Wijesundara, W.M.N.D., Thayaparan, M. and Costa, M.D.D., 2025. Addressing data management challenges in Sri Lankan construction industry through blockchain integration. In: Waidyasekara, K.G.A.S., Jayasena, H.S., Wimalaratne, P.L.I. and Tennakoon, G.A. (eds). *Proceedings of the 13th World Construction Symposium*, 15-16 August 2025, Sri Lanka. pp. 98-111. DOI: https://doi.org/10.31705/WCS.2025.8. Available from: https://ciobwcs.com/papers/

ADDRESSING DATA MANAGEMENT CHALLENGES IN SRI LANKAN CONSTRUCTION INDUSTRY THROUGH BLOCKCHAIN INTEGRATION

W.M.N.D. Wijesundara[1], M. Thayaparan[2] and M.D.D. Costa[3]

ABSTRACT

The construction industry in Sri Lanka continues to face critical data management challenges due to fragmented systems, manual processes, and a lack of interoperability among digital platforms. These inefficiencies lead to delayed decision-making, data duplication, and reduced stakeholder trust. In response, blockchain technology has gained attention as a transformative digital solution capable of enhancing transparency, traceability, and security in construction data workflows. This study first explores the DM challenges in construction and then investigates the potential of integrating BC technology to address these DM challenges within the Sri Lankan construction sector. A mixed-method research approach was employed, comprising 35 quantitative questionnaires and 13 qualitative expert interviews with industry professionals. The findings identified several persistent DM challenges, including poor real-time data access, data ownership ambiguity, and cybersecurity risks, and such challenges were mapped against the core features BC such as decentralisation, immutability, auditability, and smart contracts. While practical deployment was not undertaken, the study presents a conceptual foundation for how BC can enhance construction DM. The research contributes to the broader discourse on digital transformation in construction by offering context-specific insights and strategic recommendations for future adoption of BC in Sri Lankan built environment.

Keywords: *Blockchain; Construction Industry; Data Management; Digital Transformation; Sri Lanka.*

1. INTRODUCTION

The construction industry is widely acknowledged as one of the most data-intensive sectors, relying heavily on consistent, accurate, and timely information exchange across the entire project lifecycle from initial conceptualisation, design, and procurement to construction, handover, and facilities management (Dauda et al., 2024; Tsay et al., 2022). Thus, efficient data management (DM) is essential to ensure that critical information is accessible, accurate, and timely to support planning, execution, monitoring, and control

[1] Undergraduate, Department of Building Economics, University of Moratuwa, Sri Lanka, wijesundarawmnd.20@uom.lk
[2] Professor in Building Economics, Department of Building Economics, University of Moratuwa, Sri Lanka, mthayaparan@uom.lk
[3] PhD Scholar, Faculty of Architecture, Building and Planning, The University of Melbourne, Australia. millaniyaged@student.unimelb.edu.au

of construction activities (Dauda et al., 2024; Antunes & Gonzalez, 2015). However, poorly managed data can result in significant inefficiencies such as delayed decisions, duplicated work, rework, budget overruns, and contractual disputes (Love et al., 2013).

In the context of Sri Lanka, the construction sector continues to rely heavily on fragmented and predominantly manual DM processes (Dilaksha et al., 2024). Although digital tools such as Building Information Modelling (BIM), Enterprise Resource Planning (ERP), and cloud-based storage platforms have been introduced in some projects, these are not uniformly adopted or fully integrated into everyday workflows (Hewavitharana et al., 2025; Mohanaraj et al., 2022). The sector's digital transformation is hindered by technological inertia, inconsistent adoption across departments, lack of skills, and insufficient regulatory and organisational frameworks (Bandara et al., 2024). These issues are compounded by concerns about data ownership, version control, interoperability, and the trustworthiness of shared project information (Turk, 2020). Systemic DM limitations necessitate innovative technological interventions that can address the root causes of inefficiency, fragmentation, and lack of transparency (Nawi et al., 2014). While advanced economies have increasingly adopted integrated digital platforms (Bandara et al., 2024) Sri Lanka's construction industry remains largely reliant on manual documentation, disconnected digital systems, and paper-based approvals. This disparity necessitates a context-sensitive evaluation of blockchain, which may offer different implementation pathways and benefits than in global settings (Elghaish et al., 2023).

Blockchain (BC) technology has recently gained attention as a potential game-changer in this regard. Initially developed for financial transactions, BC is now recognised across industries for its capabilities in ensuring secure, decentralised, and tamper-proof data environments (Perera et al., 2020; Punia et al., 2024; Shishehgarkhaneh et al., 2023). Features such as immutability, consensus verification, cryptographic encryption, and smart contract automation can significantly enhance data reliability, stakeholder trust, and process integrity in construction settings (Dauda et al., 2024; Shojaei, 2019; Nawari & Ravindran, 2019). However, the practical integration of BC into construction DM particularly in developing countries such as Sri Lanka remains underexplored. A critical gap exists in understanding how BC's capabilities can be aligned with local DM challenges, industry constraints, and stakeholder readiness (Perera et al., 2020; Gamage et al., 2024).

