi <i>et al.</i> (45); Fricke and
			Buehlmann (46)
	Tensile Strength	3	Ab Latib et al.,(43); Baharuddin et al.,(47);
			Ismail (48)
	Comparative Analysis	5	Ratnasingam et al.,(23); Yi et al.,(45); Armir
	with Wood		et al.,(49); Mallo and Espinoza (50); Chen et
			al.,(51)
Environmental	Sustainability and	9	Ratnasingam et al.,(42); Mandila and
Impact	Renewability		Namaswa (44); Yi <i>et al.,</i> (45); Fricke and
			Buehlmann (46); Baharuddin <i>et al.</i> ,(47);
			Ismail (48); Mallo and Espinoza (50); Chen
			<i>et al.</i> ,(51); Dessie <i>et al.</i> ,(52)
	Carbon Sequestration	6	Mandila and Namaswa (44);Yi <i>et al.,</i> (45);
	and Environmental		Baharuddin <i>et al.,</i> (47); Ismail (48); Chen <i>et</i>
	Benefits		<i>al.</i> ,(49); Dragomir <i>et al.</i> ,(53);
	Eco-labeling and Green	3	Ab Latib <i>et al.</i> ,(43); Yi <i>et al.</i> ,(45); Fricke and
	Certification		Buehlmann (46)
	Awareness		
Economic	Cost-Effectiveness	8	Ratnasingam <i>et al.,</i> (22); Seseni and
Viability			Mbohwa (41); Mandila and Namaswa (44);
			Yi <i>et al.,</i> (45); Dragomir <i>et al.,</i> (53); Chen <i>et</i>
			al.,(51); Dessie et al.(52); Ratnasingam et
			al.,(54)

Table 3: Key Aspects Discussed on Bamboo as a Sustainable Wood Alternative

Economic	Market Demand and	5	Yi <i>et al.</i> ,(45); Mallo and Espinoza (50);
Viability	Green Consumer		Namsawat and Rugwongwan (55);
	Preferences		Ratnasingam et al.,(42); Ab Latib et al.,(43)

Aspect	Specific Focus	Number of Studies	References
Barriers to	Price Competitiveness	6	Yi <i>et al.</i> ,(45); Baharuddin <i>et al.</i> ,(47); Mallo
Adoption	with Wood and Other		and Espinoza (50); Chen <i>et al.,</i> (51);
	Materials		Ratnasingam <i>et al.,</i> (54); Kırklıkci (56)
	Financial Constraints	7	Ratnasingam <i>et al.,</i> (23); Yi <i>et al.,</i> (45);
	and Initial Investment		Dragomir et al.,(46); Fricke and Buehlmann
	Costs		(47); Chen <i>et al.</i> ,(42); Ratnasingam <i>et al.</i> ,(54);
			Kırklıkci (56)
	Cultural and Awareness	4	Seseni and Mbohwa (41); Ratnasingam <i>et</i>
	Challenges		al.,(42); Mallo and Espinoza (50); Namsawat
			and Rugwongwan (55)
Industry	Awareness of Bamboo's	9	Ratnasingam <i>et al.,</i> (23); Ab Latib <i>et al.,</i> (43);
Readiness	Potential as an		Mandila and Namaswa (44); Yi <i>et al.,</i> (45);
	Alternative Material		Baharuddin <i>et al.,</i> (47); Ismail (48); Mallo and
			Espinoza (50); Chen <i>et al.,</i> (51); Namsawat
			and Rugwongwan (55)
	Readiness in SMEs vs.	5	Ratnasingam <i>et al.,</i> (22); Seseni and Mbohwa
	Large Enterprises		(41); Yi <i>et al.,</i> (45); Dragomir <i>et al.,</i> (46);
			Rymaszewska (57)
	Technological	5	Ratnasingam <i>et al.,</i> (22); Seseni and Mbohwa
	Limitations and		(41); Yi <i>et al.,</i> (45); Dessie <i>et al.,</i> (52); Mallo
	Readiness for		and Espinoza (50)
	Automation		

Table 3: Key Aspects Discussed on Bamboo as a Sustainable Wood Alternative (Cont'd)

Material Properties

The findings reveal that material properties are essential in bamboo's use as a wood alternative. Six studies emphasise bamboo's strength and durability. In contrast, three focuses on its tensile strength. Five studies put bamboo side by side with traditional wood and demonstrate that bamboo can match or surpass the mechanical properties of timber. This emphasis on material properties indicates people's interest in bamboo's functionality and performance, suggesting that further research could offer hard evidence to guide industry adoption.

