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COMPARATIVE PERSPECTIVES ON THE FEASIBILITY OF PROMOTING TIMBER CONSTRUCTION IN SOUTH AFRICA

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ABSTRACT: The study explores the perceived barriers influencing the adoption of timber in South Africa's construction industry. An online survey was conducted to gather insights from construction industry stakeholders on perceptions of timber compared to conventional materials, barriers to adoption, and recommendations for increased adoption. Thereafter, architects' responses were compared to other industry stakeholders' responses to investigate any similarities or differences. Perceived barriers identified include negative perceptions, cost concerns, and cultural preferences for traditional building methods, while some proposed solutions include education, investment in the timber construction sector, and pilot projects. The study offers valuable insights into the perceptions and challenges surrounding timber construction in South Africa from multiple perspectives, and future research could empirically test the relevance and actual impact of these findings by examining real-world projects and data.

KEYWORDS: timber construction, architects, engineered wood products, innovation adoption, South Africa

1 – INTRODUCTION

The construction sector is increasingly adopting practices promoting sustainability in materials and processes. The industry's shift towards sustainability is driven by the urgent need to mitigate its environmental impact and respond to the growing global demand for eco-friendly solutions [1]. The industry consumes significant amounts of available resources globally, including land (12%), water (25%), raw materials (30%) and energy (40%) [2]. The industry is also responsible for about 40% of anthropogenic carbon dioxide (CO_2) released into the atmosphere [3] and the release of harmful wastes and pollutants that are harmful to organic life [4].

In response to these concerns, sustainable construction has emerged as a pivotal paradigm [5]. In recent years, several studies have proposed using timber as a structural element as a viable solution to mitigate the severe environmental impact of conventional construction materials [6, 7]. The focus in timber product manufacturing has also shifted towards timber strands, veneers, and fibres that are reconstituted into new lumber, panels, and other construction products, including cross-laminated timber (CLT) glued-laminated timber (glulam) and laminated veneer lumber (LVL) [8]. These products, collectively called engineered wood products (EWP), offer high uniformity and well-defined performance properties and have expanded the range of structural timber applications [8].

Research on the factors influencing the adoption of EWP and timber construction has been performed globally. However, very little is known about the factors affecting the adoption of timber in South Africa. This study attempts to fill that need by investigating the factors impacting timber construction in South Africa from the perspectives of stakeholders in the industry.

2 – BACKGROUND

Various stakeholders influence the selection of materials in the building construction sector. Clients and developers play a significant role due to their financial investment in the project. Factors such as time constraints and sustainability goals may influence clients' choices [9, 10]. When the client is a developer, they may often be in charge of organising and managing the construction process and making key decisions on design and costs [11]. On the other hand, architects, contractors and engineers translate the client's ideas into a physical structure [12]. Architects typically focus on designing the

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structure, while engineers ensure the structural integrity of the physical project [13]. Contractors provide the labour and on-site expertise to turn the architects' design concept into reality while taking into consideration the constraints imposed by the engineers [11]. Other stakeholders include regulators such as municipal authorities, whose responsibility is to ensure building compliance with regulations [14], and end-users or building occupants, although their input into material selection is minimal [15]. Fernando et al. [16] and Ilgin et al. [17] have also suggested that the influence of manufacturers and suppliers of construction materials, such as CLT, may increase in the material selection process due to the knowledge of the technical capabilities of the material.

Some factors may be more significant for construction stakeholders when choosing timber as a building material. According to Franzini [14], the ability of timber structures to withstand earthquakes and fire outbreaks is an essential consideration for municipal workers in Finland, in addition to other benefits such as reduced construction times and the length of building lifecycles. Salmi [18] also suggested that the cost and expenses of wood buildings, the prevailing culture and tradition in the society and support from the local forestry industry are pertinent adoption factors. On the other hand, aesthetics, thermal comfort and perceived quality of construction are just some of the reasons why end-users/building occupants may request certain materials [19]. Jones [10] also suggested that for buildings with known occupiers before construction began, lifecycle costs of the building and personal values were key determinants in the choice of timber.

