Exploring the Challenges and Impacts of Blockchain Technology in Malaysian Supply Chain Management

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ABSTRACT

Blockchain technology has gained increasing attention in supply chain management (SCM) due to its potential to enhance transparency, traceability, and trust among stakeholders. This study explores the challenges and impacts of blockchain implementation within Malaysian supply chains, addressing the limited understanding of its practical adoption. Despite global recognition of blockchain's benefits, its uptake in Malaysia remains low, primarily due to technical, financial, and managerial barriers. A significant issue identifies is the needs of skilled professionals capable of handling blockchain systems effectively, as highlighted by the National Blockchain Roadmap 2021 – 2025 (Ministry of Science, Technology and Innovation, 2022), which reported that 56% of organizations cite inadequate in-house capabilities as a key constraint. To achieve the research objectives, (1) identifying challenges and (2) examining impacts of blockchain in supply chain management, an exploratory qualitative design was adopted using semi-structured online interviews with three industry practitioners. Data were analyzed using thematic analysis to uncover themes and codes. The findings revealed that while blockchain enhances operational efficiency, data integrity, and collaboration, its implementation is hindered by limited expertise, financial costs, and lack of management support. The study contributes insights for industry practitioners and policymakers seeking to promote effective blockchain adoption and strengthened Malaysia's digital transformation agenda.

Keywords: Blockchain technology, supply chain management, digital transformation

INTRODUCTION

In the modern era of globalization, supply chain management (SCM) has become a critical component of business operations, ensuring that goods, services, and information flow efficiently from suppliers to end consumers. The effectiveness of a supply chain significantly influences an organization's competitiveness, profitability, and sustainability. However, traditional supply chains often suffer from persistent issues such as lack of transparency, data inconsistency, delayed information flow, and vulnerability to fraud or counterfeit products. These inefficiencies have motivated organizations and researchers to explore innovative technologies capable of transforming conventional supply chains into more transparent, traceable, and reliable systems. Among these emerging technologies, blockchain has gained substantial attention as a potential game-changer in supply chain management.

Blockchain technology, first introduced as the underlying architecture of cryptocurrencies such as Bitcoin, is a decentralized digital ledger system that records and verifies transactions across multiple computers. Each transaction, or "block," is cryptographically linked to previous blocks, forming an immutable chain of data. This feature ensures that once a transaction is recorded, it cannot be altered or deleted, providing a high level of data integrity and security. The decentralized nature of blockchain eliminates the need for intermediaries, fostering trust between participants who may not otherwise have direct relationships. In the context of supply

chain management, this characteristic offers remarkable potential for improving information sharing, verifying product authenticity, and enhancing transparency across global networks.

The relevance of blockchain in supply chain management stems from its ability to solve long-standing problems of traceability and data verification. In traditional systems, information is often fragmented among different entities manufacturers, suppliers, logistics providers, and retailers each maintaining its own database. This fragmentation leads to inefficiencies, limited visibility, and challenges in verifying product origins. Blockchain technology can create a single source of truth, where all stakeholders can access and verify real-time data. For example, blockchain can record every step of a product's journey from raw material procurement to final delivery allowing stakeholders to track provenance, confirm certifications, and ensure compliance with regulatory standards. This capability is especially critical in industries such as pharmaceuticals, agriculture, and food supply chains, where authenticity and safety are paramount.

Globally, many organizations have begun experimenting with blockchain to enhance supply chain performance. For instance, IBM and Maersk developed the TradeLens platform to digitize and streamline global shipping documentation using blockchain technology. Similarly, Walmart and Carrefour implemented blockchain-based food traceability systems to monitor the movement of perishable goods and enhance consumer confidence in food safety. These successful cases have inspired governments and industries worldwide to explore blockchain as part of their digital transformation strategies. However, while advanced economies such as the United States and China have made considerable progress, developing countries including Malaysia are still in the early stages of blockchain implementation.

In Malaysia, the government has recognized blockchain's potential as part of its broader initiative to foster a digital economy. The National Blockchain Roadmap 2021–2025, published by the Ministry of Science, Technology, and Innovation (MOSTI), outlines strategic plans to encourage blockchain adoption across various sectors, including logistics, finance, and manufacturing. Despite these efforts, adoption remains limited. Studies indicate that many Malaysian organizations still face substantial challenges such as lack of technical expertise, inadequate financial resources, and low awareness of blockchain benefits. The roadmap reported that 56% of surveyed companies identified a shortage of in-house capabilities as the main barrier to blockchain implementation. Moreover, the complexity of blockchain integration and uncertainty regarding its return on investment further discourage widespread adoption.

