

The Managerial Role of an Integration of Blockchain and Invoices Processing in Supply Chain Management

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Abstract

Organizations struggle with centralized supply chain management systems in service and manufacturing sectors make a supply chain under serious challenges due to the business development and expansion in the global economy such as risk of corruption, fraud, payment delving and tampering that exist effective techniques to help organizations such blockchain to play a major role to enhance business activities and cope with supply chain challenges. The main purpose of this study is to investigate the role of blockchain and invoice processing in supply chain management and how the blockchain can be integrated into supply chain to create transparency, accuracy and enhance system security. In addition, it helps to reduce the payment delayed and speed up the invoice processing in supply chain as well. The study introduces a conceptual model that includes an integration between blockchain and supply chain and invoice processing. The conceptual model suggested to reduce the invoice processing deviations, discrepancies and payment delays to suppliers. It is expected to aid the company in planning and managing its financial resources.

Keywords: *Blockchain, Supply, Chain, Management, Integration, Invoice, processing.*

Introduction

Development of global economy has led to an increasing number of businesses transaction facing supply chain management problems. Organizations struggle with centralized supply chain management systems in service and manufacturing sectors that put the supply chain at serious challenges such as risk of corruption, fraud and tampering (Azzi, Chamoun & Sokhan, 2019). Blockchain has emerged as a new distributed information technology represents a new approach in supply chain area, where visibility and transparency of product and service flows are the principal challenges. Manufacturing and distribution functions rely on intermediaries in supply chain activities (Edvard, Aksentijević, Ivanić, and Jardas, 2019). Intermediaries bring the entire supply chain management under a centralized management system. Despite information and communication technologies have reduced the information irregularity and increased the degree of inter-organizational collaboration (Thies and Stanoevska-Slabeba, 2011). Therefore, it is more significant to conduct the research on blockchain to help business organizations by identifying the problems that face supply chain and the role of Blockchain and invoice processing in supply chain and reduce the challenges that affect business activities.

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1. Literature Review

Supply chain management is a complex network-connected process includes many aspects through a very vast network of retailers, distributors, transporters and widespread operations before reaching the end customers (Muckstadt, Murray, Rappold, & Collins, 2001). A supply chain system that includes organizations, people, activities, information and resources involved in moving a product or service from supplier to customer (Kain and Verma. 2018). In business manufacturing activities and distribution functions depends on intermediaries in supply chain process (Edvard, Aksentijević, Ivanić, and Jardas, 2019). A centralizing process of management affect intermediaries in supply chain management. Despite the role of technology infrastructure and tools in information process and communication ways to reduce the information irregularity and increased the degree of inter-organizational collaboration, Blockchain technology has the potential to rebuild the way businesses conduct their operations and being one of the innovative technologies (Engelhardt, 2017) that enhances predominant factors of digitalization supply chain process such as disintermediation, transparency, traceability, digitalization, data security and smart contracts (Cole, Stevenson & Aitken, 2019).

1.1 Blockchain Technology

Blockchain Technology is the innovative information technology support the internet transactions (Edvard, et al., 2019). Blockchain technology started in 2008 by Satoshi Nakamoto, it is known as a Bitcoin where the participants can exchange goods with electronic cash (Cole, et al., 2019). Blockchain is a network of connected computers that acts as a distributed ledger of transactions (Sarmah, 2018). Every time a new transaction occurs on the blockchain, a record of that transaction is added to each participant's ledger. Each block in the chain contains several transactions (Politou et al., 2019).

The blockchain is a system that comprise of multiple nodes that keep a set of shared state and perform transactions modifying the states and these transactions must be validated by the majority of network nodes, before being ordered and packaged into a timestamped block (Azzi et al., 2019). This mining process depends on the consensus mechanism adopted by the blockchain network (Azzi et al., 2019). Blockchain works in a highly secure cryptographic technique (hash). Blockchain technology has the potential to rebuild the way businesses conduct their operations and being one of the innovative technologies that enhances predominant factors of digitalization supply chain process such as disintermediation, transparency, traceability, digitalization, data security and smart contracts (Cole, Stevenson & Aitken, 2019). Moreover, Hashing algorithm is a process to convert a transaction into another value. Hence, it is impossible to identify the original data to ensure data security real-time transparency, reliability and efficiency (Zhang, 2019).

