Exploring the Role of Blockchain Attributes in Automating Payments in the Construction Sector: A Systematic Review

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ABSTRACT

This systematic literature review analyses the impact of blockchain attributes on the automation of payments within the construction industry, where delays, disagreements, and insufficient transparency have historically impeded performance and confidence. Thirty-seven studies sourced from Scopus and Web of Science were examined in accordance with PRISMA guidelines to identify five principal themes namely smart contracts and payment automation, enabling technologies and data integration, financial mechanisms and cash flow, supply chain visibility and provenance, and adoption with governance considerations. The results demonstrate that blockchain-enabled smart contracts especially when integrated with BIM, IoT, and reality capture, facilitate precise, automated, and transparent payment procedures that diminish disputes and improve efficiency. Blockchain-based financial instruments like project bank accounts and tokenised settlements, enhance liquidity and cash flow management. Nonetheless, technical immaturity, interoperability deficiencies, regulatory ambiguity, and cultural resistance persist in hindering implementation. Blockchain exhibits significant potential to synchronise construction payment systems with the goals of Construction 4.0, subject upon the advancement of solid governance frameworks and pilot implementations.

Keywords: blockchain technology, smart contract, automation, payment

INTRODUCTION

The construction industry is infamous for its complex and frequently ineffective payment procedures, resulting in considerable delays, disagreements, and a deficiency of transparency. These challenges not only impede project effectiveness but also undermine stakeholder trust. Recent study has suggested the integration of blockchain technology with Building Information Modelling (BIM) to automate payments in the construction sector, thereby addressing these persistent challenges. Blockchain, featuring a decentralised ledger and smart contract functionalities provides a safe and transparent approach for documenting and performing transactions. Together with the accurate project data provided by BIM, this interface can enable real-time payments upon milestone completion, increasing stakeholder trust, decreasing conflicts, and increasing transparency [1], [2], [3].

The construction industry has long faced systemic challenges related to delayed payments, disputes, and fragmented financial accountability, which significantly hinder project performance, stakeholder trust, and overall sector productivity [4], [5], [6]. Conventional payment processes typically involve multiple intermediaries and manual verification procedures, resulting in prolonged approval cycles, information asymmetry, and opportunities for opportunistic behaviour [4], [5], [6]. As the industry progresses toward digital transformation under the broader agenda of Construction 4.0, there is a growing imperative to rethink payment mechanisms to ensure transparency, automation, and equitable financial flow among project participants [7], [8].

Despite increased interest in digitalization, payment processes in construction projects remain predominantly manual, opaque, and vulnerable to disputes [8], [9], [10]. Existing financial procedures are frequently disconnected from real-time project progress data, leading to inaccuracies in certification and delays in disbursement [8], [11], [12]. While blockchain technology and smart contracts have demonstrated the capacity

to provide immutable records, decentralised verification, and automated transaction execution [8], [10], [13], their adoption in construction remains limited [13], [14]. The industry lacks clarity regarding how blockchain attributes can be effectively leveraged to automate payment flows, what enabling technologies are required, and which barriers must be addressed for successful implementation [8], [13], [15]. Accordingly, there is a need for a systematic synthesis of current knowledge to establish how blockchain can contribute to payment automation in construction and to identify the key mechanisms, challenges, and research gaps [8], [13], [14].

This study seeks to systematically examine the role of blockchain technology in enabling payment automation within the construction sector. The specific objectives are:

1. To examine the role of blockchain-enabled smart contracts in automating construction payment processes and assess their effectiveness in reducing disputes and delays.
2. To analyse how enabling technologies such as BIM, IoT, and reality capture can be integrated with blockchain systems to enhance transparency and improve progress verification.
3. To identify blockchain-based financial mechanisms that support improved liquidity and cash flow management in construction projects.
4. To evaluate how blockchain contributes to enhancing supply chain visibility, asset provenance, and payment security within construction projects.
5. To determine the key adoption factors, governance frameworks, and organizational strategies required to overcome barriers to blockchain implementation in construction payment systems.

To address these objectives, the systematic review is guided by the following research questions:

1. How do blockchain-enabled smart contracts influence the automation of construction payment processes, and what effects do they have on reducing disputes and delays?
2. In what ways can enabling technologies such as BIM, IoT, and reality capture be integrated with blockchain systems to enhance transparency and progress verification?
3. What blockchain-based financial mechanisms have been proposed to improve liquidity and cash flow management in construction projects?
4. How does blockchain contribute to enhancing supply chain visibility, asset provenance, and payment security in construction?
5. What adoption factors, governance frameworks, and organizational change strategies are necessary to overcome implementation barriers?

