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Using TOE Framework to Explore Determinants Affecting Blockchain Adoption at Vietnamese Logistics Enterprises

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Abstract: Blockchain technology has the significant ability to revolutionizese economic sectors, and the logistics industry is no exception. In Vietnam, there is a growing interest in blockchain technology among logistics enterprises. Therefore, the main focus of this study is to better understand the influence of technology-organization-environment contexts (TOE model) on the behavior of applying blockchain technology in Vietnamese logistics enterprises. To gather data for the study, a survey was conducted with 508 individuals from logistics companies in Vietnam. The results of the study indicated that top-management support plays a crucial role in enhancing the adoption of blockchain technology among logistics enterprises in Vietnam. Several recommendations for businesses to increase the adoption of blockchain technology have been proposed in this study with the aim of improving work efficiency. The study has reinforced previous studies and developed a model for applying blockchain technology in logistics enterprises in Vietnam. The authors hope that their findings will contribute to logistics management and provide valuable information for future research in this field.

Keywords: Blockchain, logistics, technology adoption, TOE, digitalization.

Subject classification: Economics.

1. Introduction

Since its launch by Nakamoto in 2008, blockchain technology has emerged as one of the most transformative drivers in the business world, and it is expected to be widely adopted by various industries and services (Iansiti, 2017). Recent surveys of industry experts and logistics and supply chain managers indicate that the adoption of blockchain technology is on the rise. Moore (2018) also believes that blockchain technology has a promising future.

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Logistics refers to the intricate procedures involved in producing and distributing commodities (Vietnam Government, 2017). Depending on the product, a supply chain may include multiple phases, geographical locations, accounts, and payment options, involving various stakeholders, entities, and vehicles. Companies in the logistics industry are particularly interested in adopting and developing blockchain technology to improve logistics procedures in the supply chain and enhance the sustainability of the chain, addressing the complexity and lack of transparency found in traditional supply networks. Although cryptocurrencies often dominate discussions and applications of blockchain technology, its applicability extends to a wide range of other industries. As a distributed ledger with numerous uses, blockchain can be employed for various data transmissions, including contracts, shipping tracking, and financial transactions. The system's transparency arises from recording every operation in a block, which is then disseminated among multiple nodes (computers). Each block is connected to the preceding and succeeding blocks, enhancing system security and boosting the efficiency and transparency of the logistics process. Implementing blockchain-based tracking of items can greatly improve decision-making and enhance consumer satisfaction.

Despite being a relatively young technology, blockchain has the capacity to develop new business models and revolutionize logistical procedures. The goals of blockchain technology include decentralization, real-time operation, anonymity, transparency, irreversibility, and integrity. However, it is important not to overlook the limitations of this technology. One prominent limitation is its performance, as verifying every transaction requires confirmation from every node in the network, which can take significantly longer compared to a centralized system. Nonetheless, blockchain technology is increasingly gaining traction as a significant trend and playing an important role for businesses in general, and logistics businesses in particular.

In the current context of Vietnam, the logistics service industry plays a crucial role as a pioneer service industry with high added value, serving as a foundation for trade development and contributing to enhancing the competitiveness of the economy. However, most logistics service providers in Vietnam are small and medium-sized enterprises that face challenges related to capital and infrastructure, including warehousing, information technology (IT), and even vehicles. This necessitates the emergence of new technological trends in the logistics field.

Blockchain technology is considered a pivotal technology for digitalization and the establishment of future IT systems, according to authors Casino, Dasaklis, and Patsakis (2021) in the era of the Fourth Industrial Revolution. Casino, Dasaklis, and Patsakis (2021) asserts that blockchain represents a turning point as it enables transparent and real-time sharing of information and data, offers efficient storage capacity, and provides high-level security. The forthcoming utilization of this technology allows all logistics businesses to develop a transparent and efficient system for capturing all transactions, tracking assets, and managing paperwork related to transport industry activities.

However, in almost every segment, logistics companies require various detection methods. Thus, the question arises as to which variables will contribute to the successful application of blockchain technology for logistics businesses. Consequently, the authors have undertaken an investigation with the topic "Using the TOE Framework to Explore Determinants Affecting Blockchain Adoption at Vietnamese Logistics Enterprises".

2. Literature review

2.1. Blockchain technology

In 1991, Stuart Haber and W. Scott Stornetta published their research on cryptographically secure chains of blocks, which marked the emergence of the concept of blockchain technology. The significance of blockchain technology grew with the release of the Bitcoin white paper in 2008 by the pseudonymous Satoshi Nakamoto. However, there is still no consensus among scientists regarding the exact definition of blockchain, as different scientific disciplines such as economics, computer science, and law have conflicting and overlapping terms used in the practical application of the technology.