From an organizational perspective, implementing blockchain is not merely a technological upgrade it represents a fundamental transformation in operational processes, governance structures, and interorganizational relationships. It requires rethinking traditional business models and promoting collaboration among supply chain actors who may be competitors. Resistance to change, particularly from management and employees unfamiliar with digital technologies, also poses a serious obstacle. Some organizations fear that blockchain might automate tasks traditionally performed by humans, leading to concerns about job displacement. Others worry about data privacy issues since blockchain, by design, allows information sharing across distributed networks. Therefore, understanding both the challenges and the tangible benefits of blockchain adoption is vital to ensure a smooth transition toward digitalized and intelligent supply chains.

Academically, numerous studies have highlighted blockchain's transformative potential in improving supply chain efficiency, visibility, and sustainability. Scholars such as Agi and Jha (2022) and Gohil and Thakker (2021) emphasized that blockchain can strengthen customer trust by offering immutable transaction records and authentic product verification. On the other hand, researchers such as Yadlapalli et al. (2022) pointed out that blockchain implementation is constrained by human, technological, and financial limitations. Despite the growing body of literature, empirical studies focusing on developing countries especially Malaysia remain limited. Most existing research is conceptual, leaving a gap in understanding the practical realities, challenges, and impacts of blockchain implementation within local industries.

Given this background, this study aims to explore the challenges and impacts of implementing blockchain technology in supply chain management within the Malaysian context by adopting a qualitative exploratory approach and gathering insights from industry practitioners, this study provides practical perspectives that complement existing theoretical discussions. The research focuses on two primary objectives:

RO1: to identify the key challenges organizations face when adopting blockchain in supply chains, and

RO2: to examine the impacts of blockchain technology on supply chain performance

Problem Statement

Although blockchain technology has been widely recognized as a revolutionary tool for enhancing supply chain transparency, traceability, and trust, its implementation within the Malaysian industrial landscape remains limited and fragmented. While global corporations such as Walmart, Maersk, and IBM have successfully deployed blockchain to streamline logistics and enhance traceability (Kshetri, 2018; Wang et al., 2019), Malaysian organizations have only begun experimenting with the technology on a small scale. According to the National Blockchain Roadmap (MOSTI, 2021), Malaysia's blockchain maturity level is still in the developmental phase, with low adoption rates across most sectors. This contrasts with the significant attention blockchain has received in developed economies, highlighting a digital divide that poses challenges to Malaysia's competitiveness in global supply chain networks.

Despite growing awareness, Malaysian industries continue to face technical, managerial, and financial barriers that hinder effective blockchain implementation. Prior research reveals that limited technical expertise is one of the most persistent obstacles, as local companies often lack personnel skilled in blockchain development and system integration (Aisyah et al., 2022; Teoh, 2021). Additionally, organizational challenges such as inadequate top management support and employee resistance— complicate adoption efforts (Pournader et al., 2020). Financial constraints also impede adoption, as blockchain requires substantial investment in infrastructure, cybersecurity, and training (Cole et al., 2019). Moreover, regulatory uncertainty surrounding data governance and privacy protection under Malaysia's Personal Data Protection Act (PDPA) has discouraged firms from pursuing large-scale blockchain projects (Queiroz & Fosso Wamba, 2021). Consequently, while the theoretical benefits of blockchain are well-established in international studies, their practical realization within Malaysia's socio-economic context remains underexplored.

This limited empirical understanding creates a critical research gap. Although studies have examined blockchain's potential to improve transparency, security, and efficiency (Saberi et al., 2019; Kouhizadeh et al., 2021), few have focused specifically on how Malaysian organizations experience and respond to the challenges of blockchain adoption in supply chain operations. Therefore, this study seeks to explore the challenges and impacts of implementing blockchain technology in Malaysian supply chains through a qualitative, exploratory approach.

Purpose of the Study

The significance of this research lies in its contribution to both academic and industrial domains. Academically, it extends the existing literature on digital transformation and supply chain innovation by offering insights into Malaysia's adoption landscape. Moreover, it will contribute to the academic literature by contextualizing blockchain implementation challenges in a developing economy where resource constraints, organizational culture, and digital maturity levels differ substantially from those of developed nations. Practically, it may assist policymakers, business leaders, and technology developers in understanding the enablers and barriers of blockchain adoption. The findings will help businesses understand the factors influencing blockchain readiness. Furthermore, the study's findings may guide organizations seeking to enhance competitiveness and sustainability through digital technologies, aligning with Malaysia's aspirations to become a digitally driven nation by 2030.