The transaction cannot be changed or modified unless the participants among the networks have audited and confirmed the transaction (Sankar, Sindhu, & Sethumadhavan, 2017). Furthermore, blockchain is efficient for several activities, such as supply chain, financial transaction, health care and insurance claims (Cole, et al., 2019; Chang, et al., 2019; Chiu and Shang, 2019 Ritchi, et al.2023). In addition, there are four characteristics of blockchain in supply chain management: decentralization, security, auditability and smart contract (Surjandy et al., 2020) .The blockchain, serving as a shared ledger (database), may facilitate trade finance by means of its distributed network, which maintains transparent records of critical transactions among trading stakeholders (Chang et al., 2019) .The study proposed the concept of a decentralized supply chain system management that allows peer-to-peer exchange or transactions without centralized authorities that may provide a better foundation of trust as well as benefits resulting from the absence of a centralized authority (Sankar et al., 2017).

1.2 Blockchain Technology in Supply Chain Management:

Increasing number of businesses transactions due to rapid development in the business world that that exist supply chain management problems and many of organizations struggle with centralized supply chain management systems in service and manufacturing sectors that put the supply chain at serious challenges such as financial problems such as risk of corruption, fraud and tampering. Therefore, blockchain has emerged as a new distributed information technology represents a new approach in supply chain area, where visibility and transparency of product and service flows are the principal challenges.

Blockchain technology has the potential to change the manufacturing and service industries. Supply chain management is a network which a product or service flows through suppliers, manufacturers, distributors, and retailers to the customer (Mahdikhani et al., 2023). The integration of blockchain technology in the supply chain speeds up the old business model processes such as: tracing, recording, sharing information and decision making.

Blockchain is distributed ledger that records transactions over a network of users (Wang, Han and Beynon-Davies, 2019). Furthermore, large corporations deal with numerous suppliers and pay many invoices by the accounts payable department. Accounts payable is a short-term debt that refers to the amount owed to the suppliers for goods/services purchased on credit (Kosala, Francis, and Sirimewan, 2021). Moreover, the account payable department goes through steps for invoice processing that includes capturing and coding invoices and sending them for approval or rejection. It also involves submitting invoices for payment, paying them in the financial system and finally archiving invoice history that can be easily searched for editing (Bezuglov, 2018). Several organizations face many challenges that increased the complexity of supply chain management system such as: data entry errors, duplicate payments, slow processing, financial transaction and inaccurate forecast demand (Edvard, et al., 2019).

Using blockchain in manufacturing processes can enhance the quality documentation and management by eliminating the fraud in the supply chain. There are differences between traditional supply chain and blockchain in the manufacturing form different aspects. For instance, in traditional supply chain there is a gap between the date of the invoice and the actual delivery of the product (Chiu and Shang, 2019). Blockchain relies on a huge data of the organizations and keeps recording in the decentralized ledger that helps to achieve accurate forecast demand, real-time transparency and reduce delay (Chiu and Shang, 2019; Kambel, Gunasekaran and Arha, 2019).

There are some characteristics of blockchain in supply chain management such as disintermediation that means reducing the need of the middlemen such as: distributors, wholesalers, brokers, bookkeepers or agents (Maher, 2022). Blockchain threats and disrupts the traditional cycle of the supply chain (Wang, et al., 2019; Chiu and Shang, 2019; Chen and Bellavitis, 2020). In reintermediation, the traditional intermediaries will redesign a new role to maintain their positions whereas introducing blockchain disrupt the traditional value chain (Chiu and Shang, 2019; Filimonau and Naumova, 2019). In other word, reduces the need of central authority or third party to verify transaction and maintain records that help to create network with a copy of original ledger with all historical transaction (Chen and Bellavitis, 2020; Heutger, et al., 2018). This ledger controls by one organization or department while the distributed ledger is operated among the network of stockholder. Smart contract is another feature of blockchain in supply chain that is known as a digital contract between two or more parties that allows to interact and contact processes (Hoek 2019). In order to understand how a smart contract works, it is clear through the comparison between the traditional process and transaction based-smart contract (Chang, et al., 2019; Pratap, 2018). Smart contract considers as a self-execution helps to solve many problems in the traditional contract such as: the payment gap between the date of the invoice and the actual delivery of the product,

supply and demand matching and inefficiency of transaction (Nanayakkara, Perera, Senaratne, Weerasuriya and Bandara, 2021).

