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Blockchain and Supply Chain Efficiency: Implications for Managerial Economics

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Abstract

This study aims to examine the relationship between blockchain technology, supply chain efficiency, and its implications for decision making within the framework of managerial economics. Through a literature study approach, this study reviews and synthesizes various related literature to map the conceptual contribution of blockchain integration in supply chain management. The study's results demonstrate that the characteristics of blockchain, namely decentralization, immutability, and transparency, have a significant impact on operational efficiency, transaction cost reduction, increased supply chain visibility, and risk management. From a managerial economics perspective, blockchain implementation enables more rational and efficient decision-making through reducing information asymmetry, optimizing resource allocation, and transforming market structures within the supply chain ecosystem. However, the adoption of this technology also presents several challenges, including high implementation costs, the need for standardization, and adjustments to organizational structures. This study provides a conceptual foundation for managers and policymakers to understand how blockchain can be a strategic tool for improving corporate competitiveness through supply chain transformation.

Keywords: *blockchain, supply chain management, managerial economics, operational efficiency, strategic decision making.*

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INTRODUCTION

The global business environment has undergone rapid changes over the past two decades, driven by globalization, the Fourth Industrial Revolution, and increasing market demands for speed, efficiency, and transparency. Companies are now required not only to compete on a local scale but also to possess the adaptive capabilities needed to navigate the ever-evolving global market landscape. One of the primary challenges facing the business world today is maintaining business continuity amid pressure for efficiency and rising consumer expectations. Supply chain management (SCM) plays a central role in determining a company's competitiveness.

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SCM is no longer viewed as merely a logistics or distribution function, but rather as a strategic system involving the coordination of cross-functional and cross-organizational activities, from raw material suppliers to end consumers. Supply chain efficiency has become a key factor in achieving business success, as it enables cost efficiency, service speed, and customer satisfaction (Christopher, 2016). However, conventional SCM practices often face challenges such as information delays, data duplication, fraud, and limited visibility into the flow of goods and information. The need for more transparent, efficient, and reliable systems has prompted companies to seek innovative solutions. One technology that is currently attracting widespread attention is blockchain. Originally known as the technology behind cryptocurrency, blockchain has evolved into a revolutionary data recording system across various sectors, including logistics and supply chain management. The decentralized, immutable, and transparent characteristics of blockchain are believed to address fundamental issues in supply chain management (Saberi et al., 2019).

The implementation of blockchain enables real-time product tracking, automatic data validation, and secure transaction recording without the need for a central authority. This has significant implications for improving operational efficiency, reducing administrative costs, and enhancing trust among parties within the supply chain. Therefore, an increasing number of companies, both large and medium-sized, are beginning to explore the implementation of blockchain in their operational systems. However, the adoption of blockchain in supply chains not only impacts technical or operational aspects but also has consequences for business decision-making, particularly from a managerial economics perspective. Managerial economics is a branch of applied economics that bridges economic theory with business management practices. This discipline focuses on how managers use economic principles and analytical tools to make rational and efficient decisions (Mansfield & Yohe, 2005). Therefore, it is essential to comprehend how the application of blockchain in supply chains can enhance managerial decision-making, particularly in areas such as cost management, resource allocation efficiency, and risk management.

Although studies on blockchain and supply chains are increasing, research specifically examining its implications for decision-making within a managerial economics framework remains limited. Most studies emphasize technical implementation aspects or their impact on operational efficiency, without directly linking them to decision-making theory and practice in business. Based on the above description, this study aims to provide a more comprehensive understanding of the relationship between blockchain technology, supply chain efficiency, and its implications for managerial economics. Through a literature review approach, this study aims to review and synthesize relevant literature to map the conceptual contributions of blockchain integration in supply chain management, as well as its impact on strategic decision-making in the context of managerial economics.

Blockchain: Basic Concepts and Developments

Since it emerged as a supporting technology for Bitcoin in 2008, blockchain has undergone significant evolution. Tapscott and Tapscott (2016) categorize the evolution of blockchain into three generations: Blockchain 1.0 (focused on cryptocurrency), Blockchain 2.0 (encompassing smart contracts and decentralized applications), and Blockchain 3.0 (utilizing blockchain applications beyond the

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financial sector, including supply chain management, healthcare, and government). These developments highlight the growing potential of blockchain applications across various economic sectors. At its core, blockchain is a distributed ledger technology that enables the decentralized, transparent, and permanent recording of transactions (Nakamoto, 2008). Technically, blockchain consists of a series of interconnected blocks linked through cryptographic functions, where each block contains a set of validated transactions. The main characteristics of blockchain include decentralization (no single authority), transparency (all participants can view all transactions), immutability (data that has been recorded cannot be changed), and consensus (agreement among nodes to validate transactions) (Zheng et al., 2018).

