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**BLOCKCHAIN TECHNOLOGY CHARACTERISTICS IN SUPPLY CHAIN
MANAGEMENT: EVIDENCE FROM VIETNAMESE ENTERPRISES**

**Hoang Le Minh¹, Nguyen Ngoc Diep², Nguyen Hoang Anh³, Do Phuong Linh⁴, Assoc. Prof.
PhD Dinh The Hung⁵, Tran Le Phuc An⁶, Nguyen BaoKhanh⁷ and
Vu ThiThanh Binh. PhD⁸**

¹²Advanced International Business Administration 63C,
National Economics University (Vietnam)

³Resource Economics 63, National Economics University (Vietnam)

⁴Finance - Banking 64D, National Economics University (Vietnam)

⁵National Economics University (Vietnam)

⁶Sir Winston Churchill High School (Canada)

⁷Appleby College (Canada)

⁸VNU University of Economics and Business (Vietnam)

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ABSTRACT

This study surveys the application of blockchain technology in supply chain management in Vietnam. In a context where businesses face many challenges and are looking for opportunities for comprehensive business transformation, the trend of digitally transforming the supply chain is growing strongly with blockchain as a potential technology. The study analyzed data from 259 valid responses from businesses and used descriptive statistical methods to analyze important characteristics of blockchain when applied in the supply chain in Vietnam. Research results show that 6 characteristics of blockchain, including security, real-time information sharing, transparency, reliability, visibility and traceability, are evaluated quite well. When applied in supply chain businesses in Vietnam. Among them, security, traceability and reliability are three outstanding features. However, businesses need to carefully consider the benefits and costs of implementation, as well as the decisive role of humans in urgent situations.

KEYWORDS:- Blockchain, supply chain, logistic firm, supply chain management.

1. INTRODUCTION

The economic fluctuations caused by inflation, energy crises, geopolitical tensions, and especially the Covid-19 pandemic have severely disrupted supply chains across many manufacturing and service industries. Global and Vietnamese supply chains have become increasingly unstable, error-prone, and lacking adaptability. To survive in this complex environment, businesses need comprehensive business transformation. This requires tight control from various departments and rapid deployment to compete with global rivals in rebalancing supply chains and seeking new workforces. Vietnam's economy cannot be absent from this race, as logistics and supply chains are emphasized as the foundation for socio-economic development. In this context, one of the leading solutions is to promote supply chain digitalization. According to the 2023 LPI ranking, Vietnam dropped to 43rd out of 139 economies, but in terms of score group, Vietnam continued its upward trend from 3.27/5 points in 2018 to 3.3/5 points in 2023 and ranked 11th (World Bank, 2023). Additionally, according to Agility's latest 2023 Emerging Markets Index, Vietnam made the top 10 out of 50 emerging logistics markets globally (Agility, 2023).

For supply chain digitalization trends, the secret of the top 5% of organizations with the highest operational performance worldwide is applying technology to operations, allowing them to observe, collect, and analyze supply chain data (PwC Vietnam, 2023). Common technologies applied include Artificial Intelligence (AI), Blockchain, Internet of Things (IoT), Cloud Computing, and Robotics. The LPI report (2023) states that supply chain digitalization helps developing countries reduce port dwell times by 70% compared to developed countries. For Vietnam, since June 2020, after the "National Digital Transformation Program to 2025" was approved by the Prime Minister, the trend of applying information technology in supply chains in general and logistics enterprises in particular has become stronger. However, experts assess that Vietnam's E-logistics industry has not developed commensurate with its potential. In terms of technology application and digital transformation potential in Vietnam, 80% of enterprises report that increasing business efficiency is their motivation for digital transformation, and 38.4% of them find blockchain very useful when applied to supply chains (Vietnam Ministry of Industry and Trade, 2023). Therefore, the demand and potential for digital supply chains, especially blockchain technology, are substantial.

Blockchain is a secure and transparent technology for storing and transmitting information by linking data blocks over time. In logistics, this technology can be applied to develop blockchain-based transportation management platforms, supporting secure and transparent tracking of shipments, schedules, and payments. Additionally, blockchain-based smart contracts are used to automate delivery and payment processes based on agreed conditions. In this way, blockchain improves supply chain performance and brings many benefits to businesses.

Currently, many studies have measured the characteristics of blockchain technology (Aslam et al., 2021; Kim & Shin, 2019; Wang et al., 2020). However, these characteristics differ in different research contexts. Furthermore, while blockchain is considered to have many advantages when applied in supply chains, there is little empirical research in Vietnam. Therefore, studying the outstanding characteristics of blockchain technology with data from Vietnamese enterprises is necessary and will provide evidence to contribute theoretically and practically, supporting managers in improving supply chain efficiency.