Many advantages can be availed by using smart contract. It can be automated tracing and payment process that makes changes in manufacturing industry and supply chain structure (Wang, et al., 2019). In this regard blockchain relies on immutable digital information and offers highly secure access to supply chain data by cryptographic system (Wang et al., 2019) The participants can access any transaction through the distributed ledgers to ensure information validity easily, while the centralized database is more likely to be hacked, corrupted, or crashed (Sara, et al., 2019). Therefore, smart contract plays a major role to exchange money, shares and services over a network with high security and value (Heutger, et al., 2018; Modi, 2018; Zhang, 2019). Logistic process and supply chain network one of the most important issues in manufacturing industry, where handling a huge number of goods need to leverage new technology to speed up shipping and tracing process (Chang, et al., 2019). For example, in China, the agri-food loss ratio is up to 30% yearly mainly due to their centralized logistic system, where decentralized traceability system based on blockchain was proposed to reduce the losses during the logistics process and enhance food safety (Tian, 2016).

Blockchain contributes to trace process to ensure real-time tracking of delivery item with high level of transparency (Shamsuzzoha, et al., 2013). Traditional tracing process depends on manual technique allows the flow of data, money and goods over a network while blockchain-based tracking process depends on automation supply chain processes among the participants (Bhaskar et al., 2020). Furthermore, the blockchain influences the tracing process quality and to solve supply chain problems e.g., losing order and order delay (Bhaskar et al., 2020).

Blockchain based business model in the supply chain system have been less discussed in the extant literature, this study contributes to provide an overview of extant blockchain-related supply chain research on invoice processing issues and shed light on potential research gap. Future research must address several blockchains related management issues such as use and manage Big Data in blockchain, that enhance the decision-making process. In addition, further works are needed in managerial issues that should be addressed the perspective of resource allocation and network collaboration. Blockchain applications and scientific research are interested subjects to be conducted in future research in different sectors includes the logistics, medical, insurance and public sectors. Similar efforts are limited and related quantitative study regarding these topics. Further research requires to address the diffusion of blockchain technology and managerial implications and social impact.

Previous research found that blockchain and supply chain management is one of these potential applications (Azzi, et al., 2019; Al-Jaroodi and Mohamed, 2019). In this regard, some studies focused on how blockchain can improve supply chain effectively in various management areas such as medical record management (Azaria, Ekblaw, Vieira and Lippman, 2016), trade finance (Guo and Liang, 2016), voting (Pawlak, Poniszewska-Marańda, and Kryvinska, 2018) and insurance industries (Sheth and Subramanian, 2019). Other research related the application of blockchain in supply chains is rather fragmented and diverse in topics (Peng et al., 2019). This phenomenon indicates a promising research interest, while researchers presented their early efforts regarding blockchain-based supply chain literature (Chang et al., 2020). Therefore, there is a lack of further research to identify the effectiveness of blockchain into supply chain process (Chang et al., 2020). This study focuses to contribute some knowledge by implement blockchain to deal with an invoice processing deviations and discrepancies that resulted in late payment to suppliers in International Developer Experts Company by using the integration of blockchain and invoices processing in supply chain management (Chan et al., 2023).

2. Research Model

The study introduces the conceptual model that mentioned in Figure (1) which describes the process of suppliers and company transactions to reduce payment delay and speed up the invoice processing. In the model, supply chain participants over the network request a transaction and send data directly to the blockchain. Each participant in the network must agree on the information of each transaction. The information is broadcasted over a peer-to-peer network consisting of nodes. These nodes will verify the information of the transaction. All transactions are recorded and spread among all participants in the blockchain network.