Architects and structural engineers are generally considered the most important decision-makers in the material selection process [20], and studies show they might have different motivations. Architects may be more likely to choose timber products because of a desire to be more innovative [21], for timber's aesthetic appeal [22], or for a desire to use renewable and sustainable building materials [23]. However, it is important not to discount the fear of professional liability and its impact on stifling innovative material use [24]. Structural integrity and material performance are factors for structural engineers [13, 25], while developers may prioritise financial considerations [22]. Furthermore, differences have been observed among end-users in different contexts. One study found that security, comfort, and health are prioritised by Chinese users in building material selection, while cosy living, fire resistance, and sound insulation are priorities for the Japanese. The same study found that while timber is considered new and modern in China, it is considered dated in Japan. [26].

These arguments form the basis for this study: first, to investigate stakeholders' opinions in the South African construction industry on perceptions of timber attributes and to identify similarities or differences between stakeholders with a specific focus on architects and engineers.

3 – PROJECT DESCRIPTION

South Africa was the first country in Africa to implement a locally developed green building rating tool and has a growing number of green building projects, demonstrating a commitment to environmentally friendly construction practices, including the use of timber products [27]. Despite the potential benefits of timber, the state of timber construction in South Africa is mixed. It is estimated that 70% of sawn wood produced in South Africa is used in construction [28]. However, the use of timber is mainly limited to roof truss structures [29]. The surge in the market share of multistorey timber buildings globally has piqued stakeholders' curiosity in the South African construction industry [30]. As the construction industry evolves, timber and EWPs will likely become essential materials in South Africa's built environment.

The previous section showed that several stakeholders play critical roles in the material selection. In the South African context, studies have shown that architects, alongside structural engineers, are the necessary technical actors involved in the conceptualisation and design of building projects [31, 32]. Based on this background, the objectives of this study are to:

- Evaluate perceptions of timber as a structural construction material compared to other materials across various quality elements.
- Identify the primary barriers hindering the widespread adoption of timber construction in South Africa as perceived by different stakeholder groups.
- Propose potential solutions to overcome these barriers and promote timber construction within the South African construction industry.

4 – METHODOLOGY

This study utilised an online survey to evaluate the perceptions of construction stakeholders. As an exploratory study, the intention was to capture the opinions of as many stakeholders as possible; hence, convenience sampling was utilised. According to [33], non-probabilistic sampling methods, such as

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convenience sampling, are practical in exploratory studies. A database of more than 1000 email addresses belonging to construction stakeholders within the South African industry was compiled through various means, including internet searches and from the second author's networks, to which an anonymous link to the survey was sent. Additionally, to improve reach, the link to the survey was distributed via social media groups on LinkedIn and Facebook. In total, 96 people completed the survey.

Since the target demographic for this investigation was construction stakeholders working in South Africa, respondents were asked to state their profession and to indicate whether they practised their profession within or beyond South Africa. Responses from two respondents who said that they practice outside South Africa were removed. Of the remaining 94, 22.3% self-identified as Engineers, 21.3% as Architects and the remaining 56.4% from several related professions, including academia, forestry, property developers, sawmillers, financers and government agencies.

Beyond the demographic questions, respondents were asked to compare timber to conventional materials such as brick, concrete and steel based on 25 different parameters. For these questions, respondents would state whether they considered timber inferior, similar or superior to conventional building materials. This produced ordinal data for analysis from which median values were retrieved. The median represents the middle value in the ordered data set and provides information about the typical or central value of the ordinal data, around which other data are distributed [34]. It is preferred over the mean for ordinal data because it is less affected by extreme values and outliers [35]. In this dataset, the median value signified the prevailing perception of respondents, offering a clear indication of the prevailing sentiment within the group [36].

In their own words, Respondents were asked to provide their opinions on the barriers to using timber in construction and recommendations to increase its use. This produced qualitative data for analysis. Answers to the open-ended survey questions were transferred onto a Microsoft Word document and loaded onto ATLAS.ti for analysis. The data was analysed qualitatively using thematic analysis. Thematic analysis is a technique for finding, investigating, analysing, and documenting themes in data [37]. The themes are patterns found in the data and are essential for characterising a phenomenon connected to a particular research topic. These themes then serve as categories for additional analysis [37]. An interpretivist philosophy was used to identify patterns and themes coded as perceived barriers and potential enablers [38].

5 – RESULTS

Table 1 shows the results across the three major groups (architects, engineers and other professionals) whose opinions were sought after for this survey.