Given this context, this paper addresses two research objectives: 1) To identify challenges within current DM systems in Sri Lankan construction sector, 2) To assess the potential of BC technology as a solution to those challenges. This study provides strategic insights for leveraging BC to overcome Sri Lankan construction DM inefficiencies through targeted technological integration.

2. LITERATURE REVIEW

2.1 DATA MANAGEMENT CHALLENGES IN CONSTRUCTION INDUSTRY

The construction industry is a complex, fragmented, and multidisciplinary domain involving various stakeholders such as clients, contractors, consultants, subcontractors, suppliers, and regulatory agencies working across distinct project phases (Nawi et al., 2014). This collaborative environment generates diverse data types such as architectural

plans, structural designs, cost estimates, contracts, and maintenance logs, which must be effectively managed in real time (Yousif et al., 2021).

In recent years, the construction industry has transitioned from manual DM to digital platforms such as BIM, ERP systems, and cloud databases to improve data integration and access (Vararean-Cochisa & Crisan, 2024). However, in developing countries like Sri Lanka, adoption remains inconsistent due to infrastructural limitations, skills gaps, and resistance to change (Jaiswal et al., 2024). While advanced economies such as the UK, Singapore, and China have successfully integrated BC with digital systems, Sri Lanka continues to face low ICT penetration and weak regulatory support (Gamage et al., 2024; Bandara et al., 2024). These disparities affect BC's practical applicability. Despite digital tools' potential to improve productivity and transparency, persistent challenges such as poor interoperability, limited real-time access, cybersecurity risks, and ambiguous data ownership undermine efficient DM (Dauda et al., 2024; Chaganti et al., 2022). These issues highlight the need for secure, decentralised solutions tailored to the local context (Hua et al., 2025).

Table 1 outlines the key DM challenges identified in the literature, which form the basis for assessing BC's potential as a strategic response in addressing such challenges.

Table 1: Key DM challenges in the construction industry

Challenge	Description	Citation
Real-Time Data Access	Disconnected systems delay updates on-site and off-site, resulting in outdated decisions, rework, and project delays.	[1], [3], [11]
Data Sharing and Collaboration	Fragmented stakeholder networks and proprietary data formats hinder smooth collaboration, limiting efficiency in multi-party coordination.	[2], [7], [9], [11]
Data Security and Cyber Threats	Increasing reliance on digital systems exposes projects to phishing, ransomware, and data leaks due to inadequate cybersecurity practices.	[3], [7], [14]
Data Ownership and Responsibility	Ambiguity in contracts regarding who controls or updates data creates accountability gaps and potential legal conflicts.	[2], [3], [7]
Data Quality and Accuracy	Manual entries, lack of validation processes, and poor integration lead to inaccurate data, which affects scheduling, budgeting, and claims.	[3], [4], [7], [13], [9]
Adopting and Implementing Technology	Resistance to change, insufficient digital skills, and unclear ROI slow down the implementation of integrated DM systems.	[8], [12]
Data Collection and Integration	Data is often collected through isolated tools or paper-based methods, leading to inconsistencies and duplication across the lifecycle.	[4], [10], [15]
Cost Management	Disparate data sources and delayed reporting lead to budget overruns, inaccurate estimates, and delayed payments.	[2], [5]
Compliance with Regulations	Without tamper-proof records or audit trails, firms face challenges in meeting regulatory, contractual, and sustainability reporting requirements.	[2], [9], [13]

Challenge	Description	Citation
Interoperability of Systems	Use of non-standard software and platforms causes integration issues, requiring manual data transfers between incompatible systems.	[3], [8]
Version Control and Document Management	Poorly managed document versions result in miscommunication, outdated approvals, and project disputes.	[1], [2], [10], [12]
Training & Skills Gaps	Many professionals lack the skills to adopt emerging digital tools, including BIM and BC, limiting their practical implementation.	[1], [2], [11]

[1]-(Abu-Reishah & Hiyassat, 2021), [2]-(Bhavsar et al., 2018), [3]-(Dauda et al., 2024), [4]-(de Bruijn & Janssen, 2017), [5]-(Halttula et al. 2020), [6]-(Jaiswal et al., 2024), [7]-(Luo, 2022), [8]-(Nawari & Ravindran, 2019), [9]-(Pham et al., 2023), , [10]-Shojaei, 2019 [11]-(Tanga et al., 2021), [12]-(Turk, 2020), [13]-(Vararean-Cochisa & Crisan, 2024), [14]- (Yao & De Soto, 2024), [15]- (Zhang et al., 2017)

The challenges prove persistent and multi-dimensional, cutting across technical, organisational, and cultural domains. The identification of these challenges by academic researchers enables an assessment of how BC can be applied for their resolution.