In summary, blockchain technology offers transformative potential for enhancing transparency, trust, and traceability in supply chain management. However, realizing these benefits depends on organizations' ability to overcome critical challenges in implementation. By focusing on the Malaysian context, this study provides timely insights into the factors enabling and hindering blockchain adoption.

LITERATURE REVIEW

Overview of Blockchain Technology

Blockchain is a distributed and decentralized digital ledger designed to record transactions securely, transparently, and immutably across a peer-to-peer network (Nakamoto, 2008). Every transaction is stored as a block containing a cryptographic hash of the previous block, creating a sequential and tamperresistant chain of data. Unlike traditional centralized databases controlled by a single authority, blockchain operates on consensus mechanisms such as Proof of Work (PoW) or Proof of Stake (PoS), ensuring that all network participants validate and agree upon each transaction (Yaga et al., 2018).

The unique features of blockchain decentralization, immutability, transparency, and security make it highly applicable beyond cryptocurrency. It has been successfully integrated into various sectors, including healthcare, education, finance, and government (Kshetri, 2018). In SCM, blockchain facilitates the real-time recording of product movement, enabling the tracking of goods from raw materials to consumers. According to Cole et al. (2019), blockchain's ability to prevent data manipulation and ensure data authenticity makes it particularly suitable for addressing the information asymmetry often present in global supply networks.

Blockchain Applications in Supply Chain Management

Supply chain management involves coordinating multiple entities suppliers, manufacturers, logistics providers, retailers, and customers across different geographic regions. Traditional supply chains rely heavily on paper-based documentation and siloed information systems, leading to inefficiencies, errors, and delays. Blockchain provides a shared and trusted digital infrastructure that allows all participants to access identical, real-time information (Saberi et al., 2019).

Blockchain enhances traceability by recording every transaction in a transparent ledger. For example, in the food industry, blockchain can verify the source, transportation, and storage conditions of products, ensure authenticity and reduce contamination risks (Kamilaris et al., 2019). In the pharmaceutical industry, blockchain assists in preventing counterfeit drugs by verifying supply chain legitimacy (Tian, 2017). Furthermore, smart contracts self-executing agreements coded into the blockchain automate processes such as payments, customs clearance, and compliance verification (Wang et al., 2019).

Empirical studies show that blockchain can significantly improve supply chain performance metrics such as lead-time, transaction accuracy, and inventory visibility (Queiroz & Wamba, 2019). IBM and Maersk's TradeLens platform, for instance, demonstrated a 40% reduction in document processing time through blockchain-based digitalization (Pournader et al., 2020). These advantages underline blockchain's transformative potential for achieving sustainable and resilient supply chains in both developed and developing economies.

Challenges in Blockchain Implementation

Despite its potential, blockchain implementation faces several technical, organizational, and regulatory challenges. One major barrier is the lack of technical expertise required to design, deploy, and maintain blockchain infrastructure (Teoh, 2021). Many organizations, particularly in developing countries, lack skilled professional's familiar with distributed ledger technologies, cryptography, and consensus algorithms (Aisyah et al., 2022).

Financial constraints also hinder adoption, as blockchain integration involves substantial investment in infrastructure, software, and training (Cole et al., 2019). For small and medium-sized enterprises (SMEs), the cost of transitioning from traditional systems to blockchain-enabled platforms can be prohibitive. Moreover, top management support is critical for successful implementation. Studies by Pournader et al. (2020) and Wang et al. (2019) indicate that leadership commitment influences strategic alignment and resource allocation. Without managerial understanding of blockchain's long-term benefits, projects often face resistance or fail at the pilot stage.

Another significant concern is data privacy and regulatory compliance. Although blockchain ensures transparency, its immutable and shared nature can expose sensitive business information (Sammu & Ademide, 2025). Organizations must balance transparency with confidentiality, particularly when operating under data-protection regulations such as Malaysia's Personal Data Protection Act (PDPA 2010). Queiroz and Fosso Wamba (2021) argue that hybrid models combining public and private blockchains may address some privacy issues but add technical complexity.

Interoperability among different blockchain platforms also remains unresolved. With various blockchain frameworks operating under distinct protocols, cross-platform integration can be challenging (Kouhizadeh et al., 2021). Finally, environmental concerns related to blockchain's high energy consumption especially in Proof-of-Work systems raise questions about sustainability (Saberi et al., 2019).

Blockchain in the Malaysian Context

Malaysia has demonstrated a growing interest in blockchain technology as part of its national digital transformation agenda. The Ministry of Science, Technology and Innovation (MOSTI) launched the National Blockchain Roadmap 2021–2025 to promote research, development, and commercialization of blockchain applications across sectors such as logistics, finance, and halal certification (MOSTI, 2021).