Table 1: Comparison of timber with other materials

Attribute	Architects	Engineers	Others
Quality	Similar	Similar	Similar
Durability	Similar	Inferior	Similar
Safety of occupants during a fire	Similar	Inferior	Similar
Likelihood of damage during a fire	Superior	Inferior	Similar
Dimensional stability	Similar	Similar	Similar
Strength-to-weight ratio	Superior	Superior	Superior
Ease of construction	Superior	Superior	Superior
Appearance	Superior	Similar	Superior
Visibility	Superior	Similar	Superior
Noise suppression	Similar	Inferior	Similar
Hear and cold insulation	Similar	Similar	Superior
Construction speed	Superior	Superior	Superior
Environmental sustainability	Superior	Superior	Superior
Proof of sustainability	Superior	Superior	Superior
Local building skills	Inferior	Inferior	Inferior
Local design skills	Inferior	Inferior	Inferior
Local lumber supply	Similar	Inferior	Similar
Local EWP supply	Similar	Inferior	Similar
Material standards	Similar	Similar	Similar
Building regulations	Similar	Similar	Similar
Ease of building approval	Inferior	Similar	Inferior
Insurability	Inferior	Inferior	Inferior
Financing	Inferior	Inferior	Inferior
Ease of design	Similar	Similar	Similar
Likelihood of using timber	Very likely	Open to convincing	Very likely

Architects considered timber superior to other materials in eight attributes, similar to other materials in 10 attributes, and inferior to other materials in five attributes. Architects also indicated that they were very likely to use wood in construction. Conversely, engineers were only positive about timber's superiority in five attributes. They considered timber similar to other materials in nine attributes and inferior in another eight. They also indicated a need to be convinced about timber before utilising it.

The results also show that of the eight attributes where architects and engineers differed on the efficacy of timber in comparison to other materials, architects had a more favourable rating than engineers on 7 of them: durability, safety of occupants in a fire, likelihood of severe damage during a fire, appearance, visibility, noise suppression, local lumber supply and local EWP supply. Noticeably, however, the third group of respondents had broadly similar opinions to the architecture group.

Several themes emerged from responses to the question about the barriers limiting the adoption of timber in South Africa. Across all three groups, the negative perception of timber held by different stakeholders was one of the most common themes that was revealed. Similarly, a perceived skills gap in the industry and cost concerns were also high on the list. Still, subtle differences were observed among the groups. For the architects, industry resistance and material performance concerns rounded up the top five barriers. Figure 1 displays the factors that architects highlighted as limiting the adoption of timber in the South African construction industry.

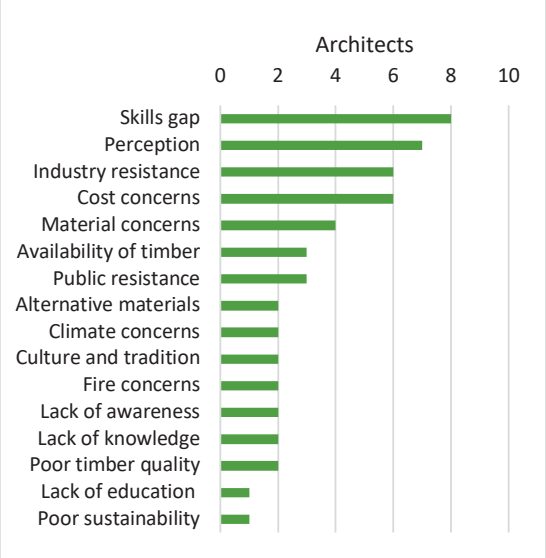

Figure 1: Architect opinions' about the barriers to timber use

For engineers, limited availability of timber and fire concerns rounded up the top five barriers. Figure 2 shows the barriers to the adoption of timber in the South African construction industry according to the Engineers surveyed in this study.