Meijer's comprehensive interdisciplinary analysis titled "Consequences of the implementation of blockchain technology" (2017) summarizes the relevant aspects of the blockchain definition across industries and concludes that blockchain technology is a distributed, shared, encrypted, chronological, immutable (public/private) computer and database system with a (permission/no) consensus mechanism that allows for direct user interaction and provides value.

Rather than storing hash pointers in a single database of an enterprise resource planning (ERP) system, blockchain technology distributes their storage, organization, and verification across multiple computers, reducing the risk of a single point of failure. Unlike ERP or database systems that require significant human involvement, blockchain is designed to operate with minimal to no human intervention. Blockchain aims to create transparency, as every member of the network has access to the same data, establishing a single source of truth. The blockchain effectively unlocks data that was previously confined to secure data stores.

There is a growing concern among corporations and consumers regarding environmental and social sustainability. Blockchain technology helps address various aspects of sustainability by providing decentralized and immutable data, trusted data sources, transparency, traceability, smart contracts, and incentives. Blockchain has a positive impact on transport chain recovery strategies, particularly through collaboration, agility, speed, and visibility (Hewa et al., 2020; Lohmer et al., 2020). With the use of blockchain technology, all transactions are transparent and auditable, and the blockchain code is often available to the public. Decentralization ensures equal rights for each member, and the blockchain remains constantly synced, verified, and up-to-date. This also means that decisions, such as code upgrades, are made by the majority. The distributed network storage of blocks, multiple nodes confirming transactions, cryptographic encryption, and complex consensus processes result in a high level of integrity and security against manipulation. As a result, blockchain technology is highly trustworthy and reputable, making it suitable for use as proof to third parties, such as health insurance providers.

Large-scale, decentralized data processing enhances reliability, providing strong defense against attacks and data loss. The use of transparent hash pointers to link individual data blocks in a distributed network enables permanent tracking of transaction history. Users have more control over how their personal information is used and protected, as well as control over the transactions themselves. Furthermore, transactions processed using blockchain are faster and more efficient compared to traditional methods, resulting in higher quality at a reduced cost when compared to other IT solutions. Additionally, the technology's ability to streamline value chains and eliminate intermediaries allows for the avoidance of monopolistic market positions. Specific intermediaries and associated charges can be eliminated through the use of blockchain. For example, banks may no longer need to rely on notary public for contract verification or conduct direct wire transfers, thus reducing corruption. It is evident that blockchain technology is not only technologically and commercially suitable but also socially appropriate, offering numerous benefits for sustainability and business operations.

2.2. Review of logistics activities

The word "logistic" was coined and is now connected to the process of human growth. The research "Relationship between Logistics and Supply Chain: Building a Common Concept of Industry" by Lummus et al. (2001) highlighted this trait. In the past, the conflicts of the Greek and Roman empires are said to be where the word "logistics" first appeared. Warriors with the title "Logistikas" were tasked with supplying and distributing supplies during that time. When the sides figure out how to safeguard their supplies and eliminate the other's supply, this "logistics" activity will be crucial to the outcome of the conflict. The operational process eventually gave rise to logistics management systems. Logistics emerged in the business field, being defined as the process of gathering materials, manufacturing, and distributing products to the right destinations in the right amount. Logistics services are codified in Article 33 of the 2005 Commercial Law as "Logistics services are commercial activities in which traders organize one or more stages, including receiving goods, transporting and storing goods, storage, customs clearance, other paperwork, customer consultation, packaging, marking, delivery, or other services related to goods as agreed with customers for an honorarium".

Wang examined the growth of logistics based on the development of the industrial revolution in his study for the International Conference on Advanced Manufacturing and Automation. Logistics goes through the following four development processes: (1) Logistics 1.0 refers to the period of automation of transportation (late 19^{th} to early 20^{th} centuries). Since the invention of the steam engine, people have used machines to travel instead of using animal resources, such as railroads, ships, and airplanes. (2) From the early 20^{th} century through 1960, Logistics 2.0: Automation of the conveyance of commodities was made possible by the development of electricity and mass production in manufacturing. As a result, logistics at this point were also automated, including automatic loading and unloading systems, automatic warehouses and sorting systems, etc. (3) Logistics 3.0 (from 1960 to 2000). The development of computers and IT led to the systematization of logistics management at this time. Logistics, inventory, and transportation management have become more automated and efficient via the use of IT systems, such as Warehouse Management Systems (WMS) and Transportation Management Systems (TMS), and have markedly enhanced. (4) The most recent stage of logistics development, known as Logistics 4.0 (2000 - present), is largely centered on the growth of the Internet of Things (IoT) and big data.

