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Towards a model to enhance the applicability of Blockchain in maritime shipping: A qualitative study from the Middle East

Ismail Abushaikha, Rana Albahsh, Mustafa Alsayes, Mohammad Al-Anaswah

Abstract

Purpose –Existing literature is still lacking field works that reflect the implications and applications of blockchain in supply chain management. This paper aims to explore the role of blockchain technology in improving the performance of maritime shipping and develop a model to enhance blockchain applicability.

Design/methodology/approach – Qualitative data were collected through 28 semi-structured interviews from several supply chain actors in the Middle East and were analysed based on a thematic analysis approach using Nvivo software.

Findings – An emerging model for improving the performance of the maritime shipping industry through blockchain technology has been developed. The findings suggest that there are transparency and process efficiency related improvements as an outcome of Blockchain implementation in the maritime shipping industry.

Research limitations/implications – As shipping industry is largely fragmented, small players finding it difficult to achieve great benefits such as those achieved by larger players in the sector. Our model provides guidance for the implementation of Blockchain.

Originality/value – This is one of the first scholarly works to investigate Blockchain applicability in shipping industry in the Middle East. The lack of a universal standard is a considerable challenge which is still hindering the development of blockchain applications that integrate the different actors.

Keywords: Blockchain, Maritime Shipping Industry, Sustainable Development Goals, Supply Chain Management, Middle East

Paper type – Research paper

1. Introduction

Blockchain is a distributed database or public records of all transactions or digital activities carried out and disseminated by the parties involved (Irannezhad., 2020; Mathivathanan, *et al*., 2021; Cole *et al*., 2019). It can be thought of as a decentralized open-source platform that allows better and more efficient, transparent, and trustworthy transactions between companies or individuals without using an intermediary, which would reduce the cost, time, and trust issues between all parties while also ensuring privacy for all participants (Irannezhad, 2020, Jum'a, 2023; Kshetri, 2018). There are many opportunities for organizations to obtain an

advantage by making use of Blockchain ahead of the competition, enabling them to enhance their market position.

Maritime shipping industry is an important field for technological innovation (Choi *et al*., 2019) in supply chain management (Voipio *et al*., 2023). Amongst these innovations is the Blockchain that led to "smart shipping" digitization and developed commercial agreements into intelligent computer-coded contracts (Pournader *et al*., 2020). In the case of shipping lines, mainly in the sea, big companies went for Blockchain to develop their own supply chain and trade line and process. Numerous maritime players embraced the usage of Blockchain like Maersk company, which applied TradeLens platform to track real time shipping data and documents amongst more than 234 marine gateways around the world (Choi *et al*., 2019).

As the supply chain and the maritime shipping industry system is complex and has its own problems like cost and issues of trust, Blockchain provides a solution for these problems that can also make it easier to access all services and infrastructure for any party interested with these services or products, with one great advantage of no human intervention, means there are no human mistakes or delayed payments or issues of a long process of multiple parties (Choi *et al*., 2019).

Despite that Blockchain is now undergoing rapid development and is applied to various sectors for long-term development, it has received little academic attention (Choi *et al*., 2019; Irannezhad, 2020; Jum'a, 2023). Consequently, there is a need for research to understand the actual development of the Blockchain and its application in the context of maritime industry. Academic literature on Blockchain in transportation and logistics is relatively fresh, as evidenced by recent studies (e.g. Saberi *et al*., 2019; Kamble *et al*., 2019; Weernink *et al*., 2017; Jum'a, 2023). This research intends to fill this gap and contributes to the growing body of literature on maritime shipping through exploring the role of Blockchain technology in improving the maritime shipping industry in the Middle East. The Middle East's strategic location, economic significance, geopolitical complexities, and impact on global trade and energy make it an important region for a study in maritime shipping. Research in this area can provide valuable insights for policymakers, industry stakeholders, and the broader academic community. Moreover, the Middle East's paramount importance as a pivotal node in global maritime supply chains is a subject of extensive scholarly inquiry (Abushaikha, 2018; Salhieh *et al*., 2021). As a result, this underscores the significance of studying the region's maritime supply chain dynamics.

Hence, the aim of this paper is to evaluate the role of Blockchain technology in improving the performance of maritime shipping. The contribution this study makes to literature is represented by providing evidence on the use of Blockchain in maritime supply chain from a non-western setting. The paper develops an emerging model for improving the performance of maritime shipping industry through Blockchain technology.

The remainder of the paper is organised as follows: Section 2 provides a review of relevant literature and develops a theoretical framework. Section 3 presents and discusses the research methodology. In Section 4, the analysis and findings are presented. Section 5 presents the discussion. Section 6 presents the conclusions. Section 7 provides the research limitations and directions for future research.