Supply Chain Management and Its Challenges

Supply chain management (SCM) is defined as the systematic and strategic coordination of traditional business functions within a company and across the supply chain to enhance the long-term performance of individual companies and the supply chain as a whole (Mentzer et al., 2001). In a modern perspective, SCM encompasses the planning and management of all activities involved in procurement, conversion, and logistics management, as well as coordination and collaboration with channel partners, which may include suppliers, intermediaries, third-party service providers, and customers (CSCMP, 2013). However, conventional supply chain management (SCM) faces various challenges. Min and Zhou (2002) identified four primary challenges in SCM: network complexity, information asymmetry, a lack of coordination among supply chain members, and uncertainty in the business environment. Furthermore, Chopra and Meindl (2016) emphasize that in the digital age, SCM challenges are increasing, driven by demands for greater supply chain visibility, faster responses to changes in demand, and the need for sustainability.

Managerial Economics: Economics-Based Decision Making

Managerial economics is the application of economic theory and quantitative methods to inform managerial decision-making. Baye and Prince (2017) define managerial economics as the study of how managers can use available resources effectively to achieve organizational goals. The primary focus of managerial economics includes demand analysis, production and cost analysis, market structure and competition, pricing strategies, and risk and uncertainty analysis. In the context of decision-making, managerial economics emphasizes a rational and analytical approach to decision-making. Expected utility theory and decision theory form the basis for optimal decision-making under uncertainty (Keat, Young, & Erfle, 2013). Additionally, transaction cost economics, developed by Williamson (1985), explains how firms choose governance structures that minimize transaction costs in economic activities, including in supply chains.

Blockchain Integration in Supply Chain

The application of blockchain in supply chains has become a topic of increasing research in recent years. Kshetri (2018) identified several key benefits of blockchain integration in supply chains, including increased transparency, enhanced data security, improved cost efficiency, and improved traceability. Meanwhile, Saberi et al. (2019) classify the application of blockchain in supply chains into four

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categories: identity management and authentication, asset tracking and supply chain visibility, smart contract fulfillment, and payment and financial management. An empirical study conducted by Queiroz et al. (2019) reveals that the adoption of blockchain in supply chains is influenced by technological factors (perceived ease of use and perceived usefulness), organizational factors (top management support and technological readiness), and environmental factors (competitive pressure and trust between business partners). On the other hand, Casino et al. (2020) highlight that the implementation of blockchain in supply chains still faces challenges related to interoperability, scalability, data privacy, and the development of regulatory frameworks.

Conceptual Framework: Blockchain, Supply Chain, and Managerial Economics

Based on the above literature review, a conceptual framework can be developed that links blockchain technology, supply chain management, and managerial economics. This framework emphasizes that the implementation of blockchain in supply chains not only impacts operational aspects but also has significant implications for managerial decision-making, grounded in economic principles. From a managerial economics perspective, the integration of blockchain in supply chains has the potential to transform how managers analyze and make decisions regarding resource allocation, cost structures, inter-firm relationships within the supply chain, and risk management strategies. This aligns with the views of Schmidt and Wagner (2019), who argue that blockchain can restructure economic relationships within the supply chain ecosystem by reducing transaction costs, increasing transparency, and strengthening trust mechanisms among parties.

METHODOLOGY

This study employs a qualitative approach, utilizing a systematic literature review method. This approach was chosen for its ability to comprehensively synthesize various recent literature on blockchain, supply chain management, and managerial economics. Unlike the narrative approach, which tends to be subjective, the systematic method provides structured and transparent stages, allowing results to be reproduced and critically evaluated (Tranfield, Denyer, & Smart, 2003). Additionally, this approach enables researchers to explore, analyze, and synthesize previous research findings to develop a more comprehensive and holistic conceptual framework (Snyder, 2019). Through this study, it is expected that literature gaps will be identified and relevant directions for future research will be provided.

The literature search was conducted systematically through leading academic databases, with a primary focus on Google Scholar. The keywords used included combinations of terms such as “blockchain AND supply chain,” “distributed ledger technology AND supply chain management,” and phrases related to managerial economics such as “blockchain AND managerial economics” and “blockchain AND transaction cost.” Inclusion criteria included articles published in peer-reviewed scientific journals between 2015 and 2024, written in English or Indonesian, and substantively discussing the relationship between blockchain, supply chain management, and managerial economics. Meanwhile, exclusion criteria were applied to articles that only highlighted technical aspects of blockchain without any connection to supply chains, articles on cryptocurrencies that were not relevant to the

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topic of supply chains, editorials or comments, and publications that did not provide full text.