2.2 POTENTIAL OF BLOCKCHAIN TO ADDRESS DATA MANAGEMENT CHALLENGES

BC, originally conceptualised by Nakamoto (2008) for peer-to-peer financial transactions, has evolved into a versatile digital infrastructure applicable across various sectors. It operates as a decentralised, distributed ledger that records transactions in cryptographically linked blocks. Each block is time-stamped and validated through consensus algorithms, which ensures data integrity, transparency, and immutability (Christidis & Devetsikiotis, 2016). Within the construction industry where project success hinges on real-time, accurate, and trustworthy data exchanges BC offers a set of technological features that directly respond to the sector's persistent DM challenges. The following sub-sections outline how these core features can provide targeted solutions aligned with construction project workflows:

- Decentralisation: BC reduces single points of failure by distributing data storage and validation across a peer-to-peer network. Consensus mechanisms replace central authority, enhancing traceability and system reliability (Karafiloski & Mishev, 2017; Singh et al., 2023; Sood et al., 2024).
- Transparency: BC promotes stakeholder accountability by providing real-time, tamper-evident access to transaction records. This is particularly valuable in public construction projects, reducing corruption and fostering trust (Awaysheh & Klassen, 2010; Perera et al., 2021).
- Performance and scalability: Permissioned platforms like Hyperledger Fabric support high transaction throughput. Smart contracts automate key processes tendering, procurement, payments streamlining construction workflows and reducing delays (Alharby & Van Moorsel, 2017; Bondi, 2000).
- Trust: Built through decentralised consensus, which ensures that no data entry is accepted without validation by a network majority. This process reduces

misinformation, reinforces mutual credibility among project parties, and enhances cooperative decision-making (Tanga et al., 2022).

- Security: Enhanced via cryptographic protocols, such as SHA-256, which protect sensitive project documents from tampering and unauthorised access. Peer-to-peer validation further ensures that only verified entries become part of the immutable record (Sood et al., 2024).
- Immutability: Guarantees that once information is entered into the BC, it cannot be modified without collective agreement. This feature is critical for managing design revisions, procurement logs, and change orders, as it preserves the integrity of historical data (Underwood, 2016; Wu et al., 2019).
- Auditability: Achieved through time-stamped, sequential data blocks that enable easy tracking of activities such as inspection reports, delivery schedules, and contractual milestones. This feature enhances regulatory compliance and internal project governance (Selvanesan & Satanarachchi, 2023; Collinge et al. 2009).

Overall, BC's technological enablers provide a transformative framework for solving critical DM issues in construction, offering improved real-time access, interoperability, security, and stakeholder collaboration.

3. METHODOLOGY

This study adopted a mixed methods design to investigate the potential of BC in addressing DM challenges identified within Sri Lanka's construction industry. As such both structured questionnaires and semi-structured interviews were used to collect quantitative and qualitative data, respectively. Structured questionnaires distributed to 55 professionals, with 35 valid responses were analysed using the Relative Importance Index (RII) method to rank key DM challenges identified using the comprehensive literature review. While the sample size is modest, it is considered adequate for exploratory research in construction studies where respondents are purposefully selected based on their domain knowledge (Vasileiou et al., 2018). Similar studies in Sri Lanka have also employed comparable sample sizes to examine digitalisation in construction (Gamage et al., 2024). A non-probabilistic purposive sampling method was used to ensure participants had experience in digital tools and DM processes. The sample included professionals actively involved in data-driven decision-making, making the responses highly relevant. Additionally, as younger professionals tend to engage more with digital platforms, the selection did not limit based on years of experience. Table 2 presents the experience breakdown and response rates, showing that a majority of respondents had less than five years of experience.

Table 2: Experience and response rate of respondents for the questionnaire

Experience (Years)	Distributed	Valid responses	Response rate (%)
0–5 years	25	20	80%
6–10 years	15	8	53%
11–15 years	10	4	40%
Over 15 years	5	3	60%
Total	55	35	63.64%

To complement the survey findings and add more richness to the identified challenges, 13 expert interviews were conducted using a semi-structured format. The experts included construction professionals familiar with DM processes and IT experts with BC knowledge. The construction professionals have comparatively limited knowledge about BC technology in Sri Lanka, as those technologies are not adopted to the construction. Due to their limited knowledge, they are unable to see the full potential a BC can bring to improve DM challenges. To address this limitation the authors also interviewed IT experts who had provided the technical insights on BC in addressing DM challenges. The researcher has played a key role during the interview in terms of bridging the knowledge gap about BC and DM in construction to both construction and IT experts, respectively. The interviews offered qualitative insights into the feasibility, barriers, and strategic integration of BC in the local context. Manual content analysis was used to analyse the qualitative data. The respondent profile in terms of years of experience and the knowledge / experience on the key areas of the research, i.e., BC, DM, construction are summarised in Table 3.

