ARTIFICIAL INTELLIGENCE, DATA SCIENCE AND COMPUTATIONAL INTELLIGENCE

BLOCKCHAIN TECHNOLOGY IN CONSTRUCTION DOCUMENTATION MANAGEMENT AND PREVENTION OF DOCUMENT FORGERY

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Abstract. The construction industry involves complex procedures, extensive documentation, and cooperation between multiple stakeholders. These characteristics can lead to administrative inefficiencies, disagreements, and an increased risk of document falsification. This study examines the potential of blockchain technology to improve the security and reliability of document management in construction. Its main objective is to assess how this technology can ensure document authenticity, prevent fraudulent practices, and support transparency and traceability throughout the different stages of construction projects.

The research adopts a qualitative methodology based on a review of relevant academic publications and a comparative assessment of conventional document management methods and blockchain-based systems. It also considers existing pilot projects and findings from empirical studies to understand the practical implications of adopting blockchain in construction. Previous research suggests that traditional systems frequently face challenges related to human error, fragmented information, and unauthorized alterations. By contrast, blockchain enables the creation of verifiable records that preserve information about document transactions and modifications.

The findings suggest that blockchain can improve data reliability, transparency, and accountability through cryptographic hashing, distributed verification, and timestamping mechanisms. Smart contracts may further facilitate administrative procedures, including document validation, approval processes, and the implementation of contractual obligations. These functions can help reduce processing times and minimize disagreements between project participants. Research findings also point to better information consistency and more complete documentation when blockchain-based solutions are implemented effectively.

The study demonstrates that blockchain technology can provide an additional layer of protection against document manipulation and fraudulent activities. Its capacity to maintain traceable records allows stakeholders to verify document histories and identify unauthorized changes. However, its practical implementation remains constrained by technical scalability, financial investment requirements, and the absence of sufficiently clear regulatory standards in some jurisdictions.

Keywords: blockchain, construction management, document security, forgery prevention, smart contracts, distributed ledger.

JEL Classification: O33; L74; D23; K42.

INTRODUCTION

The construction industry involves a large amount of documentation, including contracts, technical drawings, building permits, technical specifications, inspection reports, and documents confirming compliance with legal requirements. These documents are used at different stages of a construction project, from its planning to its completion. Their proper management is important for controlling costs, preventing disagreements, respecting legal requirements, and ensuring that projects are carried out successfully. However, traditional document management systems (DMS) used in construction are generally based on centralized storage and control, meaning that access to information depends on a particular system or administrator. This situation can create certain risks, especially when documents are changed without authorization, information is lost, or the accuracy of records cannot be easily verified. In addition, limited transparency in document management may cause misunderstandings between project participants and make it more difficult to identify who made particular changes and when they occurred. These problems can result in delays, additional costs, administrative difficulties, and conflicts related to contractual obligations. As a result, traditional document management methods may not always provide an adequate level of security and transparency for the needs of modern construction projects. According to Gartoumi (2024), the limitations of conventional document management systems can affect project quality, increase administrative costs, and weaken trust between the parties involved.

For these reasons, the construction sector needs document management systems that offer greater security, reliability, and transparency. The limitations of existing methods have encouraged researchers to examine new technologies that could help reduce these risks and improve the way construction documents are managed.

In recent years, blockchain technology has received increasing attention as a possible solution to the problems associated with traditional document management. Blockchain is a decentralized digital system in which information is recorded and verified across a network of computers rather than being controlled by a single authority. Each new record is validated according to established rules and linked to previous records. Through cryptographic methods and consensus mechanisms, blockchain makes unauthorized changes more difficult to carry out and easier to identify. This can help protect construction documents against manipulation, accidental loss, and unauthorized modifications. It can also allow project participants to check information and follow the history of documents more easily.

Blockchain may be particularly useful in Architecture, Engineering, and Construction (AEC) projects, where many parties need to exchange documents and keep track of different versions. For example, contracts, technical plans, inspection reports, and approval documents may be revised several times during a project's development. Keeping an accurate record of these changes is important for avoiding misunderstandings and determining who made a particular decision. Das *et al.* (2021) discuss the potential of blockchain-based systems to improve document approval procedures by using verified timestamps and audit trails. These features make it possible to follow document updates and identify the actions taken by different participants. In this way, blockchain can contribute to better document control and greater accountability throughout a construction project. Although its implementation still requires further consideration, the technology offers an interesting alternative to conventional systems and may help improve both administrative efficiency and the reliability of construction records.