LITERATURE REVIEW

Blockchain technology, characterised by its decentralised, secure, and transparent attributes, holds considerable potential for automating payments within the construction industry. The construction industries marked by complex projects and many players, frequently encounters issues pertaining to trust, transparency, and efficiency in financial dealings. This technology can resolve these concerns by offering a distributed ledger that securely and immutably records and shares data. Permissioned blockchain platforms, such as Hyperledger Fabric, can establish a business connection among project participants, enabling automated financial transactions during the construction process [16]. This connection can improve transparency, security, and oversight of financial transactions, as evidenced by frameworks that integrate Building Information Modelling (BIM) and cost planning data into blockchain systems [16]. Moreover, blockchain's capacity to automate interim payments and oversee contracts via smart contracts can markedly diminish payment delays and conflicts, hence facilitating more efficient project execution [17], [18].

In addition, the application of blockchain in the construction industry encompasses not only payment automation but also many elements of project management and supply chain logistics. The attributes of blockchain, including immutability, security, and transparency can optimise procurement procedures, increase project accountability, and elevate overall efficiency [19], [20]. For instance, blockchain enables real-time monitoring of materials and safe preservation of transaction records in which essential for establishing trust and transparency among stakeholders [21]. Furthermore, blockchain-based smart contracts can automate complex contractual agreements, diminishing the necessity for intermediaries and minimising the likelihood of

disagreements [22]. The integration of blockchain with technologies such as AI and IoT may enhance its functionalities, offering intelligent and secure solutions for the management of construction projects [23]. Notwithstanding these benefits, the use of blockchain within the construction sector remains still emerging, necessitating further research to tackle technological, regulatory, and cultural obstacles [13], [24].

With these considerations in mind, empirical research and case studies have revealed the practical advantages and obstacles associated with the implementation of blockchain in construction. Blockchain-based frameworks for contract management and payment automation have demonstrated potential in mitigating risks associated with cash flow and conflict resolution [17]. Case studies have illustrated blockchain's capacity to enhance supply chain management through improved data sharing, reduced transaction costs, and increased transaction efficiency [25]. Nevertheless, obstacles such as company's hesitance to incur extra expenses, the scarcity of blockchain-based software applications, and the necessity for comprehensive digitalisation initiatives across the industry persist as significant challenges [24]. To address these problems, it is important to establish industry-specific blockchain platforms, improve stakeholder education, and formulate comprehensive regulatory frameworks [13]. The construction industry is increasingly integrating blockchain technology, which is expected to enhance transparency, efficiency, and sustainability, hence revolutionising the management and execution of construction projects [21], [26], [27].

In a nutshell Figure 1 depicts the conceptual framework of blockchain applications for automating payments in the construction industry. The diagram highlights three main domains where blockchain has influence such as data integration, smart contracts, and automation of payments. Data integration emphasizes the interoperability of blockchain with application programs, IoT, legacy systems, and Building Information Modeling (BIM), ensuring seamless information flow across platforms. Smart contracts are linked to Ethereum applications and contract administration, reinforcing efficiency, transparency, and trust in contractual processes. Meanwhile, the automation of payments is linked to regulatory compliance and cash flow management, highlighting blockchain's capacity to enhance financial operations and mitigate payment delays. The image illustrates how blockchain attributes link technological, contractual, and financial aspects to resolve ongoing payment issues in the construction sector.

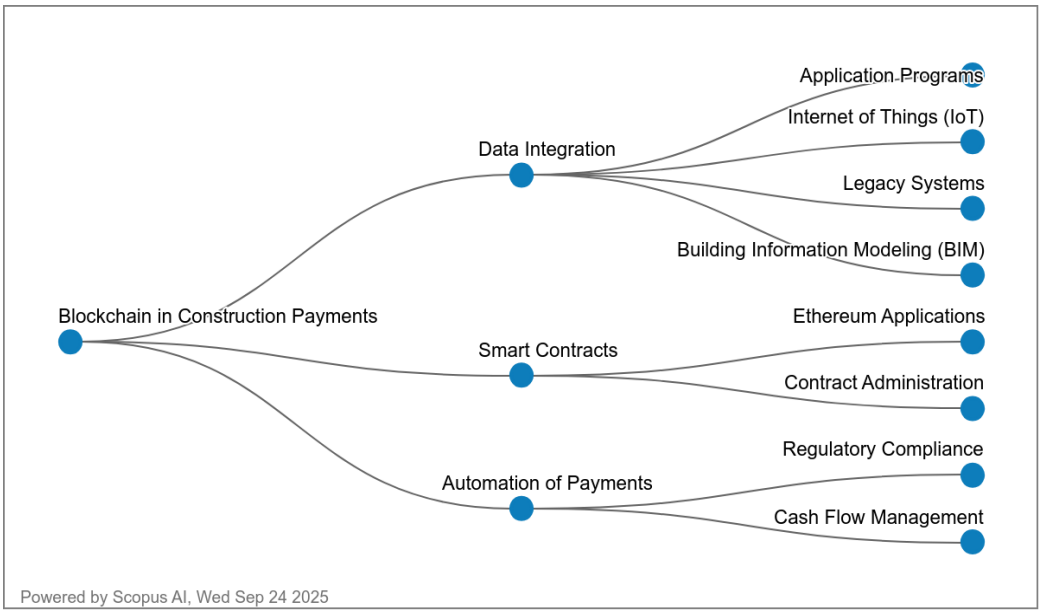

Figure 1 Concept map for the introduction of Exploring the Role of Blockchain Attributes in Automating Payments in the Construction Sector (Source: Powered by Scopus AI, Wed Sep 24 2025)