The major goals of logistics 4.0 are labor cost reduction and workforce standardization in supply chain management. Processes that need human judgment and operation are being attempted to be replaced by technologies like autonomous automobiles and warehousing robots. Finding a balance between automation and mechanization is the goal of logistics 4.0. Although there are many logistics concepts, they share some common characteristics. *First*, logistics is a structured, strict, and ongoing process. *Second*, logistics is a series of continuous activities from planning, managing, implementing, and checking the flow of goods, information, capital, etc., throughout the process from input to output of products. Third, logistics is the process of planning and controlling the flow and storage of goods and services from the point of origin to customer satisfaction. *Fourth*, logistics encompasses all raw materials, fuel, resources, and inputs required to produce a product or service. *Fifth*, logistics encompasses both the planning and organizational levels. The first level addresses the issue of where, when, and how to obtain raw materials, semi-finished products, and so on. Sixth, logistics is the process of optimizing the movement of materials and information based on location, time, cost, customer needs, and profit.

Logistics plays an essential part in economic growth and globalization in Vietnam, accounting for 20.9% of the country’s GDP at a scale of USD 20-22 billion per year. Logistics, as a key service industry with high added value, is the foundation for goods trade, contributing to the economy’s competitiveness. With the explosion of digital technology and Industry 4.0, the logistics industry has many game-changing opportunities to contribute more to the economy if digital transformation is accelerated.

2.3. TOE as overarching analytical framework

The TOE framework, also known as the technology-organization-environment model, was developed by Tornatzky and Fleischer (1990) to test company-level acceptance of information system products and services. The TOE explains the adoption of technology in organizations and describes how the adoption and implementation of technological innovations are influenced by the technology, organizational, and environmental context. It has emerged as a broad theoretical perspective on the application of IT (Zhu, 2004).

TOE has been used to explain the adoption of inter-organizational systems (Grover 1993; Mishra et al., 2007), e-business (Zhu et al., 2006), and electronic data interchange (EDI) (Zhu et al., 2006). The TOE model has been used to explain the adoption of innovations in a wide range of industries, including manufacturing (Mishra et al., 2007), retail, wholesale, and finance (Zhu et al., 2006). Furthermore, the TOE model has been tested in the European, American, and Asian contexts, as well as in both developed and developing countries (Zhu and Kraemer, 2005). In each study, three technological, organizational, and environmental factors were shown to influence how a company identifies new technology needs, searches, and adopts.

The TOE model identifies three contexts related to a firm's adoption of complex technology: technology, organization, and environment (Kuan & Chau, 2001; Swanson, 2015). It explains the factors influencing the process by which a company adopts IT based on constructs-technology context, organizational context, and external mission environment context (Chan et al., 2013). The technology landscape includes internal and external technologies relevant to innovation adoption within the company. The organizational context includes the quality of human resources, the complexity of the management structure, the degree of centralization, the degree of formalization, and the size and scope of the enterprise. Finally, the environmental context refers to the industrial framework and the company's relationship with stakeholders and competitors (Kuan & Chau, 2001). It includes the relevant industry, government policy, and regulatory environment (Oliveira et al., 2014).

The TOE offers an insightful analytical framework for researching how various forms of innovation are adopted. Although the precise elements discovered in the three contexts may vary among investigations, the TOE framework has a sound theoretical basis and consistent empirical support. Zhu and Kraemer, for instance, believe that TOE is a key foundation for comprehending the predominance of e-business, whereas Wang et al. (2010) suggest a TOE-based model to explain the adoption of RFID in manufacturing organizations aiming to boost supply chain visibility and improve process efficiency.

TOE offers an advantage over other application models in evaluating technology adoption, technology usage, and value generation due to the integration of technological, organizational, and environmental elements. It also has no restrictions on the scale of the industry or the size of the firm. As a result, it provides a comprehensive picture of how technology is adopted by users, how it is implemented, what challenges it presents, how it affects value chain activities, how post-adoption spillovers affect firms, and what factors influence firms' decisions to adopt business innovation and improve organizational capabilities using technology (Zhu, 2004).

2.4. Hypothesis development

Two aspects of the technology context likely to influence technology adoption include perceived usefulness and perceived security. Davis (1989) defines perceived usefulness as "the degree to which a person believes that using a particular system will improve their job performance". People tend to use or not use an app to the extent they believe it will help them do a better job. In addition, even if potential users believe an application is useful, they may simultaneously believe that the system is too difficult to use and that the performance benefits of using it far outweigh the effort of using it. Meanwhile, security concerns in blockchain are a comprehensive plan for risk management in blockchain networks to avoid online attacks or fraud by ensuring trust in transactions. Blockchain enables authentication, security, privacy, access control, data, and resource origin and ensures integrity in the services. It operates on the principles of cryptography, decentralization, and consensus, allowing for the formation of a risk control analytical framework to study the links between business, information, and technology and to gather analytical views. Formally, we hypothesize that:

H1: Perceived usefulness has an effect on behavioral intention to adopt blockchain technology.

