Smart Contract Adoption in Sarawak's Construction Industry: A Schematic Review of Drivers, Barriers, and Innovation Attributes

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ABSTRACT

The construction industry in Sarawak is undergoing a gradual digital transformation driven by initiatives such as the Sarawak Digital Economy Strategy and the Integrated Project Monitoring System (iPMS). However, persistent issues—including payment delays, disputes, and inefficient contract management—continue to hinder project performance. Smart contracts, enabled by blockchain technology, offer a promising solution by automating contractual execution, improving transparency, and strengthening accountability. Despite these advantages, adoption in Sarawak remains limited due to regulatory ambiguity, low digital literacy, and inadequate technological infrastructure.

This study investigates the acceptance of smart contracts in Sarawak's construction industry by identifying key drivers, barriers, and innovation attributes influencing adoption. A schematic review methodology was employed, synthesizing peer-reviewed journals, industry reports, and policy documents. The analysis integrates institutional theory (regulative, normative, and cognitive pillars) with diffusion of innovation attributes, including maintainability, reliability, functionality, and usability.

Findings reveal strong regulative support through state-led digitalization policies but highlight critical challenges such as limited stakeholder awareness, resistance to workflow changes, and uneven ICT infrastructure in rural areas. To operationalize adoption, the study recommends a multi-stakeholder, phased implementation roadmap that integrates digital literacy programs, pilot smart contract projects, and regulatory alignment strategies. Comparative benchmarking with other Malaysian and ASEAN regions is suggested to identify best practices and scalability potential.

Future research should explore cost–benefit analyses, cybersecurity concerns, and integration of smart contracts with BIM and iPMS platforms to enable fully digitalized and secure project delivery systems. By aligning with Sarawak's digital economy agenda, smart contracts can strengthen efficiency, accountability, and competitiveness in the state's construction sector.

Keywords: Smart Contracts, Digitalization, Construction 4.0, Contract Management

INTRODUCTION

Sarawak, the largest state in Malaysia located on the island of Borneo, possesses a unique socio-economic and geographical landscape that distinguishes its development trajectory from Peninsular Malaysia. Characterized by vast land areas, diverse topography, and dispersed rural settlements, infrastructure development in Sarawak faces logistical and connectivity challenges that directly influence its construction practices (Department of Statistics Malaysia [DOSM], 2024). The state's construction industry plays a pivotal role in regional growth, contributing significantly to employment and economic output through public infrastructure, housing, and energy projects (Construction Industry Development Board [CIDB], 2023). In recent years, Sarawak's construction sector has experienced modernization efforts aligned with the Sarawak Digital Economy Strategy

2018–2022, emphasizing digital transformation, sustainable practices, and the adoption of innovative technologies such as Building Information Modelling (BIM) to enhance project delivery and governance (Sarawak Multimedia Authority, 2022).

The construction industry in Sarawak has seen increased digital engagement, spurred by the Sarawak Digital Economy Strategy 2018–2022 and subsequent infrastructure modernization initiatives. Government-led digital tools such as the Integrated Project Monitoring System (iPMS) and efforts to increase Building Information Modelling (BIM) adoption reflect a broader push for transparency, efficiency, and accountability in project delivery (Sarawak Multimedia Authority, 2022). The construction sector continues to grapple with traditional issues such as payment delays, disputes, and inefficient contract management, which hinder productivity and project outcomes (CIDB Malaysia, 2023).

Globally, smart contracts have shown potential to address inefficiencies by enhancing trust among partners (Chen, He & Chu, 2022; Vionis & Kotsilieris, 2024), reducing transaction and administrative costs (Zheng et al., 2024; Wang et al., 2023), and minimizing delays in execution (Wahab et al., 2023). In Sarawak, the adoption of smart contracts and blockchain-based solutions is still at a nascent stage. In broader Malaysian context, challenges such as ambiguous regulatory frameworks and limited stakeholder awareness continue to hinder progress (AL-Ashmori et al., 2023). Moreover, local reports highlight the absence of clear policies governing blockchain-related activities in Sarawak, alongside concerns about technological readiness and infrastructure, further constraining widespread adoption (The Borneo Post, 2024; The Borneo Post, 2025).