2. THEORETICAL BACKGROUND

Supply Chain: A supply chain is a network of organizations and related resources participating in the production and transportation of finished products to the final customer (Sanders, 2012). A basic supply chain will involve business partners such as suppliers, manufacturers, distributors, retailers, and customers. Supply Chain Management (SCM) is the management of upstream and downstream relationships to deliver higher value to customers and minimize costs in the supply chain (Cahyono et al., 2023). From these studies, SCM can be understood to include two main aspects: (1) planning, implementing, and controlling activities in the supply chain to optimize operational efficiency, and (2) integrating and coordinating business processes within and between companies. Facing intense competition and a constantly changing business environment, supply chain management (SCM) strategy is becoming more important than ever.

Blockchain Technology: Blockchain technology can be defined as "a decentralized and distributed digital ledger, where transactions are recorded and added in chronological order with the aim of creating permanent and tamper-proof records" (Treiblmaier, 2018). Blockchain technology allows everyone to own a copy of the data and access it quickly anytime, anywhere (O'Dair & Beaven, 2017). Additionally, blockchain has a high-level encryption system, ensuring data immutability and tracking the transaction chain over time (Ølnes et al., 2017). The consensus mechanism in the peer-to-peer architecture ensures quality and integrity in the blockchain by verifying and enforcing the time order of blocks (Brandon, 2016). Smart contracts are another important feature of blockchain, allowing for automatic verification and enforcement of contract terms (Szabo, 1997). These features together create a secure, decentralized, and automated system for transactions and contracts within the blockchain network. Blockchain technology has the potential for application in various industries due to its outstanding advantages such as security, transparency, decentralization, automation, and traceability, which help improve efficiency, transparency, and safety. According to IBM, the three main functions of blockchain are distributed ledger technology, immutable records, and smart contracts. Cole et al.(2019) identified four main characteristics of blockchain: distribution and decentralization, smart contracts, peer-to-peer (P2P) communication, and information immutability. Later, Hasan et al. (2020) added two new characteristics: traceability and visibility. Finally, Aslam et al. (2021) concluded from synthesizing previous studies that there are six main characteristics affecting supply chains, including: Confidentiality (CI), Real-time Information Sharing (RI), Transparency (TS), Reliability (RE), Visibility (VI), and Traceability (TR).

Blockchain application in SCM: When applied to supply chains, blockchain will change behavior in the SCM process, thereby indirectly improving supply chain efficiency. Hald & Kinra, (2019) concluded that the strongest potential application of blockchain in SCM is to enhance transparency and accountability. Treiblmaier (2018) argued that blockchain could create unprecedented trust, transparency, and efficiency in supply chains. Petersen et al. (2018) identified 49 different applications of blockchain in SCM, such as product tracking, product traceability, and finance. Raw materials are encoded using RFID tags and barcodes, an intermediate step to store data on the blockchain network. As a result, each step in the supply process is recorded, and stakeholders can access the data and directly track the progress accurately. Although most managers recognize the potential impact of new technology, logistics companies are hesitant to invest in blockchain applications due to unclear performance benefits and potential negative impacts on employees (Hald & Kinra, 2019).

For Vietnam, most supply chain enterprises are in the early stages of digitalization. Therefore, one of the biggest barriers to the digitalization process in general and blockchain application in particular is the high investment and development costs. Many enterprises believe that the high

investment cost for a comprehensive digital transformation process of the enterprise leaves them lacking resources and proactiveness in investment. Additionally, the risk of technology implementation and concerns about uncertain returns on investment when investing in digital transformation are barriers that prevent Vietnamese enterprises, especially small and medium-sized ones, from being bold and resolute in implementation (Vietnam Ministry of Industry and Trade, 2023).

3. METHODOLOGY

Measurement of research variables: The characteristics of blockchain technology were measured according to the previous study by Aslam et al. (2021). Accordingly, 06 aspects of blockchain, including: (i) Real-time Information Sharing, (ii) Cybersecurity, (iii) Transparency, (iv) Reliability, (v) Traceability, and (vi) Visibility, were measured by 25 indicators.

Data collection: This study was conducted at the organizational level, so data was collected through a survey. The subjects were supply chain enterprises operating in various manufacturing industries, either applying or interested in blockchain. Participation in the survey was voluntary, and only those with at least one year of experience in the industry were selected to ensure a minimum level of understanding of the specifics of this field. Therefore, the target respondents were supervisors, managers, or directors in manufacturing companies in Vietnam. With the assistance of the Vietnam Blockchain Association, a non-profit government organization, the authors were able to access and interview leading experts on blockchain technology in Vietnam, thereby supplementing and deepening the topic.