Moreover, these transactions are secured by cryptography (hash), each block on the blockchain has its own unique hash. If the information on a block is changed or updated, the hash code of that block will be changed. Consequently, it is inevitable for the information on the blockchain to be changed without notification and get approved by all participants. Once the contract is made, the new block is then added to the existing blockchain as shown in Figure (1). Blockchain performs as a distributed ledger that stores data in blocks synchronously, which means that the company and its suppliers can see the same data, and the documents will be recorded and shared between the supply chain participants at the same time i.e., when the buyer sends the purchase order to the supplier that will be recorded automatically in distributed ledger (Kolinski et al., 2020).

Once the goods are delivered, receipt note will be approved by a manufacture and a supplier. Consequently, the invoice will be recoded in a decentralized ledger and will be available to all participants in the network at the same time. Each party has a copy of a distributed ledger which is highly authorized, transparent and accountable. Additionally, one of the model elements is smart contract that describes and handles invoices, create transactions, verify orders and make payment process. Also, these smart contracts can execute terms and conditions automatically by sending a transaction to the blockchain.

The system analyzes and filters the information to address any discrepancies in documents automatically. Once the supplier has accepted the contract, payments can be made automatically. This enhances efficiency, security and trust immensely. Each member in the supply chain is able to make an order and communicate with the participants on the network to achieve a real-time transparency, accurate forecast demand, automation of agreement, data matching, time saving and fast processing. Hence the main objective of the study is how a blockchain plays a major role in supply chain management by solving payment issues.

