Remittances Review
June 2024,
Volume: 9, No: 3, pp. 71-88
ISSN : 2059-6588(Print) | ISSN 2059-6596(Online)
Received : 15 March 2024, Accepted: 25 April 2024
DOI: https://doi.org/10.33282/rr.vx9i2.03

The Impact of Blockchain Technology on Supply Chain Management Efficiency in the Maritime Industry

Authors;

1. Sikandar, M.Phil scholar of International Trade, School of Economics and management Shanghai Maritime, Sikandarkhhn@gmail.com

2. Osama bin Shahid, Management Sciences (COMSATS University Islamabad,Attock Campus), osamashahid.obs@gmail.com

3. Zarish Assad, Department: Faculty Of Business & Communication

4. Hafiz Moazam Hussain, Health services academy Islamabad, Sardar.moazam10@gmail.com

Abstract:

Blockchain technology has emerged as a disruptive force in various industries, promising enhanced transparency, security, and efficiency in business operations. In the maritime industry, characterized by complex supply chains and multiple stakeholders, blockchain holds significant potential for streamlining processes and reducing costs. This paper explores the impact of blockchain technology on supply chain management efficiency in the maritime industry. Through a comprehensive review of relevant literature and case studies, we examine how blockchain facilitates improved transparency, traceability, and automation of transactions in maritime logistics. Furthermore, we analyze the challenges and opportunities associated with the adoption of blockchain technology in maritime supply chains, including issues of interoperability, scalability, and regulatory compliance. By highlighting successful implementations and potential future developments, this research contributes to a deeper understanding of the transformative

potential of blockchain technology in revolutionizing supply chain management practices within the maritime industry.

1. Introduction

Background and Context

Today's business environment has expressed enhanced concern towards the blockchain as the global innovative technology for enhancing the effectiveness and credibility of operations across sectors. Blockchain was launched as a technological base of virtual financial instruments as bitcoins and evolved to cover other areas of application. Due to decentralization and the capability of records being un-alterable, this increases its suitability in industries such as supply chain or where transactions have to be secure and the record irrefutable (Attaran and Gunasekaran. , 2019). The promising areas for using the blockchain technology are the supply chain, smart contracts, and identity. In this regard, the application include the tracking of goods, authorization of transactions, and documentation authorization. This is even more relevant in sectors with multiple and many supply chain partners such as the maritime business (Dutta, et al.
, 2020). Due to maritime global nature and its processes are intricate, the application of blockchain technology can also bring some potential advantages.

Maritime indeed is one of the largest operational broken down of transport and is used largely in the shifting of a good portion of the trade loads around the world. But it is not without its disadvantages which are; documentation fraud, delay in shipment and generally secrecy. These problems do not only increase expenses but they are also a barrier and a source of conflict with other actors. These challenges can be met through blockchain hence accelerating the efficiency of the supply chain in the maritime industry (Czachorowski, Solesvik and Kondratenko. , 2019). The findings of this research will include details on how blockchain can enhance the effectiveness, responsibility, and sound management of the MSC. This paper examines theexisting problems, assesses the effectiveness of blockchain technology based on the case studies,analyses the factors influencing its adoption, and outlines the preferred future uses of blockchain in the maritime logistics.

Problem Statement

Supply chain management problems in the maritime industry are quite visible because the industry is large and operationally complicated hence relies on traditional methods. Some of the current practices are on document archiving, individual processes, which make fraud, datainaccuracy and, inefficiency to prevail. These challenges are compounded by the lack of real time visibility on transactions across the supply chain thus leading to improper shipment tracking, document forgery, and delayed delivery. This is why it is essential to come up with efficient mechanisms to optimize various supply chain processes, increase their transparency andeffectiveness. Currently, the challenges mentioned above can be solved with the help of blockchain technology as it provides secure and transparent records of transactions.

Research Question

How does blockchain technology impact supply chain management efficiency in the maritime industry?

Research Aim

This research aims to explore the impact of blockchain technology on supply chain management efficiency within the maritime industry, focusing on improvements in transparency, traceability, and process automation.

Research Objectives

- To analyze the current challenges in maritime supply chain management.
- To evaluate the potential benefits of blockchain technology in addressing these challenges.
- To examine real-world case studies of blockchain implementation in the maritime industry.
- To identify the challenges and opportunities associated with the adoption of blockchain technology in maritime supply chains.
- To provide recommendations for future developments and implementations of blockchain in maritime logistics.

Through these objectives, it is the aim of this research to come up with a holistic approach of how the application of blockchain technology can impact on the management of maritime supply chain. The outcome of the study will bring insight towards the general discourse on howblockchain technology can revolutionalise complex supply chain, thereby improving efficiency and accountability within the maritime industry and all its stakeholders.