2. Literature Review

Supply chain has been addressed in many sectors. For example, Kumar & Nath (2019) focused on identifying and addressing supply chain issues at the procurement and production levels, with the implementation of IT solutions to improve sugar cane processing. Kumar *et al.,* (2015) underscored the importance of a well-structured supply chain, particularly for farmers engaged in sugarcane production, aiming to optimize yields and foster overall development. In the olive oil industry, Kumar (2017), discussed decision-making approaches for assessing the industry across countries, offering insights into supply chain criteria evaluation. Kumar & Kansara (2018), focused on the phases of the supply chain and suggests the use of multi-criteria decision methods to improve the industry's processes and improve quality and efficiency. Other studies emphasized the essential role of the supply chain in company performance within service industries. (Bangwal *et al*., 2023). Rajani *et al.,* (2022a), and Rajani *et al.,* (2022b), highlighted the importance of managing Supply Chain Risks and implementing Demand Management Strategies to enhance sustainability and overall performance. Arora *et al.*, (2023) highlighted the need to address issues in the frozen food cold chain in India, emphasizing their impact on stakeholders and the importance of enhanced management. Kumar & Bangwal (2023) focused on sustainability in the Indian automobile industry's supply chain, with environmental factors deemed of utmost significance.

Due to intensified global competition in international trade, the maritime supply chain plays a crucial role in containerized freight transportation. To enhance maritime supply chain efficiency, Kashav *et al*., (2023) identified and evaluated several strategies to overcome these barriers. Results indicate that dedicated feeder and hub ports, competitive port charges, and

modern equipment like Automated Guided Vehicles (AGVs) and Radio Frequency Identification (RFID), and ship profile scanning systems are key strategies. This research proposes a structured policy framework for the step-by-step implementation of these strategies to improve MSC effectiveness and efficiency (Kashav *et al*., 2023). However, other researchers have also investigated the role of Industry 4.0 technologies such as Blockchain to improve maritime and supply chain performance, and attaining certain Sustainable Development Goals that are related to food security and the environment (Tsolakis et al., 2021). Peronja et al. (2020) show that by implementing blockchain technology savings in time and money could be generated by presenting costs of container freights and rates in the previous years and assumes possible future costs of container freights and rates. Kapnissis *et al*. (2022) investigated the willingness of shipping companies to adopt Blockchain technology using a survey study of Greek bulk shipping businesses.

Blockchain is a distributed digital ledger that allows for decentralization, real-time peer-to-peer transactions, and transparency. It is built on a mechanism that allows previously unknown persons to collaboratively construct and manage nearly any database (Dutta et al.; Juma, 2023). Since the disruptive technology of blockchain was applied in 2008, it expanded overturning the current quo in supply networks enhancing decentralization, speed, tamper resistance, security, openness, transparency, traceability, automatization, and network integrity, which built trust in complicated, dynamic, and interdependent systems (Yli-Huumo *et al*., 2016).

Table 1 describes the definition of Blockchain and its perspectives within the existing literature. Moreover, validating blocks of data requires consensus of all participants, even if they do not trust one another, makes it extremely difficult for anyone to interfere with the data recorded, ensuring immutability and tamper resistance (Kapnissis et al., 2022), and hence ensures security and trust (Kapnissis et al., 2022; Peronja et al., 2020). If someone wants to seize control of the blockchain, the hazards will greatly outweigh the financial benefits (Tapscott and Tapscott, 2016).

[Take in Table 1]

The decentralized nature of blockchain technology allows for open communication and data sharing among participants. This prevents decision-making authority, transaction approval,

and data storage and validation from being delegated to a single entity. Additionally, since multiple Distributed Ledger Technologies (DLTs) are employed within the blockchain network, various versions of data records are kept on multiple nodes and across multiple locations. This makes data immutable and well-preserved. Moreover, the necessity for intermediaries is eliminated with Blockchain systems thereby reducing the overall cost of the process (MI News Network, 2019). Fourth, in BT, all parties involved in a transaction can access, display, and validate data that is kept in a distributed manner on the blockchain, increasing transparency and traceability. (MI News Network, 2019). With smart contracts, automated payments can be made. Finally, Security, a single-point attack on a Blockchain network is much less likely due of the distributed nature of the ledgers, and because of the structure of Blockchain systems, they are generally referred to as more secure than traditional systems (MI News Network, 2019; Mendling *et al*., 2018; Risius & Spohrer, 2017). Aside from technological considerations, users and society must weigh the relative value of various features that influence end-user adoption (e.g., safety, security, usability, and latency). Legal issues are also a concern to the developers and users (Mendling *et al*., 2018; Risius & Spohrer, 2017

2.1 Challenges to adopt Blockchain in maritime shipping

2.1.1 Security and Reliability Concerns

The maritime sector's security issues and vulnerabilities necessitate the creation of data protection and security solutions. While blockchain enhances data protection and reliability over conventional centralized databases, and though resolves and removes security and reliability issues (as blockchain is immutable), actual application of blockchain in the system revealed flaws and security and reliability matters.