Sarawak provides a distinctive context for examining smart contract adoption in the construction industry due to its unique geographical dispersion, semi-autonomous governance structure, and evolving digital landscape. As Malaysia's largest state, Sarawak's construction projects often occur across vast rural and semi-urban areas, presenting logistical and communication challenges that hinder efficient contract administration (CIDB Malaysia, 2021). The state's Post-COVID-19 Development Strategy (PCDS) 2030 emphasizes digital transformation and sustainable infrastructure, offering a supportive policy environment for exploring blockchain-based innovations (Sarawak Government, 2021). However, the industry remains dominated by small and medium-sized contractors (SMEs) who face digital readiness gaps and rely heavily on conventional practices (The Borneo Post, 2025). Combined with regulatory ambiguity arising from localized governance and uneven workforce digital literacy (MIPD, 2022; Zainuddin et al., 2023), these factors make Sarawak an ideal case to explore the interplay between innovation drivers, barriers, and attributes influencing smart contract adoption in a developing yet digitally ambitious construction environment.

Therefore, this study presents results on the acceptance of smart contracts within Sarawak's construction industry by exploring stakeholder awareness, identifying key enablers and obstacles, and proposing an implementation framework. Emphasis is placed on local conditions, including geographic dispersion, public sector readiness, and technological capacity, to provide a contextualized analysis of adoption potential.

LITERATURE REVIEW

Smart Contracts are self-executing agreements encoded on blockchain platforms in which are recognized for their ability to automate contract execution (Zheng et al., 2019), eliminate intermediaries, and improve transaction transparency and trust (Xu et al., 2021). Research shows that blockchain-enabled systems can boost supply chain visibility significantly and enhancing completeness compared to traditional methods (Hamledari & Fischer, 2021). These advantages make smart contracts particularly appealing in multiparty construction environments with complexity, delays, and high administrative burdens.

The literature on smart contract adoption in the construction industry underscores the growing intersection between digital innovation, institutional influence, and technological readiness. As blockchain-based smart contracts emerge as a transformative mechanism for automating contractual obligations, researchers have examined their theoretical foundations, drivers, and barriers through various analytical frameworks. Existing studies highlight how institutional pressures, innovation attributes, and regional dynamics jointly shape the trajectory of adoption across different contexts. This section critically reviews prior research to establish the conceptual underpinnings of smart contracts, the institutional and innovation-based factors influencing their adoption, and the regional insights that contextualize their implementation within Malaysia—particularly focusing on Sarawak's distinctive construction environment.

Institutional Pressures, Innovation Attributes, and Smart Contract Adoption

Smart Contract adoption in construction must be understood as the outcome of an interplay between institutional pressures and perceived innovation attributes. Institutional theory posits that organizations respond to regulative, normative, and cognitive pressures that shape legitimacy seeking behaviour and lead to isomorphism across organizational fields (Akena & Mwesigwa, 2023; Westphal, 2024). Institutions are structured around three main pillars which are regulatory, normative, and cultural-cognitive. The pillars together form the foundations for order and legitimacy within organizations. The regulatory pillar encompasses formal rules, laws, and sanctions that guide compliance; the normative pillar involves shared values and norms that define what is appropriate or desirable behaviour; and the cultural-cognitive pillar reflects shared beliefs and meanings that shape how individuals understand and enact institutional practices. These pillars interact to sustain institutional stability and legitimacy across social contexts (Diniz Costa Filho & Rodrigues Oliveira, 2022).

Shang et al. (2024) identify 29 institutional factors that include 15 drivers and 14 significant barriers in which summarized as Table 1.

