ANALYSIS OF QUALITATIVE PARAMETERS IN THE FIELD OF WOOD-BASED CONSTRUCTION

Jozef Švajlenka*[,1], Terézia Pošiváková[2], Pavol Packo[1], Denis Konovalov[3]

*jozef.svajlenka@tuke.sk
[1]Department of Construction Technology, Economy and Management, Faculty of Civil Engineering, Technical University of Košice, Slovakia
[2]Department of Breeding and Diseases of Game, Fish and Bees, Ecology and Cynology, University of Veterinary Medicine and Pharmacy of Košice, Slovakia
[3]Institute of Architectural Engineering, Faculty of Civil Engineering, Technical University of Kosice, Slovakia

Abstract

Quality in the construction industry is essential for the safety, durability, and overall value of buildings. Timber structures are increasingly popular due to their ecological and energy advantages. This study focuses on the qualitative parameters of wooden buildings and presents findings from a survey conducted among 35 entities active in the field of timber construction in Slovakia. The analysis reveals that while many entities are capable of identifying and partially declaring the quality of materials used, only about one-third actively communicate these parameters to end customers. The study highlights a gap in awareness and consistency in quality declarations and points to the need for enhanced education and standardisation. These findings suggest that improving transparency and the use of certification could strengthen customer trust and promote sustainable development in the sector.

Keywords
Quality, sustainability, wood structures, wood buildings

1 INTRODUCTION

Quality in the construction industry is a key factor that affects the safety, durability and overall value of buildings [1]. Every construction project, whether it is a family house, an office building or a large infrastructure development, must meet strict standards and technical requirements. Emphasis on quality materials, professional implementation and compliance with applicable regulations helps prevent design errors and increases the satisfaction of investors and users [2], [3], [4]. In this article, we will look at the most important aspects of quality in construction and the factors that influence it.

Sustainability in the construction industry is becoming an integral part of modern construction projects, emphasising the efficient use of resources and environmentally friendly materials, and the minimising of negative environmental impacts [5], [6]. Qualitative parameters of buildings, such as energy efficiency, structural durability, safety, and user comfort [7], are closely related to the principles of sustainability [8], [9], [10], [11]. Timber buildings represent a significant trend in modern architecture and construction, mainly due to their environmental benefits and high energy efficiency. Scientific studies show that timber as a building material has a lower carbon footprint compared to conventional materials such as concrete and steel [12].

Wooden buildings have been increasing in popularity in recent years due to their ecological, energy and aesthetic advantages. Wood as a building material offers excellent thermal insulation properties, fast construction and a pleasant indoor climate [13]. In addition, it is a renewable resource that contributes to the sustainability of construction [14]. Modern technologies and innovations allow wooden buildings to compete with classic brick houses not only in strength but also in durability [15]. This article also addresses, to a limited extent, the main advantages of wooden buildings, their types, and factors that affect their quality and long-term value. However, in order for wooden buildings to meet all expectations and provide long-term comfort, it is necessary to pay attention to the quality of the materials used, the precision of processing and compliance with technical procedures. A high-quality wooden building must not only be resistant to weather conditions, but also be properly treated against pests, mould, moisture and other factors.

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The aim of this manuscript is to address, within a limited scope, topics related to quality and wood-based structures. As a practical output, part of an implemented survey focused on the evaluation of qualitative parameters by entities operating in the field of timber structures is presented.

2 SUSTAINABILITY AND QUALITY PARAMETERS OF BUILDINGS

Sustainability in construction is one of the most important trends in contemporary architecture and construction [16], [17]. Growing environmental challenges and demands for the efficient use of resources lead to the need to reduce the negative impacts of the construction industry on the environment [18]. The concept of sustainability in construction is becoming an increasingly important factor in the design and implementation of new buildings, as well as in the reconstruction of existing buildings. It focuses on optimising the use of natural resources, minimising negative environmental impacts and improving the quality of life of building users. Sustainability in construction is based on the principles of making efficient use of energy, water and materials, and ensuring the long-term service life of buildings [19], [20], taking into account their impact on the environment, the economy and society. In this context, innovative technologies and ecological materials are increasingly being applied, contributing to a more environmentally friendly and responsible approach to the construction and operation of buildings. The main factors that influence the sustainability of buildings [21], [22] include:

- *Use of ecological materials* – Preferring renewable, recyclable and locally available building materials, such as wood, recycled concrete and natural insulation.
- *Energy efficiency* – Designing buildings with low energy consumption, using passive house standards, solar panels and smart technologies to manage energy consumption.
- *Carbon footprint reduction* – Minimising CO_2 emissions during the construction and operation of buildings, which includes the optimisation of construction processes and the transportation of materials, along with the use of low-emission technologies.
- *Long-term durability and adaptability of buildings* – Designing buildings with regard to their long-term use, and the possibility of their reconstruction and adaptation to the changing needs of users.

Qualitative parameters of buildings

In order for a building to meet the requirements for sustainability, it must exhibit high qualitative parameters that ensure its functionality, safety and comfort. The most important qualitative factors [23], [24] include:

- *Durability of the building* – The use of quality materials and correct technical procedures extends the life of the building and reduces the need for frequent repairs. The protection of structures from moisture, frost, pests and other external influences guarantees the long-term stability of the building.
- *Energy efficiency and efficiency of operation* – Low-energy and passive houses can significantly reduce energy consumption thanks to their high-quality insulation, heat recovery equipment and the use of renewable energy sources. Intelligent energy management systems enable the optimisation of building operations and the reduction of energy costs.
- *Ecological aspects* – Sustainable buildings minimise waste production during construction and support the recycling of building materials. Green roofs, rain gardens and the use of rainwater contribute to ecological balance and the reduction of environmental burden.
- *Safe and healthy indoor environment* – High-quality ventilation and the use of non-toxic materials ensure a healthy indoor environment free from harmful emissions and allergens. Lighting, acoustics and thermal comfort affect the well-being of users and their productivity.

Wooden buildings as an example of sustainable construction

Wooden buildings represent one of the best examples of sustainable and high-quality construction. Wood is a renewable, recyclable and environmentally friendly material with excellent thermal insulation properties. Modern wooden buildings meet high quality standards and, thanks to advanced technologies, achieve a long service life and high durability. The main advantages of wooden buildings in the context of sustainability and quality are [25], [26], [27]:

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- *Ecological balance* – Wood as a material binds CO_2, and its processing is less energy-intensive than the production of concrete or steel.
- *Energy efficiency* – Wooden buildings have excellent insulation properties, which contributes to their low energy consumption for heating and cooling.
- *Speed of construction* – Modular wooden buildings allow for shorter construction times, thereby reducing energy consumption and the production of construction waste.
- *Pleasant microclimate* – Wood regulates indoor humidity and creates a healthy indoor environment.

Qualitative parameters in the field of wooden buildings

The resistance of wood to environmental influences depends mainly on its type, processing and protection, and other properties [28]. High-quality timber construction depends, for example, on the following parameters [29], [30]:

- *Type of wood* – For example, spruce, pine, oak, or glued timber (BSH, CLT) increase the strength and stability of the structure.
- *Proper processing and protection* – Drying of wood, impregnation and pest protection are important factors for a long service life.
- *Quality of execution* – Precision of execution, as well as the joints and airtightness of the building envelope, affect stability, service life and energy efficiency.
- *High-quality insulation materials* – For example, the use of natural insulation (e.g. wood fibre, hemp, sheep's wool) can further improve the sustainability of the building.

3 CERTIFICATION SYSTEMS ALSO APPLICABLE IN THE FIELD OF WOOD-BASED CONSTRUCTION

To verify the quality and sustainability of wooden buildings, there are several certification options that take different perspectives, from materials and products to technological processes to the evaluation of buildings in general.

Sustainable forestry certifications

Sustainable forestry certifications ensure that the wood used for construction comes from environmentally and socially responsible managed forests [31], [32].

- *PEFC (Programme for the Endorsement of Forest Certification)* – A global certification system for sustainable forestry. Guarantees that the wood comes from legally managed forests. Mainly used in Europe and Asia.
- *FSC (Forest Stewardship Council)* – An international certification system aimed at protecting forests. FSC-certified wood comes from responsibly managed forests. Mainly used in Europe, the USA and Latin America.