Environmental Impact

The word "environmental" is used in all bamboo research, with nine studies pointing out how sustainable and renewable it is compared to wood. Six studies discuss how it traps carbon, and bamboo leaves a minor environmental mark compared to other materials; three studies bring up eco-labels and green certifications, which are becoming more common as the industry moves towards products that are certified as friendly. This focus on the environment aligns with worldwide goals to be more sustainable, so the effect on nature is a big reason why different markets use bamboo.

Economic Viability

Economic viability plays a key role, too; eight studies point out how cost-effective bamboo is. Research also examines buyer interest and eco-friendly choices as shoppers lean towards green products. How bamboo prices stack up against regular wood matters; six studies note that bamboo's lower cost can boost its market share. The mix of affordability and consumer interest suggests that price could drive bamboo use, but we need more numbercrunching to back this up.

Barriers to Adoption

Despite the advantages, barriers still exist. Six studies show that a lack of technical skills is the main problem. Limited know-how in bamboo processing and manufacturing might slow its broader use for small and medium-sized enterprises (SMEs).

Additionally, seven studies mention that money issues are a significant roadblock. The high upfront costs might stop smaller companies from switching to bamboo-based materials. Meanwhile, four studies reveal that culture and awareness challenges exist. With this, the gaps in knowledge and wrong ideas about bamboos potential can further slow adoption. We need focused efforts like industry training programs and government support to overcome these barriers.

Industry Readiness

The potential of bamboo as an alternative material and industry readiness are hot topics, with nine studies highlighting this aspect. Research shows that big companies are more aware of this potential than small and medium-sized enterprises because they have more money and resources to access, as five studies point out. Past studies acknowledge technological limitations, including automation preparedness, which suggests better processing technologies are required for bamboo utilization. The research shows that industrial readiness exists within financial constraints and modern technology requirements alongside organizational structures, which determine how quickly factories can adapt to using bamboo.

Synthesis of Findings

Our analysis highlights both the advantages and challenges of using bamboo as a sustainable wood

alternative. While bamboo offers high-quality material properties, environmental benefits, and financial viability, three key barriers hinder its widespread adoption: lack of technical expertise, insufficient funding, and the need for industry adaptation. А collaborative effort among policymakers, industry stakeholders, and researchers is essential to overcome these challenges. Policymakers must establish supportive regulations and incentives, industries should invest technological advancements and process in optimization, and researchers must drive innovation to enhance material performance and cost efficiency.

Proposed Framework

The proposed framework in this systematic literature review (SLR) uses critical literary dimensions. including material properties, environmental impact, economic viability, barriers to adoption and industry readiness to help promote bamboo as a sustainable alternative material in different industries. The Figure 2 model shows a systematic pathway that enables researchers to study the adoption phases of bamboo while examining both industrial preparedness and implementing solution strategies to overcome barriers, along with effective bamboo promotion strategies.



Figure 2: Proposed Framework – Stage for Adoption of Bamboo as an Alternative Material

framework complies The proposed with systematic literature review insights through its stepwise methodology to handle identified adoption challenges and gaps in bamboo as an alternative material. The first stage of industry profiling addresses the differences between businesses in size, market regions, and operational capabilities, which shows that transformation needs individualized methods. The next phase involves raising stakeholder knowledge about bamboo's potential to solve the understanding deficits observed throughout previous research, demonstrating durability strengths, economic advantages, and environmental sustainability. The barriers to adopting bamboo include developing strategies, implementing training programs,

securing funding resources, and establishing acceptance policies. The benefits of bamboo adoption provide stakeholders with information about environmental advantages, economic profitability, and product uniqueness. This benefit also helps stakeholders make decisions on bamboo adoption despite perceived risks. The readiness for adoption framework unites the bamboo technological elements with financial factors and policy requirements to establish a concrete approach toward transition. The framework provides detailed guidance by aligning every step with the core themes between SLR-derived material properties, environmental impact, economic feasibility, and industry preparedness, thus creating a systematic pathway for hindering challenges and enabling stakeholder collaboration and successful bamboo implementation.