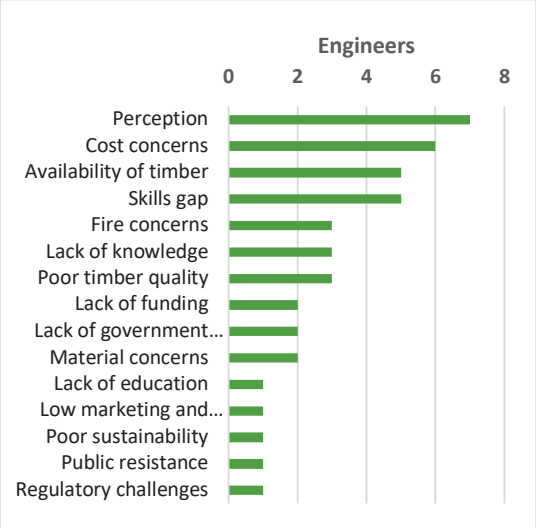

Figure 2: Engineers' opinions about the barriers to timber use

For the rest of the respondents, lack of knowledge and government support completed the top five barriers. Figure 3 displays the barriers to the adoption of timber in the South African construction industry according to other construction stakeholders.

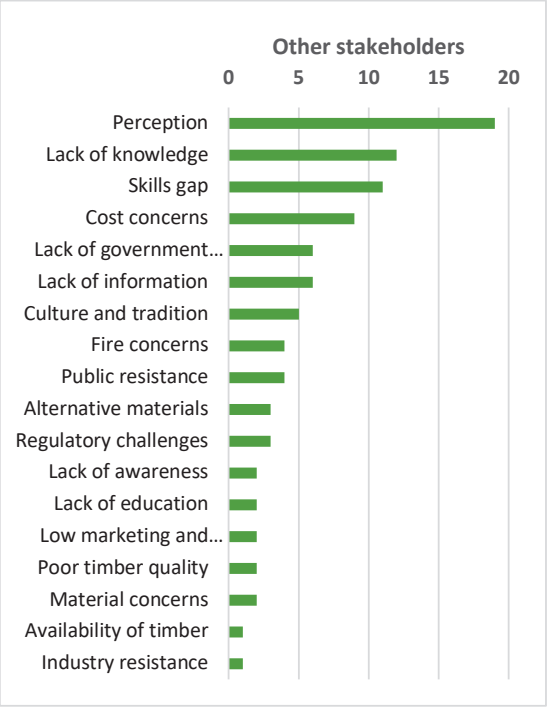

Figure 3: Other stakeholders' opinions about the barriers to timber use

Descriptions for each of these themes are provided below.

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Perception

It is important to state at the outset that all the responses in this survey are perceived factors because they are the respondents' subjective opinions. Still, respondents often mentioned the negative perceptions held by various stakeholders, including construction professionals, the general public, and the "market" as a reason for the low adoption of timber. These perceived negative perceptions span various factors, including the idea that timber is inferior to other materials, masonry is a superior practice, wood is expensive in South Africa, building standards and certifications for timber construction do not exist in South Africa and that timber buildings are associated with the less fortunate or for Wendy houses – small prefabricated structures typically made from wood used as playhouses for children, garden sheds for storage or for storing workplace tools. Other less common perceptions that respondents mentioned include the idea that timber construction is unsustainable or might lead to high unemployment because it requires less labour.

Skills gap/Lack of knowledge, education, awareness and information

The second most common barrier observed was a perceived skills gap in the South African construction industry. This skills gap was perceived to extend across the industry. Specifically, respondents highlighted the lack of skills in carpentry, design, structural engineering, and contractors as critical limitations. In general, timber construction in South Africa, particularly in domestic applications, was regarded as lacking significant input from sophisticated, modern design in contrast to high-end designs in Europe and Asia that emphasise the environmental, thermal and aesthetic benefits of timber, showcasing it as a mainstream and modern construction material.

Similar to the skills gap, a perceived lack of knowledge about timber across the design and engineering fields in South Africa was identified as a significant barrier to the adoption of timber construction. Related elements include limited avenues for knowledge transfer within the industry and the need for more knowledge about constructing timber buildings. Moreover, tertiary architecture and engineering curricula do not typically focus on timber construction. In addition, a lack of awareness across the industry and a lack of information on the benefits of timber construction were noted. It is also essential to include the education of the public in these considerations.