RESEARCH METHODOLOGY

Research Design

This study adopts a Systematic Literature Review (SLR) approach to synthesise existing research on the application of blockchain technology in automating payment processes within the construction sector. The

SLR method was selected to enable an exhaustive, transparent, and replicable examination of scholarly evidence, consistent with established review protocols. The review adheres to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, ensuring methodological rigour in the identification, screening, eligibility assessment, and final selection of relevant literature. The review focuses on peer-reviewed journal articles to ensure reliability and academic integrity, while excluding non-scholarly sources that may lack methodological robustness.

Screening

Two major academic scientific databases—Scopus and Web of Science (WoS)—were selected as the primary data sources due to their extensive coverage of high-impact and peer-reviewed publications across engineering, construction management, and digital technology domains. The search strategy was developed through iterative refinement of keywords and Boolean operators, informed by preliminary scoping studies and terminology mapping using thesauri and subject indexing references.

The final search strings were constructed to capture studies that simultaneously addressed blockchain, payment processes, and the construction industry. The search terms included variations and synonyms to maximise retrieval sensitivity, as shown in Table 2. The searches were conducted in September 2025, resulting in an initial dataset of 165 records across both databases.

Table 1 Search string

Scopus	(TITLE-ABS-KEY ("Blockchain*" OR "Distributed Ledger*" OR "Blockchain technolog*") AND TITLE-ABS-KEY ("payment*" OR "construction payment*" OR "interim payment*" OR "progress payment*" OR "payment automation*" OR "payment authorization" OR "automated payment*") AND TITLE-ABS-KEY ("construction industr*" OR "construction sector*" OR "construction project*" OR "building construction*" OR "building industr*" OR "architecture, engineering and construction*" OR "AEC"))Date of Access: September 2025
Wos	("Blockchain*" OR "Distributed Ledger*" OR "Blockchain technolog*") AND ("payment*" OR "construction payment*" OR "interim payment*" OR "progress payment*" OR "payment automation*" OR "payment authorization" OR "automated payment*") AND ("construction industr*" OR "construction sector*" OR "construction project*" OR "building construction*" OR "building industr*" OR "architecture, engineering and construction*" OR "AEC") (Topic)Date of Access: September 2025

Screening and Eligibility

The screening phase involved the systematic removal of duplicate entries and the evaluation of remaining records based on relevance to the research objectives. Duplicate elimination reduced the dataset to 93 unique records. These records underwent a title and abstract screening according to predefined inclusion and exclusion criteria:

Table 2 Selection criterion is searching

Criterion	Inclusion	Exclusion
Language	English	Non-English
Manuscript type	Peer-reviewed journal articles	Books, theses, conference papers, reviews, editorials
Research focus	Blockchain applied to construction payment or financial workflows	Blockchain unrelated to construction, or construction research without payment relevance

Following screening, 54 articles proceeded to full-text eligibility review. Full-text examination resulted in the exclusion of 17 records due to lack of relevance, insufficient empirical grounding, or unavailability of full text. A final set of 37 articles was selected for qualitative synthesis. A PRISMA-compliant flow diagram summarising the identification, screening, eligibility, and inclusion stages is presented in Figure 2.

Data Abstraction and Analysis

To derive systematic insights from the selected literature, an integrative thematic synthesis approach was applied. First, a structured data extraction matrix was developed to record key attributes from each study, including research objectives, methodology, technological focus, implementation context, and reported outcomes. This facilitated systematic comparison and categorization.

Second, the extracted data were analysed to detect conceptual patterns, recurring research foci, and thematic linkages across studies. Codes were generated inductively through iterative reading, cross-verification among the research team, and memo-logging to trace interpretive decisions. Through successive refinement, these codes were clustered into five overarching themes representing the core dimensions of blockchain-enabled payment automation in construction:

1. Smart Contracts and Payment Automation
2. Enabling Technologies and Data Integration
3. Financial Mechanisms and Cash Flow Governance
4. Supply Chain Visibility and Asset Provenance
5. Adoption Barriers, Governance, and Knowledge Transfer

The thematic synthesis ensured that findings were not merely aggregated but conceptually interpreted, thus providing meaningful insights into the technological, procedural, and organisational implications of blockchain adoption in construction payment systems.