Industry Profiling

In phase one, the industry profiling stage; we collate further information on company size, range of products, years in business, and market type. Profiling defines the industries and companies that can be potential beneficiaries of bamboo adoption as they bear their structural and operational attributes. The most significant phase expresses the aspects contributing to a business's readiness to integrate new material, including economic capabilities and market orientation, which usually differ between small-to-medium enterprises (SMEs) and giant corporations. Industry profiling appeared in most references to investigate company dimensions ranging from large enterprises to SMEs (41, 50, 57) while also noting the business's wood product or furniture types (45, 46, 49) and operational duration (42) and market focus including domestic, export, or mixed markets (32, 35). Different sources explained that knowing the company's location gains value because it achieves influence over supply chain distribution networks (50, 53). This background information is crucial as it highly affects awareness and readiness to adopt new production material. In a different context of Industry 4.0, large companies are more ready to embrace the latest technology because of their higher financial capacity to invest in advanced technology than SMEs (45). Additionally, large organizations tend to show higher levels of environmental awareness, which leads them to adopt sustainable solutions (23).

Awareness of Bamboo's Potential and Key Attributes

The second phase educates manufacturing organizations about bamboo's distinct properties. Bamboo's complete set of properties consists of strong attributes with extended durability, sound environmental effects, and efficient cost performance. The broad usage options of bamboo in furniture and construction should convince industries about its production suitability. Bamboo's distinctive advantages must be highlighted for businesses to view it as a valuable, sustainable replacement for conventional materials.

Awareness is the foundation to comprehend how people interact with specific topics of interest.

Studies demonstrate that higher levels of knowledge lead individuals to adopt new products because better information reveals their worth and advantages (50, 55). Identifying bamboo market targets depends on producers' knowledge of the material's applicable uses for tables and chairs. The deep knowledge allows them to enhance their manufacturing processes with this environmentally friendly material. Businesses will likely adopt bamboo because increased awareness demonstrates its superior mechanical properties and affordable cost (47).

Barriers and Benefits to Bamboo Adoption

Adopting bamboo involves two kev considerations: barriers and benefits. Financial limitations, technical hurdles, and a lack of skilled workers are vital challenges. Recognizing these obstacles helps us develop targeted strategies, such as offering financial incentives or investing in training programs, to prepare for the transition (57). It is also crucial to highlight the benefits of bamboo. This material provides environmental sustainability, economic competitiveness, and product differentiation. Its renewability and carbon sequestration capabilities make it a strong choice for sustainable practices. When stakeholders understand these benefits, they are more likely to see them outweighing the challenges, boosting their confidence in adopting bamboo. Common reasons for hesitation include high initial costs (46, 38, 53)) and limited adoption by significant market players (45, 52). On the other hand, motivating factors include bamboo's mechanical solid properties (42, 43),environmental benefits (44, 48), and economic advantages like premium pricing and a competitive edge (54).

Readiness for Bamboo Adoption

The final step in this evaluation is to assess how ready an industry is to use bamboo as an alternative material. This stage considers factors like technology, finances, worker skills, and government support. Evaluating readiness is essential to ensure a smooth transition to bamboo without disrupting operations. Industries with advanced technology and skilled workers are generally better equipped to adopt innovative materials like bamboo than those lacking these resources. While there is no specific breakdown of readiness, several studies suggest that factors like financial capacity (41, 52, 53), technical accessibility (52), the availability of skilled workers (22, 41), workplace environment (22), and supportive government policies (51, 54) contribute to overall readiness.