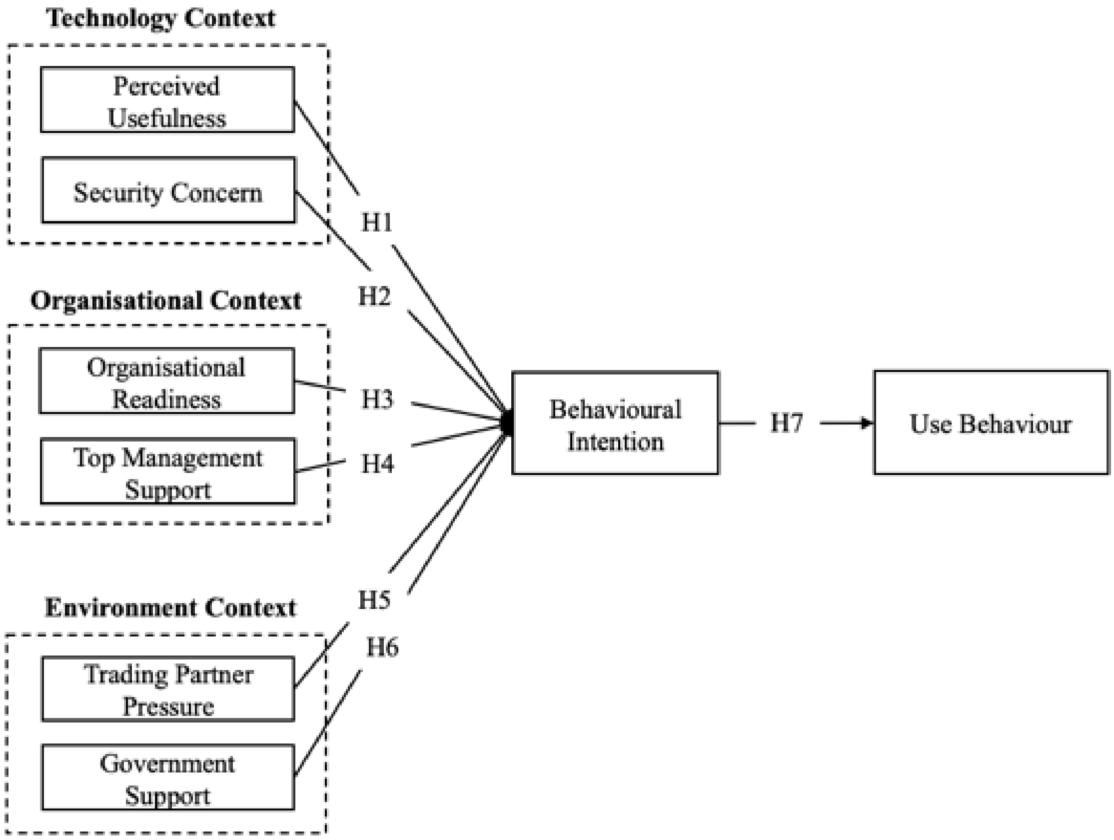
H2: Security concern has an effect on behavioral intention to adopt blockchain technology.

Mirchandani and Motwani (2001) and Stylianou, Robbins, and Jackson (2003) identified organizational receptivity as one of the factors affecting technology adoption. Organizational receptivity is the availability of specific organizational resources to adopt new technological innovations (Weiner, 2020; Wang et al., 2010). When an organization's readiness for IT innovation is high, its management and employees are likely to initiate change, exhibit greater effort and persistence, and engage in enhanced cooperative behavior (Weiner, 2020; Wang et al., 2010). Hence, this leads to more efficient adoption of blockchain technology. Regarding the organizational context, in any business, leadership plays a central role in planning the business strategy, so their role in applying new technology is essential (Wu et al., 2003). In addition, leaders provide significant financial resources to implement organizational change, especially with large investments such as technology transformation. Along with that, the application of blockchain technology may also require restructuring and reorganizing external relationships with customers and suppliers, both in terms of information-sharing networks with other businesses in the region. Therefore, we hypothesize that:

H3: Organizational readiness has an effect on behavioral intention to adopt blockchain technology.

H4: Top management support has an effect on behavioral intentions to adopt blockchain technology.