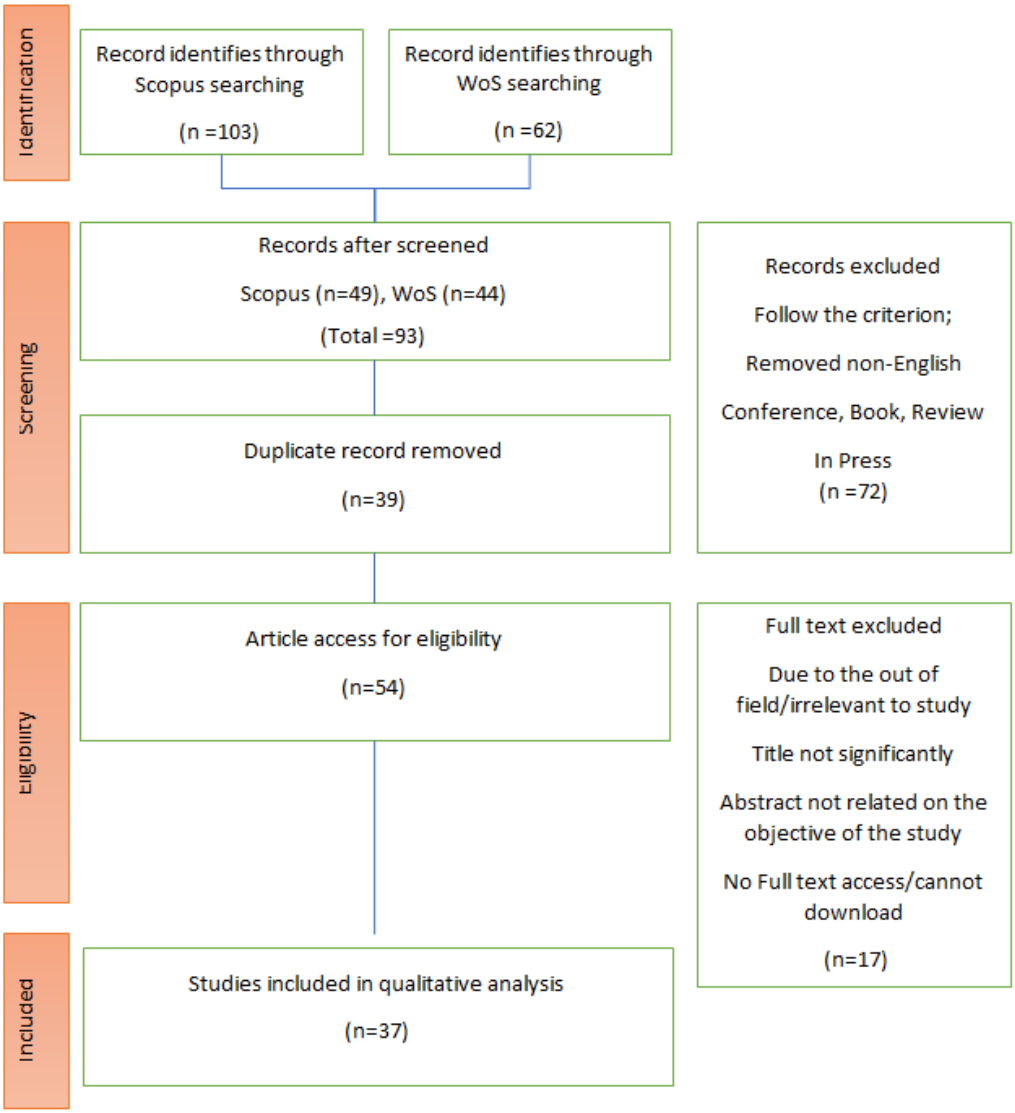

Figure 2 Flow diagram of the proposed searching study

FINDINGS AND DISCUSSIONS

Theme 1: Smart Contracts and Payment Automation

The continuing issue of delayed and disputed payments in the construction sector has prompted researchers to explore blockchain-based smart contracts as a possible solution. Numerous studies emphasise that automation using smart contracts enhances efficiency, precision, and reliability in payment administration. [28] created a model-based system (BCT-SmContract) that demonstrated expedited execution and improved information accuracy, thereby dramatically reducing disputes among stakeholders. Likewise, [29] introduced an extensive blockchain-based solution for lump-sum contracts, mitigating delays and conflicts through the provision of secure and transparent payment records. In addition to these findings, [30] proposed a blockchain-based architecture targeting the payment freezing and disbursement cycle, demonstrating enhancements in the reliability and efficiency of progress payments. Collectively, these findings underscore the significance of blockchain technology in revolutionising payment processes into more reliable and dispute-resistant systems [28], [29], [30].

The integration of blockchain with digital technologies, including BIM and automated data capture, has emerged as a notable study area. [3] presented a scan-to-BIM methodology integrated with blockchain smart contracts, guaranteeing automatic payment disbursement upon the verifiable completion of tasks. [11] presented a payment automation solution that integrated blockchain smart contracts with robotic reality capture, facilitating efficient and transparent cash flow while reducing intermediaries. [7] extended this approach by introducing an integrated BIM-blockchain system (BBS), demonstrating significant efficiency in decentralised progress payments while enhancing transparency and auditability. The cumulative evidence indicates that integrating blockchain with BIM and automation tools establishes a transparent connection between physical advancement and financial transactions, mitigating conventional inefficiencies in certification and payment processes [3], [7], [11].