Studies on the use of blockchain technology in the construction industry have approached the subject from different perspectives and have used various research methods. For example, Idrissi Gartoumi (2024) reviewed the existing literature on blockchain in construction management, focusing on the main challenges faced by the industry and the ways this technology could help improve project performance. The author identified several potential advantages of blockchain, but also pointed out that further research is needed. One important issue is the lack of comprehensive approaches specifically designed to protect construction documents and ensure that the information they contain remains accurate and reliable.

A different approach was taken by Das *et al*. (2021), who developed and tested a prototype for applying blockchain to construction document management. Their proposed system uses smart contracts to manage document approval procedures and cryptographic methods to keep track of document versions. The researchers considered whether a decentralized system could improve the security of project records and make document management processes more reliable. By recording activities in a verifiable way and automating certain procedures, such a system could reduce human error and limit unauthorized changes. It could also help project participants better understand when documents have been modified or approved. However, the practical value of these solutions needs to be examined further, particularly in real construction projects where many organizations and professionals are involved. Taken together, these studies show that blockchain could help address some of the weaknesses of traditional document management, although further testing is necessary to determine how effectively it can be applied on a larger scale.

Other researchers have also explored the role of blockchain in project management and construction activities. Their work highlights the possibility of improving cooperation between stakeholders by allowing them to access the same verified information. This may reduce disagreements caused by inconsistent records and make document handling more transparent. In addition, smart contracts can automate certain administrative tasks, including document verification and approval procedures, reducing the need for repeated manual checks and direct intervention by a central authority (Jadidoleslami & Azizi, 2022).

However, although blockchain offers several advantages, previous studies show that there is still limited practical evidence of its effectiveness in real construction projects. Most research has focused on theoretical analysis or the development of prototype systems, with less attention given to the results obtained when this technology is used in everyday construction activities. For this reason, it is still difficult to determine how much blockchain can improve existing practices and whether it can solve the problems encountered during the management of actual projects. Another limitation is the small number of case studies and pilot projects available. Since construction projects differ in size, complexity, and the number of people involved, the results obtained in one situation may not be applicable to all types of projects.

Although blockchain has attracted the attention of researchers since around 2017, its use in the construction industry remains relatively limited. Further research is therefore necessary to understand its practical benefits. Studies carried out on real construction sites, together with research conducted over longer periods, could provide a clearer picture of how blockchain influences document management, transparency, and cooperation between project participants. Such research could also help establish whether this technology reduces administrative work and improves trust among the parties involved.

Considering these limitations, the present study examines how blockchain technology can be used to improve the management of construction documents and reduce the risk of document falsification. Particular attention is given to the use of distributed records, smart contracts, and cryptographic methods in existing document management processes. These tools may help protect information, make document changes easier to track, and ensure greater transparency throughout the project lifecycle.

The research has three main objectives. The first is to examine how blockchain can help preserve the authenticity and integrity of construction documents through secure recordkeeping, document version tracking, and the recording of activities. The second objective is to compare blockchain-based solutions with traditional centralized document management systems (DMS), considering their security, efficiency, and reliability. The third objective is to identify the main difficulties that could affect the implementation of blockchain in construction, including technical limitations, the costs of introducing new systems, compatibility with existing technologies, and legal requirements.

By addressing these objectives, the study aims to clarify the potential benefits and limitations of blockchain in construction document management. It also seeks to explain how this technology could help prevent unauthorized changes, reduce the risk of fraud, and improve cooperation between project participants. In this way, the research connects the possibilities described in academic literature with their potential practical application in the construction industry.

MAIN CONTENT

1. Materials and Methods

This study explores how blockchain technology could improve the management of construction documents and help prevent their falsification in the Architecture, Engineering, and Construction (AEC) sector. The research is based on scientific publications, literature reviews, conceptual models, and prototype systems developed by previous researchers. Particular attention is given to the studies conducted by Das *et al*. (2021), Idrissi Gartoumi (2024), and Jadidoleslami and Azizi (2022).