2. Literature Review

Blockchain Technology and Its Features Relevant to Maritime Supply Chains

Blockchain is an open database that is distributed, shared and provides an unalterable record of activities on a transaction. It performs through related blocks of information, where each block includes a time stamp and a reference to the prior block, creating a chain. They include nodes (the computers in the network) , the blocks or the records of the data and the consensus which is the processes of validation of the transactions. Smart contracts are digital contracts written in codes that automatically enforce and execute the agreed terms of the contract, thereby eliminating intermediaries (Gurtu and Johny., 2019). This literature review focuses on the utility of blockchain technology in the management of maritime supply chain supply chain and its potential in improving the transparency and efficiency as well as the operations in the supply chain. It also discusses essential controversies regarding technological, economic, regulatory aspects, and the existing research gaps.

Every transaction is documented in a block which receives a timestamp and is then linked to the previous block to create a chain. This design helps in making the structures to be as transparent as possible thus protecting the data from being manipulated or altered. However, in industries such as maritime supply chain where transparency and transaction verifiability are important blockchain provides a more secure ledger system to track goods and transaction (Peronja, Lenac and Glavinovic., 2020). Central to blockchain are its key components: they distributed such elements like blocks, chains, nodes and the consensus mechanisms. Blocks are the structures thatcontain the transaction data with time stamp and a hash value of previous block in the chain. Participants of the network, which are computers, store the blocks of the blockchain and process the transactions based on the consensus algorithms. These include PoW and PoS through which

nodes are able to come to consensus about the validity of a transaction without the need for a single point of trust in the system which makes the blockchain ledgers to be reliable (Wagner and Wiśnicki., 2019).

Smart contracts enrich the use of blockchain even more because the latter enables contract fulfillment guided by rules embedded in software code. In maritime supply chain smart contracts help in simplification of activities such as; cargo handling, insurance processing and customs clearance. Through these types of transactions, smart contracts eliminate bureaucracy, error- prone actions, and increase system effectiveness. The following automation of the transactions enhances the chain of supply increases efficiency to stakeholders by cutting expenses and increasing reliability (Li and Zhou., 2021).

Security and data integrity is a priority when it comes to the blockchain technology. Encryption techniques and consensus algorithms are the otherwise crucial elements pertaining to protection of data. Every block in the blockchain is associated with a distinct alphanumeric code known as the cryptographic hash, which detects modified data. It is a distributed consensus algorithm that checks and approves transactional activities among the network nodes for any form of fraudssuch as double-spending and ensures the authenticity of the ledger. These features render blockchain immune to cyber risks and therefore offer assurance to the stakeholders of the supply chain within maritime logistics (Carlan, et al., 2020).

Applications of Blockchain in Optimizing Maritime Supply Chain Processes

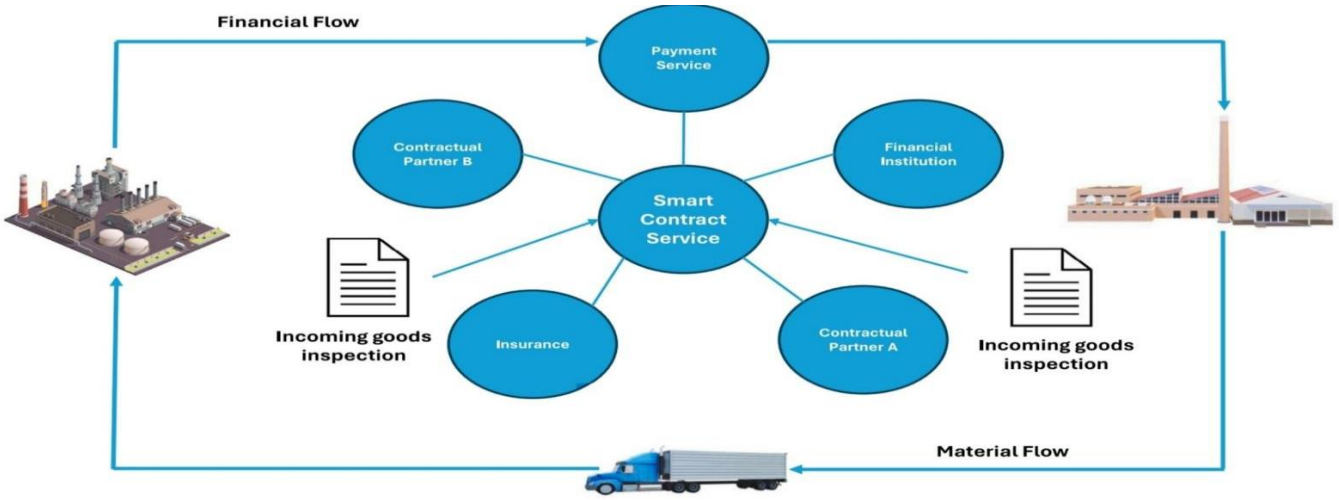
Maritime chain of supply benefits from blockchain in a profound manner especially in the aspect of improving the processes involved through increased transparency and traceability. By means of its core attribute, data sharing within a distributed ledger, blockchain avails live data tracking of products and transactions in the maritime supply chain networks. This makes information easyto verify and extremely hard to manipulate and thus such information reduces chances of fraud and increases credibility among users. Blockchain excludes the possibility of data distortion; hence, all the members working in the supply chain can depend on the accuracy of the information they need for more efficient and less erroneous supply chain flow (Li, et al. , 2020). In the aspect of the logistics operation, it also has a major contribution to the maritime industry through offering such functions like a cargo tracking system, documentation, and customs