Energy efficiency and green building certifications

Energy efficiency and green building certifications fundamentally assess a building's environmental footprint, energy consumption, and the use of green materials [33], [34], [35], [36].

- *Passivhaus (PHI)* – German passive house certification. Requirements: low energy consumption for heating (< 15 kWh/m² per year), high-quality thermal insulation, airtightness. Ideal for wooden buildings in combination with modern technologies.
- *LEED (Leadership in Energy and Environmental Design)* – American certification for sustainable buildings. Points are awarded for the use of environmentally friendly materials, efficient water and energy consumption, and indoor environment quality. A popular system for development projects.
- *BREEAM (Building Research Establishment Environmental Assessment Method)* – British assessment system for the environmental performance of buildings. Criteria: project management, health and comfort, materials, energy, water, waste, ecology. Suitable for both large and small projects.

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- *DGNB (Deutsche Gesellschaft für Nachhaltiges Bauen)* – German sustainability assessment system for buildings. Takes into account the entire life cycle of the building. Strong emphasis on economic, environmental and social aspects.

Technical and safety certifications of wooden buildings

The technical and safety certification of wooden buildings guarantees the quality and safety of structural materials and technologies [37], [38].

- *ETA (European Technical Assessment)* – European quality certificate for construction materials. Required for new construction products that do not yet have harmonised standards.
- *CE mark (Conformité Européenne)* – Mandatory marking of construction materials in the EU. Guarantees that the product meets basic safety and technical standards.
- *Natureplus* – European certification of ecological construction materials. Materials must be harmless to health and have low emissions and a minimal impact on the environment.

4 ANALYSIS OF THE DECLARATION OF QUALITATIVE PARAMETERS BY ENTITIES OPERATING IN THE FIELD OF TIMBER CONSTRUCTION

Methodology

The research presented in this article was conducted using a quantitative approach, based on an online survey targeting various stakeholders in the Slovak timber construction sector. The survey was distributed to manufacturers, sellers, material suppliers, and construction companies. The sample consisted of 35 respondents, selected through targeted sampling based on their activity in the wood construction value chain. The questionnaire included both closed and open-ended questions designed to capture information on the use of certification systems, methods of quality declaration, and general attitudes towards quality parameters. The data were analysed using descriptive statistics, with a focus on the frequency and proportion of selected responses. This methodological design allows for a contextual understanding of how quality is perceived and communicated within the sector and provides a basis for identifying gaps and potential areas for improvement.

Results and analysis

This chapter focuses on the analysis of selected parts of broader research investigating the qualitative parameters of wooden buildings from the perspective of entities operating in this segment. The aim of the analysis is to identify key factors influencing the quality of wooden buildings on the Slovak market and to understand the opinions and experiences of experts from various fields.

The research sample consists of 35 respondents operating in various sectors of the timber construction industry. The analysed groups include timber building manufacturers, timber building sellers, material manufacturers, material sellers, construction and assembly companies, as well as other entities closely related to this industry. Each of these groups has a specific view of the qualitative parameters of timber construction, and their experiences and assessments can provide valuable information about the current market situation. The research was conducted within Slovakia, with an emphasis on obtaining relevant data from experts with practical experience in the field of the production, distribution and construction of wooden buildings. The analysis of the results will provide an overview within a defined scope of respondents' behaviour regarding the declaration of the quality of wooden buildings and identify potential areas for improvement within the wooden buildings value chain.

The specific percentage representation of individual entities within the areas of operation was as follows: manufacturers of wooden buildings 32.26%, sellers of wooden buildings 16.13%, manufacturers of materials 16.13%, sellers of materials 9.68% and construction and assembly companies 25.81%. The following table (Tab.1) presents the occurrence of the mentioned certification systems and quality marks in relation to wood in general and to wood-based buildings in the declarations concerning quality made by the analysed entities operating in the field of wooden building construction. As a part of this analysis, the respondents expressed their responses to the question of how they declare the quality of the resulting building to their customers.