Table 1: Institutional Drivers and Barriers to Smart Contract Adoption (Adapted from Shang et al. (2024) in Singapore)

Institutional Pillars	**Drivers**	**Barriers**
Regulative	D1: Government grants & initiatives D2: Protection against delayed payments D3: Improved project transparency	B1: Contractual ambiguity & disputes B2: Rigidities in change orders B3: Lack of legal/jurisdictional framework B4: Absence of procedures in standard forms of contract
Normative	D4: Top management support D5: Supply chain partner pressure D6: Competitor pressure D7: Client pressure	B5: Lack of client demand/market acceptance B6: Change-averse top management B7: Threats to legitimacy & compliance B8: Reluctance to alter workflows B9: Reluctance to change technical systems
Cognitive	D8: Compatibility with existing infrastructures D9: Availability of training programs D10: Enhanced contractual coordination D11: Enhanced efficiency D12: Enhanced traceability & integrity D13: Enhanced collaboration & trust D14: Enhanced process consistency D15: Delegation to middle managers	B10: Low learning capacity B11: Immaturity of smart-contract technology B12: Interoperability & scalability challenges B13: Perceived performance risks B14: Job security concerns (not significant) B15: Unclear value/low perceived usefulness

The evaluation of innovation attributes provides a complementary micro-level lens for understanding adoption intent. Everet Rogers' diffusion model highlights attributes such as relative advantage, compatibility, complexity, trialability and observability as key predictors of adoption. Empirical and theoretical work in blockchain and Smart Contract domains shows that these attributes remain central: expected efficiency and cost gains (relative advantage) and compatibility with existing workflows are consistently strong predictors of managerial willingness to experiment with blockchain-based contracting (Weerapperuma et al., 2025).

Weerapperuma et al., (2025) extend Rogers' core attributes (Rogers, 2003) by operationalizing nine perceived innovation attributes (the five (5) classic attributes adding maintainability, reliability, functionality, and usability), providing a richer diagnostic instrument tailored to construction informatics. The extension is theoretically warranted in high-reliability industries: construction projects demand high degrees of auditability, recoverability, and contractual maintainability.

Table 2 explains the extended nine (9) perceived innovation attributes which includes 32 items provide a robust diagnostic lens to assess organizational intent and readiness. They illuminate how adoption is mediated not only by technical performance but also by institutional trust, professional values, and perceived risk.

Table 2: Perceived Innovation Attributes (Adapted from Weerapperuma et al., 2025)

Attribute	Description	Measurement Items		Effect/Perception
Perceive Relative (PR) Advantage	Captured by perceptions of efficiency, cost savings, and reputational gains, highlighting that firms weigh both economic and symbolic benefits	PR1: PR2: PR3:	Increase efficiency and effectiveness Aids to economic gains Increase social prestige	Positive Positive Positive
Perceived Compatibility (PC)	Assessed in relation to organizational culture, technical environment, and strategic alignment, underscoring the importance of fit with prevailing practices and infrastructures	PC1: PC2: PC3:	Organization's value, experiences, work, practices and norms Existing operating environment (hardware and software) Organizational need	Positive Positive Positive
Perceived Non-Complexity (PNC)	Defined through the absence of steep skill requirements, cognitive load, or interpretive difficulty, reflecting the cognitive ease with which smart contracts can be understood and applied	PNC1: PNC2: PNC3:	Do not required greater technical skills Do not require extra effort in thinking Easy to understand and reach up consensus	Positive Positive Positive
Perceived Trialability (PT)	Emphasizing opportunities to experiment, reduce risk, and build confidence before full-scale deployment	PT1: PT2: PT3:	Allow checking to suit to the existing individuals' knowledge level Reduces perceived risks Able to try out for future adoption	Positive Positive Positive
Perceived Observability (PO)	Gauged through evidence of adoption in peer industries, visibility of positive	PO1: PO2: PO3:	Other industry using the same technology Other industries have positive consequences	Positive Positive Positive

Attribute	Description	Measurement Items		Effect/Perception
	outcomes, and the ability to evaluate impacts		Positive effects	
Perceived Maintainability (PM)	Concerned with the ease of modifying, scaling, and sustaining systems, and the resource requirements of ongoing maintenance	PM1: PM2: PM3: PM4: PM5:	Difficult to modify Maintains the uniformity of contract management Arises portability issues Arises scalability issues Requires frequent maintenance routings	Negative Positive Negative Negative Negative
Perceived Reliability (PR)	Incorporating accountability, auditability, data protection, accessibility, and resilience, reflecting the trustworthiness needed in contractual automation	PE1: PE2: PE3: PE4: PE5: PE6:	Ensure accountability Enhance the auditability Encourage disintermediation and fraud-resistant Protects confidentiality of the data Arises recoverability issues Ensure the permitted accessibility	Positive Positive Positive Positive Negative Positive
Perceived Functionality (PF)	Considering effectiveness, interoperability, system overlap, and customization, aligning with the practical realities of integrating smart contracts into complex project environments	PF1: PF2: PF3: PF4:	Maintains the effectiveness throughout the process Arises interoperability issues Occurs overlapping with existing systems Difficult to customize	Positive Negative Negative Negative
Perceived Usability (PU)	Capturing human factors such as learning curve and resource intensity (e.g., energy consumption), which influence acceptance by end-users	PU1: PU2:	Emerges a steep learning curve Consumes large amount of energy	Negative Negative