In fact, until data is reviewed and authenticated on the network, blockchain systems cannot guarantee that it has not been altered or tampered. For example, if a system sensor or network equipment fail, become unreliable, or interfered with, or if data becomes corrupted or inaccurate for any reason, incorrect data will be stored in the Blockchain (Reyna *et al*., 2018;

2.1.2 Transaction Costs

Applying blockchain in the system can reduce some types of costs like transaction costs, broker fees. However, blockchains have their own set of costs, which in some situations are significant. as well as the associated equipment, computers. The Blockchain system costs

include hardware, software, devices, and infrastructure, as well as services and fees (BitInfoCharts, 2019). Actually, the cost of developing, implementing, and maintaining a blockchain-based system vary greatly depending on the type of platform, data and storage requirements, and the number of users, turning whether the cost reductions promised by blockchain will be exceeded by the cost of implementing it. An issue that must be addressed for each individual case scenario (Andoni *et al*., 2019; Reyna *et al*., 2018).

2.1.3 Technical limitations of Blockchain

Many shipping applications create large amounts of data, which require continual processing and storage over time. Blockchain technology lacks the substantial storage space, as well as the significant amount of computer power to process data. Third, Transaction Speed of Blockchains is slower than that of conventional databases. Moreover, permission-less blockchains now process a modest number of transactions per second compared to hundreds of transactions per second processed by centralized databases. Another difficulty is the misalignment of blockchain design specifications with those of IoT or other systems, as blockchain requires powerful central processing units and vast data storage capacity that IoT and smart devices cannot supply (Reyna *et al.,* 2018).

2.2 Considerations for Developing Blockchain Applications

The successful application of blockchain technology in the maritime industry can be achieved through certain considerations (Kapnissis et al., 2022; Peronja et al., 2020), it may need changing the business model and governance and not just replace the new technology with the traditional one as this may have a negative value on the company (Martin, 2018). The required business model structure requires decentralization, governance frameworks, enterprise-grade security, native compatibility of legal, tax, and accounting systems, and scalability.

2.3 Conceptual Model

Figure 1 shows the conceptual model of the study. The Blockchain will be studied in the context of the maritime shipping industry.

[Take in Figure 1]

The purpose is to understand how this technology may improve the performance of the shipping industry. The model is simplified in order to be consistent with the nature of this exploratory qualitative study.

3. Methodology

Consistent with our research aim, we employed an inductive research design (Miles & Huberman, 1994) using a qualitative case study methodology (Towers *et al*., 2020). Data were collected from several actors who are using Blockchain in the maritime shipping industry to gain an understanding of the role of this technology in this industry. A semi-structured interview is used in this study. This study collected data from the 28 interviews as shown in Table 2. The company's employees direct contact by online or face to face meeting were used to ensure more deeply data sources.

[Take in Table 2]

In order to overcome the subjectivity issues, the research used multiple sources of data to improve overall validity. To minimize interpretation bias, the collected data is presented whenever possible in the respondents' exact words with exact quotations of interviewees to explain the resulting interpretations. Furthermore, to increase construct validity and the reliability of the information, every step of this qualitative study was documented in order to create a chain of evidence. To increase reliability, the case study protocol and interview guide were used, and a question for conducting the interviews with list of interviewees was developed, as shown in Appendix A. All interviews were recorded, transcribed, and documented. Research procedures were documented.

4. Analysis and results

For analyzing the collected qualitative data, we used Nvivo software for data tabulation, data coding, thematic analysis, and data summaries. Data codes were labelled for allocating units of text with the same meaning which created the main themes in this study.

The Blockchain stores an immutable record of transactions that cannot be changed. The system is then powered by cryptography and includes consensual mechanisms that reduce fraud. Interviewee (28) commented on this: "Blockchain technology is secure, meaning that it cannot be tampered with or monitored. It does not have a single point of

control since it is a decentralized system that does not belong to any particular person or group. Blockchain technology is used in the marine industry to track shipments from start to end, exchange, and transfer electronic "smart" Bills of Lading, store and keep records, digitalize and decentralize shipping logistics, and declare and handle hazardous items."

Interviewee (15) explained: "Blockchain technology and distributed ledgers are attracting massive attention and trigger multiple projects in different industries". Interviewee (5), who has experience in using and creating Blockchain platforms, so he clarified: "Anyone can build their own Blockchain, but you have to have the right skills for this. You will not only need programming experience and willingness to learn more about Blockchain development but also work on building a network of users, and it is likely that you will need people and hardware to do the mining."

Table 3 shows the answers reached through the interviews about the difficulties of Blockchain implementation.

[Take in Table 3]

Most interviewees confirmed that the main challenges of the Blockchain process in the maritime shipping industry are the lack of understanding of the new technology. Hence, the parties would know the benefits of go through Blockchain, and the second element is the conflict coming from the core feature of Blockchain which is the decentralization when it faced with local or global regulations .

Interviewee (1) provided his view: "I know that many firms save their data in large servers to obtain information. Blockchain allows us to deal partners in the supply chain directly and this improves confidence in exchanging information between the different players in the shipping industry and the whole supply chain."