In the agriculture and halal food sector, blockchain is being piloted to ensure product authenticity and religious compliance. Abdullah et al. (2020) found that blockchain could provide end-to-end visibility, verifying halal certification at each stage of the supply chain. Similarly, the Malaysian Palm Oil Board (MPOB) has explored blockchain to trace palm oil origins, ensuring compliance with sustainability standards and addressing global environmental concerns (Teoh, 2021).

However, the adoption rate remains slow. Studies reveal that only a small percentage of Malaysian firms have implemented blockchain beyond the pilot phase. Aisyah et al. (2022) identified limited awareness, lack of policy clarity, and inadequate human capital as major barriers. Many companies perceive blockchain as complex, costly, and unnecessary for daily operations, especially among SMEs. Additionally, regulatory uncertainty such as unclear taxation and data-governance policies creates hesitation among potential adopters (Queiroz & Wamba, 2019).

METHODOLOGY

Research Design

This study employed a qualitative exploratory research design to examine the challenges and impacts of blockchain technology implementation in supply chain management within the Malaysian context. A qualitative approach was deemed appropriate because blockchain adoption in Malaysia remains an emerging phenomenon with limited empirical research. As Creswell and Poth (2018) emphasize, qualitative inquiry allows researchers to explore complex, context-dependent issues in depth by capturing the perspectives, experiences, and meanings expressed by participants.

The exploratory nature of this study was guided by the need to gain first-hand insights from practitioners directly involved in blockchain-based supply chain operations. The focus was not on testing hypotheses but on uncovering patterns, relationships, and themes through interpretive analysis. By employing this design, the

study sought to construct a conceptual understanding of blockchain implementation dynamics in real-world business environments.

Research Setting and Participant Selection

Data were collected from three organizations in Malaysia that had adopted or piloted blockchain solutions within their supply chain operations. The organizations represented different industries agriculture, manufacturing, and pharmaceuticals to ensure diversity in experiences and contexts.

A purposive sampling technique was used to select participants with relevant expertise and direct involvement in blockchain initiatives. According to Patton (2015), purposive sampling is suitable for qualitative research as it enables researchers to select information-rich cases that provide deep insight into the studied phenomenon.

Three participants were identified based on their professional roles:

Interviewee	**Position**	**Related Responsibility**
Interviewee 1	Head of Emerging Technologies	responsible for technological implementation and system integration.
Interviewee 2	Supply Chain Specialist	overseeing logistics, procurement, and operational workflows influenced by blockchain.
Interviewee 3	Regulatory Executive	ensuring compliance with data governance, privacy, and industry standards.

Each participant possessed more than five years of industry experience, and more the two years of involvement in blockchain projects, which contributed to the richness of the data collected.

Although the study involved three participants, this sample size aligns with recommendations for exploratory qualitative research where the aim is depth rather than generalizability. As Creswell and Poth (2018) and Patton (2015) emphasize, information-rich cases allow researchers to uncover nuanced insights into emerging phenomena such as blockchain adoption, particularly when participants hold specialized expertise. Given the infancy of blockchain implementation in Malaysia and the limited number of organizations currently experimenting with the technology, the selected sample is appropriate and reflective of current industry realities. Moreover, thematic saturation was observed across the interviews, as no new themes emerged after the third interview.

Data Collection Procedures

Data collection was conducted through semi-structured interviews, chosen for their flexibility and depth. Semi-structured interviews allow participants to elaborate on their experiences while enabling the researcher to probe further into emerging topics (Bryman, 2016).

All interviews were conducted virtually via online platform namely Google Meet. Each interview were conducted approximately 45 to 60 minutes, and participants were briefed on the study objectives and confidentiality procedures beforehand. An interview guide was developed based on prior literature and the study objectives. It included open-ended questions grouped under two categories:

1. Section A: General information about the organization’s blockchain adoption background.
2. Section B: Challenges and impacts of blockchain implementation in supply chain processes.

All interviews were audio-recorded with participants' consent and subsequently transcribed verbatim for analysis. To ensure ethical compliance, participants were anonymized (Interviewee 1, 2, and 3), and no identifiable company information was disclosed.

Data Analysis

The transcribed data were analyzed using thematic analysis, a systematic method for identifying, analyzing, and interpreting patterns or themes within qualitative data (Braun & Clarke, 2006). The analysis followed the six-step framework recommended by Braun and Clarke, ensuring a rigorous and transparent process:

1. Familiarization with the data: All interview transcripts were read multiple times to gain a deep understanding of the content.
2. Initial coding: Key phrases and ideas were highlighted and coded line-by-line.
3. Searching for themes: Similar codes were grouped into potential themes representing broader ideas.
4. Reviewing themes: Themes were refined by checking their relevance to research questions and internal coherence.
5. Defining and naming themes: Each theme was clearly defined and supported with representative quotes.
6. Producing the report: The final themes were organized into two major dimensions challenges and impacts to align with the study's objectives.