The main research method is a systematic review of the existing literature. Relevant studies are examined to identify the main findings, the ways blockchain can be used in document management, and the benefits and limitations reported by researchers. The study also compares blockchain-based solutions with traditional document management systems, focusing on aspects such as document security, transparency, and the possibility of tracking changes. In addition, a qualitative analysis is used to identify common findings and challenges related to the practical implementation of this technology. To make the analysis more reliable, findings from different sources and research approaches are considered together. This helps connect the theoretical aspects of blockchain with its possible use in real construction projects.

2. Results and Discussions

The results of this study suggest that blockchain technology could improve the way construction documents are managed, especially in terms of data security, transparency, and reliability. The analysis of existing research shows that traditional document management systems are often based on centralized structures, which can create difficulties when information needs to be shared, updated, or verified. These systems may be affected by unauthorized changes, errors, and the fragmentation of information between different parties. As a consequence, misunderstandings, contractual disagreements, project delays, and additional costs may occur.

Blockchain offers another way of managing construction documents by storing information in a distributed digital ledger. Through cryptographic methods and the validation of records by network participants, this technology makes it more difficult to change information without authorization. Once a record has been added to the blockchain, any subsequent modification can be identified, while the history of previous transactions remains available for verification. This feature can help reduce the risk of document falsification and improve confidence in the information used throughout a construction project.

Another advantage of blockchain is its potential to simplify document management procedures. It can support the tracking of document versions, facilitate the secure exchange of information, and automate certain approval procedures through smart contracts. When compared with traditional Construction Document Management Systems (CDMS), blockchain-based solutions offer important benefits in terms of traceability and the possibility of checking document histories. They can also improve cooperation between project participants by making relevant records more accessible and easier to verify.

Overall, blockchain could contribute to more reliable document management in the construction sector. By providing records that are difficult to alter without detection, the technology allows participants to check the origin and history of documents at different stages of a project. This may help prevent disagreements, support better decision-making, and clarify the responsibilities of the parties involved. Similar benefits are discussed by Mahmudnia *et al.* (2022), who examine the potential of blockchain applications in construction management.

The use of smart contracts can also help improve the way construction projects are managed, especially when it comes to administrative tasks and document approval. Smart contracts are digital agreements based on blockchain technology that automatically perform certain actions when specific conditions are met. In construction, they could be used for checking documents, confirming approvals, verifying compliance with established requirements, and processing payments. By automating some of these activities, the need for manual work can be reduced, which may help prevent errors and avoid unnecessary delays.

Another advantage of smart contracts is that they follow rules established in advance, making procedures clearer for the parties involved. When the conditions and steps are known beforehand, it becomes easier for participants to understand their responsibilities and follow the progress of different activities. This can also reduce misunderstandings that occur when information is incomplete or decisions are not communicated properly. In addition, automated procedures may improve coordination between contractors, engineers, project managers, and other participants.

The use of smart contracts does not eliminate every possible conflict, since disagreements may still arise over contractual terms or the quality of construction work. However, when they are properly designed and implemented, these tools can make certain procedures more transparent and easier to verify. In this respect, blockchain-based systems that include smart contracts may contribute to more efficient project management, clearer responsibilities, and better cooperation between stakeholders. Similar benefits are discussed by Awsan *et al.* (2021) in relation to the use of blockchain technology in construction.

Another important finding of this study is that blockchain technology can help improve trust and cooperation between people involved in construction projects. Since the system allows authorized participants to access the same digital records, everyone can work with consistent and updated information. This is important because, in traditional document management systems, information is

sometimes stored in different places or shared only with certain participants. Such situations can lead to misunderstandings and difficulties in verifying the accuracy of documents.

Blockchain can reduce these problems by allowing participants to check the information recorded in the system without depending entirely on a central administrator. They can follow document changes and verify the status of records, which may help increase confidence in the information used during the project. As a result, communication between contractors, engineers, clients, and public authorities could become more effective. Better access to reliable information may also support faster decisions and help prevent conflicts caused by incomplete or inconsistent documentation. The importance of blockchain for cooperation and information sharing in construction projects has also been discussed by Shishehgarkhaneh *et al.* (2023).

These findings are relevant to the Republic of Moldova, where improving administrative procedures and the digital management of construction documents remains an important objective. The use of blockchain could complement the digitalization of public services and contribute to greater transparency in the construction sector. For example, connecting blockchain-based systems with existing electronic platforms for construction permits or public procurement could make it easier to verify documents and follow the history of administrative decisions. Such solutions may also help clarify the responsibilities of institutions and reduce disagreements concerning the authenticity of records. However, their effectiveness would depend on how well they are integrated into existing systems and legal procedures.