To ensure the reliability of the questions, a pilot survey was conducted with the support of academic researchers. The survey questions used a 5-point Likert scale, with 1 being "Strongly Disagree" and 5 being "Strongly Agree." A total of 600 survey forms were sent by mail, with 280 responses received and 259 valid responses retained, resulting in a response rate of 46%.

4. RESULTS AND DISCUSSION

With 259 valid responses, the study analyzed the characteristics of survey participants. The characteristics of the survey participants are presented in Table 1.

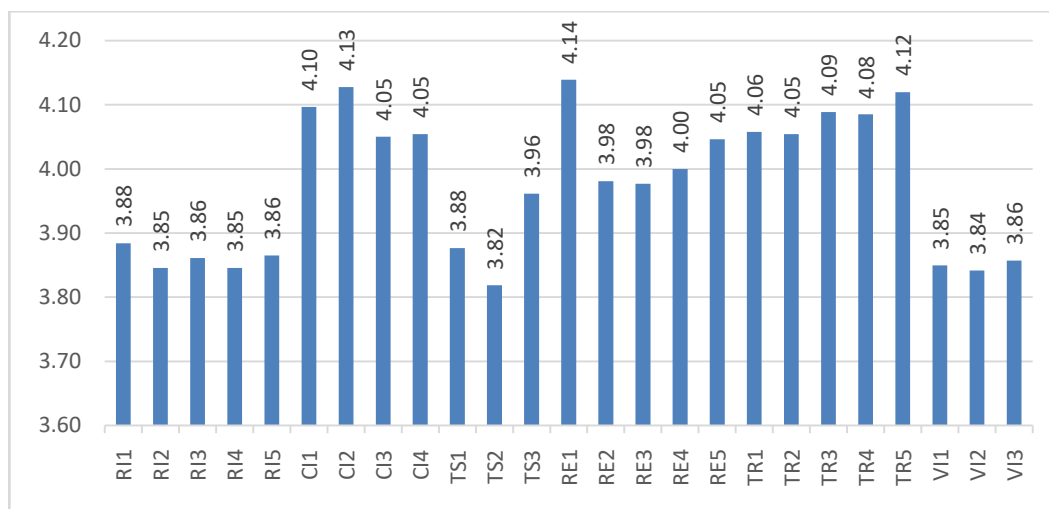
Table 1. Characteristics of the study sample (n = 259)

Sample characteristics		%	Sample characteristics		%
Workplace	Executive/Director	1.9	Age	18 – 30 years old	84.6
	Senior Manager	13.5		30 – 45 years old	13.5
	Planning and Forecasting Manager	6.6		Over 45 years old	1.9
	Supervisor	8.9	Experience	1 to 3 years	51
	Department Head	3.1		3 to 5 years	39.8
	Distribution and Retail Specialist	16.2		Over 5 years	9.3
	Sourcing Specialist	13.9			
	Accountant	1.9			
	IT	25.9			
	Other related jobs	8.1			

Source: Authors' compilation

The results in Table 1 show a diverse distribution of age, experience, and job positions among the survey participants. Notably, for technology-related positions, the under-45 age group is the majority, indicating that enterprises with a younger workforce will be more adaptable to technology. In particular, new technologies like blockchain require a knowledgeable and adaptable workforce capable of analyzing the benefits and limitations of applying this technology in a way that suits the enterprise.

The descriptive statistics of the mean values of the indicators measuring the 06 characteristics reflecting blockchain technology are presented in Figure 1 below.