Table3: Profile of interviewees

Respondent	Total work experience (Years)	Knowledge and Experience on the key areas related of the research
CI1	6+	Construction, BC technology, and DM
CI2	6+	Construction and DM
CI3	9+	PhD in BC for DM in construction
CI4	5-10	Experience in both BC and DM in construction
CI5	5+	BC for Sri Lankan tendering processes
CI6	15+	Construction industry and DM experience, PhD research in BC
CI7	8+	PhD in BC
CI8	6+	Experience in both DM and BC
IT1	7+	Construction-based IT products, BC experience
IT2	5+	Construction data analyst, AI solutions for DM
IT3	7+	BC technology
IT4	3-4	Supply chain BC solutions
IT5	5+	Web-based application development

4. FINDINGS AND DISCUSSION

4.1 CURRENT DATA MANAGEMENT CHALLENGES

The critical DM challenges identified in the literature were contextualised to Sri Lankan construction using both quantitative RII analysis and qualitative content analysis. Table 4 outlines these challenges, combining quantitative rankings with qualitative validation to highlight key problem areas affecting efficiency, accuracy, integration, and decision-making in construction projects in Sri Lanka.

Table 4: Challenges in DM with RII and interview validation

DM Challenge	RII	CI1	CI2	CI3	CI4	CI5	CI6	CI7	CI8	IT1	IT2	IT3	IT4	IT5
Cost Management	0.794	✓	✓	✓		✓	✓	✓	✓				✓	
Data Security and Cyber Threats	0.761			✓	✓						✓			
Version Control and Document Management	0.761		✓											✓
Interoperability of Systems	0.755	✓	✓	✓		✓	✓	✓	✓	✓				
Real-Time Data Access	0.729	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	
Training and Skills Gaps	0.729						✓							
Adopting and Implementing Technology	0.723		✓			✓		✓	✓		✓	✓	✓	✓
Data Collection and Integration	0.716	✓	✓				✓			✓			✓	
Data Quality and Accuracy	0.703	✓	✓	✓	✓			✓	✓	✓		✓	✓	✓
Compliance with Regulations	0.703		✓		✓	✓	✓	✓		✓	✓	✓		
Data Sharing and Collaboration	0.690	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	
Data Ownership and Responsibility	0.684		✓	✓	✓	✓	✓		✓		✓	✓	✓	✓

These findings provide a structured foundation for deeper analysis of each significant challenge which are discussed below.

Among all, the cost management has been ranked as the most significant challenge which was also agreed by the experts to a certain extent. It is a leading challenge due to poor real-time tracking and budget visibility. CI6 stated, *"delays happen because of unclear cost tracking and improper budget allocation."* IT4 noted, *"BC can improve real-time cost updates,"* while CI8 warned that *"high implementation costs may deter smaller firms,"* highlighting both the promise and the barrier of adopting BC solutions.

In close alignment, cybersecurity emerged as another serious concern, where firms are increasingly storing sensitive project data on cloud platforms without adequate safeguards. IT1 stated, *"security breaches are not rare anymore… but most local firms don't have dedicated cybersecurity teams."* These insights reveal critical vulnerabilities that not only threaten data integrity but also expose firms to compliance failures and reputational harm.

Equally critical is the issue of version control and document management, with teams often working on outdated documents, leading to conflicts and added costs. CI2 noted, *"multiple document revisions between systems create chaos,"* while IT1 stated, *"BC enables transparent monitoring of updates,"* ensuring version accuracy. The lack of unified tracking systems poses operational and legal risks across project environments.

Interoperability was also highlighted as a major barrier to digital transformation in the Sri Lankan construction sector. Respondents noted that many existing digital platforms, including BIM and ERP systems, operate in isolation due to a lack of integration standards and APIs. CI6 explained, *"our BIM model can't talk to the procurement system,*

we end up duplicating everything manually." IT3 reinforced this issue, stating, *"without integration tools, digital systems just become digital islands."* These silos lead to inefficiencies in communication, data duplication, and an overall disjointed workflow that slows down collaboration.

Another pressing challenge is real-time data access. In Sri Lankan construction projects, delays in accessing up-to-date information frequently interrupt workflows, delay procurement, and cause billing inconsistencies. Survey findings confirmed this as a major issue.CI3 noted, *"we face major delays because the site team and consultants often work with different versions of data,"* while CI6 added, *"even printing outdated drawings has caused rework."* These inconsistencies not only increase the risk of errors and miscommunication but also lead to duplicated work, claims disputes, and reduced stakeholder confidence in project documentation.

Furthermore, digital literacy and skills gaps emerged as a recurring theme in both survey and interview data. CI2 mentioned, *"we invested in ERP, but staff still rely on Excel. They don't trust the new system."* IT3 reinforced this, stating, *"many project managers are afraid of making mistakes, they avoid digital platforms altogether."* Without structured training and change management, firms struggle to shift from traditional practices to efficient digital workflows.

These findings confirm the complex, interrelated nature of DM challenges in Sri Lanka's construction industry.

4.2 THE POTENTIAL OF BLOCKCHAIN TO ADDRESS DATA MANAGEMENT CHALLENGES

Survey and interview findings show strong optimism for BC in addressing construction DM issues. With 65.9% rating BC as "likely" or "extremely likely" to help, no respondents found it ineffective (Figure 1).