Interviewee (3) clarified that "Blockchain technology can be used to build applications on which several actors can make transactions directly via the network, without the need for a central authority."

Interviewee (28) explained; "Blockchain can significantly improve the performance of

supply chains by enabling faster and more cost-efficient delivery of products, which results from the enhanced cargo traceability and communication among the different partners in the chain."

Interviewee (7) provided a representative view: "Blockchain is interesting especially when it comes to shipping industry and managing supply chains as information is visible in the network which could include several different nodes of companies."

Table 4 summarizes the responses of interviewees about the benefits of Blockchain technology in maritime shipping.

[Take in Table 4]

Interviewee (8) clarified that "Blockchain in the supply chain can help participants record price, date, location, and other relevant information to manage the supply chain more effectively."

Interviewee (9) explained that "there are two main features when Blockchain impaction maritime shipping industry supply chain which are, first, transparency, where Blockchain is well applied to providing end-to-end supply-chain transparency to ensure traceability and security and second is process efficiency". The qualitative data show that most of shipping parties are confident that Blockchain could increase process efficiency within the maritime shipping industry through automatization and speed.

Table 4 shows that all interviewees agreed about scalability issues limitations, block size, response time, and high fees. A representative quote was provided by Interviewee no. 28: "There are many difficulties facing Blockchain technology and how we implement it especially in terms of scalability and skills needs. But also, the collaboration between the different parties. Are your partners in the supply chain convinced by the idea, do they understand it, do they understand the benefits and costs, are they happy to change, do they trust users, do they trust the security of this technology, are they brave enough to change? All these questions and many other you need to ask yourself, so it is not easy to decide and implement. It is much more than that, especially in our industry where many people have gained practical knowledge about this industry by experience and are generally less educated than other industries or sectors".

Interviewee (4) highlighted that the most important challenge that needs to be addressed is the increase in the processing speeds as more users join, the network tends to slow down resulting in a huge transaction fee. One interviewee commented: "I see Blockchain as a platform that helps build trust in networks without centralized control." Interviewee (6) provided an interesting view: "Blockchain facilitates our workflows with other companies in the supply chain and it gives us lots of technical support, if you like. For example, it is synchronized so that data between the different systems receives a copy of the data so all actors will have real copy of data" Interviewee (5). "Simply, what I like about is that it reduces fraud because transactions cannot be edited."

"Interviewee (26) stated that: "When companies exchange of goods that are recorded on a Blockchain, this gives them an audit trail of their asset and where it originated from and all steps in the whole pipeline. This is great… you know why? Because this gives verification, authenticity of assets, and the whole information viability improves".

Similarly, Interviewee (6) explained: "If your supply chain is geographically dispersed such as this case with the shipping industry, implementing Blockchain may be very beneficial as it is allowing us to have good visibility of the information of the shipment status and all details you might think of…We can trace products… companies who and where their goods and stocks are. Even in warehouses, it will be a simpler work, where nearly everything will be concentrated in a simple application and view the current status of stocks". Table 5 summarizes the responses about the performance improvement.

[Take in Table 5]

Interviewee (20) explained that: "you should know that most people working in shipping in Jordan and most Middle Eastern countries learnt this profession by building experiences… there was no real educational programs… that's why you find this industry is no so developed in terms of using modern scientific approach, but when we see Blockchain is coming we feel this will make a revolution in our business."

5. **Discussion**

Our findings suggest that blockchain can improve supply chain of maritime shipping industry

through an improvement in the flows of products and/or services and information. The Blockchain benefit maritime shipping industry through improving the efficiency of port traffic management, including container stacking, while reducing cost and improving security.

Current Examples and potential applications of Blockchain in the maritime sector is tracing shipments and cargo from beginning to end; electronic exchange and transfer of "smart" Bills of Lading; storing and maintaining records, digitalizing, handling of hazardous goods and declaration as well. These are all possible uses of Blockchain in the shipping and maritime industry and the whole supply chain. Payments for maritime shipping facilities, bringing stakeholders together to facilitate cooperation, fuel provenance, an emissions credit or certificate scheme, registration, maritime insurance, and classifying ships are all issues that must be resolved.

The findings suggest that players in the shipping industry should collaborate intensively to reap higher benefits from integrating their transaction in Blockchain. Our results are consistent with Jum'a (2023) and Mathivathanan *et al*. (2021) who also suggested that firms should raise blockchain awareness and actively collaborate with IT companies developing blockchain-based supply chain solutions, to meet supply chain managers' expectations about blockchain technology and its utility for supply chain management. While Kapnissis *et al*. (2022)'s findings showed that there is willingness of shipping companies to adopt Blockchain technology using a survey study of Greek bulk shipping businesses, our study provided how shipping companies in the Middle East benefit have benefited from the adoption of Blockchain.