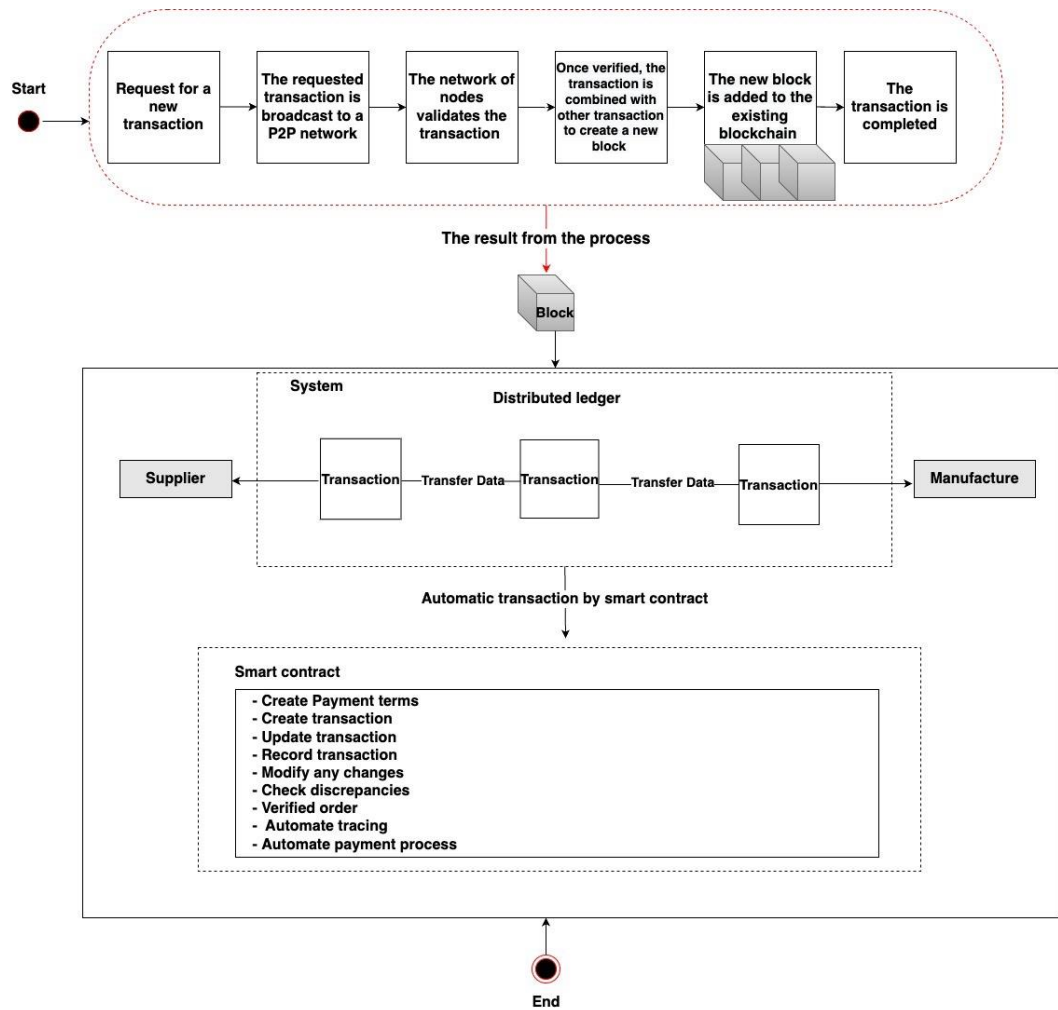


Fig.1. Research Model

3. Methodology

To achieve the research objectives and to gain further insight related to a blockchain technology and supply chain management. This study proposed an integration model of blockchain and invoice processing in supply chain and investigated the differences between the outcomes of traditional method of invoice payment records and invoice payment by using blockchain as well. The study’s model implements in International Developer Experts Company in Saudi Arabia. Data are gathered from documents, observations and interviews with employees in accounts payable department where secondary data were collected from the company records of financial data (financial report, 2021-2022); purchase number, due date, paid date and payment status for a period of two years 2021-2022 quarterly basis that analyzed by using analytical analysis for 3681 invoices across multiple suppliers.

4. Discussions

Blockchain and its unique traits that lead to growing attention from management, engineers, researchers and practitioners in the last decade. Blockchain technology has found practical applications from both academic and practical perspectives (Ritchi et al., 2023). To attain the research objectives and getting a better understanding of blockchain and supply chain management, this study analyzed the data to compare the invoice payments processing in legacy system (before applying blockchain) and after applying blockchain in the company. Next sections will discuss how the company handles supply

chain transactions in both cases; before and after integrating blockchain technology and invoice processing.

4.1 Processing data in the legacy system (before applying blockchain)

Table1: invoice payments in the legacy system in 2021

Payment status	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Grand Total	Reasons %
Paid late	569	525	641	490	2225	
Retrospective purchase order PO	116	100	130	83	429	12%
Bank Delay	34	65	76	27	202	5%
Logistic Issue	70	50	100	57	277	7%
Goods Receipt Not Created	89	99	80	100	368	10%
Quantity Variance	80	55	64	21	220	6%
Delay by Supplier	60	66	90	112	328	9%
Price Variance	120	90	101	90	401	11%
Paid on Time	419	402	310	325	1456	
Reduction in Payment run	319	350	250	250	1169	
Paid on Time	100	52	60	75	287	
Grand Total	988	927	951	815	3681	
paid late	15%	14%	18%	13%	60%	
paid on time	11%	11%	9%	9%	40%	

Table 1 showed the invoice processing payment status in legacy system. The result indicated there were payment delays. The findings showed that the invoice payment delay was increased throughout the entire year, where in quarter 1 was 15%, 14% in quarter 2, 13% in quarter 4 and the proportion of invoices paid late was the highest represent 18% in quarter 3. The mentioned variations in payment delays were caused by; retrospective purchase order, bank delay, logistic issue, goods receipt not created, quantity variance, delay by supplier and price variance. The result aligned with Nanayakkara et. al., (2021) and Wejer and Patterson (2015), who identified similar factors that lead to payment delay which is one of the key challenges in such industry. In addition, the results indicated that 12% of invoices were retrospective purchase order (PO) which means the process of creating purchase orders after providing goods and receiving invoices. This result supported by Chuensunk et al., (2018) who found that purchase order process is one of financial issue that contribute of payment delay. Moreover, there were discrepancies in invoice matching process. 11 % of invoices were delayed due to price variance and the invoice details did not match with the purchase orders and delivery receipts. Furthermore,