Through this process, four challenge-related themes (technical expertise, top management support, financial constraints, and privacy concerns) and three impact-related themes (traceability, security, and partnership) were identified.

RESULT AND DISCUSSION

This section presents the qualitative findings obtained from three semi structured interviews conducted with professionals involved in blockchain-enabled supply chain systems across different industries in malaysia—namely agriculture, manufacturing, and pharmaceuticals. participants included a head of ai, iot & blockchain, a supply chain specialist, and a regulatory executive.

Thematic Analysis Revealed Two Overarching Dimensions:

Table 1: Summary Of Thematic Analysis

Dimensions	Themes	Codes
Challenges Of Blockchain Implementation	Technical Expertise And Skills	High Demand For Blockchain Professionals Need For Internal Digital Skills Programs
	Top Management Support	Fear Of Replacing Human Jobs With Technology Difficulty In Aligning Blockchain With Long-Term Goals
	Financial Constraints And	Costs Of Infrastructure And Hardware Budget Allocation For Blockchain Training

	Cost Implications	
	Privacy And Data Security Concerns	Concerns Over Exposing Sensitive Data Risk Of Reputational Damage From Data Breaches
Impacts Of Blockchain Implementation	Traceability And Transparency	Real-Time Tracking Of Goods And Services Improved Supply Chain Visibility
	Data Integrity And Security	Fraud Prevention Through Immutable Records Reduction In Counterfeiting Via Authentication
	Partnership And Collaboration	Enhanced Collaboration Via Shared Ledgers Strategic Alliances Driven By Trust And Transparency

Each dimension is discussed below with supporting evidence from participant quotes and compared with findings from existing literature.

challenges of blockchain implementation

lack of technical expertise and skills

all interviewees consistently identified the shortage of skilled personnel as a primary barrier to implementing blockchain in malaysia's supply chains. technology's complexity particularly in cryptography, distributed systems, and smart contract development requires highly specialized knowledge that is scarce in local industries.

one participant emphasized the steep learning curve:

"most companies here are still trying to understand what blockchain really is. we have it staff, but blockchain requires a completely dif1erent
set of skills. it's not something you can learn overnight." interviewee 1 another participant noted that even when companies invest in pilot projects, they struggle to find suitable consultants or training institutions:

"we wanted to explore a blockchain pilot project, but there were very few local experts. most of the consultants we found were foreign, and their fees were very high." interviewee 2

This finding aligns with teoh (2021) and aisyah et al. (2022), who reported that malaysia's blockchain ecosystem is constrained by limited human capital and insufficient academic-industry collaboration. without skilled professionals, organizations often face delays and cost overruns in system implementation.

thus, the evidence underscores the need for structured capacity-building initiatives, university-led blockchain programs, and government support for professional training to bridge the technical knowledge gap.

limited top management support

The second major theme concerned the lack of commitment and awareness among top management. respondents observed that many executives view blockchain as a speculative or emerging technology rather than a strategic investment.

one respondent expressed this challenge clearly:

"our management is very conservative. they see blockchain as something futuristic good to talk about but not a business priority yet." interviewee 2.

another interviewee explained that limited managerial understanding leads to hesitation and delayed decisions:

"we tried to propose a blockchain-based logistics tracking system, but top management wasn't convinced. they thought it was too expensive and complex, and they didn't see immediate benefits." interviewee 3

these perspectives confirm the findings of pournader et al. (2020), who emphasized that top management support is critical for technology adoption because it determines strategic alignment, resource allocation, and change management readiness.

moreover, resistance to change was observed not only among leaders but also among employees. as interviewee 1 described:

"some staff think blockchain will replace their jobs. there's fear that automation will make them redundant."

this resistance highlights the importance of effective communication, employee training, and leadership advocacy to promote a shared understanding of blockchain's value rather than perceiving it as a threat.

financial constraints and cost implications

a third major challenge identified was the high cost of blockchain
implementation. all three organizations reported that financial limitations are a key deterrent, particularly for small and medium enterprises (smes).

one participant from the manufacturing sector explained:

"to implement blockchain properly, you need new servers, licenses, and trained personnel. it's not cheap. for an sme like us, it's a huge financial burden." interviewee 3

similarly, a participant from the technology sector stated:

"blockchain is a long-term investment. the benefits come after several years, but the cost comes now. that's why many companies hesitate." interviewee 1