In addition to that, a prevalent subject in the literature is the significance of decentralisation and transparency in addressing trust and administrative issues in construction payments. [31] presented the SMTSEC system, which ensures safe transactions via a decentralised blockchain protocol, eliminating dependence on costly intermediaries. This aligns with the findings of [4] which indicate that decentralised solutions eliminated reliance on significantly intermediated payment apps, hence enhancing efficiency. [5] reinforced this perspective by introducing BIMcontracts, a blockchain-based framework that enables automated and traceable billing processes, thus enhancing trust among stakeholders. These contributions together demonstrate that decentralised smart contracts improve trust in financial transactions while reducing dependence on conventional financial institutions or administrative intermediaries [4], [5], [31].

Another body of research has investigated smart contracts for complex payment cycles and project-specific constraints. [12] introduced a BIM-integrated smart contract approach to progress payments, which reduced disputes and expedited disbursements, especially in lump-sum projects. [32] furthered this idea by developing a workflow engine for the production and visualisation of smart contracts, thereby improving collaboration and automation in construction business operations. [30] developed a system architecture that addresses payment guarantees and disbursement cycles, highlighting its compliance with existing contractual arrangements while including smart automation. These contributions together emphasise how blockchain-enabled frameworks are being tailored to fit in with the complex reality of construction payment procedures, assuring both practical application and legal compliance [12], [30], [32].

Lastly, numerous studies validate the extensive benefits of blockchain-enabled payment automation in reducing conflicts and improving performance at the project level. [28] exhibited enhancements in the speed and accuracy of contract execution, resulting in a reduction in disputes. [7] claimed enhanced transparency and accountability, especially with financial misconduct and cash flow security. [3] emphasised the advantages of trust-building facilitated by payment automation linked to verifiable construction progress. The findings altogether demonstrate that blockchain-enabled smart contracts represent a transformative innovation, consistently evidencing their capacity to enhance timeliness, accuracy, and fairness in construction payments across diverse contexts [3], [7], [28].

Across the literature, smart contracts consistently emerge as a core mechanism for reducing payment delays, enhancing transparency, and improving trust among contracting parties. Their effectiveness relies on accurate, verifiable progress data, which underscores the importance of integration with BIM and reality capture technologies. Decentralisation reduces dependency on third-party institutions and lowers administrative burdens. While technical feasibility is well established, wider adoption depends on alignment with legal frameworks and industry-standard contracting practices.

Theme 2: Enabling Technologies & Data Integration (BIM, IoT, Reality Capture, Scan)

The construction sector has encountered persistent issues with productivity, inefficiencies, and payment delays, which have caused researchers to investigate blockchain-enabled smart contracts as a viable solution. Numerous studies emphasise the significance of blockchain in promoting safe, traceable, and automated payment systems. [33] highlighted that blockchain adoption can improve productivity by optimising project management payments, procurement, and asset management. Meanwhile, [34] created a framework that integrates blockchain with smart contracts and other advanced technologies to strengthen security of payment (SOP) mechanisms. [5] enhanced this discussion by introducing a blockchain-based smart contract model for automated billing integrated with BIM, which enhances payment traceability and transparency, hence mitigating persistent trust issues in construction contracts. These studies collectively indicate that blockchain establishes a basis for enhanced efficiency and accountability in payment management for construction projects.

The integration of blockchain with digital technologies such as BIM, IoT, and robotic data collection further enhances automation. [35] presented a prototype integrating BIM, IoT, and Blockchain to automate monitoring operations and enable prompt contractor payments via decentralised data management. [11] introduced an autonomous payment system utilising UAVs and UGVs equipped with sensors to monitor construction progress, then integrating this data with blockchain-based smart contracts for automated payments. [12] introduced a BIM-integrated smart contract framework to expedite progress payment processes, mitigate disputes, and enhance cash flow efficiency. These studies collectively illustrate that the integration of blockchain with BIM and IoT technology generates robust systems wherein payment automation is directly linked to accurate, real-time project performance data.

The necessity for accurate, verifiable data to facilitate payment automation has been tackled through novel methods in construction progress monitoring. [3] illustrated the integration of scan-to-BIM technology with blockchain-based smart contracts, employing photogrammetry and 3D modelling to authenticate progress prior to initiating automatic payments. [11] explored robotic sensing and distributed storage systems to authenticate off-chain progress data prior to on-chain payment execution. These approaches emphasise the necessity of integrating off-chain and on-chain realities, wherein tangible construction operations are securely translated into blockchain-based payment triggers. These methods augment trust, reduce disputes, and guarantee the transparent disbursement of funding based on verifiable progress milestones.

In addition to payment automation, blockchain has been explored for its capacity to guarantee material provenance, enhance supply chain transparency, and facilitate compliance management, all of which indirectly influence financial flows. [36] introduced an IoT-blockchain framework for monitoring the provenance of construction materials, enhancing transparency and mitigating fraud in complex supply chains. [37] utilised QR codes in conjunction with blockchain technology to facilitate semi-automated compliance verification and asset tracking, offering immutable transaction records that diminish disputes and foster trust among stakeholders. [38] supported this perspective by presenting a BIM-blockchain system that utilises bitcoin for immediate payments, thereby linking construction advancements with financial transactions without the need for intermediaries. These studies demonstrate that blockchain not only automates financial operations but also enhances governance frameworks within building supply chains.