The findings from our work corroborates with Tijan *et al.* (2019), Tsolakis et al. (2021), and Dutta *et al*. (2020) who found that Blockchian contributes to improving coordination in the supply chain and can create a one-step solution for many coordination problems in the shipping industry. Blockchain improves maritime shipping industry through implementation at ports including, enhancing the efficiency of port traffic management, container stacking, improved energy management at the port while reducing cost and improving security. These results are consistent with Schmidt (2019) who found that Blockchain contributes to reducing transaction costs in the supply chain. Although our findings are similar to those by Peronja et al. (2020) who showed that by implementing blockchain technology savings in time and money could be generated by calculating costs of container freight rates in the

previous years, our study is different in that it provided qualitative evidence from the field of the benefits and challenges of Blockchain.

6. Conclusion

6.1 Theoretical contribution

This study provided rich in-description qualitative evidence of the Blockchain impact, challenges, and benefits in the maritime shipping industry in the Middle East. Actors from several sectors involved in the maritime shipping in the Middle East provided their insight into the use of Blockchain in this context. The contribution this study makes to literature is represented by providing evidence on the use of Blockchain in maritime supply chain from a non-western setting, and by developing an emerging model explaining the different aspects associated with the implementation of Blockchain in maritime shipping. Investigating blockchain within the context of shipping industry provided interesting insights into the developing body of research within this area. Numerous difficulties, such as inadequate cargo monitoring accessibility and lack of transparency including maritime transport with many stakeholders could be solved using Blockchain technology.

Blockchain technology enabled faster processing time and real-time updates which reduced the amount of email communication and document exchange among to various parties. Higher accuracy: Since all the execution of contracts and other processes are automated, the errors are much less probable. Transparency: The information is stored in a place where everyone can have access if he has the required access key. This gives full transparency to market participants. Increased security: All information is encrypted, something which adds security on its own. Lower transaction cost: A big part of the trade financing costs is related to documentation, procedural delays, discrepancies, or errors. These costs can be omitted, and total cost currently spent to various intermediaries will be avoided and replaced by a much cheaper cost of the Blockchain.

Figure 2 below depicts the emerging model of the study. It reflects the findings from the qualitative data analysis conducted. The model consists of several components and elements as shown below.

[Take in Figure 2]

The emerging model shows that Blockchain facilitated greater transparency and efficiency,

resolving key challenges around inefficiency and information asymmetry among supply-chain players. Blockchain is well applied to providing end-to-end supply-chain transparency, and it overcomes situations in which trust is lacking between the different actors. The findings suggested that most of maritime shipping parties feel Blockchain could increase process efficiency within the maritime shipping industry through automatization and speed. A further Blockchain specific advantage is that every party in the value chain can access the same data and reduce the burden of traditional communication amount parties of the supply chain.

Finally, Blockchain technology development is still in the infancy stage; although there are some Middle Eastern companies using blockchain technology in the trial run, the full-scale operation achievement needs to test the effect of blockchain in the whole value chain from both theoretical and empirical perspectives.

6.2 Practical, political, and social implications

The Middle East's prominence in global maritime supply chains has emerged as a rich field of study, attracting scholars from various disciplines. The region's unique geographical position, energy resources, infrastructure investments, and trade relationships offered a compelling context for the exploration of Blockchain implementation. In-depth investigations into these facets not only shed light on the region's importance but also contribute to a deeper understanding of Blockchain implementation in different settings. Organizations in the maritime shipping industry in the Middle East should first assess the potential impact of the use of Blockchain instead of striving for first-mover advantages by rushing quickly into Blockchain applications. Typically, most of the small organizations in the maritime shipping industry are still unable to involve in this technology because they must use it through an existing Blockchain programming such as Ethereum, and thus networks are requesting high costs for each transaction. They can avoid this problem by managing a collaboration together to create their own platform with zero transaction fees.

Organizations should strive to hire training and quick-to-learn individuals who can understand new applications in context. firms should raise blockchain awareness and actively collaborate with IT companies developing blockchain-based supply chain solutions, to meet supply chain managers' expectations about blockchain technology and its utility for supply chain management. Shipping companies need also to consider the needs of business partners from other sectors who are involved in the maritime supply chain, as suggested by our qualitative evidence.

The lack of recognition of the digital currency so far is a reason for limited integration between public Blockchain and private Blockchain as shipping companies and other actors in the supply chain are not able to use their digital currency such us Bitcoin to pay their payable in private Blockchain platforms. Thus, growing recognition of digital currency would develop integration platforms and generally the implementation of Blockchain across the supply chain.

7. Limitations and Future Research

There are several limitations of this study which opens avenues for future research. First, data were collected only through a qualitative approach, and thus results cannot be generalized. Future researchers are encouraged to conduct survey-based studies which can be analyzed using structural equation modelling to be able to make the results more generalizable. Second, the study was limited to the maritime shipping industry and did not study other sectors. Future researchers could test the developed model in other industries and contexts. Future studies are also recommended to carry out an investigation that embraces the whole supply chain to improve our understanding of the technology. Future studies could also investigate cultural aspects in the implementation of Blockchain.