Data analysis was conducted using a thematic content analysis approach as described by Braun and Clarke (2006). This process comprises three main stages: coding, which involves extracting important information using NVivo 12 software; categorization, which involves grouping information based on themes such as operational efficiency and transaction cost reduction; and synthesis, where the categorized findings are integrated to form a comprehensive understanding.

In conducting the literature analysis, this study adopted the TCCM (Theory, Context, Characteristics, Mechanisms) framework as developed by Paul and Criado (2020). This framework consists of four main dimensions, namely: Theory, which includes theoretical foundations such as transaction cost theory and agency theory; Context, which describes the context of blockchain implementation in various industrial sectors; Characteristics, which refers to the main features of blockchain such as decentralization and transparency; and Mechanisms, which is how blockchain works in impacting supply chain efficiency and effectiveness.

To ensure the quality and reliability of the research results, several validation techniques were applied. Source triangulation was conducted by utilizing various types of literature from different sources. The peer debriefing process involved independent researchers in the coding stage to minimize subjective bias. Additionally, a thorough audit trail or documentation of the research process was conducted to ensure the traceability of the research steps. The validation of the results was also strengthened through member checking, which involved seeking input from academics and practitioners related to the topic discussed.

RESULTS AND DISCUSSION

Supply Chain Transformation through Blockchain Technology

The implementation of blockchain technology in supply chains has led to significant transformations in various aspects of supply chain management. One fundamental change is the increased visibility and transparency throughout the supply chain. With its decentralized and immutable characteristics, blockchain enables all parties in the supply chain to access the same reliable information regarding the movement of goods, transaction status, and related documentation (Tian, 2016). This addresses the issue of information asymmetry, a significant obstacle in conventional supply chain management (SCM).

A case study conducted by IBM and Maersk as part of the TradeLens project demonstrates how blockchain can optimize supply chain processes in the container shipping industry. TradeLens successfully reduced document processing time by 40% and significantly lowered administrative costs (Jensen, Hedman, & Henningsson, 2019). Similarly, Walmart implemented blockchain technology to track fresh food products, resulting in an improvement in the product recall process from 7 days to just 2.2 seconds to trace the origin of the product (Kamath, 2018).

Additionally, smart contracts—contracts that are automatically executed when specific conditions are met—enable the automation of various processes within the supply chain. Wüst and Gervais (2018) explain that smart contracts can automate payment processes, verify product quality, and ensure compliance with regulatory requirements, thereby reducing manual intervention and the potential for errors.

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This aligns with the principle of operational efficiency in managerial economics, where automation is seen as a strategy to reduce variable costs and increase productivity.

The Impact of Blockchain on Managerial Economic Decision-Making

From a managerial economic perspective, the integration of blockchain in the supply chain has several strategic implications for business decision-making:

- Blockchain transaction cost reduction fundamentally changes the transaction cost structure in supply chains. According to transaction cost theory (Williamson, 1985), companies must consider the costs of information search, negotiation, monitoring, and enforcement of agreements in every economic transaction. Schmidt and Wagner (2019) argue that blockchain can reduce these costs through disintermediation, automated verification, and increased transparency. Empirical studies by Kamble, Gunasekaran, and Arha (2019) show that blockchain implementation in supply chains can reduce administrative costs by up to 30% and documentation costs by up to 50%. These reductions in transaction costs have significant implications for make-or-buy decision-making, enabling managers to make more rational decisions about whether an activity is more efficient to perform internally or outsource to an external party.
- Optimization of Resource Allocation: A fundamental principle in managerial economics is the optimal allocation of resources to maximize a company's value. With better visibility of the supply chain through blockchain, managers can make more accurate and timely resource allocation decisions. One real-world example is in inventory management. Francisco and Swanson (2018) demonstrated how blockchain can enhance the accuracy of demand forecasts by providing reliable, real-time data, enabling companies to optimize inventory levels and reduce storage costs. This aligns with the Economic Order Quantity (EOQ) model in managerial economics, where decisions about order quantities and frequencies are made based on a trade-off between ordering costs and storage costs.
- Risk and Uncertainty Management In the context of managerial economics, decision-making often faces conditions of uncertainty and risk. Blockchain makes a significant contribution to supply chain risk management through improved traceability and provenance, which minimizes the risk of product counterfeiting, theft, or supply chain deviations (Montecchi, Plangger, & Etter, 2019). Furthermore, Cole, Stevenson, and Aitken (2019) explain that blockchain can enhance supply chain resilience by fostering greater transparency and trust among business partners. From the perspective of managerial economic decision theory, this means that managers have better information to assess the expected value of each strategic decision, enabling them to choose alternatives that maximize expected utility.
- Market Structure Transformation and Competition Dynamics Blockchain also has the potential to transform market structures within supply chain ecosystems. By eliminating the need for intermediaries and central authorities, blockchain creates a new form of coordination between companies known as "decentralized coordination" (Seidel, 2018). This aligns with the concept of