quantity variances are other issue where the number of items invoice did not match with the number on the purchase order or the delivery receipt by 6%. The results show that 10 % of invoices were processed after goods receipt not created (GRNs) and paid late because of accounts payable team did not process a purchase order in the first place. In addition, 9% of invoices generated exceptions in the system due to suppliers' mistakes and inefficiencies. Approximately 7% of the shipment arrived damaged or missing. Subsequently, the issues had created delay affect negatively on supply chain processes, which affected the company's financial resources. In IDE Company, accounts payable department faces numerous challenges such as the intermediaries who is responsible for not issuing goods receipt directly after receiving the goods. As a result, the finance department was concerned about invoice payment status and the accounts payable department was unable to process the invoices leading to late payments and negative impact on the supplier relationships. As financial issues are one of the major problems faced by management that affects all organization especially in the small and medium business with lack of the financial resources (Wejer and Patterson, 2015).

As consequences, the company struggled with invoice processing and late payments which had a significant impact on the company's functions Wejer and Patterson (2015) that may lead to some problems as follows:

- Increasing in overdue payment: the invoices that exceeded the due date payment resulted in inaccurate financial records.
- Managing the cash flow: unpaid invoices and late payments made the amount of money the company owes to the suppliers exceeds the available cash, that resulted in got negative cash flow which is a warning sign.
- Measuring KPI: The performance indicators yielded a negative result, as the company defined key performance indicators (KPI) for the accounts payable department to measure the efficiency and the outcome of the company's process, for instance: overdue invoices got negative results in KPI#1: Invoice processing cycle time, KPI#2: Paid on time rate.
- Impacting on accounts payable turnover ratio: the ratio measures the efficiency of IDE Company at paying to the suppliers. As a result, the late payments showed that the company's performance was too poor to manage the short-term debts. This aligned with Wejer and Patterson, (2015) who mentioned similar reasons for payment delay and their financial consequences on the companies.

In order to overcome the challenges that faced the company, deal with invoice processing deviations and discrepancies that resulted in late payments to the suppliers. Therefore, the study introduced a model to implement blockchain technology instead of traditional legacy system as a reliable network with the supply chain to proceed with invoice processing to achieve transparency, reliability and integrity of the stored data in the account payable, because blockchain could help to solve payment issues compared with traditional legacy system (Wang and Kogan, 2018)

4.2 Data analysis after applying Blockchain.

Blockchain is an efficient technique that help the company to deal with the challenges that existed through applying the legacy system as discussed in the previous section supported by study of kamble, et al., (2019) who revealed that blockchain helps organization to reduce costs of transaction, enhance the accuracy and tracing process and participants can enjoy the timeliness of information transmission among entities (Dai and Vasarhelyi, 2017). In this section, the study explains how blockchain manages data, affects company results and improves relationships with suppliers because blockchain, as a shared distributed ledger has the potential to mitigate trust issues among stakeholders (Dai and Vasarhelyi, 2017). The figure below shows the outcomes of applying

blockchain to invoice processing. Figure 2 shows the effectiveness of the company's payment process before and after implementing blockchain.