Figure 1: Research Model



Regarding the environmental context, according to Wu et al. (2003), in the context of digitalization, pressure comes from trading partners with a large influence since the initial growth phase is formed based on the sudden increase in technology application density. This trend begins when market leaders adopt digital technology, opening the way for small businesses or directly dependent businesses. Smaller businesses will increase their ability to adopt technology because they inherit the knowledge and expertise help from top large enterprises. Besides this, government support is the second factor in the environmental context that affects the application of technology in enterprises. It is because the government can introduce policies that encourage or restrict firms to adopt new technologies (Tornatzky et al., 1990). Building on the results of previous studies on technology adoption (Hameed and Counsell, 2012; Lai et al., 2018; Wahab et al., 2021), government regulations taking the form of support and incentives will stimulate the adoption or acceptance of the technology. Then, we hypothesize that:

H5: Trading partner pressure has an effect on behavioral intention to adopt blockchain technology.

H6: Government support has an effect on behavioral intention to adopt blockchain technology.

Behavioral intention is defined as the expression of an individual's willingness to perform a specified behavior, and it is considered a direct antecedent or motivation for the behavior. The applied behavior is directly influenced by the behavioral intention of the individual. Based on the above discussion, we hypothesize that:

H7: Behavioral intention to adopt blockchain technology has an effect on use behavior.

3. Research methodology

The theoretical framework and literature review, the authors construct the research model and preliminary scales. Following the survey, the authors collected 508 valid responses. Concerning age, only 2.6% of the survey respondents were over 65, ranging from 56 to 65 years old. The age group of 41-55 years old also constituted a small proportion of survey participants (8.5%). The majority of participants were mostly between the ages of 18 and 40, with 35.6% falling between 25 and 35 years old. The age group of 26 to 40 years old accounted for 53.3% of the participants, representing the highest percentage.

Table 1: Demographic Profile of Respondents

	Characteristics	Frequency	Percentage
Age	18 - 25	181	35.6
	26 - 40	271	53.3
	41 - 55	43	8.5
	56 - 65	13	2.6
Position	Intern	10	2.0
	Staff/Experts	379	74.6
	Team Leader/Head of Department/Manager	91	17.9
	Board of Directors/Director/President	28	5.5
Experiences	<5 years	294	57.9
	5 -10 years	141	27.8
	10 - 15 years	58	11.4
	>15 years	15	3.0
Total		508	100

Regarding position, the majority of survey respondents are "employees/experts" in logistics companies, comprising 74.6% of the total participants. The group of "Team Leader/Department Leader" ranked second, accounting for 17.9% of all survey respondents, and "Interns" accounted for 5% of the total.

In terms of experience, the majority of survey respondents have five years or less of experience, with nearly 300 people falling into this category. Respondents with "5-10 years" of experience accounted for 27.8% of the total, with 141 survey participants employed in logistics enterprises belonging to this category. The proportion of individuals with "10-15 years" of work experience is lower, with 58 survey respondents falling into this group. The group of survey participants with "15 years" or more of experience accounted for the smallest percentage, with only 15 people.

Based on the authors clarify the issues raised through quantitative research.

4. Result

4.1. Reliability test with Cronbach's Alpha

Table 2: Cronbach's Alpha Reliability Coefficient

Components	Label	Cronbach's Alpha	Corrected Item-Total Correlation	Number of deleted items
Perceived usefulness	PU	0.846	0.601-0.720	0/4
Security concern	SC	0.816	0.638-0.697	0/3
Original readiness	OR	0.819	0.606-0.760	0/3
Top management support	TMS	0.891	0.746-0.778	0/4
Trading partner pressure	TPP	0.875	0.650-0.758	0/5
Government support	GS	0.820	0.652-0.690	0/3
Behavioral intention	IN	0.847	0.688-0.745	0/3
Use behavior	BE	0.813	0.614-0.692	0/3

Cronbach's Alpha reliability coefficient (Table 2) is utilized to assess the reliability of the scales across three contexts: technology, organization, and environment. The scale's reliability was evaluated using the preliminary survey sample, yielding an overall Cronbach's Alpha coefficient above 0.690. Additionally, the Cronbach's Alpha coefficient exhibited consistent correlation with the total variable, ranging from 0.601 to 0.778. These findings demonstrate that the factors' scales are reliable, and the data correlation aligns with the constructed scales, meeting the criteria for utilization in SEM analysis.