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Tab. 1 Certification systems used, quality marks and declaration of the quality of the resulting building mentioned by respondents in the field of timber construction.

Use of quality schemes in relation to materials (in the context of wood) reported by respondents	Declaration of the quality of the resulting structure stated by respondents
ISO CPR (Construction Products Regulation) (30.26%) ETA (European Technical Assessment) (16.30%) PEFC (Programme for the Endorsement of Forest Certification) (12.90%) FSC (Forest Stewardship Council) (3.10%) PCR (Post-Consumer Recycled content) (3.10%) BTRI (Building Testing and Research Institute) (3.10%) CE (Conformité Européenne) (32.26%)	CE of materials (35.50%) Blower-door test (22.5%) Energy certificate (16.00%) BTRI (Building Testing and Research Institute) (9.70%)

Based on the research conducted, it can be stated that the subjects involved in the survey are able to identify and declare the quality of the materials used to a certain extent, especially with a focus on wood as the primary construction element of wooden buildings. However, the data obtained indicate that not all subjects perceive quality parameters at the right level or in a sufficiently complex context. In several cases, it was possible to observe that the understanding of quality is often reduced only to the technical properties of the material itself, while broader aspects such as environmental certifications, the harmlessness to health of materials, or their origin and ecological impact, are neglected. Another significant finding is that only almost one third of entities demonstrate the quality parameters of their products or services to end customers. The methods of declaring quality vary between entities, and include mainly quality certificates, technical sheets or references to the materials used. This figure points to a relatively low degree of transparency in the area of demonstrating quality standards, which may raise questions regarding the credibility and awareness of customers.

In addition to the overview of certifications, further analysis revealed differences in how entities from different sectors declare quality. For example, manufacturers of wooden buildings were more likely to use formal certifications (e.g., CE, ETA), whereas sellers and distributors relied more on technical datasheets and supplier declarations. Only 22.5% of all respondents conducted blower-door tests to verify airtightness, a critical factor in evaluating energy performance. This suggests there may be a disparity between declared and measured performance indicators. Moreover, a cross-tabulation of data showed that larger companies (with over 10 employees) more frequently adopted multiple certification systems compared to smaller firms, indicating resource-based differences in quality assurance practices. These findings underline the fragmented nature of quality communication in the timber construction sector and suggest there is a need for standardised best practices.

Gaps in the Perception of Quality

A critical finding from the survey is the narrow interpretation of quality among certain stakeholders. While many respondents can identify and declare the technical quality of materials, they often fail to account for broader aspects such as environmental impact, harmlessness to health, and the origin of materials. This points to a reductionist approach to quality that overlooks important elements that could influence customer satisfaction and market competitiveness. For example, certifications such as PEFC and FSC, which deal with sustainable forestry practices, were mentioned less frequently, indicating that environmental considerations are not always a priority.

Moreover, a lack of transparency in how quality is communicated to end customers was highlighted. Although a significant proportion of entities claim to demonstrate quality parameters, the methods of communication vary widely. Technical datasheets, certificates and references to materials used were the primary methods, but only a third of respondents actively communicated quality to their customers. This discrepancy raises concerns about credibility and customer awareness, which are critical for fostering trust and promoting the long-term success of timber construction businesses.

The research further reveals significant differences in quality declaration practices based on company size. Larger companies, especially those with over 10 employees, were more likely to adopt multiple certification systems, potentially due to their having greater resources available for maintaining and verifying these certifications. On the other hand, smaller firms, which are likely to face more resource constraints, may not have the capacity to implement such robust quality assurance practices. This highlights the role of resources in shaping quality practices and suggests that smaller firms may need additional support or incentives to improve their quality assurance and certification practices.

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Another key finding is the discrepancy between declared and measured performance. For instance, while 22.5% of respondents conducted a blower-door test to measure the airtightness of buildings (a key indicator of energy performance), a much larger proportion did not conduct such tests. This gap underscores the potential for the overestimation of the actual quality of buildings and raises concerns about the reliability of quality claims made by certain entities. It suggests that energy performance and other technical properties may be declared without proper validation, leading to potential customer dissatisfaction and future regulatory complications.