A major finding in these studies is the agreement that blockchain-enabled smart contracts hold considerable promise for addressing persistent problems of delayed or non-payments, cash flow interruptions, and contractual disputes in construction projects. The frameworks presented by [33], [34], [38] underscore the feasibility of implementing blockchain solutions, whereas research by [3], [35] and [12] highlights the

advantages of incorporating BIM, IoT, and scan-to-BIM technologies for accurate progress validation. Moreover, [36] and [37] enhance the discussion by demonstrating how blockchain applies to supply chain provenance and compliance, which are closely related to secure payment methodologies. Collectively, these studies reinforce the prevailing agreement that blockchain characteristics, including transparency, immutability, automation, and decentralisation, are crucial in enhancing payment automation and mitigating systemic inefficiencies within the construction industry.

The findings show that blockchain's effectiveness in payment automation is highly dependent on the quality and reliability of the data used to trigger transactions. Thus, BIM, IoT, robotics, and scan-to-BIM technologies function as essential enablers rather than supplementary tools. When integrated, they create a continuous, verifiable digital record of work progression. However, integration requires interoperability standards, digital literacy, and organisational readiness, which remain ongoing challenges.

Theme 3: Financial Mechanisms, Cash Flow & Banking (PBAs / Crypto / Financial Admin)

Blockchain technologies show significant potential to enhance cash-flow reliability and payment execution in both offsite and conventional projects. [39], a blockchain-BIM cash-flow management system for offsite construction was proposed, which automates progress payments, accommodates various procurement arrangements, and records transactions immutably; proof-of-concept scenarios demonstrated safe financial transfers without third-party mediation. [40] analysed the hosting of project bank accounts (PBAs) on blockchain and identified four operational advantages: diminished PBA management workload, potential democratisation of PBAs throughout supply chains, significantly expedited setup relative to conventional banking, and enhanced traceability of cash-flow data. [41], a decentralised PBA application was developed that merged segregated procedures, enhanced liquidity management, and provided an open-source, repeatable interface for testing. Combined evidence indicates that blockchain serves as an effective tool for reducing payment friction and enhancing transparency in payment management [39], [40], [41].

Permissioned networks and coded contract functions enable automated financial governance that aligns with collaborative delivery models. [42], an Integrated Project Delivery (IPD) financial framework was developed that incorporated reimbursed costs, profit shares, and cost-saving distributions into smart contract functions, validated through a Hyperledger proof-of-concept, with results emphasising feasibility and user accessibility. [43], the approach was enhanced through the integration of Hyperledger Fabric and chaincode solutions, showcasing secure transaction recording and invocation throughout project phases, while facilitating programmatic rights management during liability periods; case testing validated the system's functionality and scalability. [44] demonstrated the automation of payment terms and significant reductions in human processing time in theoretical circumstances. Collectively, these studies demonstrate that permissioned blockchains and chaincode can facilitate automated financial transactions within project delivery frameworks [42], [43], [44].

The utilisation of crypto assets and tokenised settlement demonstrates the potential for a more integrated connection between product movement and payment settlement. [45] demonstrated through field tests that cryptocurrency assets can enhance the granularity and atomicity of connections between cash and product flows, facilitating payments directly contingent upon product movement, while acknowledging regulatory, security, and volatility risks. [44] illustrated that a programmable cryptocurrency blockchain may establish an autonomous economic ecosystem that safeguards financial transactions and minimises human intervention in payment processing. [39] demonstrated that a blockchain-based cash system for offsite construction can facilitate claims processing and various procurement techniques while maintaining immutable records—attributes that assist in aligning physical-phase evidence with financial settlement. These contributions indicate that crypto-enabled settlements enhance integration between physical and financial supply-chain layers, depending on careful risk management [39], [44], [45].

Other than the above, practical implementation faces governance, legal, and technical challenges despite successful prototypes. [45] identified regulatory ambiguity, security issues, and price volatility as primary hazards associated with token-based settlement and examined solutions for mitigation. [40] warned that the deployment of adoption by the organization necessitates consideration of current workflow integration, stakeholder incentives, and legal compliance, despite blockchain's potential to reduce administrative burdens

for PBAs. [43] underscored the necessity of carefully selecting data storage architecture and endorsement rules to provide scalability, secure endorsements, and role-based controls; the evaluated Hyperledger systems shown viability yet exhibited context-dependence. [39] employed many scenarios to validate functioning, but observed that procurement flexibility and claims management necessitate a robust design. Literature indicates that the validation of technical prototypes should be coupled with governance frameworks, legal compliance, and stakeholder involvement to facilitate wider adoption [39], [40], [43], [45].

