DOI: 10.46541/978-86-7233-443-2_478

XXX International Scientific Conference
Strategic Management
and Decision Support Systems
in Strategic Management
SM2025
Subotica (Serbia), 16 May, 2025

Ismail Rishwaan Rashid
Ph.D. Student, Doctoral School of Regional Policy and Economics, University of Pécs Faculty of Business and Economics, H-7622 Pécs, Rákóczi út 80., tel.: +36206612848

e-mail rashidhrishvan@gmail.com

Dr. habil. Gabor Juhasz, PhD
Assistant Professor, Head of Research Center, University of Pécs Faculty of Business and Economics, Department of Leadership and Organizational Sciences, H-7622 Pécs, Rákóczi út 80., tel.: +36302475819

e-mail juhasz.gabor@ktk.pte.hu

Name6 FamilyName6 (Style: SM-AuthorsName)
Affiliation, (Style: SM-Information)
City, Country (Style: SM-Information)

e-mail (Style: SM-Information)

Participation (direct/virtual): Virtual
JEL: O33, M15, M11, L14, L23, R11, F63

BLOCKCHAIN FOR SUPPLY CHAIN EFFICIENCY IN THE MALDIVES

Abstract: Blockchain technology presents a potentially transformative opportunity for Small Island Developing States (SIDS), particularly for the Maldives. With inefficiencies in supply chain of primary economic sectors such as tourism, fisheries, and public procurement, blockchain offers solutions for greater transparency, security, and operational efficiency. This study examines the current state of blockchain technology and its adoption in the Maldives, investigating its use in supply chain digitalization, and determining key barriers and facilitators. Findings indicate the Maldives is seeing a growing interest in blockchain, however, there is no legal or regulatory framework in place yet. Although the government has undertaken some initiatives primarily towards enhancing trade facilitation, there is limited evidence of blockchain adoption in the private sector. The study explores the potential benefits of blockchain for supply chain efficiency, focusing on improvements in traceability, transparency, automation, and risk management and the challenges hindering blockchain adoption, including technical, regulatory, financial, and institutional barriers. Finally, it puts forward strategic considerations for blockchain-enabled supply chains in the Maldives and other SIDS, highlighting the importance of investing in complementary technologies, capacity building, regulatory frameworks, and pilot projects.

Keywords: Blockchain Technology, Small Island Developing States (SIDS), Maldives, Sustainable Supply Chains, Supply Chain Digitalization, Smart Contracts

INTRODUCTION

Improving supply chain performance goes beyond organizational boundaries and companies are shifting their focus from individual organizational performance to supply chain performance. The blockchain-driven supply chain has a positive impact on supply chain management, as well as supply chain innovation and sustainable supply chain performance (Estampe *et al.*, 2013).

Global supply chains are undergoing digital transformations driven by the need for enhanced security, transparency, and efficiency. Blockchain technology has emerged as a crucial factor in this transformation, providing decentralized and immutable digital records that significantly improve traceability in supply chains. Developed countries are leveraging this technology for logistics and trade, however, SIDS face various barriers to its adoption. Like many other SIDS, the

Maldives relies heavily on imports, tourism, and fisheries exports (Van Driessche, 2024; Marinakou, 2025). To manage these sectors efficiently, a robust and digital supply chain system is essential (Lee, 2021).
This paper examines the current state of blockchain adoption in the Maldives, identifies the challenges and benefits of the technology, and offers strategic recommendations for facilitating blockchain-driven supply chains.

METHODOLOGY

This study adopted a structured literature review approach, which, unlike a systematic review with strict criteria for inclusion and exclusion, uses narrative synthesis to organize the literature into clear themes. Preliminary searches of peer-reviewed literature did not reveal any studies specifically on the Maldives and blockchain. This highlights the significance of this review as it tries to fill this important gap by synthesizing insights from global practices and identifying their potential for the Maldives and other SIDS.
This literary gap also stands as the primary reason for including news media articles, reports from international organizations, and government publications in this study. These sources served as the basis for assessing the existing state of blockchain adoption in the Maldives, given the lack of peer-reviewed literature. However, the remainder of the discussion is based on peer-reviewed journal articles from 2018 and onwards, sourced from major academic databases. These studies were selected based on their relevance to blockchain's use in supply chains. The analysis focused on several themes including the benefits of adopting blockchain on supply chains, potential challenges, and strategic considerations for effective implementation and management. Structuring the discussion around these themes allowed us to contextualize the literature to provide insights relevant to the Maldives and other SIDS.