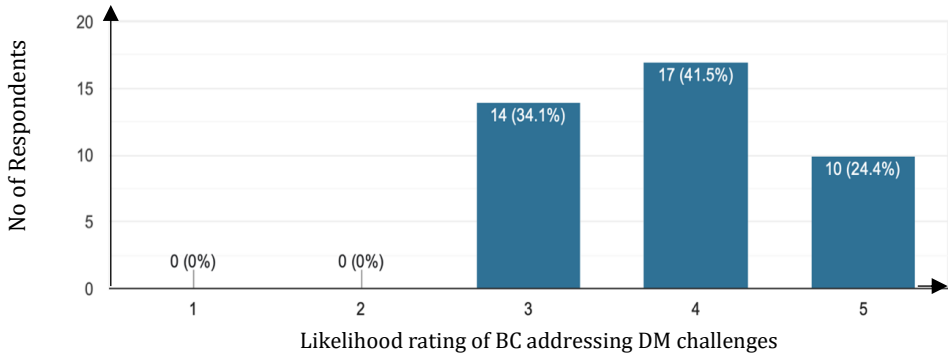

Figure 1: Likelihood rating of BC addressing DM challenges from questionnaire analysis

These findings form the foundation for evaluating specific BC features and their alignment with the critical challenges identified earlier. This subsection further investigates key features of BC such as security, auditability, transparency, decentralisation, performance & scalability, immutability, trust and disintermediation to directly map with construction DM.

To begin with, security was highlighted as a significant challenge, BC can address this through advanced cryptographic protocols, such as SHA-256 and asymmetric encryption,

to authenticate access and detect tampering. IT1 emphasised, *"once a file is in the chain, nobody can alter it without permission. That's the kind of integrity we need for compliance and audits."* CI4 added, *"without real encryption, it's just a data dump, BC gives structure and defense."* These features are critical for safeguarding procurement records, site data, and sensitive communications.

In addition to security, auditability is a core benefit of BC. BC's timestamped entries and full historical traceability support compliance with legal, regulatory, and quality standards. CI7 remarked, *"the audit trail in BC can reduce the effort needed for dispute resolution or compliance reviews."* By maintaining unalterable records of contracts, transactions, and communications, BC offers greater certainty in audits and builds confidence among clients and government agencies.

Closely linked to auditability is transparency, which directly impacts collaboration and accountability. BC allows all participants to trace data origins, monitor alterations, and verify user access through immutable logs. As CI5 noted, *"when people can see exactly who changed what and when, trust builds naturally. BC can offer that."* IT2 echoed, *"visibility builds confidence, when data access is logged, people stop hiding updates."* In collaborative, multi-party environments, BC thus fosters accountability and encourages proactive data sharing and improved coordination.

Equally important is decentralisation, a foundational attribute of BC. Its decentralised nature ensures that data is stored and updated across multiple nodes, allowing all authorised users to access synchronised, real-time information. This feature directly addresses the challenge of outdated or inconsistent data. CI3 explained, *"BC's structure means everyone works off the same real-time ledger, reducing delays caused by outdated files."* CI6 added, *"the data flows immediately once verified; you don't need to chase it across departments."* This systemic improvement enhances workflow continuity, particularly during procurement and billing milestones.

Moreover, BC offers high performance and scalability, especially through API-based interoperability. This capability is crucial in resolving challenges around fragmented software ecosystems. Interoperability issues affect nearly every construction firm surveyed, with disparate tools such as BIM, ERP, and project management software often functioning in isolation. IT5 highlighted, *"with smart contracts, you can link milestones in BIM to payment releases in ERP. It's like getting everything to finally speak the same language."* The flexible architecture of BC allows tailored implementation, making cross-platform automation more achievable than with traditional systems.

When it comes to immutability, BC plays a vital role in addressing version control issues. Once data is entered into the BC, it cannot be altered without consensus, effectively protecting records from unauthorised edits. CI6 commented, *"the immutability of BC means we can trace every step of a design change, every update to a BOQ, without confusion."*

Furthermore, trust is a central factor in any data-sharing environment, and BC enhances this through verifiable, tamper-proof records and transparent workflows. CI5 mentioned that transparency naturally builds trust, while CI2 reflected, *"yes, training is needed, but once teams see the system protecting their input and giving credit, adoption becomes easier."* Trust increases when team members can independently verify data without relying on intermediaries, fostering a sense of ownership and accountability.

Finally, BC facilitates disintermediation by eliminating unnecessary intermediaries in data validation and approvals. This is especially relevant in projects involving multiple tiers of subcontractors and consultants. IT2 and CI6 emphasised that disintermediation not only cuts costs but also enhances transparency and decision-making speed across the value chain.

In summary, BC's unique features directly respond to longstanding challenges in construction DM, offering a structured and secure pathway for digital transformation.

4.3 MAPPING THE BC FEATURES WITH DATA MANAGEMENT CHALLENGES

The Figure 2 visually represents summary of the analysis discussed above about BC features and DM challenges in the construction industry. The color-coded cells indicate the level of endorsement from respondents, showing which BC features are widely recommended, highly rated, strongly agreed upon, or mentioned by the respondents, reinforcing the survey findings that BC can significantly enhance DM in construction projects.