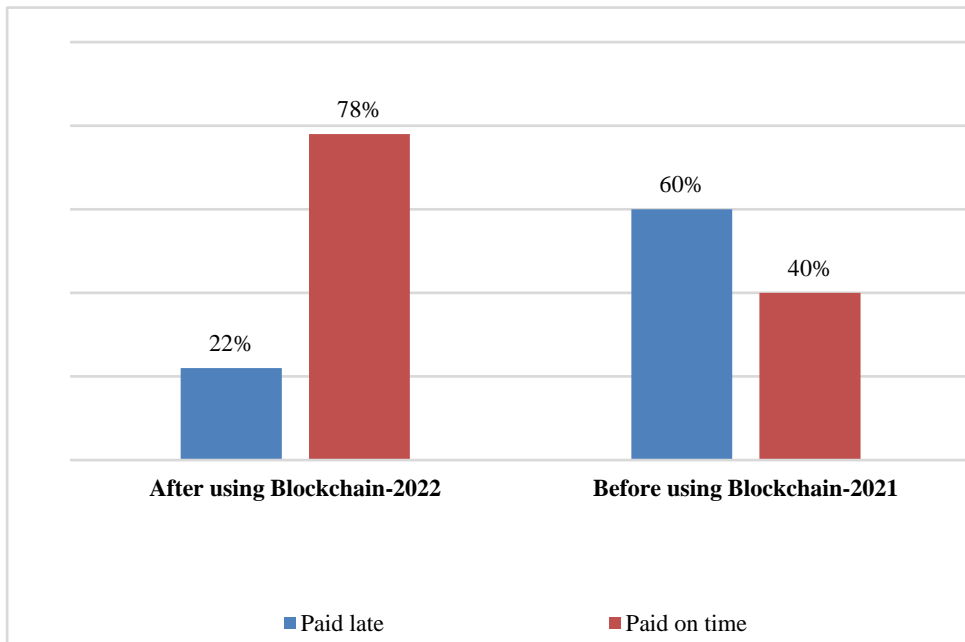


Figure 2: grand total invoice payments 2021-2022

Figure 2 illustrates how the percentage of invoices paid on time increased to 78% from 40% before the blockchain was applied. Furthermore, the number of invoices paid late dropped from 60% before blockchain adoption to 22%. These findings are supported by previous studies of (Dai and Vasarhelyi, 2017 ;Kamble, et al., 2019; Casad0-Vara, et al., 2018; Nanayakkara et al., 2021; Shamsuzzoha, et al., 2013) who indicated that blockchain has the potential to mitigate trust issues among stakeholders, which in turn could alleviate business frictions, improve the visibility of supply chain activities (Dai and Vasarhelyi, 2017).

Table2: the results of invoice payments after applying Blockchain Technology in 2022

Payment status	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Grand Total	Reasons %
Paid late	317	190	167	142	816	
Bank Delay	77	90	62	52	281	8%
Logistic Issue	240	100	105	90	535	15%
Paid on Time	390	790	830	855	2865	
Grand Total	707	980	997	997	3681	
paid late	9%	5%	5%	4%	22%	
paid on time	11%	21%	23%	23%	78%	

Based on study findings, the reasons for late invoice payments after applying blockchain are shown in Figure 3 below