Limitations of the research

However, this study has several limitations. The sample size was relatively small and geographically limited to Slovakia, which may affect the generalisability of the findings. Additionally, the reliance on self-reported data introduces potential bias into the assessment of quality declaration practices.

Future research should aim to:

- Expand the sample size and include international comparisons.
- Conduct in-depth interviews or focus groups to gain richer qualitative insights.
- Explore customer perspectives on quality perception and decision-making criteria.
- Develop a standardised framework for declaring and evaluating quality in wooden buildings.

5 DISCUSSION

The survey results thus raise an important question: do customers really trust their suppliers enough to not require specific evidence of quality, or is there a prevailing ignorance and low awareness on the part of end users about the possible means of verifying the quality of materials used? This aspect opens up space for further research focused on customer awareness and expectations in the area of the quality parameters of timber buildings, as well as on the options for increasing transparency and trust within the entire timber building value chain. Some of the results of the survey point to the need for more intensive education in the field of quality and certification, and not only among suppliers and manufacturers, but also among end customers. Improving awareness and more consistent communication of quality parameters could contribute to increases in market transparency, the strengthening of customer trust, and support for sustainable development in the timber construction segment.

Timber buildings have become increasingly popular in the construction industry in recent years, which is mainly due to their environmental benefits and sustainability. The quality parameters of these buildings include various technical and environmental aspects, such as thermal insulation properties, acoustic insulation, durability of materials, structural stability and safety. The quality parameters of wooden buildings are often ambiguously defined in building regulations, which can lead to differences in interpretation arising between manufacturers and engineers [39]. The basic challenge in the analysis of quality parameters by entities operating in the field of wooden buildings is the inconsistencies in the declaration of these parameters. Each entity may use different standards and methods to measure and evaluate quality [40].

Environmental factors and their compliance with technical standards play an important role in assessing the quality of wooden buildings. Wooden buildings are often presented as ecologically sustainable, but their true environmental footprint depends on the materials, technologies and construction processes used. Currently, there are various certification systems (e.g. LEED, BREEAM) that assess the environmental sustainability of buildings, which should be taken into account when declaring quality parameters. It turns out that ecological certifications can improve the quality of wooden buildings and provide objective criteria for evaluating environmental parameters that are important for customers [41]. In this context, it is also necessary to take into account factors such as the durability of materials, energy consumption and the recyclability of the components used.

Technological advances in timber construction, such as the use of new materials and construction techniques, can affect the way in which quality parameters are declared. New materials such as CLT (Cross-Laminated Timber) or other innovative composites make it possible to create stronger and more durable wooden buildings, which has a direct impact on the declared quality parameters [42].

In relation to the above, it is essential to note that there are different approaches to the declaration of the quality parameters of timber structures. Such approaches depend on the technological innovations, environmental standards and methodological approaches used by different actors in the sector. Further research in this area should also be encouraged so as to improve the performance and durability of timber buildings.

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6 CONCLUSION

The sustainability and quality parameters of buildings are important considerations for the construction industry today. Ecological building materials, low-energy solutions and the long-term durability of buildings not only contribute to environmental protection but also raise the quality of housing. Wooden buildings represent one of the most suitable solutions for sustainable construction, as they combine ecological advantages with a high level of comfort and energy efficiency. The results of the research indicate that entities operating in the field of wooden buildings are able to define and declare the quality of the materials used, especially wood, to a certain extent, but not always in the right context. Only approximately a third of respondents actively demonstrate the quality of their materials and services to customers, and the forms of declaration vary - from certifications to references to their own company standards. This situation indicates that either customers trust suppliers so much that they do not require formal confirmation of quality, or there is insufficient awareness on the part of consumers about the possible options for objective quality verification. Some of the results of the survey highlight the need for more intensive education in the field of quality and certification, not only among suppliers and manufacturers, but also among end customers. Improvements to awareness and the more consistent communication of quality parameters could contribute to increases in market transparency, strengthening customer trust and supporting sustainable development in the timber construction segment. The future of construction is thus moving towards intelligent and sustainable solutions that will enable the creation of an efficient and healthy living environment for future generations.

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