DM Challenges \ BC Feature	Security	Auditability	Transparency	Decentralisation	Performance & Scalability	Immutability	Trust	Disintermediation
Cost Management								
Data Security and Cyber Threats								
Version Control and Document Management								
Interoperability of Systems								
Real-Time Data Access								
Training and Skills Gaps								
Adopting and Implementing Technology								
Data Collection and Integration								
Data Quality and Accuracy								
Compliance with Regulations								
Data Sharing and Collaboration								
Data Ownership and Responsibility								

Minimally recommended- Chosen by 4 or fewer respondents	
Moderately recommended - Chosen by 5–9 respondents	
Mostly recommended - Chosen by 10 or more respondents	

Figure 2: Correlation between BC features and DM challenges in Sri Lankan construction industry

Figure 2 indicates that BC features are contributing to address the DM challenges, though the extent of contribution from each feature varies from challenge to challenge. It is also observable that each DM challenge can be addressed by using at least one of the BC features. This clearly indicates the potential of integrating BC technology to address these DM challenges within the Sri Lankan construction sector.

5. CONCLUSIONS AND RECOMMENDATIONS

This paper explored the DM related challenges in Sri Lankan construction sector and assessed how BC technology could help address key challenges. Findings from both questionnaire survey and expert interviews confirmed most of the critical DM challenges identified in the literature, that include lack of real-time data access, poor system interoperability, cybersecurity risks, and document version inconsistencies. These inefficiencies significantly undermine project performance, collaboration, and trust among stakeholders.

BC technology demonstrates strong potential in mitigating these challenges through its core features such as security, auditability, transparency, decentralisation, performance & scalability, immutability, trust and disintermediation. The study highlighted that BC could ensure synchronised access to real-time data, secure information exchange, and enhance traceability across project phases. It also provides a robust mechanism for document management, reducing version conflicts and ensuring accountability through immutable records.

Although the implementation of BC was not explored in depth, the study concludes that BC is a promising technological intervention with high potential and capability of addressing fundamental DM challenges in the construction industry. Future research should explore real-world pilot projects, implementation strategies, and the regulatory and organisational support needed to operationalise BC solutions within Sri Lankan construction context.

6. REFERENCES

Abu-Reishah, L., & Hiyassat, M. A. (2023). The severity of design-construction interface risks in Jordanian construction industry. *International Journal of Construction Management, 23*(9), 1540–1548. https://doi.org/10.1080/15623599.2021.1983930

Alharby, M., & van Moorsel, A. (2017). Blockchain based smart contracts: A systematic mapping study. In *3rd International Conference on Artificial Intelligence and Soft Computing.* (pp. 125-140). https://doi.org/10.5121/csit.2017.71011

Antunes, R., & Gonzalez, V. (2015). A production model for construction: A theoretical framework. *Buildings,* 5(1), 209–228. https://doi.org/10.3390/buildings5010209

Awaysheh, A., & Klassen, R. D. (2010). The impact of supply chain structure on the use of supplier socially responsible practices. *International Journal of Operations & Production Management,* 30(12), 1246–1268. https://doi.org/10.1108/01443571011094253

Bandara, D., Jayasinghe, J., & Coomasaru, P. (2024). Advancing digital technology adaptation in Sri Lankan construction firms. In Y.G. Sandanayake, K.G.A.S. Waidyasekara, K.A.T.O. Ranadewa, & H. Chandanie (Eds.), *Proceedings of the 12th World Construction Symposium* (pp. 120–131). CIOB. https://doi.org/10.31705/wcs.2024.10

Bhavsar, V., Kadlak, A., & Sharma, S. (2018). Study on phishing attacks. *International Journal of Computer Applications,* 182(33), 27–29. https://doi.org/10.5120/ijca2018918286

Bondi, A. B. (2000). Characteristics of scalability and their impact on performance. In M. Woodside, H. Gomaa & D. Menasce (Eds.), *Proceedings of the 2nd International Workshop on Software and Performance,* (pp. 226-234). Association for Computing Machinery, New York, NY, United States. https://doi.org/10.1145/350391.350432

Chaganti, R., Ravi, V., & Pham, T. D. (2022). Image-based malware representation approach with EfficientNet convolutional neural networks for effective malware classification. *Journal of Information Security and Applications,* 69, 103306. https://doi.org/10.1016/j.jisa.2022.103306

Christidis, K., & Devetsikiotis, M. (2016). Blockchains and smart contracts for the internet of things. *IEEE Access, 4,* 2292–2303. https://doi.org/10.1109/access.2016.2566339

Collinge, W., Harty, C., Liu, K. & Tang, Y. (2009). Improving information sharing across construction stakeholders: An organizational semiotics approach. In *CIB W065 & W055 Joint International Symposium 2009, Dubrovnik, Croatia.* https://www.researchgate.net/publication/265849140