These remarks align with cole et al. (2019), who noted that high initial investment costs and unclear short-term returns are major obstacles for firms in adopting blockchain technology. participants further mentioned that most blockchain software solutions are foreign developed, leading to additional expenses due to currency exchange and licensing fees.

moreover, interviewee 2 suggested that government incentives could help mitigate financial barriers:

"if the government could provide grants or tax reductions for blockchain adoption, more companies would take the risk."

this observation echoes malaysia's national blockchain roadmap (mosti, 2021), which advocates for financial assistance and pilot funding to encourage blockchain diffusion across industries.

privacy and data security concerns

the final challenge involves data security and confidentiality issues. although blockchain's transparency is generally perceived as an advantage, all respondents expressed concern over the exposure of sensitive business information.

interviewee 2 noted:

"in our industry, transparency is good for traceability, but we can't afford to make all our supplier and pricing data public. competitors could easily use that against us." interviewee 2

another participant highlighted the tension between transparency and privacy:

"blockchain ensures data can't be altered, but once it's recorded, you can't delete or modify it even if it's a mistake. that creates compliance issues with data protection laws." interviewee 3

this finding is consistent with queiroz and fosso wamba (2021), who observed that data privacy paradoxes remain unresolved in many blockchain implementations. participants recommended using permissioned (private) blockchains to control access and comply with malaysia's personal data protection act (pdpa 2010).

however, interviewee 1 pointed out that privacy-protective configurations often increase system complexity and cost:

"setting up a private blockchain with strict access control is technically demanding. it requires more maintenance and higher costs."

these insights highlight that while blockchain enhances trust and visibility, balancing transparency with confidentiality remains a key design challenge for malaysian organizations.

Impacts of blockchain implementation

Enhanced traceability and transparency

all respondents reported that blockchain dramatically improved traceability within their supply chains. products and transactions could now be tracked in real-time from the point of origin to the end consumer, reducing errors and fraud.

interviewee 1 shared:

"with blockchain, every transaction is automatically logged and verified. we can trace where our materials come from, who handled them, and when they arrived. that visibility was impossible before." interviewee 1

similarly, the agricultural sector representative emphasized consumer trust:

our customers can now scan a qr code to see the entire product journey— from farm to shelf. it has boosted our brand's credibility tremendously." interviewee 2

this finding supports kamilaris et al. (2019) and abdullah et al. (2020), who observed that blockchain enhances supply chain transparency and consumer confidence, especially in sectors requiring authenticity verification such as halal and organic products.

respondents also indicated that traceability helped improve operational efficiency, as data verification no longer required manual checks. by integrating blockchain with iot tracking systems, organizations achieved real-time data synchronization, leading to faster decisionmaking and reduced administrative burden.

Improved data integrity and security

another significant benefit observed was enhanced data security and integrity. participants consistently highlighted blockchain's immutability as a major factor in reducing fraud and data manipulation.

interviewee 3 shared a practical example:

"before blockchain, we had frequent disputes over shipment records and invoices. now, everything is time-stamped and verified automatically. it has reduced conflicts and improved our audit accuracy." interviewee 3

this aligns with cole et al. (2019) and wang et al. (2019), who assert that blockchain's cryptographic features and distributed architecture minimize unauthorized access and tampering.

furthermore, the decentralized ledger structure enhances resilience against cyberattacks since data are replicated across multiple nodes. interviewee 1 explained:

"even if one server fails or is attacked, the data is still safe on the other nodes. that redundancy gives us confidence in our system's reliability."

however, respondents also noted the importance of proper governance mechanisms. as interviewee 2 cautioned:

"blockchain doesn't prevent human error. if wrong data are entered, it becomes permanent. so, we need strict data validation rules before input."

this highlights that while blockchain strengthens security, data accuracy depends on human input quality and procedural discipline.

Strengthened partnership and collaboration

the third key impact was the improvement of inter-organizational relationships and collaboration. all respondents agreed that blockchain fosters a culture of trust and cooperation among supply chain partners.

interviewee 1 observed:

"before blockchain, we relied on paper contracts and manual verification. now, all parties share the same data in real-time. it has reduced disputes and built stronger trust between us and our suppliers."

interviewee 2 added:

"even our smaller suppliers now have equal visibility. they feel included in the process, which improves accountability and teamwork." interviewee 2

this finding echoes saberi et al. (2019) and kouhizadeh et al. (2021), who concluded that blockchain promotes collaborative ecosystems by creating shared, immutable records accessible to all participants.

the respondents also mentioned that transparency has enhanced reputation and credibility in international markets, where buyers demand ethical sourcing verification. interviewee 3 stated:

"our foreign partners trust us more because they can verify our compliance instantly on the blockchain. it strengthens our global partnerships."

these findings demonstrate blockchain's transformative potential in building trust-based networks that go beyond transactional efficiency to create sustainable partnerships across supply chain tiers.