By juxtaposing the institutional drivers and barriers with the innovation attributes and measurement items, it becomes clear that Smart Contract adoption in construction is multi-dimensional. Institutional factors dictate the external legitimacy and internal alignment necessary for adoption, while innovation attributes and their operational metrics explain how individuals and organizations evaluate the perceived benefits, risks and usability of the technology. Together, these frameworks provide a comprehensive map for understanding, measuring, and facilitating the transition toward digital contracting in construction.

Smart Contract Adoption in Malaysian Construction: Regional Insights and Challenges

Within the Malaysian construction context, Bolhassan et al. (2022) highlight that the implementation of Smart Contracts holds notable promise in enhancing project delivery mechanisms. Specifically, the technology facilitates improved risk apportionment through the automated execution of predefined contractual obligations, thereby reducing ambiguity in responsibility allocation between stakeholders. Moreover, the use of blockchain-backed agreements is argued to accelerate dispute resolution by eliminating reliance on lengthy adjudication or arbitration processes, given that performance outcomes are transparently recorded and verified in real time (Gabuthy, 2023; Cong & He, 2019). Despite these advantages, significant challenges remain. (Andesta et al.,

2019) emphasize that the immutability of Smart Contracts in which while ensuring reliability, it can also be problematic, as errors in coding are irreversible once deployed on the blockchain. This exposes projects to risks of operational inefficiency or unintended liabilities stemming from human error in contract programming, an issue also echoed in global construction studies where contract adaptability and legal enforceability are still under debate (Agapiou, 2023).

Empirical findings from Klang Valley further contextualize these theoretical propositions. Ng et al., (2023), in their quantitative investigation of adoption drivers, revealed that time management emerged as the most significant predictor influencing practitioners' willingness to adopt smart contracts in construction projects. This finding underscores the pressing concern within Malaysia's fast-paced urban construction sector, where timely project completion is directly tied to cost efficiency and client satisfaction (CIDB Malaysia, 2020). Interestingly, factors traditionally associated with contractual inefficiencies such as dispute frequency, administrative cost, and late payment that were not found to be statistically significant predictors of adoption in this region. Such results suggest that the determinants of Smart Contract adoption may be highly context-specific, shaped by the local industry environment and project delivery priorities. In Klang Valley, where construction schedules are often compressed due to rapid urban development and market demands, time-related benefits appear to outweigh other considerations (Shang et al., 2024).

Taken together, these studies indicate that while Smart Contracts theoretically offer wide-ranging benefits in risk management and dispute resolution, their practical uptake in Malaysia is nuanced. The emphasis on time management as a critical adoption driver signals the need for policymakers and industry stakeholders to design implementation frameworks that foreground efficiency gains, while simultaneously addressing technical barriers such as coding errors and system rigidity. These insights provide valuable groundwork for developing regionally tailored strategies to foster smart contract integration in Malaysia's construction industry.

Bridging the Gap: Smart Contract Adoption in the Sarawak Construction Industry

The discourse on smart contract adoption in the Malaysian construction industry has gained momentum in since 2020 with Sarawak providing a distinctive case due to its geographical, logistical, and institutional characteristics. Smart contracts, powered by blockchain technology, are recognized for their potential to automate contractual execution, reduce reliance on intermediaries, and enhance transparency in project delivery (Rathnayake et al., 2022). These benefits align with the challenges faced in Sarawak, where construction projects are often dispersed across remote and rural areas, compounding issues of contract administration, payment delays, and dispute resolution (Bamgbade et al., 2024).