Despite these potential benefits, the implementation of blockchain in construction also presents several difficulties. One of the main obstacles is the cost of introducing and maintaining the technology. In addition, integrating blockchain with existing software may require technical expertise and considerable changes to current working procedures. Scalability is another concern, particularly for large construction projects that generate significant amounts of documentation and data. Legal questions also remain important, including the recognition of electronic records, the protection of personal and confidential information, and the rules governing access to stored data.

A further limitation is the lack of sufficient practical evidence concerning the results of blockchain implementation in real construction projects. Much of the existing research focuses on theoretical models, experimental systems, or small pilot projects. Consequently, it is difficult to establish whether the expected benefits can be achieved in large and complex projects or whether the investment is justified by the results. As noted by Gartoumi (2024), further research is needed to better understand the practical application of blockchain in construction. Studies based on real projects and longer observation periods would help clarify its advantages, limitations, and actual costs, providing a stronger basis for decisions about its wider use in the construction industry.

The scientific value of this research lies in examining how blockchain technology can be used to improve the management of construction documents and reduce the risk of falsification. While previous studies have mainly discussed blockchain in relation to project management and contract administration, this research focuses more specifically on the authenticity, security, and traceability of construction documentation. This approach makes it possible to examine the technology in connection with a practical problem faced by the construction industry, namely, how to ensure that documents remain reliable and that unauthorized changes can be identified.

Another important aspect of the study is the analysis of how different blockchain features can work together in document management. Cryptographic methods help protect recorded information and make unauthorized modifications easier to detect. The decentralized structure allows participants

to verify records without depending entirely on a single administrator. At the same time, smart contracts can automate certain procedures, such as document approval and verification, when predefined conditions are met. Used together, these features could improve document security and reduce the opportunities for fraud or unauthorized alterations.

The study also highlights the practical importance of understanding how these mechanisms can be applied in construction projects. Although blockchain cannot guarantee the accuracy of information entered into the system in the first place, it can help preserve records and make subsequent changes more traceable. This may be particularly useful when several organizations and professionals are involved in preparing, checking, and approving construction documents.

In conclusion, blockchain technology offers a possible way to improve the security and management of construction documentation. Its main advantages include decentralized recordkeeping, the ability to trace document changes, and the automation of certain administrative procedures through smart contracts. These features could help increase transparency, strengthen accountability, and reduce the risk of document manipulation.

For the Republic of Moldova, this topic deserves particular attention because the digitalization of administrative processes and the reliability of construction documentation are important for the development of a more transparent construction sector. The introduction of blockchain-based solutions could complement existing electronic systems and make document verification more reliable. However, their practical use would require appropriate technical solutions, clear legal rules, and further research based on real construction projects. Therefore, blockchain should be considered a promising option whose effectiveness needs to be assessed in relation to the specific needs and conditions of the Moldovan construction sector.

Table 1. Blockchain adoption in construction documentation in the Republic of Moldova

Aspect	Traditional CDMS	Blockchain-Based Systems	Implications for Republic of Moldova
Data Integrity	Centralized, vulnerable to manipulation and errors	Immutable records with cryptographic protection	Reduces risks of document falsification and unauthorized edits in Moldovan construction projects
Transparency & Trust	Fragmented information, limited stakeholder visibility	Decentralized ledger ensures full visibility and traceability	Improves collaboration and stakeholder confidence across contractors, regulators, and clients
Version Control & Traceability	Difficult to track document history and edits	Every transaction is recorded chronologically and tamper-proof	Enables reliable audit trails for permits, contracts, and approvals, supporting legal certainty
Workflow Efficiency	Manual approvals, high administrative burden	Automated smart contracts streamline approvals, compliance checks, and payments	Reduces delays and administrative inefficiencies common in Moldovan construction workflows
Risk Mitigation	High risk of disputes, miscommunication, and financial losses	Immutable records, distributed validation, and smart contracts reduce fraud and errors	Supports national digitalization efforts and alignment with European construction governance standards

Table 1 (continued)

Aspect	Traditional CDMS	Blockchain-Based Systems	Implications for Republic of Moldova
Challenges & Limitations	Limited data security, inefficiencies	High deployment cost, technical complexity, integration with legacy systems, regulatory uncertainty	Requires policy support, technical training, and pilot projects to validate effectiveness

Source: *Adapted by information Das et al., 2021*

This table captures the practical benefits, risks, and context-specific implications of blockchain adoption for construction documentation management in the Republic of Moldova.