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Appendix A. Interview Protocol

General background

- Provide an overview of the research project.
- Get interviewee details and experiences.
- Explain that this interviewee will be recorded upon their approval

Core areas of discussion

- Challenges and issues related to the use of the platform as a new technology in the supply chain
- The changes in the supply chain management after the applying of the platform
- The implications of the Blockchain in the maritime shipping industry
- Difficulties in implementing Blockchain technology, which may restrict its?
- Benefits/Strengths of Blockchain in the sector
- Areas of improvements in the supply chain performance
- Examples of existing blockchain project in the maritime shipping sector
- Future projects of blockchain implementation in shipping and supply chains

Table 1: Blockchain definitions and characteristics (Source: Developed by the authors)

Author, Year	Definition	perspective
Nakamoto (2008)	The Blockchain is a decentralized database that works without a central authority and does not rely on third-party verification.	Decentralized distributed ledger that everyone agrees on, with no mediation
Juma (2023)	The Blockchain is a peer-to-peer record-keeping technology that stores transaction records and makes them available to all computers in a network	Distributed ledger to keep track of transactions and available to all in the network
Winebrake (2019)	A Blockchain is a digital ledger made up of linked entries called blocks that contain data that varies depending on the application	Digital ledger linked with blocks of data
Suominen (2018)	Blockchain is frequently portrayed as a young technology that promises to disrupt status quo operations in a variety of industries and supply networks	Operational disruptive technology with many uses
Chang et al. (2020)	Blockchain is a cutting-edge technology that has the potential to disrupt applications and use cases across a wide range of industries, including marine	Operational disruptive technology with many uses
Dutta et al. (2020)	A distributed database of records or a public ledger that keeps track of all transactions that have been executed.	All participants have access to the data of all transactions within that blockchain

Table 2: Overview of interviews (Source: Developed by the authors)

No.	Role	Company/Industry	Country	Language	Interview Mode	Duration (Minutes)
1	Purchasing Supervisor	Maersk	Jordan	English	Face-to-face	45
2	IT Manager	Gezairi	Lebanon	Arabic	Virtual / teams interview	60
3	logistics Manager	Nestle exclusive distributor	Iraq	English	Face-to-face	60
4	Logistics Supervisor	G Mac shipping	Dubai	English	Face – to Face	40
5	General Manager	G Mac Logistic	Dubai	English	Virtual / teams interview	60
6	Project Manager	Levant logistics	Jordan	Arabic	Face – to Face	60
7	CEO	Gezairi Transport	Lebanon	English	Virtual / teams interview	45
8	Developer	Alpha technology development co	Saudi	English	Virtual / Zoom interview	35
9	Maritime Manager	Green Road for logistic – Jordan	Jordan	Arabic	Face to Face	40
10	Project Manager	DB Shenker	Iraq	English	Face to Face	50

11	Logistics Manager	Levant for transport and transit – Jordan	Jordan	English	Face To Face	35
12	General Manager	Gezairi Transport – Turkey	Turkey	English	Face to Face	30
13	Exclusive Manager	Gezairi Transport – Iraq	Iraq	English	Face to Face	40
14	General Manager	Gezairi Transport Iraq	Iraq	English	Face to Face	45
15	Developer	International development technology – Egypt	Egypt	English	Virtual / Zoom interview	35
16	Developer	International development technology – Jordan	Jordan	English	Face to face	35
17	LCL Manager	Gulftainer Terminal management – Iraq	Iraq	Arabic	Face to face	45
18	Dep manager	smart technology co – Jordan	Jordan	Arabic	Face to Face	35
19	Purchasing Manager	Ministry of Defense Iraq	Iraq	Arabic	Virtual / Zoom interview	35
20	Clearance Manager	Dijlah shipping CO	Dubai	Arabic	Face to Face	45
21	Operations Manager	Food distribution	Egypt	Arabic	Face to Face	40
22	Shipping supervisor	Shipping	Jordan	Arabic	Face to Face	45
23	Shipping Manager	Shipping	Dubai	English	Virtual / Zoom interview	40
24	Logistics Manager	Food distribution	Jordan	Arabic	Face to face	35
25	Supply officer	Food distribution	Egypt	Arabic	Face to face	45
26	Purchasing Manager	Seaport Management	Egypt	Arabic	Face to Face	40
27	Clearance Manager	Shipping	Jordan	Arabic	Virtual / Zoom interview	35
28	Operations Manager	Shipping	Saudi	Arabic	Face to Face	55

Table 3: Difficulties of Blockchain technology implementation in maritime shipping (Source: Developed by the authors)