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market structure and competition dynamics in managerial economics. Beck et al. (2018) argue that blockchain can reduce switching costs between suppliers and alter the dynamics of bargaining power within the supply chain. These changes have strategic implications for managers in formulating competitive strategies, pricing, and negotiating with business partners, which are core topics in managerial economics.

Challenges and Obstacles to Implementation

Despite offering a range of potential benefits, the implementation of blockchain in supply chains also faces several challenges that need to be considered in managerial decision-making:

- Implementation Costs and ROI One of the primary considerations in technology investment decisions is cost-benefit analysis. Wang et al. (2019) identified that high blockchain implementation costs—including infrastructure investment, system development, integration with existing systems, and personnel training—are significant barriers to the adoption of this technology. Within a managerial economics framework, managers must conduct a comprehensive Return on Investment (ROI) analysis, considering not only direct benefits, such as cost reduction, but also indirect benefits, including enhanced customer trust and product differentiation.
- The Need for Standardization and Interoperability The lack of standardization and interoperability issues between various blockchain platforms are significant barriers to the widespread adoption of this technology. Casino et al. (2020) emphasize that standard fragmentation makes it challenging to integrate blockchain with existing systems or between different blockchains in complex supply chains. From a network economics perspective, the value of blockchain increases as the number of participants adopting the same standards grows, a phenomenon known as the network effect. Therefore, decisions to adopt blockchain technology in supply chains must consider external factors such as industry adoption trends and standardization initiatives.
- Organizational Implications and Business Structure Changes The implementation of blockchain requires not only technological changes but also transformations in business processes, organizational structures, and corporate culture. Saberi et al. (2019) indicate that resistance to change and a lack of understanding of blockchain are significant internal barriers. In the context of managerial economics, this relates to the concepts of organizational change and transaction cost economics, where managers must consider the costs associated with adapting their organizations to new technologies.

Prospects and Future: Blockchain as a Catalyst for Supply Chain Transformation

The development of blockchain technology in the coming years is expected to continue influencing the evolution of supply chain management. Gartner (2019) projects that by 2025, blockchain will generate more than $176 billion in business value and reach $3.1 trillion by 2030, with the supply chain sector being one of the leading drivers of adoption. One of the emerging trends is the integration of blockchain with other technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), and big data analytics.

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This combination of technologies, often referred to as "Blockchain+," enables more comprehensive real-time data collection and analysis, as well as more thoughtful decision-making in the supply chain (Rejeb, Keogh, & Treiblmaier, 2019).

From a managerial economics perspective, this evolution has the potential to change the paradigm of business decision-making. Data-driven and automated systems will enable faster and more precise decision-making, while decentralization will drive more flexible and adaptive business models and organizational structures. In the long term, blockchain will not only be a tool for improving operational efficiency but also a catalyst for more fundamental business model transformation.

CONCLUSION

This study has examined the relationship between blockchain technology, supply chain efficiency, and its implications for managerial economics. Through a comprehensive review of the current literature, it can be concluded that the integration of blockchain in the supply chain not only provides operational benefits but also fundamental transformations in the way managerial decisions are made based on economic principles.

The decentralized, immutable, and transparent characteristics of blockchain enable improved supply chain visibility, reduced transaction costs, optimized resource allocation, and more effective risk management. From a managerial economics perspective, this implies more rational and efficient decision-making through reduced information asymmetry, enhanced coordination among parties in the supply chain, and a transformation of market structure.

However, the adoption of blockchain in supply chains also faces several challenges, including high implementation costs, the need for standardization, and organizational restructuring. Managers must conduct a comprehensive cost-benefit analysis, considering not only short-term benefits such as operational efficiency but also the long-term strategic value of implementing this technology.

The integration of blockchain with other technologies, such as IoT, AI, and big data analytics, has the potential to become a catalyst for more fundamental transformations in supply chain management and business decision-making. In this context, a deep understanding of the economic implications of blockchain technology is becoming increasingly important for managers and policymakers. Further research is recommended to develop quantitative models that can measure the economic impact of blockchain implementation in supply chains, as well as to conduct more comprehensive empirical studies on the factors influencing the adoption success of this technology across various industrial and geographical contexts.

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