FINDINGS AND DISCUSSION

This section examines the current state of blockchain adoption in the Maldives, the potential benefits of the technology, and the challenges hindering its widespread adoption. Finally, it presents strategic considerations for establishing blockchain-enabled supply chains.

The Current State of Blockchain Adoption in the Maldives

The exploration of blockchain technology is in its early stages in the Maldives. There are no existing legislations in place that regulate the technology and its use in the nation. Although this lack of a regulatory framework has created an uncertain environment for investors and entrepreneurs looking to engage with blockchain, it also opens an opportunity for the Maldives to be more proactive about its regulatory approaches by observing and tailoring strategies taken by other nations to best suit Maldivian economic and social needs.
The Maldives Monetary Authority (MMA) has taken a cautious stand regarding cryptocurrencies. They have issued public warnings about the potential risks of using it in trading and explicitly stated that they have granted no entities in the Maldives to use virtual currencies (Abdulla, 2021). Despite this, it has been reported that the MMA is currently drafting regulations to introduce asset-backed digital money in the Maldives (Corporate Maldives, 2024). This shows a potential openness toward exploring blockchain-based solutions in a more regulated and controlled environment. Most recently, the government of Maldives signed several agreements with Estonia to collaborate on using emerging technologies in the public sector (Corporate Maldives, 2025b).
A 2022 national stakeholder survey examined the Maldives' capability to implement Central Bank Digital Currencies (CBDCs) and stablecoins (Hrnjic and Clarke, 2022). Although this survey did not specifically focus on blockchain-based digital solutions, the findings highlighted a need for greater digital literacy and knowledge exchange to support the adoption of advanced digital solutions. Based on recommendations from this survey report published by the Economic and Social Commission for Asia and the Pacific (ESCAP), a commission of the United Nations (UN), MMA has established frameworks and a sandbox environment for testing new fintech solutions under supervision (Hrnjic and Clarke, 2022; Corporate Maldives, 2025a). This could potentially serve as the experimental environment for blockchain-based financial solutions in the Maldives.
Another government-backed blockchain initiative involves the South Asia Subregional Economic Cooperation (SASEC) National Single Window Project, supported by the Asian Development Bank (ADB). This project aims to develop a single electronic platform to enhance the speed and efficiency of cross-border control procedures in international trade. A major component of this project is the blockchain pilot testing for supply chain management and trade facilitation, supported by the ADB's High-Level Technology Fund (Asian Development Bank, 2020).
Despite an initial pilot phase that saw the development of an application integrated with key Maldivian institutions and user training, the project faces major setbacks. The original turnkey contract was terminated and ADB halted a substantial portion of its funding due to concerns regarding potential anti-corruption policy violations and contractor eligibility (Shaahunaz, 2020). While the ADB has required a new tendering process for funding, these events have caused

considerable delays, indicating the complexities of implementing such large-scale technology projects in small island nations. Beyond these projects and initiatives led by the government, limited evidence exists of blockchain adoption among private enterprises in the Maldives.

BENEFITS OF BLOCKCHAIN FOR SUPPLY CHAIN EFFICIENCY

Enhanced Operational Efficiency and Transparency

Global supply chains are being made significantly more transparent, efficient, and reliable through secure, real-time data management solutions provided by blockchain technology. Blockchain consolidates data into a permanent, shared ledger which ensures all records are tamper-proof (Liu and Wang, 2024). This leads to an overwhelming reduction in fraud and a more reliable supply chain. Blockchains real-time tracking ability improves operational efficiency by streamlining different processes and sharing data among stakeholders consistently (Azzi, Chamoun and Sokhn, 2019; Dutta et al., 2020; Dhivya et al., 2024; Espahbod et al., 2024). In pharmaceutical and food industries where traceability is essential to prevent contamination, blockchain provides the chance to carry out prompt product recalls, thereby improving customer safety and trust (Melendez, Bergey, and Smith, 2024).