The following table presents a more detailed analysis of smart contracts and collaboration between stakeholders, taking into account the situation in the Republic of Moldova.

Table 2. Smart Contracts and Stakeholder Collaboration in the context of the Republic of Moldova

Aspect	Traditional CDMS	Blockchain with Smart Contracts	Implications for Republic of Moldova
Workflow Automation	Manual approvals, slow processing	Self-executing smart contracts automatically trigger approvals, compliance checks, and payments	Reduces administrative delays and human errors in document workflows within Moldovan construction projects
Procedural Clarity	Ambiguity in responsibilities, inconsistent procedures	Predefined rules embedded in smart contracts ensure consistent execution	Improves accountability and clarity in project roles among Moldovan contractors, engineers, and regulators
Error Reduction	High likelihood of mistakes due to manual handling	Automated processes minimize human intervention and errors	Decreases risk of discrepancies in permits, certifications, and contracts, which are common in local practice
Stakeholder Coordination	Fragmented communication, information asymmetry	All participants access a shared, transparent database in real-time	Enhances trust, reduces miscommunication, and fosters better collaboration across multi-actor projects in Republic of Moldova
Conflict & Dispute Minimization	Frequent disputes due to inconsistent records and delays	Transparent, immutable records with automatic execution reduce potential for conflicts	Supports smoother project delivery, fewer legal disputes, and more reliable verification of document authenticity
Operational Efficiency	Repetitive administrative tasks, slower project timelines	Streamlined approvals and automated workflows speed up processes	Optimizes project schedules and resource allocation, addressing inefficiencies in the Moldovan construction sector

Source: *Adapted by information Das et al., 2021*

This table emphasizes how blockchain and smart contracts together improve collaboration, transparency, and efficiency, specifically tailored to the challenges faced in the Republic of Moldova.

However, the use of blockchain in real construction projects is still at an early stage. There are several difficulties that need to be addressed, such as the high costs of implementation, the lack of

specialists with the necessary technical knowledge, and problems integrating blockchain with existing digital systems. Another important issue is the lack of clear legal rules regarding the recognition and use of records stored on blockchain platforms. For these reasons, more practical research is needed, including pilot projects and case studies, to understand whether this technology can be used effectively on a larger scale and whether its benefits justify the costs.

In conclusion, blockchain could improve the way construction documents are managed by making them more secure, transparent, and easier to verify. However, its wider use will depend on further technological development, appropriate legal regulations, and support from public institutions and the construction industry. Cooperation between researchers, construction professionals, and policymakers will be important in overcoming the existing challenges. If these conditions are met, blockchain could help protect the authenticity of construction documents, strengthen trust between project participants, and improve the overall management of construction projects.

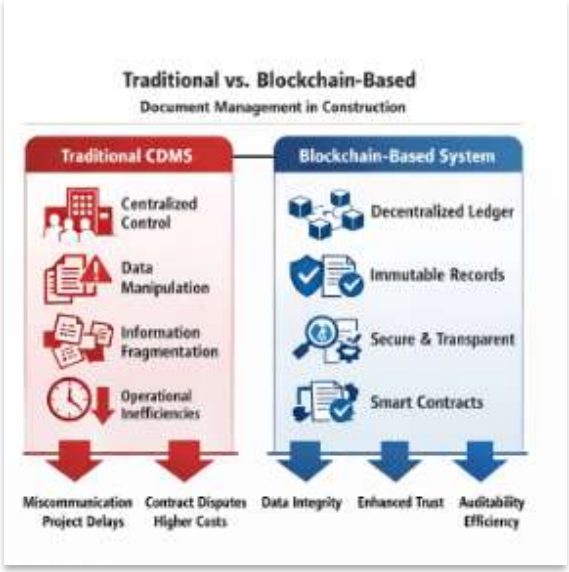


Figure 1. Traditional vs. Blockhain- Based. Document Management in Construction
Source: *Personal idea of diagram*