Interview	Maritime Shipping Implementation difficulties				
	- Storage, Transaction Speeds, and Scalability - Integration of Data Communications	Blockchain is emerging technology, and the skills needed to develop	The Info of Blockchain technology cannot be edited	-Huge transaction fee - Difficulties with Updating - Difficulty of Development - Crime – - Human error –	Blockchain scalability issues limitations, block size, response time, and high fees
Interviewee 1	✓		✓	✓	
Interviewee 2			✓	✓	
Interviewee 3			✓	✓	
Interviewee 4			✓	✓	✓
Interviewee 5	✓	✓	✓	✓	✓
Interviewee 6	✓		✓	✓	✓
Interviewee 7	✓		✓	✓	✓
Interviewee 8	✓		✓	✓	✓
Interviewee 9	✓		✓	✓	✓
Interviewee 10	✓	✓	✓	✓	✓
Interviewee 11	✓		✓	✓	✓
Interviewee 12	✓	✓	✓	✓	
Interviewee 13	✓	✓	✓	✓	
Interviewee 14	✓		✓	✓	✓
Interviewee 15	✓	✓	✓	✓	
Interviewee 16		✓	✓	✓	
Interviewee 17			✓	✓	✓
Interviewee 18			✓	✓	✓
Interviewee 19			✓	✓	✓
Interviewee 20			✓	✓	✓
Interviewee 21	✓	✓	✓	✓	
Interviewee 22	✓		✓	✓	✓
Interviewee 23	✓	✓	✓	✓	
Interviewee 24		✓	✓	✓	
Interviewee 25			✓	✓	
Interviewee 26			✓	✓	
Interviewee 27			✓	✓	
Interviewee 28			✓	✓	

Table 4: Benefits of Blockchain in maritime shipping industry (Source: Developed by the authors)

Interview	Benefits in Maritime Shipping industry						
	Increased Transparency and Traceability	Trust Decentralized structure - Improved security and privacy	No third-party interference No government or financial institution	Reduced Transaction Costs (or Information Sharing Costs)	The Blockchain responsible for keeping record of all the transactions	Speed - Visibility and traceability	Blockchain allows peer-to-peer and business-
Interviewee 1	✓	✓		✓	✓		✓
Interviewee 2	✓		✓	✓	✓	✓	
Interviewee 3		✓	✓				✓
Interviewee 4				✓	✓	✓	
Interviewee 5		✓	✓	✓	✓		✓

Interviewee 6	✓					✓	✓
Interviewee 7	✓	✓	✓	✓		✓	
Interviewee 8	✓	✓	✓	✓			
Interviewee 9	✓	✓		✓		✓	✓
Interviewee 10				✓	✓	✓	
Interviewee 11	✓	✓			✓	✓	✓
Interviewee 12	✓	✓					
Interviewee 13			✓		✓	✓	✓
Interviewee 14	✓		✓				
Interviewee 15	✓	✓		✓	✓	✓	✓
Interviewee 16	✓		✓	✓	✓	✓	
Interviewee 17		✓	✓		✓		
Interviewee 18	✓			✓	✓		✓
Interviewee 19	✓	✓	✓	✓		✓	✓
Interviewee 20		✓	✓		✓		✓
Interviewee 21			✓		✓	✓	✓
Interviewee 22	✓		✓				
Interviewee 23	✓	✓		✓	✓	✓	✓
Interviewee 24	✓		✓	✓	✓	✓	
Interviewee 25		✓	✓		✓		
Interviewee 26	✓			✓	✓		✓
Interviewee 27	✓	✓	✓	✓		✓	✓
Interviewee 28		✓	✓		✓		✓

Table 5: Performance improvement in the supply chain (Source: Developed by the authors)

Interview	Blockchain benefits in maritime shipping industry				
	Improved operational efficiency	Less use of documents – faster transactions	Delivery performance /lead time and delivery reliability	Integrated view of the geographically dispersed supply chain	Higher security
Interviewee 1	✓		✓		
Interviewee 2	✓		✓	✓	
Interviewee 3		✓		✓	✓
Interviewee 4		✓	✓	✓	✓
Interviewee 5		✓	✓	✓	✓
Interviewee 6	✓	✓	✓		
Interviewee 7		✓	✓	✓	✓
Interviewee 8	✓	✓		✓	✓
Interviewee 9	✓	✓	✓	✓	✓
Interviewee 10	✓		✓	✓	✓
Interviewee 11	✓	✓	✓	✓	✓
Interviewee 12	✓	✓	✓	✓	✓
Interviewee 13	✓	✓		✓	✓
Interviewee 14		✓	✓	✓	✓
Interviewee 15	✓	✓	✓	✓	✓
Interviewee 16	✓		✓	✓	✓
Interviewee 17		✓	✓	✓	✓
Interviewee 18		✓	✓	✓	✓
Interviewee 19	✓	✓	✓	✓	
Interviewee 20	✓	✓	✓	✓	✓
Interviewee 21			✓		✓
Interviewee 22	✓		✓		✓
Interviewee 23	✓		✓	✓	✓
Interviewee 24	✓	✓	✓	✓	✓
Interviewee 25	✓	✓	✓	✓	✓
Interviewee 26	✓	✓	✓	✓	✓
Interviewee 27	✓	✓	✓	✓	✓
Interviewee 28				✓	✓