4.2. Exploratory factor analysis (EFA)

Table 3: KMO and Bartlett's Test

Kaiser-Meyer-Olkin measure of sampling adequacy		.804
Bartlett's test of sphericity	Approx. Chi-Square	5360.956
	df	231
	Sig.	.000

Table 4: Rotated Component Matrix

	Component					
	1	2	3	4	5	6
TPP5	.866					
TPP4	.836					
TPP3	.830					
TPP2	.784					
TPP1	.766					
TMS4		.892				
TMS3		.861				
TMS2		.858				
TMS1		.849				
PU3			.864			
PU2			.840			
PU1			.829			
PU4			.773			
GS1				.871		
GS2				.858		
GS3				.840		
OR3					.914	
OR1					.839	
OR2					.806	
SC2						.873
SC3						.866
SC1						.817

Eigenvalue = 1.593

Extraction sums of squared loadings (Cumulative %) = 71.869%

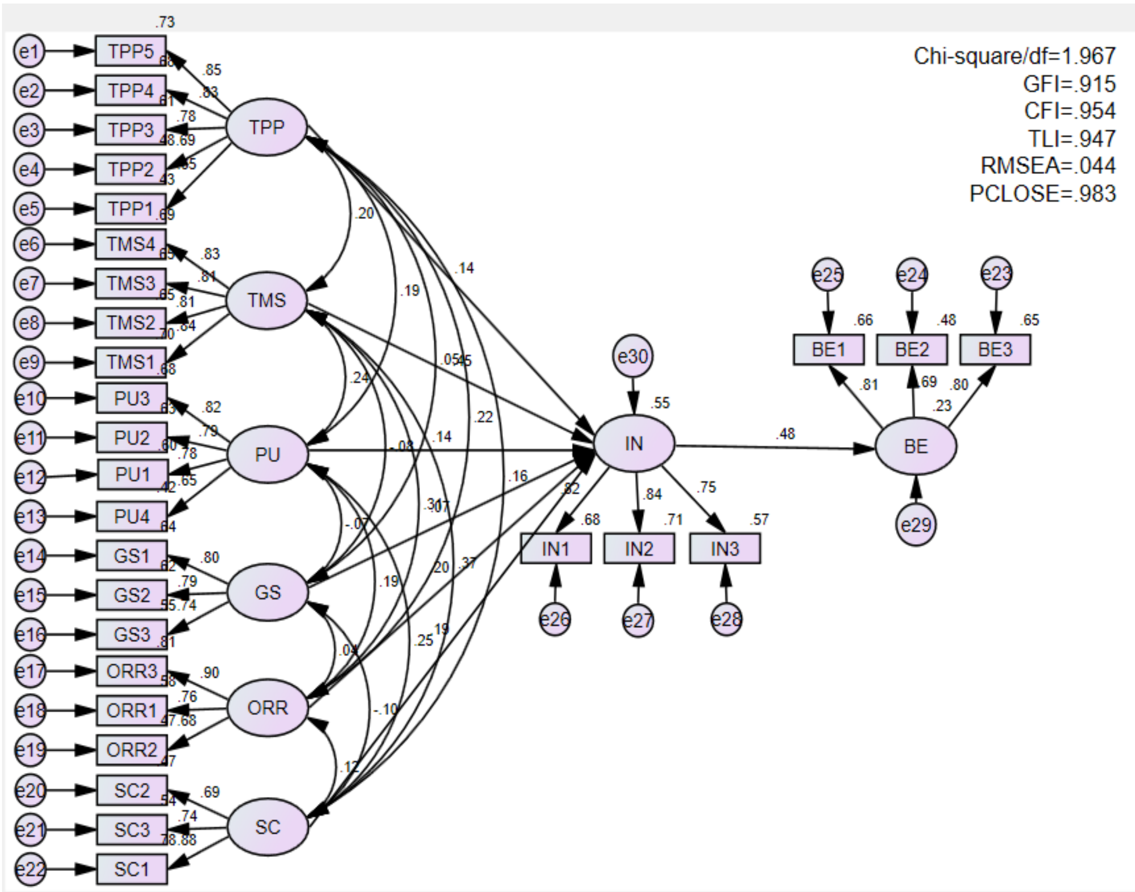
The research findings indicate that the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy = 0.804, which is greater than the threshold value of 0.5. This confirms that the data employed for factor analysis is highly suitable. Moreover, the results of Bartlett's test, with a significance level of Sig = 0.000, demonstrate that the variables are correlated with each other and meet the requirements for conducting factor analysis.

The rotation matrix for the loading coefficients reveals that the coefficients are all above 0.5. Additionally, the extraction process stops at an Eigenvalue of 1.593, resulting in the extraction of six factors. These factors account for a total extracted variance of 71.869%, which exceeds the satisfactory threshold of 50% in kernel analysis. This indicates that 71.869% of the variations in the factors are elucidated by the observed variables within the model.