Contribution of the Proposed

Framework

The framework provides practical implementation steps through industry profiling awareness development and barrier elimination, followed by benefit promotion and readiness assessment to help stakeholders adopt bamboo effectively. All stages of bamboo material adoption provide defined responsibilities for stakeholders, including manufacturers for optimization and cost reduction, policymakers for supportive regulations and researchers for innovative technology development. At the same time, consumers create interest in sustainable switches. The framework appears in Figure 2 to improve understanding, yet its universal use faces barriers due to policy unevenness, bamboo supply chain irregularities, and company resource differences. The framework needs local modifications and further validation to prove its general value and practical effectiveness.

Conclusion

This review paper achieves its target by developing an assessment framework for bamboo adoption as a wood substitute in furniture chipboard or particleboard production industry. The findings present essential factors shaping bamboo adoption as a wood replacement, such as material properties and environmental effects, economic aspects, adoption hurdles, and industry capability. The proposed conceptual framework offers a structured approach, encompassing stages from industry profiling to assessing readiness for adoption. This framework can aid stakeholders in evaluating and facilitating bamboo integration in various sectors. This research reviews the potential of bamboo wood substitution with practical implications that affect furniture industry building sector workers, employees, and environmental authorities. Bamboo demonstrates exceptional material properties alongside environmental advantages and economic gains, making it suitable for renewable resource utilization. This study highlights three obstacles to widespread bamboo adoption: technological complications, manufacturing barriers, and funding shortages for small to medium enterprises. The successful implementation of bamboo material requires cultural change and expanded public perception regarding bamboo's usefulness. The positive research findings on bamboo sustainability create hope, but researchers must maintain caution because analysis relies on a few datasets. Future scholarly research should increase the size of its collected data and use advanced modeling procedures before verifying the current findings. The achievement of bamboo market penetration demands organizations to establish coordinated education projects which receive official government backing. This research vields findings that help solve barriers and enhance bamboo market reception, thus leading more corporations to implement sustainable practices (58, 59). The main constraints in this study are based on previously published studies that may not address international market variations combined with omitted current methods of bamboo processing. Selection of appropriate materials can turn into an obstacle in this phase. The designated bamboo wood alternatives used in this research context may not function similarly when applied to technology or business organizations. Future investigations should collect materials from diverse research areas to accurately assess and discover the best available framework. Future investigations must assess innovations by testing the proposed methodology, particularly in locations with plentiful bamboo resources, to better clarify sizing possibilities and environmental advantages. The practicality and sustainability of bamboo material as a substitute should be supported by studies which assess its environmental and economic implications. Nonetheless, this review paper is a stepping stone for the following research agenda of assessing the actual awareness and readiness of Malaysia's particleboard, chipboard, or furniture manufacturing industry to adopt bamboo as an alternative material.

Abbreviations

CA: Casually Applies, CR: Closely Related, DP: Duplicate, LC: Language Compatibility, NF: No Full Text, NR: Non-Related, PR: Partially Related, PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses, SLR: Systematic Literature Review.

Author Contributions

Final approval for submission.

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Conflict of Interest

The authors state that they do not have any conflicts of interest.

Ethics Approval

This study did not involve human participants or animals. The data utilized in this study were obtained from publicly available sources, and no ethical approval was required.

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References

- 1. Research & Market [Internet]. Bamboo Furniture Market - Global Industry Size, Share, Trends, Opportunity, and Forecast, 2019-2029F. 2024. https://www.researchandmarkets.com/reports/60 22988/bamboo-furniture-market-global-industrysize
- 2. Grand View Research [Internet]. Bamboo Furniture Market Size, Share & Trends Analysis Report By Type (Chair & Tables, Stools, Beds), By End Use (Residential, Commercial), By Region (Europe, APAC, MEA), And Segment Forecasts, 2024 – 2030. 2024. https://www.grandviewresearch.com/industryanalysis/bamboo-furniture-market
- 3. Zion Market Research [Internet]. Bamboo Furniture Market By End-User (Commercial and Residential), By Types (Beds, Chairs, Stools, and Others), By Distribution Channel (Offline and Online), and By Region - Global and Regional Industry Overview, Market Intelligence, Comprehensive Analysis, Historical Data, and Forecasts 2023 – 2030. 2023 https://www.zionmarketresearch.com/report/bam boo-furniture-market
- 4. Data Bridge Market Research [Internet]. Global Bamboo Furniture Market – Industry Trends and Forecast to 2031. 2024. https://www.databridgemarketresearch.com/repo rts/global-bamboo-furniture-market
- Jiang H, Du Y, Wang J, Cao Y, Jin C, Yan Y. Enhanced Bamboo interfacial bonding performance based on toughening phenol formaldehyde resin by flour. Polymer Compos. 2022;44(1):524-35.
- Chen H, Shi J, Zhong T, Fei B, Xu X, Wu J, Xia C. Tunable physical-mechanical properties of eco-friendly and sustainable processing bamboo self-bonding composites by adjusting parenchyma cell content. ACS Sustain Chem Eng. 2023;11(28):10333-43.