Blockchain also minimizes risks associated with counterfeit products by ensuring authenticity and secure ownership transfers (Nadime et al., 2025). This further strengthens the credibility of the supply chain. When combined with other technologies like IoT and big data analytics, blockchain not only enhances efficiency but also improves engagement in industries such as tourism, where smart contracts can potentially streamline transactions (Luo and Zhou, 2021). In an increasingly digital economy, blockchain stands as an invaluable tool to foster transparency, security, and efficiency, and reinforce stakeholder confidence in supply chains.

Improved Security and Trust

Blockchain technology plays an increasingly essential role in improving security and trust in trade and supply chain management. Its decentralized and immutable nature ensures data integrity, significantly minimizing the risks of fraud and deception (Lustenberger and Spychiger, 2025). By maintaining an unalterable ledger of transactions, blockchain strengthens the security of supply chains, mitigating threats such as cyberattacks, errors, and fraudulent activities, thereby promoting stakeholder confidence (Dutta *et al.,* 2020).

Beyond security, blockchain enhances credibility by ensuring traceability and authenticity, which is essential for consumer trust and satisfaction (Liu and Wang, 2024). This is particularly beneficial for island nations like the Maldives that depend on the reputation of their exports, such as sustainable fishery products. By preventing counterfeiting and ensuring verifiable traceability, blockchain helps protect the integrity of exports, empowering small economies to enter niche, sustainable markets (Queiroz, Telles and Bonilla, 2019).

Smart Contracts and Automation

With the development of blockchain, smart contracts have also become considerably popular as they offer an innovative technology to be used in a blockchain system to mechanically negotiate, conduct, and enforce the terms and conditions of a legally binding contract (Rouhani and Deters, 2019; Taherdoost, 2023). This technology enables seamless execution of agreements by eliminating the need for intermediaries and manual processing. It also reduces transaction costs and administrative burdens on supply chains (Queiroz, Telles, and Bonilla, 2019; Lustenberger and Spychiger, 2025). Similarly, blockchain helps further reduce administrative overhead by automating several processes including customs declarations, billing, and monitoring warehouses (Nadime *et al.,* 2025). It also facilitates faster decision-making and improves supply chain agility by allowing real-time automation and eliminating paper-based processes (Melendez, Bergey and Smith, 2024).

However, Ioannou and Demirel, (2022) warn that changing paper-based processes to a blockchain-enabled system poses potential legal risks including issues with legal recognition and enforceability of smart contracts. In nations like the Maldives without an existing regulatory or legal framework, smart contracts and other blockchain-based solutions may not fully align with current laws designed around paper-based, physical documentation. This puts the validity of digitally signed contracts and the allocation of liability into question. To minimize these risks, stakeholders need to collaborate with regulators to reform and update legal and regulatory structures. Such reforms would help ensure that blockchain-enabled processes are standardized and that there are effective dispute-resolution mechanisms in place (Ioannou and Demirel, 2022).

Supply Chain Finance

Blockchain offers significant opportunities to enhance supply chain finance including addressing information asymmetry and improving credit access for small and medium-sized enterprises (SMEs). SCF often faces inefficiencies and uncertainties which stand as a barrier for SMEs to secure necessary working capital, especially in small economies. Blockchain eases access to finance by enabling financial institutions to carry out more reliable and cost-effective credit assessments (Chen *et al.,* 2024). This is only possible due to the transparent and decentralized nature inherent to blockchain technology (Queiroz, Telles and Bonilla, 2019). Similarly, Kumar *et al.,* (2023) argue that blockchain helps improve managing working capital in SMEs by reducing transaction costs, streamlining different processes, and extending financing options.