SYNTHESIS AND DISCUSSION

a conceptual diagram was developed to synthesize and visually present the key findings of this study, particularly the challenges and impacts associated with blockchain adoption in malaysian supply chains. the diagram highlights two central dimensions that emerged from the thematic analysis: the barriers that hinder effective implementation and the positive outcomes achieved by organizations that have adopted the technology. the challenges reflect structural, organizational, and regulatory constraints that limit blockchain diffusion, while the impacts demonstrate blockchain's potential to enhance supply chain performance through improved transparency, data integrity, and collaborative efficiency. figure 1 brings these themes together to offer a clearer understanding of how blockchain adoption unfolds within the malaysian context and to guide policymakers, practitioners, and researchers in addressing gaps and leveraging opportunities.

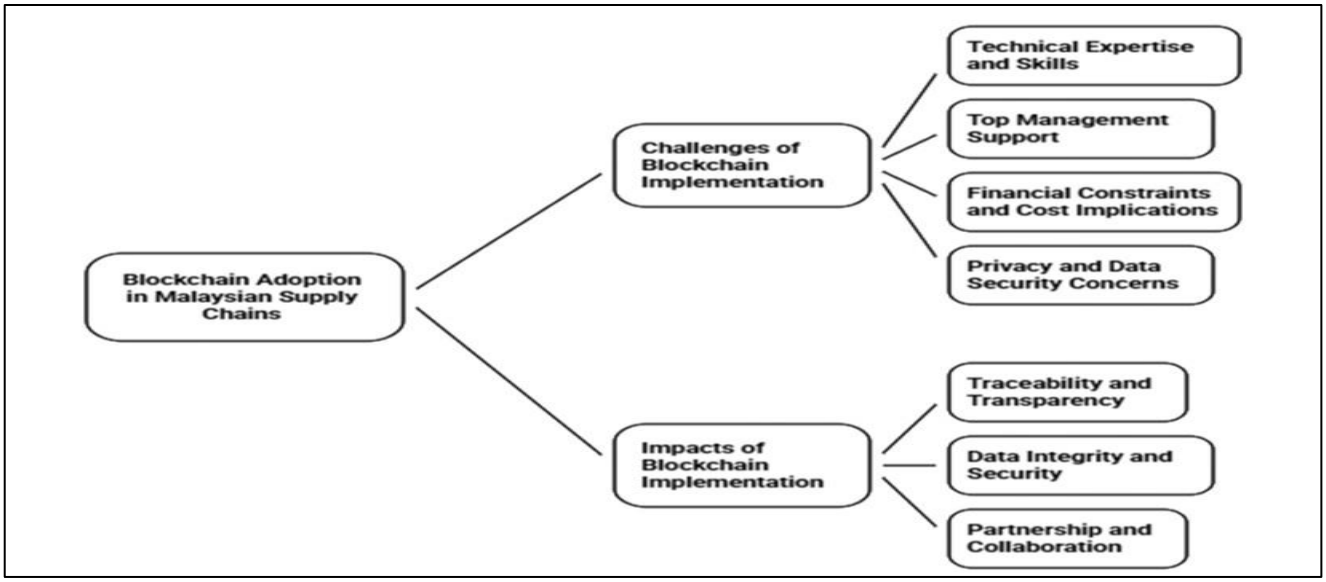

figure 1: concept map of blockchain adoption challenges and impacts in malaysian supply chains

overall, the findings reveal that blockchain technology presents both significant opportunities and formidable challenges for supply chain management in malaysia. while organizations struggle with technical, financial, and regulatory hurdles, they recognize blockchain's value in improving transparency, traceability, and trust. for instance, while a lack of technical expertise is a global concern, the issue is intensified in malaysia due to limited local training providers and dependence on foreign consultants, echoing concerns raised in national policy documents (mosti, 2021). this suggests that adoption barriers are not purely technological but institutional.

the interviews confirm that the key enablers of successful blockchain implementation include top management commitment, adequate funding, skilled personnel, and supportive government policy. conversely, resistance to change, privacy concerns, and the lack of interoperability slow progress. top management hesitancy appears rooted not only in cost concerns but also in cultural orientations toward incremental rather than disruptive innovation. the interviews show that malaysian executives often require clearer evidence of short-term returns, indicating a need for demonstration projects or government-sponsored
pilots.