- 7. Parthasarathy P, Mackey HR, Mariyam S, Zuhara S, Al-Ansari T, McKay G. Char products from bamboo waste pyrolysis and acid activation. Front Mater. 2021; 7:624791.
- 8. Lou Z, Zheng Z, Yan N, Jiang X, Zhang X, Chen S, Xu L. Modification and application of bamboo-based materials: a review—part II: application of bamboobased materials. Forests. 2023;14(11):2266.
- Kurniawan KB, Shahman N, Purnomo A, Ezran M. Bamboo material for sustainable development: a systematic review. E3S Web Conf. 2023; 444:01011.
- Zhang J, Du C, Li Q, Hu A, Peng R, Sun F, Zhang W. Inhibition mechanism and antibacterial activity of natural antibacterial agent citral on bamboo mould and its anti-mildew effect on bamboo. R Soc Open Sci. 2021;8(4):202244.
- 11. Li Z, Chen C, Mi R, Gan W, Dai J, Jiao M, Hu L. A strong, tough, and scalable structural material from fastgrowing bamboo. Adv Mater. 2020;32(10). https://doi.org/10.1002/adma.201906308
- 12. Shi J, Xu X, Zhong T, Zhang W, Yuan S, Feng X, Fei B. Fabrication and application of eco-friendly bamboo self-bonded composites for furniture. ACS Sustain Chem Eng. 2023; 11(20):7833-43.
- Huang Y, Ji Y, Yu W. Development of bamboo scrimber: a literature review. J Wood Sci. 2019;65(1). https://doi.org/10.1186/s10086-019-1806-4
- 14. Francois D, Liaw S. Important applications and the perceived benefits of bamboo: a comparison between consumers and businessmen. Int J Bus Manag. 2019;14(6):12.
- 15. Lian C, Chen H, Fei B, Pang X, Lian J, Wu Z. Using statistical methods to comparatively analyze the visual characteristics of flattened bamboo boards in different bamboo culms. Polymers. 2022;14(20):4327.
- Zhao W, Zhang W, Zhang J, Yuan S, Chen H. Effect of bamboo particle blending system on the properties of its composites. Polymer Compos. 2023;44(6):3301-12.
- 17. Vuong T, Huyen N, Tu L, Loi N. Status of bamboos in Binh Duong province, Vietnam: distribution, species diversity, conservation and utilization. Trees For People. 2021;6:100137.
- 18. Sain A, Gaur A, Khichad JS, Somani P. Treatment of bamboo for sustainable construction practice: a comprehensive review. IOP Conf Ser Earth Environ Sci. 2024;1326(1):012049.
- 19. Li H, Yang S, Zha Z, Fei B, Wang X. Hygrothermal properties analysis of bamboo building envelope with different insulation systems in five climate zones. Buildings. 2023;13(5).

https://doi.org/10.3390/buildings13051214

- Wen-xin D, Lin H, Jiang M. Research on bamboo furniture design based on D4S (design for sustainability). Sustainability. 2023;15(11):8832.
- 21. Yang D, Vezzoli C. Designing environmentally sustainable furniture products: furniture-specific life cycle design guidelines and a toolkit to promote environmental performance. Sustainability. 2024;16(7):2628.
- 22. Ratnasingam J, Yi LY, Azim AAA, Halis R, Liat LC, Khoo A, Amin MNZM. Assessing the awareness and

readiness of the Malaysian furniture industry for industry 4.0. BioResources. 2020;15(3):4866-85.