Dauda, J. A., Chavan, N. N., Saka, A. B., Ajayi, S. O., & Oyegoke, A. S. (2024). An appraisal of barriers to digitalisation of construction industry in developing countries: perspective from India. *International Journal of Construction Management, 25*(7), 770–782. https://doi.org/10.1080/15623599.2024.2362014

de Bruijn, H., & Janssen, M. (2017). Building cybersecurity awareness: The need for evidence-based framing strategies. *Government Information Quarterly, 34*(1), 1–7. https://doi.org/10.1016/j.giq.2017.02.007

Dilaksha, S., Ranadewa, K., Weerasooriya, D., Parameswaran, A., & Weerakoon, P. (2024). Comparative analysis of challenges in manual and automated construction progress monitoring in Sri Lanka. In Y.G. Sandanayake, K.G.A.S. Waidyasekara, K.A.T.O. Ranadewa, & H. Chandanie (Eds.), *Proceedings of the 12th World Construction Symposium* (pp. 379–394). CIOB. https://doi.org/10.31705/wcs.2024.30

Elghaish, F., Hosseini, M. R., Kocaturk, T., Arashpour, M., & Ledari, M. B. (2023). Digitalised circular construction supply chain: An integrated BIM-Blockchain solution. *Automation in Construction, 148,* 104746. https://doi.org/10.1016/j.autcon.2023.104746

Gamage, N., Ambagala, A. K. K., Nanayakkara, S., & Perera, S. (2024). Towards a framework for implementing blockchain technology in the construction industry of Sri Lanka. *Built Environment Project and Asset Management.* https://doi.org/10.1108/bepam-12-2023-0222

Halttula, H., Haapasalo, H., & Silvola, R. (2020). Managing data flows in infrastructure projects - The lifecycle process model. *Journal of Information Technology in Construction, 25,* 193–211. https://doi.org/10.36680/j.itcon.2020.012

Hewavitharana, S., Perera, A., Perera, S., Perera, P., & Nanayakkara, S. (2025). Framework for systematic adoption of ERP systems in the Sri Lankan construction industry. *Built Environment Project and Asset Management.* https://doi.org/10.1108/bepam-12-2023-0226

Hua, Y., Kang, M., Yao, H., & Fu, Y. (2025). How to foster project organization resilience in the construction industry: The role of data Governance Capabilities. *Buildings, 15*(8), 1219. https://doi.org/10.3390/buildings15081219

Jaiswal, S. V., Hunt, D. V. L., & Davies, R. J. (2024). Construction 4.0: A systematic review of its application in developing countries. *Applied Sciences, 14*(14), 6197. https://doi.org/10.3390/app14146197

Karafiloski, E., & Mishev, A. (2017). Blockchain solutions for big data challenges: A literature review. In L. Karadzinov, G. Cvetkovski & P. Latkoski (Eds.). *IEEE EUROCON 2017 -17th international conference on smart technologies* (pp. 763-768). IEEE. https://doi.org/10.1109/eurocon.2017.8011213.

Love, P. E., Matthews, J., Simpson, I., Hill, A., & Olatunji, O. A. (2013). A benefits realization management building information modeling framework for asset owners. *Automation in Construction, 37,* 1–10. https://doi.org/10.1016/j.autcon.2013.09.007

Luo, Y. (2022). A general framework of digitization risks in international business. *Journal of International Business Studies, 53*(2), 344–361. https://doi.org/10.1057/s41267-021-00448-9

Mohanaraj, R., Ganeshu, P., & Gowsiga, M. (2022). Enhance the collaborative involvement of stakeholders through cloud-based BIM in the Sri Lankan construction industry. In Y.G. Sandanayake, K.G.A.S. Waidyasekara, K.A.T.O. Ranadewa, & H. Chandanie (Eds.), *10th World Construction Symposium* (pp. 441–453). CIOB. https://doi.org/10.31705/wcs.2022.36

Nakamoto, S. (2008). *Bitcoin: A peer-to-peer electronic cash system.* Bitcoin. https://bitcoin.org/bitcoin.pdf

Nawari, N. O., & Ravindran, S. (2019). Blockchain and the built environment: Potentials and limitations. *Journal of Building Engineering*, *25*, 100832. https://doi.org/10.1016/j.jobe.2019.100832

Nawi, M. N. M., Baluch, N., & Bahauddin, A. Y. (2014). Impact of fragmentation issue in construction industry: An overview. In *MATEC Web of Conferences Building Surveying, Facilities Management and Engineering Conference (BSFMEC 2014).* (pp. 01009). EDP Sciences. https://doi.org/10.1051/matecconf/20141501009

Perera, S., Nanayakkara, S., & Weerasuriya, T. (2021). Blockchain: The next stage of digital procurement in construction. *Academia Letters, 119*. https://doi.org/10.20935/al1119

Perera, S., Nanayakkara, S., Rodrigo, M. N. N., Senaratne, S., & Weinand, R. (2020). Blockchain technology: Is it hype or real in the construction industry? *Journal of Industrial Information Integration, 17,* 100125. https://doi.org/10.1016/j.jii.2020.100125

Pham, H. T., Pham, T., Truong Quang, H., & Dang, C. N. (2023). Supply chain risk management research in construction: A systematic review. *International Journal of Construction Management, 23*(11), 1945–1955. https://doi.org/10.1080/15623599.2022.2029677