Additionally, blockchain can potentially transform the credit and financing environment for SMEs as it offers a reliable basis of credit for different financial institutions. It helps resolve the information asymmetry issues inherent in traditional supply chains (Xiao, Salleh and Cheng, 2022; Kumar *et al.,* 2023). Recording and verification of transactions in real-time in blockchain platforms further enhances the trust among SMEs and financial institutions. This facilitates better credit risk assessments while improving financing options (Chen *et al.,* 2024). Blockchain platforms also enable small nations to engage with larger firms and international financial institutions, expanding access to diverse funding sources (Du *et al.,* 2020).

Supply Chain Resilience and Sustainability

When met with disruptions such as global crises or natural disasters, blockchain and other integrated technologies including the Internet of Things (IoT) and Radio Frequency Identification (RFID), can together track real-time data to allow rapid response and recovery (Dutta *et al.,* 2020). This is especially significant for the Maldives and other SIDS where supply chain interruptions pose severe economic and social repercussions (Lopes, Gomes and Mané, 2022; Tchonkouang, Onyeaka and Nkoutchou, 2024).

Blockchain further enhances the resiliency of supply chains by improving overall governance as it increases security and visibility within supply networks. Its immutable ledger system ensures transparency and reduces fraud (Queiroz, Telles and Bonilla, 2019; Dutta *et al.,* 2020). This will provide significant value for small nations battling inefficiencies and corruption (Martin *et al.,* 2022), as blockchain verifies and safeguards transactions against tampering (Queiroz, Telles and Bonilla, 2019).

The technology also enables the adoption of lean, agile, resilient, green, and sustainable (LARGS) practices into supply chains. This facilitates organizations to trace sustainability credentials, verify authenticity, and improve overall resource efficiency and environmental management (Espahbod *et al.,* 2024). By establishing such practices, Maldives and other SIDS have an opportunity to use blockchain to meet global regulatory standards as well as address the rise of ethical consumerism (Kutaula *et al.,* 2024).

In food supply chains, blockchain is commonly viewed through two distinct lenses. Some consider it a valuable tool with significant technical attributes, while others have embraced a much broader philosophical take on it. This philosophy entails blockchain's ability to foster democratic participation, decentralization, and equitable distribution of power, positioning the technology as a key driver of organizational change (Friedman and Ormiston, 2022). Considering this view, SIDS can apply blockchain as a tool to improve its supply chain efficiency. However, accepting and advocating for the broader philosophy of blockchain could potentially empower local fishermen, farmers, and entrepreneurs, giving them more direct access to markets, cutting out intermediaries, and ensuring fairer prices. This can increase the economic viability of small-scale sustainable fisheries and agricultural projects to improve the resilience of local supply chains and promote sustainable practices.

CHALLENGES IN BLOCKCHAIN ADOPTION

High Implementation Costs

Blockchain technology and its solutions require substantial upfront investment. At times, these costs and subsequent expensive challenges outweigh the benefits of adopting blockchains into supply chains. Consequently, many blockchain initiatives remain in the pilot stages (Lustenberger and Spychiger, 2025; Nadime *et al.,* 2025). The financial burden posed by blockchain includes continuous investment in security updates, maintenance, and regulatory compliance, acquiring advanced hardware and software integration, and extensive system overhauls to make it compatible with legacy systems(Alimohammadlou and Alinejad, 2023; Sharabati and Jreisat, 2024).

Similarly, Vu, Ghadge and Bourlakis, (2023) argue that having to integrate and master blockchain technology along with the need to invest in complementary hardware and software poses a significant financial risk. While large enterprises may justify these costs in anticipation of long-term benefits, smaller firms with lower profit margins face a critical challenge in accepting blockchain, as a sudden spike in expenses can make the investment unjustifiable (Vu, Ghadge and Bourlakis, 2023). These financial obstacles can overshadow potential benefits unless organizations coordinate closely or receive

regulatory subsidies to offset the heavy upfront investment (Pun, Swaminathan and Hou, 2021; Melendez, Bergey and Smith, 2024; Awasthy, Haldar and Ghosh, 2025).