- 23. Ratnasingam J, Latib HA, Liat LC, Jegatheswaran N, Othman K, Amir MA. Environmental, social, and governance adoption in the Malaysian wood products and furniture industries: awareness, adoption, and challenges. BioResources. 2023; 18(1):1436-53.
- 24. Hailemariam EK, Hailemariam LM, Amede EA, Nuramo DA. Identification of barriers, benefits and opportunities of using bamboo materials for structural purposes. Eng Constr Archit Manag. 2022; 30(7):2716-38.
- 25. Lee B. Perception and prioritization of ecosystem services from bamboo forest in Lao PDR: case study of Sangthong district. Sustainability. 2021; 13(23):13060.
- 26. Yu L, Wei J, Li D, Zhong Y, Zhang Z. Explaining landscape levels and drivers of Chinese Moso bamboo forests based on the PLUS model. Forests. 2023;14(2):397.
- 27. Shen L, Yang J, Rong Z, Shao C, Song X. The benefits and barriers for promoting bamboo as a green building material in China—an integrative analysis. Sustainability. 2019;11(9):2493.
- Adebowale OJ, Agumba JN. Bamboo in sustainable construction: effects on productivity and safety. Int J Product Perform Manag. 2024;74(11):1-20.
- 29. Suhaily SS, Gopakumar DA, Aprilia NAS, Samsul R, Paridah MT, Khalil HPSA. Evaluation of screw pulling and flexural strength of bamboo-based oil palm trunk veneer hybrid biocomposites intended for furniture applications. BioResources. 2019;14(4):8376-90.
- 30. Suhaily S, Islam MN, Mustapha A, Rizal S, Khalil HPSA. Physical, mechanical, and morphological properties of laminated bamboo hybrid composite: a potential raw material for furniture manufacturing. Mater Res Express. 2020;7(9):095301.
- Deng W, Lin H, Jiang M. Research on Bamboo Furniture Design Based on D4S (Design for Sustainability). Sustainability. 2023;15(11):8832.
- 32. Zheng Y, Zhu J. The Application of Bamboo Weaving in Modern Furniture. BioResources. 2021;16(3). https://doi.org/10.15376/biores.16.3.5024-5035
- 33. Rehema N, Kumar S, Chinnasamy G. examining the advantages of bamboo as a sustainable resource and its benefits in product manufacturing. Int Res J Modern Eng Technol Sci. 2023. https://doi.org/10.56726/irjmets35851.
- 34. Neha P, Aravendan M. A review on sustainable product design, marketing strategies and conscious consumption of bamboo lifestyle products. Intell Inf Manag. 2023;15(3):67-99.
- Prasad N, Muthusamy A. A review on sustainable product design, marketing strategies and conscious consumption of bamboo lifestyle products. Intell Inf Manag. 2023;15(3):67-99.
- 36. He Y, Jin X, Li J, Qin D. Mechanical and fire properties of flame-retardant laminated bamboo lumber glued with phenol formaldehyde and melamine urea formaldehyde adhesives. Polymers. 2024;16(6):781.
- 37. CS S, Viswanath S, Katiyar VS. Possibilities of standardising solid bamboo furniture making in India. J Bamboo Rattan. 2023;21(4):178-86.