Punia, A., Gulia, P., Gill, N. S., Ibeke, E., Iwendi, C., & Shukla, P. K. (2024). A systematic review on blockchain-based access control systems in cloud environment. *Journal of Cloud Computing, 13*. 146. https://doi.org/10.1186/s13677-024-00697-7

Selvanesan, H., & Satanarachchi, N. (2023). Potential for synergetic integration of building information modelling, blockchain and supply chain management in construction industry. *Journal of Information Technology in Construction, 28,* 662–691. https://doi.org/10.36680/j.itcon.2023.035

Shishehgarkhaneh, M. B., Moehler, R. C., & Moradinia, S. F. (2023). Blockchain in the construction industry between 2016 and 2022: A review, bibliometric, and network analysis. *Smart Cities, 6*(2), 819–845. https://doi.org/10.3390/smartcities6020040

Shojaei, A. (2019). Exploring applications of blockchain technology in the construction industry. In D. Ozevin, H. Ataei, M. Modares, A. Gurgun, S. Yazdani, & A. Singh (Eds.), *Proceedings of International Structural Engineering and Construction,* (pp. CON-31). Interdependence between Structural Engineering and Construction Management https://doi.org/10.14455/isec.res.2019.78

Singh, A.K., Kumar, V.R.P., Dehdasht, G., Mohandes, S.R., Manu, P., & Rahimian, F.P. (2023). Investigating the barriers to the adoption of blockchain technology in sustainable construction projects. *Journal of Cleaner Production, 403,* 136840. https://doi.org/10.1016/j.jclepro.2023.136840

Sood, R., Sharma, N., & Laishram, B. (2024). BIM and blockchain integrated construction management: A review. In Y.G. Sandanayake, K.G.A.S. Waidyasekara, K.A.T.O. Ranadewa, & H. Chandanie (Eds.), *10th World Construction Symposium* (pp. 291–305). https://doi.org/10.31705/wcs.2024.23

Tanga, O., Akinradewo, O., Aigbavboa, C., & Thwala, D. (2021). Usage of cloud storage for data management in the built environment. In T.Z. Ahram, W. Karwowski & J. Kalra (Eds.), *Advances in artificial intelligence, software and systems engineering* (pp. 465–471). Springer, Cham. https://doi.org/10.1007/978-3-030-80624-8_58

Tanga, O., Akinradewo, O., Aigbavboa, C., Oke, A., & Adekunle, S. (2022). Data management risks: A bane of construction project performance. *Sustainability, 14*(19). https://doi.org/10.3390/su141912793

Tsay, G. S., Staub-French, S., & Poirier, É. (2022). BIM for facilities management: An investigation into the asset information delivery process and the associated challenges. *Applied Sciences, 12*(19), 9542. https://doi.org/10.3390/app12199542

Turk, Ž. (2020). Interoperability in construction – Mission impossible? *Developments in the Built Environment, 4,* 100018. https://doi.org/10.1016/j.dibe.2020.100018

Underwood, S. (2016). Blockchain beyond bitcoin. *Communications of the ACM, 59*(11), 15–17. https://doi.org/10.1145/2994581

Vararean-Cochisa, D., & Crisan, E. (2024). The digital transformation of the construction industry: A review. *IIM Ranchi Journal of Management Studies, 4*(1). 3-16. https://doi.org/10.1108/irjms-04-2024-0035

Vasileiou, K., Barnett, J., Thorpe, S., & Young, T. (2018). Characterising and justifying sample size sufficiency in interview-based studies: systematic analysis of qualitative health research over a 15-year period. *BMC Medical Research Methodology, 18*. 148. https://doi.org/10.1186/s12874-018-0594-7

Wu, H., Cao, J., Yang, Y., Tung, C. L., Jiang, S., Tang, B., Liu, Y., Wang, X., & Deng, Y. (2019). Data management in supply chain using blockchain: Challenges and a case study. In *Proceedings of the 2019 28th International Conference on Computer Communication and Networks (ICCCN)*.IEEE. https://doi.org/10.1109/ICCCN.2019.8846964

Yao, D., & de Soto, G. (2024). Assessing cyber risks in construction projects: A machine learning-centric approach. *Developments in the Built Environment, 20*. 100570. https://doi.org/10.1016/j.dibe.2024.100570

Yousif, O. S., Zakaria, R. B., Aminudin, E., Yahya, K., Sam, A. R. M., Singaram, L., Munikanan, V., Yahya, M. A., Wahi, N., & Shamsuddin, S. M. (2021). Review of big data integration in construction industry digitalization. *Frontiers in Built Environment, 7*. 770496. https://doi.org/10.3389/fbuil.2021.770496

Zhang, J., Liu, Q., Hu, Z., Lin, J., & Yu, F. (2017). A multi-server information-sharing environment for cross-party collaboration on a private cloud. *Automation in Construction, 81,* 180–195. https://doi.org/10.1016/j.autcon.2017.06.021