4.3. Structural equation modeling (SEM) and hypothesis test

After conducting a reliability analysis of the measurement scale using Cronbach's Alpha and performing an EFA, the authors proceeded with SEM to test the hypotheses.

Figure 2: SEM Results



The results of the SEM analysis presented in Figure 2 indicate good model fit indices. These include a Chi-square/df value of 1.967, which is below 2, a TLI of 0.947 above 0.9, a CFI of 0.954 above 0.9, a GFI of 0.915 above 0.9, and an RMSEA of 0.044 below 0.08. These findings suggest that the model is suitable for further investigation.

Regarding the intention behavior, it was observed that the independent variable GS has a p-value of 0.72, which is higher than the acceptable level of 0.05. Therefore, the GS factor does not have an effect on the dependent variable. Meanwhile, the remaining independent factors (TPP, PU, TMS, SC, OR) all have p-values below 0.05, indicating that these independent factors do have an impact on the dependent variable. Furthermore, the signs of the relationships are all positive, indicating a positive relationship. These independent factors collectively explain 55.4% of the variance in the intention behavior.

In terms of use behavior, the independent factor IN has a p-value below 0.05. This suggests that all the independent factors do have an impact on the dependent variable BE, and the relationships are positive. The IN factor explains 23.5% of the variance in the use behavior. Based on these results, the authors accepted hypotheses H1, H2, H3, H4, H5, and H7, while rejecting hypothesis H6.

5. Discussion

The authors aim to gain a comprehensive understanding of the variables that influence individuals' behavioral intentions to adopt technology within a company using TOE models. After receiving the findings from the SEM analysis, the authors conducted further data analysis to derive more precise conclusions. Perceived Usefulness and Security Concern are the two primary factors that significantly impact behavioral intent. The former accounts for a 28.2% influence, while the latter has a 22.1% influence.

Based on research findings, perceived usefulness exerts a 28.2% influence on individuals' intentions to adopt blockchain technology. This highlights people's keen interest in understanding how blockchain technology can enhance their productivity in the workplace. Users hold high expectations regarding blockchain's ability to reduce costs and improve online transaction capacity. These findings are consistent with prior research conducted by Gausdal, Czachorowski, and Solesvik (2018), Jagtap et al. (2020), and Dowelani, Okoro, and Olaleye (2022). These studies also affirm that blockchain technology significantly reduces administrative costs and enhances logistics coordination. Specifically, administrative costs can be reduced by up to 15% compared to the value of transported goods. Consequently, by digitalizing the transaction process and tracing it from start to finish, blockchain enables stakeholders to track the movement and exact location of goods in the supply chain. Furthermore, to ensure cost savings, transparency, and security, smart contracts can be employed to draft the entire transaction process and execute it automatically.

The behavioral intention to adopt blockchain technology is influenced by Security Concerns, accounting for 21.1%. Thus, individuals who are more aware of blockchain technology's role in information security are more likely to develop an intention to use the technology. The research findings demonstrate that people recognize the security benefits of blockchain, as it reduces the risks associated with online transactions. Respondents noted a decrease in the "risk of fraud or abuse by stakeholders", citing that payments are "more secure", "data in transactions cannot be altered", and "transaction tracking on the blockchain becomes easier and more transparent". Similar conclusions were drawn in the studies conducted by Akram et al. (2020), and Vaghani, Sood, and Yu (2022). According to the authors, the implementation of blockchain establishes the foundation for smart logistics by eliminating labor-intensive manual processes and paperwork. By incorporating distributed ledger technology (DLT) through blockchain in business transactions, transaction security, visibility, and real-time tracking are ensured among the parties involved. Simultaneously, managers can access and manage data from contract signing to payment, as well as the transportation of goods via road, air, and sea to the buyer. Blockchain technology also provides specific security measures to prevent information manipulation and unauthorized sharing.

The authors highlight the partial exclusion of the government support hypothesis, indicating the reality of modern technology adoption in Vietnamese logistics firms. Government support can influence how companies embrace technology, as policies introduced by the government can encourage or restrict the adoption of new technology (Tornatzky et al., 1990). In Vietnam, the government has implemented specific policies to promote digital transformation in the logistics sector, such as Decision No.200/QD-TTg dated 14 February 2017 or Decision No.749/QD-TTg dated 03 June 2020. However, these policies primarily focus on promoting technology application in the overall digital transformation process, and blockchain technology is relatively new. Therefore, it can be understood that these policies may not be sufficient for logistics businesses seeking to adopt blockchain technology, which explains the relatively low outcome for the government support hypothesis. It is evident that what logistics businesses require are more specific guidelines and policies for the application of this technology in their operations, enabling easier and more effective technology implementation.