- 38. Duan Z, Zu Q, Rao F. Bamboo scrimber as a sustainable material for chairs: a property study based on the finite element method. Sustainability. 2024;16(13):5357.
- 39. Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and metaanalyses: the prisma statement. Int J Surg. 2010;8(5):336-41.
- 40. Moher D, Shamseer L, Clarke M, Ghersi D, Liberati A, Petticrew M, Stewart L. Preferred reporting items for systematic review and meta-analysis protocols (prisma-p) 2015 statement. Syst Rev. 2015;4(1). https://doi.org/10.1186/2046-4053-4-1.
- 41. Seseni L, Mbohwa C. The implications of Artificial Intelligence on Soweto Furniture Manufacturing SMEs. IEOM Society International. 2018. https://ieomsociety.org/dc2018/papers/447.pdf
- Ratnasingam J, Ab Latib H, Yi LY, Liat LC, Khoo A. Extent of automation and the readiness for Industry 4.0 among Malaysian furniture manufacturers. BioResources. 2019;14(3):7095–7110.
- 43. Ab Latib H, Cheong LW, Halis R, Mohamad Kasim MR, Yi LY, Ratnasingam J, Ioras F. The prospects of wooden building construction in Malaysia: Current State of Affairs. BioResources. 2019;14(4):9840– 9852.
- 44. Mandila B, Namaswa T. Ethnobotany of Pokot communities on bamboo species in the dryland areas of West Pokot County, Kenya. J Bamboo Rattan. 2023;21(3):86–102.
- 45. Yi LY, Ab Latib H, Ratnasingam J, Mariapan M, Liat LC, Othman K, Amir MA, Jegatheswaran N. Readiness for and adoption of industry 4.0 among small and medium-sized enterprises in the Malaysian Furniture Industry. BioResources. 2021;16(4):8289–8308.
- 46. Fricke CF, Buehlmann U. Lean and Virginia's wood industry – part I: Awareness and implementation. BioResources. 2012;7(4). https://doi.org/10.15376/biores.7.4.5074-5093
- Baharuddin N, Abd Rahman KA, Ahmad Z, Osman Al-Edrus SS, Lee SH. Potential application of bamboo in furniture products. Multifaceted Bamboo. 2023;259–273. https://doi.org/10.1007/978-981-19-9327-5_13
- 48. Ismail M, Jegatheswaran R, Shukri M, Mohamad Roslan MK, Izran K. Market Assessment On The Potential Of Oil Palm Empty Fruit Bunch (OPEFB) Particleboard In Malaysia's Wood-Based Industries. Pertanika J Agric Sci. 2012;35(3):581–592.
- 49. Armir NAZ, Zakaria S, Begum RA, Chamhuri N, Mohd Ariff N, Harun J, Mohd Talib NL, Kadir MA. The readiness of Peninsular Malaysia Wood-based industries for achieving sustainability. BioResources. 2020;15(2):2971–2993.
- 50. Mallo LMF, Espinoza O. Awareness, perceptions and willingness to adopt cross-laminated timber by the architecture community in the United States. J Clean Prod. 2015;94:198–210.
- 51. Chen H, Wang G, Cheng HT. Properties of single bamboo fibers isolated by different chemical methods. Wood Fiber Sci. 2011;43(2):111–120.
- 52. Dessie TS, Yimer AM, Ali MY. Determinants of bamboo processors' utilization level: The case of

Bahir Dar City and Injibara Town, Ethiopia. Adv Bamboo Sci. 2023;5:100043.

- 53. Dragomir M, Blagu DA, Popescu S, Fulea M, Neamţu C. How well are manufacturing companies in Transylvania, Romania adapting to the low-carbon economy in order to become sustainable? Int J Environ Res Public Health. 2022;19(4):2118.
- 54. Ratnasingam J, Macpherson TH, Loras F. An assessment of Malaysian wooden furniture manufacturers' readiness to embrace chain of custody (COC) certification. Holz Als Roh- Und Werkstoff. 2008;66(5):339–343.
- 55. Namsawat O, Rugwongwan Y. An evaluation of corporate customer need with regard to the use of product service systems for the furniture business through environmental marketing. Kasetsart J Soc Sci.2018.https://doi.org/10.1016/j.kjss.2018.07.01 4

- 56. Kırklıkçı AB. Examination of industry 4.0 awareness, perceptions, and actions of employees in furniture and board businesses. For Prod J. 2024;74(1):1–9.
- 57. Rymaszewska AD. The challenges of lean manufacturing implementation in SMEs. Benchmarking Int J. 2014;21(6):987–1002.
- 58. Escamilla EZ, Habert G, Correal JF, Archila HF, Fernández J, Trujillo D. Industrial or traditional bamboo construction? Comparative life cycle assessment (LCA) of bamboo-based buildings. Sustainability. 2018;10(9):3096.
- 59. Salzer C, Wallbaum H, López LF, Kouyoumji JL. Sustainability of social housing in Asia: a holistic multi-perspective development process for bamboobased construction in the Philippines. Sustainability.2016; 8(2):151.