Empirical studies within Malaysia highlight promising pathways for smart contract integration. Bolhassan et al. (2022), drawing on research partly anchored at Swinburne University of Technology Sarawak, proposed a conceptual framework for adoption, emphasizing digital readiness, organizational support, and regulatory alignment. Similarly, Jalong (2021) revealed that G7 contractors in Sarawak, representing the highest registration grade under Malaysia's Construction Industry Development Board (CIDB) classification, which allows them to undertake projects of unlimited value, acknowledged the opportunities of digital and automated construction technologies, though their perceptions also indicated persistent hesitancy due to skill shortages and low awareness.

From a supply chain perspective, blockchain-enabled smart contracts to have been suggested as mechanisms to address security of payment and accountability issues within Sarawak's construction industry. Bamgbade et al. (2024) found that East Malaysian contractors, including those in Sarawak, recognized the potential of such technologies in mitigating disputes and ensuring payment certainty. This echoes broader studies that stress the value of smart contracts for streamlining procurement and strengthening trust among stakeholders (Mong et al., 2024).

The Sarawak context is further shaped by state-level initiatives to promote digital transformation. The Kenyalang Smart City project and related infrastructure programs illustrate policy interest in leveraging advanced technologies to improve governance and service delivery (UKAS, 2025). While these initiatives are not

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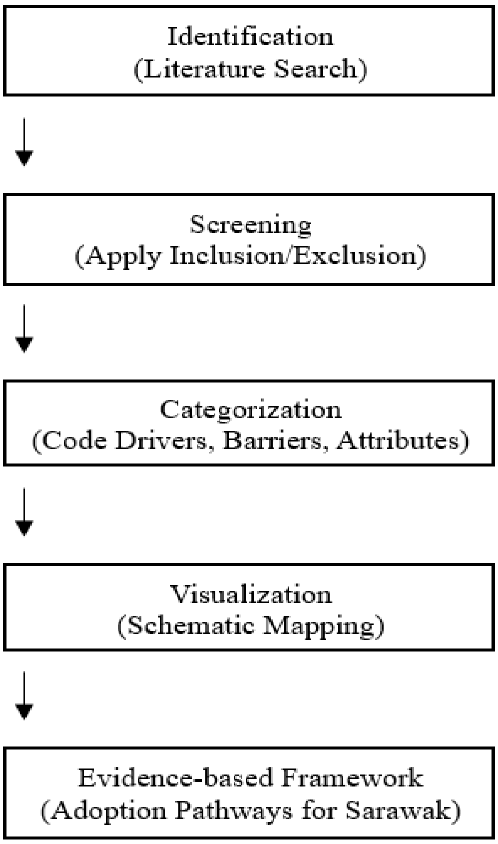
construction-specific, they provide an enabling digital ecosystem that could facilitate the integration of blockchain-based contracts into the built environment sector.

Taken together, these insights suggest that while the theoretical advantages of smart contracts—automation, transparency, and efficiency are well documented, their uptake in Sarawak remains emergent. The intersection of geographical challenges, workforce digital readiness, and institutional frameworks requires a regionally tailored strategy to enable smart contract adoption and realize their benefits in construction project delivery.

METHODOLOGY

Figure 1: Schematic Review Methodology Flow Diagram



Source: Author (2025)

Research Design

This study adopts a schematic review methodology to systematically map, analyse, and synthesise existing literature on smart contract adoption within the construction industry, with specific emphasis on Sarawak. A schematic review employs a structured process of identification, screening, categorisation, and visual mapping of evidence to ensure transparency and replicability (Wolffe et al., 2020). This approach is particularly suitable for emerging fields such as blockchain-based smart contracts in construction, where fragmented research spans across technical, legal, and institutional domains (Hamledari & Fischer, 2021; Shang et al., 2024).

Data Sources and Search Strategy

Relevant literature was identified through a comprehensive search of peer-reviewed journals, conference proceedings, industry reports, and government publications. Databases such as Scopus, Web of Science, ScienceDirect, and Google Scholar were used, alongside policy documents from CIDB Malaysia, Sarawak Multimedia Authority, and the Ministry of Infrastructure and Port Development Sarawak. Keywords combined terms such as "smart contracts", "blockchain", "construction industry", "digitalisation in Sarawak", and "Malaysia".