Organizational Resistance and Awareness Issues

Organizational resistance and a lack of awareness often stand in the way of successful blockchain adoption. A limited understanding of the technology can lead stakeholders to view it as overly complex or as a threat to traditional business practices (Dutta *et al.,* 2020; Çoban *et al.,* 2024). Concerns over information control, data privacy, and uncertainty about blockchain's advantages over existing IT systems further exacerbate this resistance (Lustenberger and Spychiger, 2025).
According to Friedman and Ormiston, (2022), resistance to blockchain adoption can take several forms, including resistance from incumbents that benefit from the status quo and actively refuse adoption, difficulties in coordinating stakeholders with different data-sharing norms, and functional resistance from perceptions that the technology is too complex or that it would not provide sufficient added value. Additional forms of resistance, according to Friedman and Ormiston, (2022) include challenges in integrating with legacy systems and the psychological resistance rooted in people's comfort with familiar practices.
However, Walsh *et al.,* (2021) find that managers are less resistant when they see clear benefits of the technology. This could include blockchain's ability to reduce expenses, enhance transparency, and accelerate different processes, which outweighs the effort or risks of switching and leaving the old practices behind. Walsh *et al.,* (2021) also find that even when switching costs such as the resources or effort that were put in are considered, the perceived benefits such as streamlined operations and automation through smart contracts have a stronger influence on minimizing resistance (Walsh *et al.,* 2021).
To overcome fears related to privacy and competition, Cozzio *et al.,* (2023) suggest developing a clear strategy and training plan for information sharing. For successful implementation, there must also be cross-functional collaboration and effective communication of the benefits of blockchain to both internal stakeholders and consumers (Cozzio *et al.,* 2023). Although awareness issues and internal resistance can create hurdles, they are minimized by the strong external incentives that encourage the integration of blockchain into supply chain management (Agi and Jha, 2022).

Data Confidentiality and Privacy Concerns

Data confidentiality and privacy remain critical challenges in blockchain adoption. Blockchain depends on accurate data input by individuals, leaving it vulnerable to intentional misinformation or bribery that can undermine trust at the point of entry (Dutta *et al.,* 2020).
Additionally, the inherent transparency of blockchain means data is openly shared among all participants, which can compromise confidentiality and negatively affect business relationships (Dutta *et al.,* 2020). In regions with high levels of corruption and political instability, such transparency may even threaten powerful vested interests. To address this, Mullet, Sondi and Ramat, (2023) designed a Blockchain-based Product-centred Confidentiality-preserving Architecture for Traceability (BPCAT). BPCAT allows making requests to the data owner to access their confidential data and compare it against the related data. This data is validated by all the blockchain participants which then helps establish authenticity.

Technical Complexity and Standardization Issues

Technical complexity and a lack of standardization obstruct interoperability (a protocol that allows blockchains to interact and share data in a uniform and reliable way (Yin *et al.,* 2023)) and integration among supply chains. These issues arise due to the absence of common standards across different blockchain platforms (Dutta *et al.,* 2020; Kotey *et al.,* 2024).
Additionally, blockchain’s inherent design makes it costly to modify default information. This creates disproportionate challenges for SMEs who are already struggling with increased compliance and financing difficulties (Li, Peng and Zhou, 2022). Ambiguities in governance structures and regulatory frameworks further add to the uncertainty and impede the expansion of blockchain solutions (Lustenberger and Spychiger, 2025). The lack of standardized protocols such as in developing smart contracts leads to operational inefficiencies and challenges smooth integration of blockchain across supply chains (Liu and Wang, 2024; Melendez, Bergey and Smith, 2024). Maldives and other SIDS must address these technical and standardization challenges to unlock blockchain's full potential in supply chain management.

Strategic Considerations for Blockchain-Enabled Supply Chains

As blockchain adoption gains momentum in global supply chains, its establishment in the Maldives presents both opportunities and challenges. Given the nation's heavy reliance on tourism, imports, and fisheries exports, blockchain can play a transformative role in improving transparency, efficiency, and credibility in trade and logistics.

However, the successful adoption of blockchain technology requires complementary technologies, better workforce capacity, comprehensive regulatory frameworks, and well-designed pilot projects. This section outlines key strategic considerations to successfully adopt and use the technology in supply chains. It highlights the significance of:

- Investing in Complementary Technologies
- Capacity Building and Skill Development
- Developing Regulatory Frameworks
- Pilot Projects.