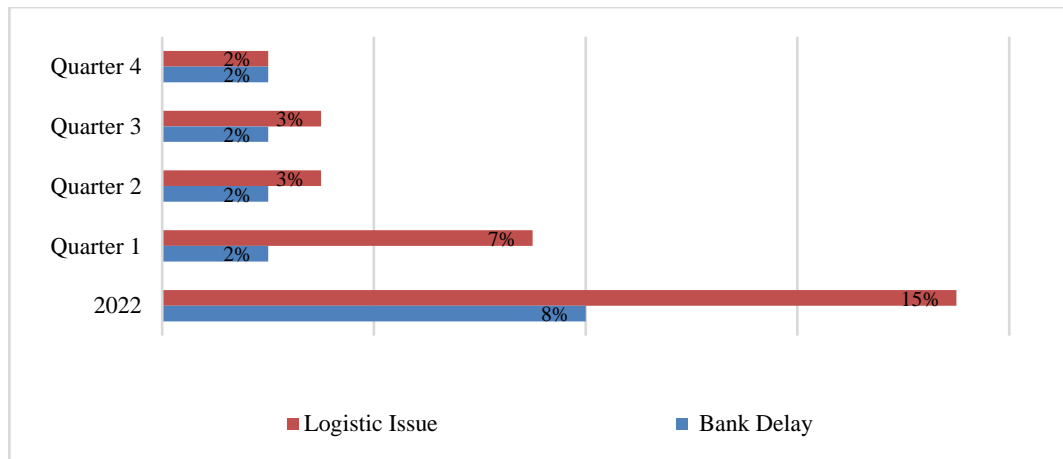


Figure 3: reasons for late invoices paid after applied Blockchain in 2022

As shown in Figure 3, in the first quarter, 7% of the problems were caused by accident of trucks or shipment arrived damaged or missing items, but no change in second, third and fourth quarters. The result supported by study of Chang, Luo, and Chen, (2020) and Nanayakkara et al., (2021) who found that companies can utilize benefit by reducing costs through implement the technological applications in supply chain. In addition, 2% of invoices were paid late due to bank transfer delays where the payment was due during public leave/holiday and the bank was closed to process the payment this aligning with Chen and Bellavitis, (2020) who mentioned that holidays and emergency times may lead to delay payments process among supply chain parts. Furthermore, the bank system failed and the company struggled to upload the payment bank file into the bank portal that leads to late payment process to the supplier. As discussed above the issues that were discussed to the application of blockchain have improved except for the logistical and banking delays because they are not within the company system.

5. Theoretical and practical implications

The findings of the study have several theoretical implications for academics, and future studies as well as practical implications for organization. The research adds to the current knowledge theoretical support for create a supply chain management system based on blockchain technology, that it is necessary to consider both the suitability of blockchain technology for the specific business and the accuracy of the data that has been collected. This research conducted to investigate the impact of blockchain technology on supply chain invoices processing. It contributes to minimize the issues in dealing with invoices processing deviations and late payments by using blockchain that showed clearly when the company used legacy system before using blockchain and after applying blockchain. The research model was designed to manage invoice processing transactions and perform accounts payable functions through the integration of blockchain-based smart contracts on the supply chain.

Moreover, it enables to deliver real-time information to all supply chain members with more secure and transparent. This significantly reduced the risks associated with late payments while also improving supplier relationships. Blockchain based business model in the supply chain system have been less discussed in the extant literature, this study contributes to provide an overview of extant blockchain-related supply chain research on invoice processing issues and shed light on potential research gap.

As far as practical implications are concerned, it is evident from the results of this study help decision makers by implement the blockchain that may improve the supply chain's objectives by reducing discrepancies, deviations and payment delays. As well as by improving visibility and ensuring that the product complies with international standards, more transparent and accurate processes will be created because a payment delay found

one of the major factors that lead to loss clients, affects suppliers' relationship and slowness in the decision-making.

Conclusion

Blockchain is an effective technology that play a crucial role to improve the supply chain's objectives by reducing discrepancies, deviations and payment delays. As well as by improving visibility and ensuring that the product complies with international standards, more transparent and accurate processes will be created because a payment delay found one of the major factors that lead to loss clients, affects suppliers' relationship and slowness in the decision-making. In order to create a supply chain management system based on blockchain technology, it is necessary to consider both the suitability of blockchain technology for the specific business and the accuracy of the data that has been collected (Yontar, 2023). This research conducted to investigate the impact of blockchain technology on supply chain invoices processing. It contributes to minimize the issues in dealing with invoices processing deviations and late payments by using blockchain that showed clearly when the company used legacy system before using blockchain and after applying blockchain.

The research model was designed to identify the major role of blockchain plays in supply chain management in solving payment issues for the company to manage invoice processing transactions and perform accounts payable functions through the integration of blockchain-based smart contracts on the supply chain (Chang, et al., 2019). Moreover, it enables to deliver real-time information to all supply chain members with more secure and transparent. This significantly reduced the risks associated with late payments while also improving supplier relationships. The main results found that blockchain reduces the invoice processing deviations and discrepancies and payment delays to suppliers. As well as by improving visibility and ensuring that the product complies with international standards, more transparent and accurate processes will be created because a payment delay found one of the major factors that lead to loss clients, affects suppliers' relationship and slowness in the decision-making.

Limitations and future research directions

Based on the research results, future researches are needed to address several blockchains related management issues such as use and manage Big Data in blockchain, that enhance the decision-making process. Furthermore, the future researches are suggested to investigate the managerial issues from the perspective of resource allocation and network collaboration. Moreover, blockchain applications and scientific research are interested subjects to be conducted in future research in different sectors includes the logistics, medical, insurance and public sectors. Similar efforts are limited and related quantitative study regarding these topics, therefore, further research requires to address the diffusion of blockchain technology and managerial implications and social impact.

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Disclosure statement

We have no known conflicts of interest to disclose.

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