Inclusion and Exclusion Criteria

Studies were included if:

1. Examined smart contracts or blockchain applications in construction.
2. Addressed institutional, technological, or organisational factors influencing adoption.
3. Focused on Malaysia or comparable regional contexts.

Exclusion criteria included publications with no relevance to construction, purely technical blockchain studies without contractual application, and papers lacking empirical or conceptual insights.

Analytical Framework

The schematic review integrates two complementary lenses:

1. Institutional Theory: regulative, normative, cognitive pillars) to identify external and internal pressures driving or hindering adoption.
2. Innovation Diffusion Attributes: relative advantage, compatibility, complexity, trialability, observability, and extended constructs, to assess how organisations evaluate and respond to smart contract technology.

Extracted findings were categorised according to the frameworks and synthesised into schematic tables and diagrams. This enabled cross-comparison between drivers, barriers, and innovation attributes in Sarawak's construction context.

Schematic Mapping Process

The review process followed four (4) stages adapted from systematic review methodologies by Turnbull et al., (2023)

1. Identification – Compilation of relevant literature and policy documents.
2. Screening – Application of inclusion/exclusion criteria.
3. Categorisation – Coding of findings into institutional drivers/barriers and innovation attributes.
4. Visualisation – Development of schematic tables and diagrams summarising opportunities, challenges, and adoption pathways.

Expected Contribution

By employing a schematic review, this methodology ensures a structured synthesis of fragmented knowledge while highlighting contextual differences between Sarawak and other regions. The output serves as a foundation for constructing an implementation framework that is both evidence-based and regionally tailored (Abdullah et al., 2022).

FINDINGS AND DISCUSSION

Institutional Drivers of Smart Contract Adoption

The analysis highlights that regulative pressures are the most significant drivers in Sarawak's construction industry. Initiatives such as the Sarawak Digital Economy Blueprint 2030 and the iPMS demonstrate strong government commitment to digitalization, creating a favorable regulatory environment for innovation (Sarawak Multimedia Authority [SMA], 2021; Economic Planning Unit Sarawak, 2022). Normative drivers, including client expectations for transparency and efficiency, are gradually emerging, particularly in urban areas such as Kuching (Bolhassan et al., 2022). Empirical work points to low awareness and resistance among contractors and industry customers as important constraints to adoption (Bolhassan et al., 2022; Kumar Singh et al., 2023).

Institutional Barriers to Adoption

Despite policy support, barriers remain considerable. Regulatory ambiguity, particularly the absence of legal frameworks defining blockchain-based contract enforceability, was highlighted as a key concern (Agapiou, 2023). Normative barriers include entrenched manual practices, resistance to altering workflows, and limited client demand (Ng et al., 2023). Cognitive challenges such as low digital literacy, insufficient training opportunities, and skill shortages—especially among SMEs in rural Sarawak—further restrict adoption (Bamgbade et al., 2024). Additionally, inadequate ICT infrastructure in remote project sites remains a fundamental obstacle (CIDB Malaysia, 2021; MIPD, 2022).

Innovation Attributes Influencing Adoption

When examined through Rogers' diffusion of innovation framework and the extended constructs of Weerapperuma et al. (2025), smart contracts reveal both potential and challenges. Relative advantage is evident in efficiency gains, cost reduction, and improved payment security (Zheng et al., 2019; Xu et al., 2021). However, compatibility is mixed; while smart contracts support transparency and accountability, they conflict with entrenched manual processes (Shang et al., 2024). Complexity and a steep learning curve pose adoption challenges, while trialability and observability remain low due to the absence of regional pilot projects (Weerapperuma et al., 2025).

Regional Context of Sarawak

Sarawak's geographical dispersion and reliance on rural and semi-urban project delivery create a unique adoption context. Unlike Klang Valley, where time management was found to be the strongest adoption driver (Ng et al., 2023), in Sarawak the key barriers are related to digital readiness and infrastructure gaps. While G7 contractors in Kuching demonstrate higher levels of awareness and interest in blockchain-enabled solutions, smaller contractors in rural regions show limited exposure (Jalong, 2021; Bamgbade et al., 2024). These findings indicate that adoption in Sarawak is highly context-specific and requires regionally sensitive strategies.