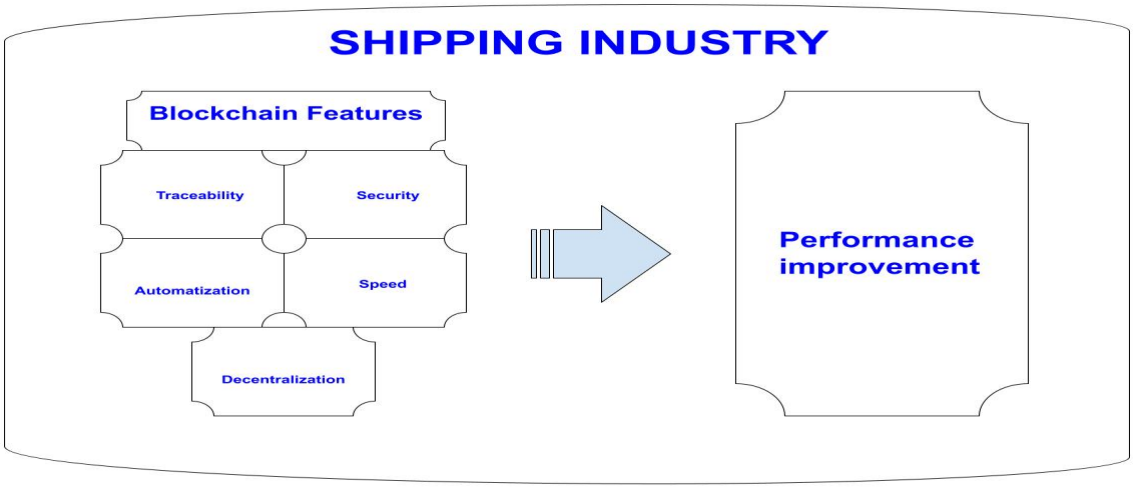

Figure 1: Conceptual model (Source: Developed by the authors)

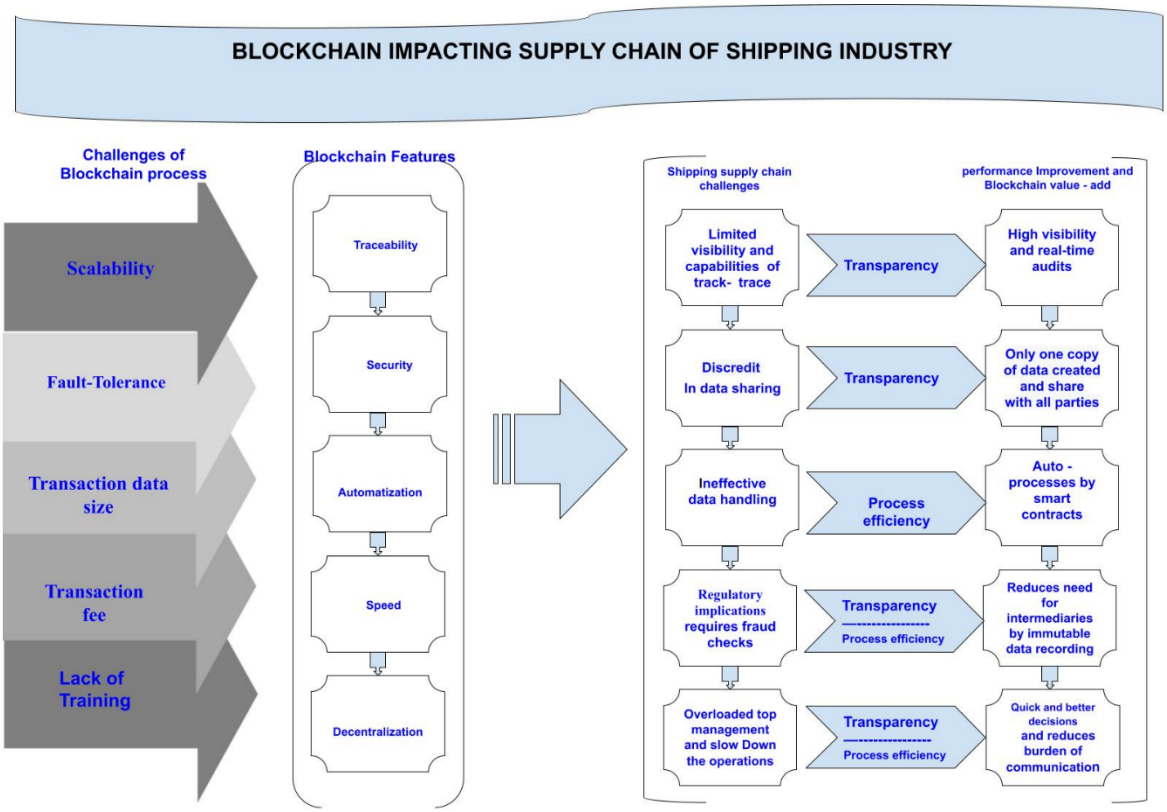

Figure 2: Emerging model (Source: Developed by the authors)