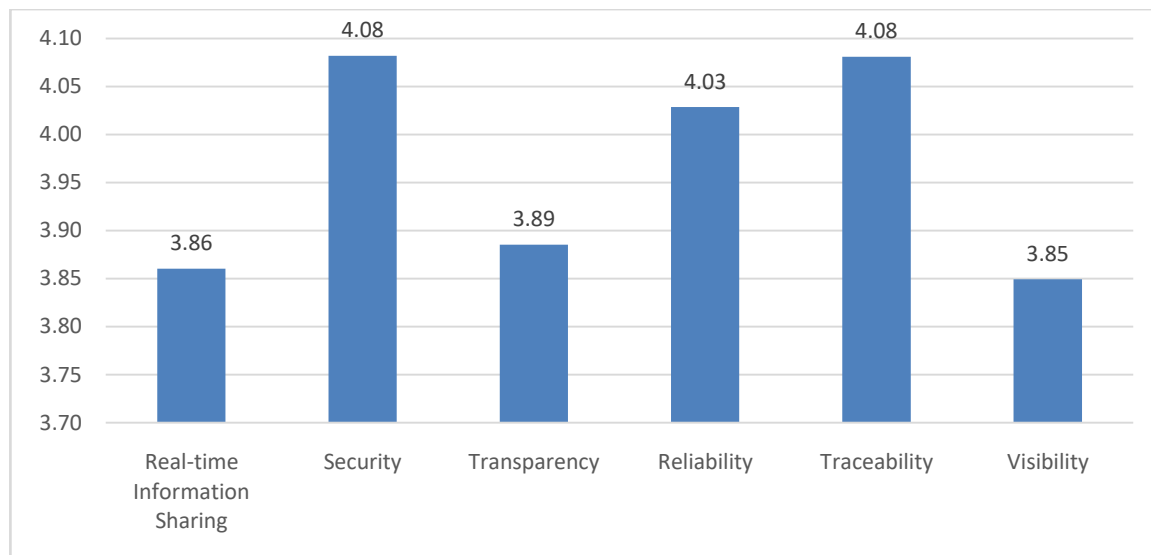


Source: Authors' compilation from analysis results

Figure 1. Descriptive Statistics Of Measurement Indicators

While the study used a 5-point Likert scale, the mean values of the measurement indicators ranged from 3.82 to 4.14. This shows that the characteristics of blockchain are rated quite highly when applied in supply chains.

Accordingly, the outstanding features of blockchain technology lie in enhancing traceability, cybersecurity, and improving reliability in the supply chain. Specifically, the use of blockchain technology in the supply chain helps "track the product manufacturing process" (mean value = 4.12) and "trace the origin of goods" (mean value = 4.09). For cybersecurity, the survey results show the consensus of enterprises in acknowledging that "blockchain technology makes information in the supply chain more secure and reliable" with a mean value of 4.13. For reliability, most surveyed enterprises believe that "blockchain technology provides a sense of security that stakeholders in the supply chain will fulfill their commitments." (mean value = 4.14).



Source: Compiled by the authors from analysis results

Figure 2. Descriptive Statistics of Blockchain Characteristics

The results in Figure 2 show that cybersecurity is the most outstanding strength of blockchain with a mean value of 4.08/5, highly rated for its ability to provide a secure transaction platform, improve privacy and inter-organizational trust with cost-saving techniques through the function of an immutable ledger. Additionally, blockchain's traceability is also a prominent feature with a mean value of 4.08/5. Blockchain helps supply chain partners transparently and clearly trace product and financial origins, enhancing collaboration and process integration efficiency. Blockchain's smart contracts allow for automatic enforcement of terms without third-party verification, thereby accelerating transaction speed and building trust among supply chain participants. Consequently, the reliability characteristic is also highly rated with a mean value of 4.03/5.

The results also show that to optimize blockchain efficiency, it is necessary to focus on exploiting its real-time information sharing, transparency, and visibility capabilities. The study by Kim & Shin, (2019) suggests that leveraging blockchain's transparency and visibility can significantly improve efficiency and enhance partner relationships. This helps overcome the bullwhip effect in the supply chain, improving revenue, fill rates, and inventory levels. Additionally, many studies have also shown that real-time information sharing helps optimize process integration, enhance planning capabilities, and increase operational flexibility (Hald & Kinra, 2019; Kshetri, 2018; Mylrea & Gouriseti, 2018; Queiroz et al., 2019).

5. CONCLUSION

This study surveyed the characteristics of blockchain technology when applied in logistics enterprises and supply chains in Vietnam. Blockchain is a technology for securely and transparently storing and transmitting information through the use of data blocks linked over time. In supply chains, blockchain is expected to bring many benefits due to its features such as real-time information sharing, cybersecurity, transparency, reliability, traceability, and visibility. The research results show that these 06 characteristics are rated quite well when applied in supply chains. Among them, cybersecurity, traceability, and reliability are the three outstanding factors. This result is entirely consistent with the reality of supply chain digitalization in Vietnam. According to the Ministry of Industry and Trade's 2023 report, 38.4% of surveyed enterprises use blockchain to improve transparency and security in supply chain management, helping to track the origin and history of goods. However, it is necessary to consider the benefits of blockchain against the implementation costs. On the other hand, blockchain cannot completely replace the role of

humans in making quick decisions in the event of an incident. Therefore, managers should carefully consider the factors that need to be implemented in supply chain management when applying blockchain.

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