Implications for Implementation Framework

The findings suggest that smart contract adoption in Sarawak should follow a phased and context-specific pathway. Pilot projects in urban centers can demonstrate feasibility and address concerns of trialability and observability (Bolhassan et al., 2022). Regulatory clarity, developed in collaboration with CIDB Malaysia and legal institutions, is essential to build trust (Agapiou, 2023). Workforce training and digital capacity-building initiatives are necessary to address normative and cognitive barriers (Rahim et al., 2022; Bamgbade et al., 2024). Finally, targeted investment in ICT infrastructure is vital to ensure that contractors in rural Sarawak are not excluded from the digital transition (CIDB Malaysia, 2021; SMA, 2021).

A summary of the findings and their implications is presented in Table 3.

Table 3: Summary of Findings and Implications for Smart Contract Adoption in Sarawak

Dimension	Key Findings	Implications
Institutional Drivers	• Strong regulative support from government digital initiatives (Digital Economy Blueprint 2030, iPMS). • Emerging normative drivers from client expectations and competitive pressures. • Cognitive drivers include trust, efficiency, and collaboration benefits.	• Leverage government policies to anchor adoption. • Promote awareness campaigns targeting clients and contractors. • Highlight trust and transparency benefits to strengthen industry acceptance.
Institutional Barriers	• Regulatory ambiguity on enforceability of blockchain contracts. • Resistance to workflow changes and entrenched manual practices.	• Develop regulatory frameworks and standard contract procedures. • Provide training and capacity-building programs.

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Dimension	Key Findings	Implications
	• Low digital literacy, limited training, and skill shortages. • Poor ICT infrastructure in rural areas.	• Invest in ICT infrastructure for rural construction sites.
Innovation Context	• Clear relative advantage in cost, efficiency, and payment security. • Compatibility is mixed: aligns with transparency goals but clashes with manual norms. • High complexity and steep learning curve. • Low trialability and observability due to lack of pilots. • Concerning maintainability, interoperability, and coding immutability.	• Demonstrate feasibility through pilot projects in urban centres (e.g., Kuching). • Simplify user interfaces and provide technical support. • Establish interoperability standards with existing systems. • Encourage industry-academic collaborations to test prototypes.
Regional Context	• Sarawak's geography (remote, dispersed projects) complicates adoption. • Urban contractors (G7) show higher awareness; rural SMEs lag. • Digital readiness is uneven compared to Peninsular Malaysia.	• Tailor adoption strategies to contractor size and location. • Focus initial rollouts in urban centers while planning rural digital inclusion. • Align with Sarawak's broader digital economy initiatives.
Implementation Framework	• Adoption requires phased, context-specific strategies. • Pilot projects are essential for visibility and risk reduction. • Regulatory clarity and training are prerequisites. • Rural infrastructure investment is critical for equitable adoption.	• Co-develop adoption roadmap with government, CIDB, and industry. Institutionalize training within CIDB certification. Promote public–private partnerships for ICT upgrades. Monitor pilot outcomes to refine large-scale implementation.

CONCLUSION

This study explored the acceptance of smart contracts in the Sarawak construction industry using a schematic review approach that synthesized institutional theory and innovation diffusion attributes. The findings reveal that Sarawak benefits from strong regulative support through government-led initiatives such as the Digital Economy Blueprint 2030 and the Integrated Project Monitoring System, which create a favorable environment for digitalization. However, the uptake of blockchain-enabled smart contracts remains limited due to regulatory ambiguity, entrenched manual practices, low digital literacy, skill shortages, and inadequate ICT infrastructure, particularly in rural areas.

Smart contracts demonstrate clear potential in delivering efficiency gains, transparency, and improved payment security, yet their adoption is constrained by low trialability and observability, as few pilot projects have been attempted in the state. Compared to urbanized regions such as Klang Valley, where time management has emerged as the dominant driver, Sarawak's adoption context is shaped by geographical dispersion, uneven digital readiness, and institutional capacity gaps. These findings highlight the need for a regionally tailored strategy to enable smart contract integration that aligns with Sarawak's socio-technical realities.