Synthesis reveals that blockchain-enabled smart contracts, permissioned ledgers, and token-based settlement constitute a cohesive toolkit for automating construction payments while enhancing traceability and liquidity. The analysed proofs of concept and case-based validations demonstrate quantifiable operational advantages—accelerated setup, reduced manual workload, immutable transaction history, and programmable controls for complex payment logics—while concurrently revealing requirements for regulation, interoperability, and broader empirical testing across various project types. Future research should emphasise cross-organizational pilots, the establishment of standards for the legal recognition of on-chain events, and the performance benchmarking of token-based versus fiat-based settlement approaches [39], [40], [41], [42], [43], [44], [45].

From this, it can be implied that blockchain can strengthen financial governance, liquidity management, and payment traceability through PBAs, permissioned ledgers, and smart contract-based allocation systems. Tokenised settlements further enhance alignment between physical progress and financial flow but require regulatory stability and risk controls. While technical feasibility is demonstrated, industry-wide implementation necessitates legal clarity, financial institutional cooperation, and coordinated governance frameworks.

Theme 4: Supply Chain Visibility, Provenance & Asset Tracking

Blockchain applications for payment arrangements show consistent empirical promise for improving transaction transparency, timeliness, and trust. [46] reported that payment-related blockchain models (for example, project bank accounts) are easier to implement than other blockchain use-cases and offer streamlined, transparent transactions that support trust building. [6] found that expert stakeholders judged blockchain plus smart contracts able to mitigate many persistent payment problems, including partial payments, nonpayment, long payment cycles, retention, and costs of finance. [47] demonstrated through comparative experiments that blockchain solutions increased information completeness and accuracy versus conventional digital practice, with the effect strongest at higher product, trade, and temporal granularity. Together, these findings indicate that blockchain-enabled payment arrangements can reduce information asymmetry and procedural delays that commonly cause payment disputes.

Integration of financial settlement with product-flow evidence is a recurrent theme and shows technical feasibility together with clear limits. [45] documented field cases where token-based payments linked on-chain settlement directly to product flow, improving granularity and atomicity of cash–product integration while flagging regulatory, security, and price-volatility risks. [36] presented a layered IoT–blockchain provenance framework (mainchain/sidechain architecture) and a Hong Kong pilot tracking steel provenance; results pointed to gains in lifecycle traceability and operational transparency but also exposed scalability, regulatory, and information-leakage concerns. [46] emphasized that benefits from payment-focused blockchain models rely on upscaling legacy IT systems and on cultural adaptation across the sector. The combined evidence suggests that conditioning payments on validated physical evidence is viable, yet practical adoption depends on handling legal, technical, and organizational constraints.

Asset-tracking and semi-automation of compliance feed directly into payment automation and conflict reduction. [37] developed a plug-and-play asset-tracking workflow using QR codes, blockchain, and smart contracts that produced semi-automated compliance checks and an immutable record of transactions; prototyping showed reduced non-value activities and potential for fewer conflicts, although procedural security remained necessary. [36] reinforced the importance of IoT-derived provenance footprints to support payment and quality management, showing how sensor data can feed blockchain custody and downstream applications. [6] highlighted that smart contracts deployed across supply chains can codify payment rules and reduce disputes, especially where many short-term suppliers are involved. Collectively, these studies indicate that

coupling tracking data with coded payment rules strengthens enforceability and reduces administrative burden, while acknowledging incomplete automation in complex contexts.

However, practical challenges and research directions focus on governance, scalability, and interoperability. [45] raised concerns about regulatory uncertainty and token-price volatility for crypto-settlements and recommended mitigation strategies. [46] and [6] noted the need for cultural change, sector-scale IT upgrades, and compliance with existing legal frameworks to enable broader uptake. [36] signalled risks of information leakage and called for further work on sidechain privacy and mainchain openness trade-offs. [37] argued that semi-automation is realistic now, but full automation requires additional procedural controls and stakeholder incentives. Future work should prioritize cross-organisational pilots that test legal recognition of on-chain events, standards for data interfaces between IoT/BIM and ledgers, performance benchmarking for token versus fiat settlement, and governance models that align incentives across multi-tier supply chains.

Findings denote that blockchain enhances supply-chain visibility by creating immutable, auditable records linking procurement, delivery, and payment processes. When combined with IoT and digital identification technologies, blockchain improves provenance assurance and reduces disputes. However, practical deployment depends on overcoming interoperability constraints, protecting commercially sensitive data, and developing shared data governance standards across organisations.

Theme 5: Adoption, Governance, Barriers, Knowledge Transfer & Reviews

Research on blockchain and smart contracts for construction payments highlights both the opportunities and challenges associated with technological adoption. One significant barrier lies in the use of cryptocurrencies as payment mechanisms. [48] reported that despite the potential of cryptocurrencies to provide traceable and secure financial transactions, their application in construction supply chains is constrained by volatility, lack of technical expertise, security gaps, and restrictive government regulations. Similarly, [49] identified technical concerns regarding blockchain's integration with centralized systems such as banking software, which further hinders adoption. Complementing these challenges, [50] observed that while blockchain serves as a core driver of Construction 4.0 by offering immutable and traceable data, its diffusion is slowed by the lack of supporting infrastructure and unresolved interoperability issues. Together, these findings indicate that while blockchain has the potential to streamline payment processes, significant technological, regulatory, and systemic barriers remain.