the impacts identified traceability, data integrity, and improved partnerships mirror global findings but carry unique implications in malaysia's supply chains, which are heavily influenced by halal requirements, export certification needs, and regulatory scrutiny.
therefore, the malaysian context does not simply replicate international lessons, it shapes blockchain adoption in culturally and institutionally specific ways. the discussion also highlights a contextual paradox, blockchain's transparency its greatest strength can also be its
most serious challenge in environments that demand data confidentiality. thus, hybrid blockchain models combining public and private architectures may offer the best balance between openness and control.

these findings align with global literature (queiroz & wamba, 2019; saberi et al., 2019) while providing localized insights into malaysia's digital transformation landscape. they suggest that blockchain's full potential can only be realized through ecosystem collaboration, capacity building, and policy alignment that bridges the gap between innovation and practice.

CONCLUSION

This study set out to explore the challenges and impacts of blockchain technology implementation in supply chain management within Malaysia. Through qualitative interviews with three industry practitioners representing agriculture, manufacturing, and pharmaceutical sectors, the research identified the multifaceted

nature of blockchain adoption in a developing economy. The findings revealed that while blockchain offers significant potential for improving traceability, transparency, and data security, its implementation remains limited due to several contextual barriers. These include insufficient technical expertise, limited managerial support, financial constraints, and data privacy concerns. Such barriers are consistent with the findings of Teoh (2021) and Aisyah et al. (2022), who noted that Malaysian organizations often lack the readiness and resources necessary for large-scale blockchain adoption.

Despite these challenges, the study found that organizations which have integrated blockchain reported substantial operational improvements. Enhanced traceability allowed for real-time visibility and product authenticity verification, thereby strengthening consumer trust. Improved data integrity reduced document fraud and improved auditability, while greater transparency fostered trust and collaboration among supply chain partners. These positive outcomes align with prior international studies by Saberi et al. (2019) and Kouhizadeh et al. (2021), confirming that blockchain can serve as an enabling technology for efficient, ethical, and sustainable supply chains. Importantly, the Malaysian cases highlight that blockchain's success depends not merely on technology but on the human, organizational, and institutional readiness that supports it.

In conclusion, blockchain technology has the potential to transform Malaysia's supply chain ecosystem by promoting trust, accountability, and digital innovation. However, realizing this potential requires strategic intervention at multiple levels. Organizations must invest in workforce training and change management to build technical competence and internal support. Policymakers should establish clear regulatory frameworks and financial incentives to encourage experimentation and adoption, while academia can contribute through continuous research and capacity building. Future research could expand this study by incorporating quantitative methods or longitudinal analysis to measure blockchain's longterm impact on performance and sustainability. By addressing existing barriers and fostering cross-sector collaboration, Malaysia can position itself as a regional leader in blockchain-enabled supply chain management, driving both economic competitiveness and digital transformation.

Suggestions for Future Research

Although this study provides valuable insights into the challenges and impacts of blockchain implementation in Malaysian supply chains, several opportunities exist for further investigation. First, future research could extend the sample size and sectoral coverage to include additional industries such as logistics, retail, and finance. This would allow researchers to compare blockchain adoption across different supply chain structures and levels of technological maturity. By involving a larger number of organizations, future studies could strengthen the generalizability of findings and capture a broader range of experiences, particularly from small and medium-sized enterprises (SMEs) that represent a major portion of Malaysia's economy (Aisyah et al., 2022).

Second, subsequent studies could employ a mixed-method or quantitative approach to measure blockchain's long-term effects on supply chain performance indicators such as cost efficiency, delivery speed, and risk mitigation. While the current study provides qualitative insights into perceptions and experiences, quantitative data could validate these findings and establish statistical relationships between blockchain implementation and supply chain outcomes. Researchers could also conduct longitudinal studies to assess how blockchain adoption evolves over time and how organizations progress from pilot projects to full-scale integration. Such longitudinal data would provide a clearer understanding of the technological diffusion process and identify key factors influencing sustained blockchain use (Pournader et al., 2020).

Lastly, future research could explore policy, governance, and sustainability dimensions of blockchain in the Malaysian context. Studies may examine how government regulations, data protection laws, and digital policies facilitate or hinder blockchain diffusion across industries. Additionally, researchers could investigate the environmental implications of blockchain technology, especially in terms of energy consumption and its compatibility with sustainable development goals (Saberi et al., 2019; Kouhizadeh et al., 2021). Future scholars might also explore how blockchain interacts with complementary technologies such as the Internet of

Things (IoT), artificial intelligence (AI), and big data analytics to create integrated, smart supply chain ecosystems. By addressing these areas, future research can contribute to a more holistic understanding of blockchain's role in driving Malaysia's digital transformation and supply chain resilience.

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