RECOMMENDATIONS

Based on the schematic review findings, the following recommendations are proposed to facilitate the structured and sustainable adoption of smart contracts within Sarawak's construction industry. The implementation should be both phased and multi-stakeholder-oriented, aligning with the state's ongoing digital transformation agenda.

A multi-stakeholder implementation roadmap is essential to operationalize smart contract integration. Collaboration among government agencies (such as the Sarawak Multimedia Authority [SMA] and CIDB Malaysia), contractors, consultants, professional bodies, and technology vendors should be prioritized to ensure comprehensive readiness and governance. This roadmap may proceed through three interconnected phases:

Phase 1 – Digital Literacy and Capacity Building:

Establish continuous professional development and certification programs that enhance digital literacy, technical competency, and regulatory understanding among construction stakeholders. Awareness campaigns should target both public and private sector actors to encourage digital adoption and dispel misconceptions surrounding blockchain technologies.

Phase 2 – Pilot Smart Contract Projects:

Implement pilot projects within major urban centers such as Kuching, focusing on public infrastructure initiatives under the Post-COVID-19 Development Strategy (PCDS) 2030. These pilots should evaluate the technical feasibility, interoperability with existing systems, and the extent of administrative efficiency achieved. Outcomes from pilot projects will provide empirical evidence to address trialability and observability concerns identified in this study.

Phase 3 – Regulatory and Policy Integration:

Develop clear and enforceable regulatory frameworks defining the legal validity, contractual enforceability, and data governance mechanisms of blockchain-based contracts. These should be formulated in collaboration with legal authorities, industry regulators, and professional institutions to ensure standardization and compliance with Malaysia's digital economy policies.

To strengthen scalability and policy benchmarking, Sarawak's readiness should be compared with other Malaysian or ASEAN regions such as Klang Valley, Singapore, and Indonesia, where digital contracting and blockchain adoption are more advanced. Such comparative analysis would highlight best practices, inform policy harmonization, and identify regional scalability opportunities for Construction 4.0 transformation.

In summary, successful implementation of smart contracts in Sarawak's construction sector requires an integrated approach that combines capacity building, pilot testing, regulatory alignment, and regional benchmarking. This phased, evidence-based strategy will enhance trust, transparency, and accountability, positioning Sarawak as a leader in blockchain-enabled construction governance.

Future Research

While this study offers a comprehensive synthesis of institutional drivers, barriers, and innovation attributes influencing smart contract adoption in Sarawak, several research directions remain open for exploration.

First, future empirical studies should validate the schematic framework proposed in this paper using quantitative or mixed-method approaches. Structural equation modelling (SEM) or regression-based analyses could be applied to examine the relationships among institutional pressures, innovation attributes, and adoption intent across different contractor categories. Such evidence would provide stronger policy insights for tailoring adoption frameworks to local industry conditions.

Second, cost–benefit analyses are needed to evaluate the economic feasibility of implementing smart contracts across varying project scales. These studies should quantify operational savings, risk reductions, and administrative efficiency gains compared to traditional contracting systems, thereby providing a business case for widespread adoption. Parallel to this, cybersecurity concerns—including data privacy, access control, and vulnerability to hacking or contract manipulation—should be systematically assessed to establish institutional trust and safeguard digital infrastructure.

Third, future work should examine the integration of smart contracts with existing digital platforms, particularly Building Information Modelling (BIM) and the Integrated Project Monitoring System (iPMS) used by the Sarawak government. Exploring these synergies would provide insights into achieving real-time automation, seamless data exchange, and improved project governance under a unified Construction 4.0 ecosystem.

Lastly, comparative and longitudinal studies between Sarawak and other regions—both within Malaysia and across ASEAN—should be conducted to assess contextual differences in policy readiness, digital maturity, and stakeholder engagement. Such research would contribute to developing regionally adaptive models of digital contracting and inform scalable implementation strategies.

Collectively, these future research pathways will enrich both theoretical and practical understanding of blockchain-enabled construction, guiding Sarawak and similar jurisdictions toward sustainable, secure, and interoperable smart contract ecosystems.

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