6. Implication

Blockchain technology has proven its value in improving the performance of logistics companies across various aspects. Therefore, the successful implementation of this technology in the administration and operations of logistics firms is crucial for achieving effective deployment. With this objective in mind, the authors conducted a study to examine the impact of different factors on the successful adoption of blockchain technology from the perspective of business participants. To ensure consistency and minimize undesired variations, coordination is necessary for the deployment of blockchain technology across departments and units. Continuous monitoring of technology usage throughout the company is essential for leadership. Moreover, businesses can consider implementing blockchain technology with their partners to learn from their experiences and gain more profound insights into their operations.

Furthermore, this study holds potential relevance for Vietnamese policymakers as they develop regulations to facilitate the adoption of blockchain technology in logistics businesses. By understanding the key factors driving technology adoption, policymakers can design effective policies that encourage the integration of new technologies in the logistics sector. This, in turn, can contribute to the growth of the logistics industry in Vietnam (Vietnam Prime Minister, 2020).

6.1. Theoretical implication

The research has systematically organized numerous theoretical foundations, paving the way for future studies. By incorporating insights from previous research on blockchain, logistics, and behavioral science theories, the research topic provides a substantial amount of scientific data and a theoretical basis. It offers valuable guidance for conducting research in technology in business.

The TOE framework has been extensively explored in various domains, particularly in information systems. However, its application in related fields such as logistics has been relatively slow, despite its significance in examining technology adoption, implementation, and utilization. Hence, this study contributes to the existing knowledge by applying the TOE framework to the vertical fields of logistics and information management. Additionally, the study integrates the TOE model to understand the relationship between intention to use and use behavior. This constitutes a crucial contribution to theory, as limited research has emphasized the antecedents of intention to use within logistics enterprises and their subsequent use behavior. The study effectively demonstrates that intention to use significantly impacts use behavior, thereby affirming the positive influence of modern technologies on enhancing organizational capabilities.

6.2. Practical implication

This research is not only useful in terms of theoretical implications for researchers, but also has practical implications, especially for leaders of companies in the logistics field. Its results will be very beneficial for managers and company leaders in a company that is in the process of learning, intending, and applying blockchain technology.

The findings of this study will be helpful for managers to comprehend the factors influencing the implementation of new technology in their operations, specifically blockchain technology. The successful adoption of blockchain technology is greatly influenced by top management support. Therefore, managers need to develop appropriate strategies to support employees in the process of applying blockchain technology. Implementing new technology is a complex process that requires the participation of all members of the company. Understanding the factors that affect the implementation process will be of utmost importance to businesses seeking to apply blockchain technology successfully, bringing practical implications to their operations.

7. Conclusion, limitations and recommendations

When evaluating the impact of factor groups on the intermediate variable behavioral intention in the proposed model, the authors discovered that "top management support" had the highest impact at 41.9%. This finding highlights the significance of leadership support in fostering employees' intention to apply blockchain technology in logistics businesses. Furthermore, when examining the relationship between behavioral intention and use behavior, the authors observed a 46.8% influence from intention to application behavior. Additionally, it is evident that government support, which encompasses policies and regulations, has minimal impact on behavioral intention. Estimating the relationship between GS and IN in practical terms proves challenging.

There are several limitations evident in this study that should be considered for future research and improvement. *Firstly*, the results of this study were collected within Vietnam, and therefore, they may not be generalizable and applicable to other countries. *Secondly*, the number of logistics businesses currently intending or applying blockchain technology is still limited, which has restricted the authors from obtaining a large amount of data for maximum objectivity. In the future, the study could be expanded to include data from a higher number of enterprises, allowing for more comprehensive and precise information to be gathered and enabling generalization of the outcomes. *Lastly*, this study solely focuses on quantitative research methods and does not incorporate qualitative research. Future research articles could integrate both research methods to provide the most accurate results.

It is essential to establish specific guiding documents on the application of blockchain technology, continuously updating and adding new policies to support businesses in achieving optimal conditions for implementing this new technology. Based on the findings of the study, the following recommendations should be considered by relevant stakeholders in this field:

1. Addressing government support policies associated with blockchain technology is crucial to ensure successful implementation. Specifically, there is a need for specific

guiding documents on the application of blockchain technology, regularly updated to incorporate new policies that facilitate and support enterprises in adopting this technology.

2. Building employee awareness and providing information about the benefits and usage of blockchain technology is necessary. Conducting campaigns and organizing meetings to familiarize all employees within the company with the application of blockchain technology should be implemented.

3. The success of blockchain implementation greatly relies on top management support. Managers should consistently demonstrate care and motivation towards employees during the technology adoption process. They should actively participate and guide employees on how to apply blockchain technology effectively.

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