Cost/Fire/Quality/Availability/Climate/Performance/ Sustainability

Cost was the third most common factor perceived to be a limitation to the adoption of timber. Cost concerns include the financial investment needed for offsite construction facilities and heavy machinery for assembly, maintenance and insurance costs, the cost of imported wood stock, and the financial complexity of funding timber buildings. Compared to brick-and-mortar construction, timber construction is perceived to be more expensive. Furthermore, the higher expenditure associated with timber buildings is not considered to provide any extra advantages over brick buildings, hence the unwillingness to use timber.

Fire was another concern for respondents. While the perceived flammability of wood was mentioned, other concerns were also raised. The lack of understanding of fire safety measures for timber was noted, as well as the difficulty in convincing fire chiefs and authorities about the fire safety of timber buildings. Persistent fires in certain parts of the country were also mentioned as a deterrent. Similarly, South Africa's hot and dry climate was considered unsuitable for timber buildings.

A related factor to the perceived low availability of timber is the perceived poor quality of local South African wood. Several respondents stated that they considered the South African (SA) pine – one of the most common species in the country – to be of poor quality. However, according to another respondent, the perception of local timber being of poor quality might result from using non-structural grade timber for structural purposes. When this fails, it gives the timber a poor reputation, which is difficult to overturn. Another material barrier was the perceived low availability of wood in South Africa. Factors such as insufficient forest resources and manufacturing capacity were suggested. Furthermore, the importation of timber is not environmentally sustainable.

Culture and Tradition/Industry Resistance/Public Resistance/Competing Alternatives

A common refrain provided by respondents was the idea that South Africa is historically a brick-and-mortar society. Masonry is the standard building method, and construction workers aspire to have expertise in masonry. Similarly, construction stakeholders are unwilling to take on the risk of materials that they consider alternative materials, such as timber. Respondents admitted also that the construction industry is traditionally risk-averse and resistant to change. Respondents also thought that the public distrusts timber as a construction material and perceives it as inferior to brick. Moreover, as arguably the most dominant building construction system in South Africa, brick-and-mortar construction is readily

available, cheaper and widely popular in the public sphere. Timber construction, therefore, faces a monumental challenge in surpassing traditional brick-and-mortar methods.

Government/Regulations/Marketing/Market Demand

Several factors limiting the adoption of timber construction were blamed on the government. Lack of promotion of timber, limited funding avenues, and the lack of incentives such as carbon tax reliefs for those who build with timber were areas where respondents felt government intervention would improve timber adoption rates. Respondents also noted municipal reticence to approve timber buildings as an additional barrier. Respondents also observed limited marketing, promotion and visibility of timber buildings as barriers. Similarly, limited market demand means no pressure for construction professionals to use timber.

The results of this survey generally align with similar studies in other contexts. Studies have shown that architects generally have a more positive attitude towards wood products than other construction professionals, with engineers typically relying on materials and methods they perceive as tried and tested [20, 22]. Engineers also tend to be more concerned about technical aspects such as fire safety and structural performance [15]. They may have limited experience with timber due to a historical emphasis on concrete and steel in engineering education [20, 39]. Xia [40] also noted that architects are more inclined to use timber in their designs. Similarly, while lack of availability and limited knowledge, training and experience were perceived as major barriers for engineers [13], they observed that architects did not perceive these as major barriers. According to Markstrom [22], architects are drawn to the aesthetic appeal and environmental benefits of using timber in construction. They are also more open to innovative solutions, such as hybrid buildings that combine timber with other materials [15].

Opinions about the barriers to the adoption of timber also support previous findings. Several authors, including [41], [18], and [42], have noted the lack of labour skilled in timber construction as a barrier. Similarly, a lack of competence and timber work experience have been observed as barriers by [43], [9], [44] and [45]. Lack of knowledge, awareness and education are often linked with a lack of expertise in the industry [41, 43]. Expertise in timber construction has been slowed by the prevalence of one-off timber projects, which have made it challenging to improve training and building techniques [44]. This has led to a lack of knowledge and awareness across the industry, holding back the use of mass timber materials [41]. The cost of timber, especially engineered wood and mass timber products, is also a well-documented barrier to the use of timber in construction [22, 41, 43]. In addition, maintenance and insurance are also additional cost elements that are perceived to increase the cost of timber construction projects [40, 46]. According to Riala [15], timber construction methods are still underdeveloped, partly explaining why wood remains a costlier choice for construction.