Investment in Complementary Technologies

Complementary digital technologies maximize blockchain's impact on supply chains, improve operational efficiency, and strengthen system resilience (Dutta *et al.,* 2020). For instance, Lukacs *et al.,* (2025), proposed a framework that combines blockchain with IoT, RFID, near-infrared spectroscopy (NIRS), and computer vision to create a seamless track-and-trace system. This integrated approach automated data collection and validation across the supply chain and connected all tools to minimize errors and ensure traceable transactions.

Similarly, Zhang *et al.,* (2025), found that integrating blockchain with IoT, AI, and big data analytics enhances transparency, traceability, and trust, while also reducing waste and supporting sustainable practices. Additionally, investments in robust technological infrastructure, including computer resources and reliable internet connectivity are essential for geographically unique nations like the SIDS (Lustenberger and Spychiger, 2025).

Capacity Building and Skill Development

Improving the capabilities and skills of the workforce is fundamental for the Maldives and other SIDS looking to adopt blockchain technology effectively. Building the specialized skill set and technological literacy requires significant investment in training, education, and awareness programs (Dutta *et al.,* 2020; Melendez, Bergey and Smith, 2024). According to Noor, (2022), employee resistance, which frequently stems from depending on traditional systems and practices requires comprehensive training initiatives such as seminars and workshops to help familiarize the workforce with blockchain and its benefits. These programs have been found to build confidence, reshape mindsets, and foster a willingness to engage with new systems. Additionally, building stakeholder awareness and demonstrating the added value of blockchain can drive broader participation at different levels (Lustenberger and Spychiger, 2025). Educational and awareness campaigns targeting the public can also help demystify blockchain, making it more approachable and reliable (Shahzad *et al.,* 2024).

Development of Regulatory Frameworks

The long-term success of blockchain adoption is also dependent on a robust regulatory and governance framework. For instance, clear guidelines addressing data privacy concerns and ownership structures of blockchain are necessary to mitigate operational risks and encourage compliance (Dutta *et al.,* 2020; Lustenberger and Spychiger, 2025). Similarly, Zhuk, (2025) argues that meticulous legal design for conflict prevention and customer protection are necessary to address the jurisdictional ambiguity and cross-border complexities inherent in blockchain technology.

Pilot Projects

Targeted simulations and case-based pilot projects can help examine the real-world impact of embracing blockchain, and customize specific solutions tailored to local needs (Dutta *et al.,* 2020). Given the technological, financial, and political hurdles facing the Maldives and other SIDS, initiating small-scale pilot projects and feasibility studies is a proactive strategy that can help build institutional capacity while minimizing risks. These carefully designed pilot projects facilitate better cost management and reinforce stakeholder confidence, potentially leading to a measured and effective scale-up (Melendez, Bergey and Smith, 2024).

CONCLUSION

Although the government of Maldives has taken the lead in initiating blockchain exploration, its widespread adoption, especially in the Maldivian private sector faces significant challenges. The absence of a comprehensive regulatory or legal framework along with weak technical, institutional, and financial capabilities requires these nations to adopt strategic planning, targeted investments, and collaborative efforts to improve the overall supply chain performance with the help of blockchain.

Future research should include longitudinal studies to examine the economic and social impacts of adopting the technology in the long run. It should also identify strong governance models and frameworks that help minimize potential risks of its use in supply chains. Additionally, future research must investigate the potential of interoperability solutions in connecting various blockchain platforms and legacy systems within supply chains. Future studies should also evaluate the role of blockchain technology in building supply chain resilience, considering the overwhelming risks of climate change and other environmental challenges faced by the Maldives and other SIDS alike.

The authors of this study acknowledge that the challenges, benefits as well as other strategic considerations in this paper may vary across different nations and contexts. It is also important to note that blockchain and its application in supply chains is a rapidly evolving field of research and practice. This could potentially limit the long-term relevance of some of the findings and it is imperative that future research address the unique circumstances in SIDS for blockchain adoption in supply chains.

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