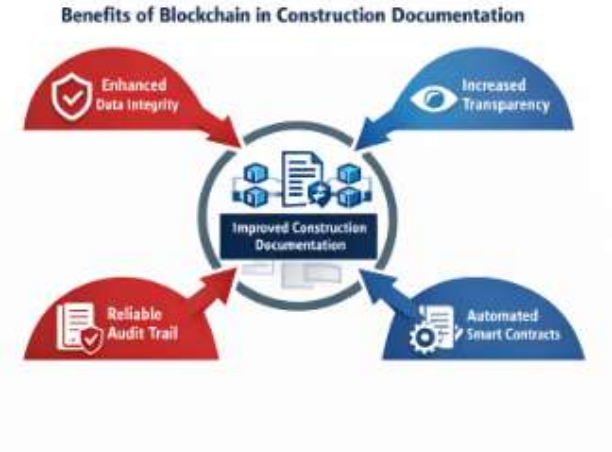


Figure 2. Benefits of Blockhain in Construction Documentation
Source: *Personal idea of diagram*

CONCLUSIONS

This study examines how blockchain technology could improve the management of construction documents and help prevent document forgery in the Architecture, Engineering, and Construction (AEC) sector, with a particular focus on the Republic of Moldova. The results show that blockchain has several potential benefits, but its practical use also involves certain difficulties that need to be considered.

The research shows that blockchain could make construction documents more secure by storing information in a way that makes unauthorized changes easier to identify. It also allows documents and their modifications to be tracked over time. Smart contracts can be used to automate certain activities, such as document approval and verification. Compared with traditional centralized Construction Document Management Systems (CDMS), blockchain may offer better traceability and make it easier to check the history of a document. The main contribution of this study is its focus on document authenticity and protection against forgery, rather than on general aspects of project management or contract administration.

Another important finding is that blockchain could improve communication and cooperation between the people involved in construction projects. Its decentralized structure and cryptographic mechanisms can help protect information and make document verification more transparent. Smart contracts may also simplify approval procedures, compliance checks, and some financial operations. These functions could reduce human errors, delays, and misunderstandings between project participants. In the Republic of Moldova, such solutions could be useful in situations where construction information is spread across different institutions and organizations. Access to reliable and updated documents could help contractors, engineers, public authorities, and clients coordinate their activities more effectively.

The introduction of blockchain into the Moldovan construction sector could also support the country's efforts to digitalize public services and bring administrative practices closer to European standards. A blockchain-based document management system could make construction permits, approval procedures, and public procurement processes more transparent. It could also help clarify the responsibilities of the parties involved and reduce disputes caused by missing, altered, or inconsistent documents. However, these benefits depend on how the technology is implemented and integrated into existing procedures.

Despite its potential, blockchain still faces several challenges. The initial costs may be high, and the technology requires specialized knowledge that is not always available. Integrating blockchain with existing information systems may also be difficult. In addition, the lack of clear and standardized legal rules concerning blockchain records can create uncertainty about their recognition and use in official procedures. Another limitation is the small number of practical studies showing how well these solutions work in real construction projects. Therefore, their effectiveness should not be assumed without further testing.

Further research should include pilot projects, case studies, and long-term evaluations to determine whether blockchain is suitable for the needs of the construction sector. It would also be useful to examine how blockchain could work together with other digital technologies and to identify the main concerns of construction companies, public authorities, and other stakeholders. Such research could help establish whether the benefits justify the costs and what legal or organizational changes would be necessary for wider implementation in the Republic of Moldova.

The study also points to a difference between the theoretical advantages of blockchain and the difficulties of applying it in practice. Although the technology may improve document security and transparency, these results cannot be achieved through technology alone. Proper training, clear regulations, institutional cooperation, and careful integration into existing workflows are also necessary. Without these conditions, the expected benefits may remain limited.

In conclusion, blockchain technology could provide a useful way to improve construction document management, make document changes easier to trace, and reduce the risk of forgery. For the Republic of Moldova, its implementation could support digitalization, increase transparency, and strengthen trust between participants in construction projects. Nevertheless, further research, practical testing, appropriate legal rules, and institutional support are needed before its advantages can be fully assessed. Cooperation between researchers, construction professionals, and public authorities will be essential to determine how this technology can be used effectively and bring lasting improvements to the construction sector.

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