The effect of moisture on wood [25, 46], insect attacks [47, 48], and uncertainty about the performance of wood [22]are some barriers that also show up in extant literature. Perceptions about the flammability of timber, the safety of occupants during a fire and restrictive fire regulations persist [22, 25, 49]. Moreover, the construction industry's general resistance to innovation is well-documented and has also been indicated as a barrier to the adoption of timber [22, 46]. Additionally, timber adoption is limited in countries that do not have a culture of using wood [15, 22], and the lack of legislative/government support may further hinder progress [40]. For some stakeholders, the perceived risk of using timber is high, and the safe option, especially financially, is still to work with conventional materials [10, 22, 47]. Moreover, expertise in using conventional materials is a source of competitive advantage which some stakeholders may not want to forego [10]. Furthermore, market demand for timber buildings is still limited, reducing motivation for the construction industry to adopt [22, 44, 46].

This study highlights a nuanced but critical point: respondents frequently identified the perception of other stakeholders, such as scepticism about the quality of timber or the high cost of wood, as a significant barrier to adoption. While many studies broadly discuss these perceived barriers – such as cost, availability, or technical performance – they seldom explicitly acknowledge that perceptions themselves, particularly the perceptions held by other stakeholders, can be significant barriers. A notable mention is Penfield [13], who observed the tendency for construction stakeholders to blame other actors for the slow adoption of timber. This study also highlights some context-specific perceptions about the adoption of timber in South Africa, including the perception that timber buildings are for the less fortunate, that South Africa is a brick-and-mortar society where masonry is well regarded, and the idea that South Africa's climate is not conducive for timber buildings.

This study has yielded results highlighting perceptions of timber held by construction stakeholders in the construction industry, including architects and engineers.

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One significant outcome was the successful evaluation of architects' perceptions regarding timber versus other materials, revealing largely positive ratings of timber compared to other materials. This provided valuable insights into which stakeholders can be leveraged in the industry to promote the adoption of timber construction. A significant challenge to overcome involves entrenched biases about timber construction and the tendency to blame other actors for having these negative perceptions. This tendency to externalise responsibility, where stakeholders attribute the challenges of educating others and improving adoption prospects to external parties, creates a significant barrier to progress. This lack of accountability may result in a cycle where each stakeholder group waits for another to take the initiative, resulting in missed opportunities for collective action. The diffusion of responsibility theory may offer insight in this regard. Research indicates that when responsibility is diffused, individuals may be reluctant to engage with new ideas or technologies [50]. Future studies may want to look into the impact the diffusion of responsibility has on the adoption and diffusion of innovation.

To improve the adoption of timber, we propose several recommendations. First, proponents of timber construction must establish a coordinated approach where key stakeholders collaborate on education, advocacy, and capacity-building initiatives to debunk a lot of the negative perceptions surrounding timber buildings. Furthermore, timber construction stakeholders should show successful case studies of buildings, particularly high-profile projects, highlighting timber's performance, sustainability, and aesthetic appeal. The University of British Columbia's Tallwood House project offers a potential framework for documenting major timber projects' construction and design processes, creating valuable resources that interested stakeholders can review and use. This approach has the potential to facilitate meaningful knowledge transfer and foster continuous improvement in the understanding and application of timber in construction [51]. Additionally, adopting innovation frameworks such as open innovation, disruptive innovation, frugal innovation, and others could play a critical role in accelerating the adoption of timber in construction.

6 – CONCLUSION

This study shed light on the perceptions and barriers of timber construction in South Africa by adopting an online survey targeted at stakeholders in the industry to provide an understanding of current perspectives on timber construction. The study also noted some differences between the perceptions of architects compared to engineers in the industry. The study revealed several barriers, including negative perceptions about timber's suitability as a structural material, concerns about its cost and ingrained cultural preferences for established building materials and processes. One limitation of this study is its reliance on survey-based data, which captures perceptions and self-reported insights from stakeholders rather than objective measures or real-world outcomes. While these perceptions are valuable for understanding barriers and enablers to timber adoption, they may not fully reflect the actual challenges encountered in practice. Further empirical research is needed to validate the findings and assess their broader applicability in real-world contexts. Despite these limitations, the study provides valuable insights into the perceptions and attitudes of key stakeholders, offering a nuanced understanding of the factors influencing the adoption of timber in South Africa.

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