Beyond barriers, studies also emphasize the critical drivers of blockchain-enabled smart contract adoption in construction projects. [51] revealed that factors such as trialability, relative advantage, and compatibility with existing systems significantly influence adoption decisions. These results align with the conclusions of [52], who identified decentralization, contract autonomy, and enhanced dispute resolution as major benefits of adoption, particularly in public–private partnership (PPP) projects. [53] reinforced this perspective by demonstrating that blockchain smart contracts can mitigate power imbalances in construction payment by decentralizing decision-making and building stakeholder confidence. Collectively, these studies establish that the technological characteristics of blockchain and smart contracts particularly transparency, autonomy, and decentralization, form the foundation for broader industry adoption.

The role of blockchain in ensuring fairness, security, and efficiency of interim payments has also been addressed in several works. [54] developed a blockchain-based framework for automating interim payment processes, which ensures selective transparency by allowing sensitive financial data to remain private between parties while publicly sharing general payment records. Similarly, [53] highlighted how smart contracts embedded in blockchain frameworks enable trust-building and mitigate late or non-payments through automatic enforcement. Complementing these studies, [55] conducted a systematic review and argued that blockchain, along with other technologies such as building information modeling and artificial intelligence, serves as an imperative solution for issues related to quality, progress, and payment certifications. These findings collectively illustrate blockchain's ability to create transparent, automated, and enforceable mechanisms for interim and progress payments in construction projects.

Blockchain also facilitates systemic improvements in the efficiency of construction project delivery, particularly when examined through the lens of Construction 4.0. [52] showed that the application of blockchain-enabled smart contracts in PPP projects ensures greater supply chain visibility and prevents contractual misapplications, while [50] underscored its role in enabling trustworthy production relationships, quality traceability, and government regulation. [49] further observed that blockchain enhances data integration across fragmented software systems, while [54] demonstrated that blockchain-based key management strategies ensure confidentiality and authenticity in payment systems. Taken together, these findings suggest that blockchain and smart contracts are not limited to payment functions but extend to broader roles in construction digital transformation, aligning with the values of Construction 4.0.

In summary, the literature indicates that blockchain and smart contracts hold strong potential for addressing long-standing payment issues in construction projects, including delays, disputes, and power imbalances. However, their successful implementation requires overcoming barriers related to technical expertise, interoperability, regulatory acceptance, and infrastructure readiness. Studies by [48], [51], [52], [55], [53], [54], [49], and [50] provide a comprehensive foundation that illustrates both the transformative potential and the practical limitations of blockchain-enabled payment automation in the construction industry.

The literature shows that blockchain adoption extends beyond technical capability and requires cultural, organizational, and regulatory alignment. Successful implementation depends on stakeholder readiness, digital skill development, legal recognition of smart contracts, and collaborative governance structures. Therefore, adoption strategies must be phased, evidence-based, and supported by pilot implementations to build confidence and institutional learning.

CONCLUSION

This study set out to examine how blockchain technology can enable payment automation in the construction sector, addressing long-standing issues such as delayed payments, disputes, fragmented accountability, and inefficiencies in financial workflows. The construction industry continues to rely on manual and intermediary-dependent payment processes that lack transparency and often lead to conflict and mistrust among stakeholders. Motivated by the principles of Construction 4.0, this review explored how blockchain, combined with digital technologies such as BIM, IoT, and reality capture, can support real-time, verifiable, and automated payment execution.

The literature indicates that blockchain-enabled smart contracts play a central role in automating progress payments, improving the traceability of financial records, and reducing reliance on intermediaries. When integrated with accurate progress data captured through BIM, IoT sensors, robotic scanning, and scan-to-BIM workflows smart contracts can ensure that payments are triggered only upon verifiable construction milestones. Additionally, blockchain-based financial mechanisms, including project bank accounts (PBAs), permissioned ledgers, and tokenised settlements, enhance liquidity, transparency, and cash-flow reliability across supply chains. The findings also show that blockchain strengthens supply-chain provenance and asset tracking, although widespread adoption remains constrained by interoperability limitations, regulatory ambiguity, and organisational readiness challenges.

This review contributes to current knowledge by synthesising the technological, financial, and organisational dimensions of blockchain-enabled payment automation and highlighting how integrated digital ecosystems can link physical construction progress with automated financial settlements. However, most existing studies rely on prototypes, simulations, or limited-scale pilot projects, indicating that empirical, real-world implementation evidence remains scarce.

Future research should focus on developing validated implementation frameworks, conducting cross-organisational pilot trials, establishing interoperability and data-governance standards, and examining legal recognition of smart-contract-triggered payments. Expanding studies across different procurement contexts and regional regulatory environments will be essential to support broader industry adoption.

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