clearance. Typically, these functions struggle with paper-based documentation that is often times isolated support systems which causes delays. To overcome these challenges, Blockchain emerges as a solution that centralizes data and ensures all the individuals who have permission toaccess that data as well. This central platform increases the productivity of the system through eliminating paperwork in document reviewing and cutting the number of interventions to provide faster movement of goods through the supply chain (Czachorowski, Solesvik and Kondratenko. , 2019).

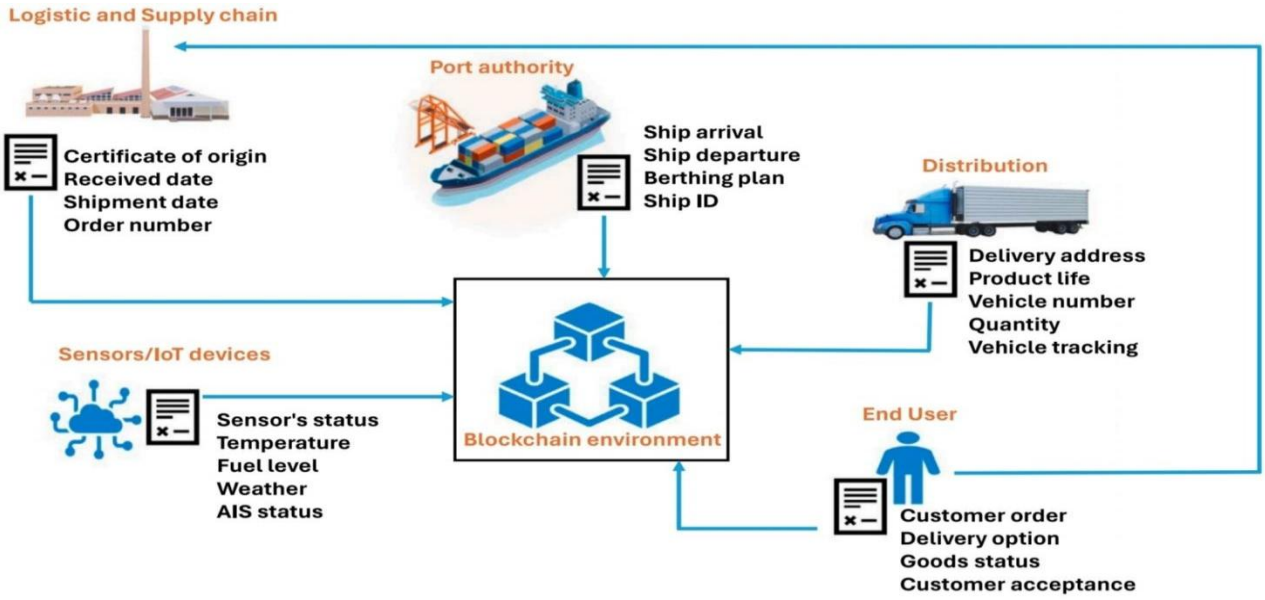
The potential impact of blockchain seems to be especially appealing for port managementbecause of its potential to improve data management and operations. Blockchain benefits the portthrough better accuracy of data, reduction of paperwork and other related bottlenecks, and hence better efficiency. For instance, blockchain-based systems such as smart contracts can monitor ships' real-time movements, match berthing preferences to vessel requirements, and accelerate cargo interactions. These improvements facilitate shorter turnaround time for the vessels, less congestion and thus improved resource utilization and thus leading to cost reduction and increased competitiveness of the ports (Ahmad, et al., 2021).

Practical cases of adoption and application of blockchain in the maritime sector illustrate its efficacy. Blockchain technology has also been implemented in the major ports and shipping companies to increase work automation and achieve security, reduce cost among other benefits. For example, ports in Rotterdam and Singapore have applied blockchain to container supply chain management and the chain of supply, with tangible gains on the efficiency of data and flow(Chen, 2020). Despite these successes, there are certain issues like regulatory impact, integration with other systems, and and initial investment costs remain significant considerations for wider blockchain adoption in maritime supply chains (Surucu-Balci, Iris and Balci., 2024).

Remittances Review
June 2024,
Volume: 9, No: 3, pp. 71-88
ISSN : 2059-6588(Print) | ISSN 2059-6596(Online)



Blockchain in supply chain management



Challenges in Adopting Blockchain in Maritime Logistics

Adopting blockchain technology in maritime logistics brings certain technological issues that need to be solved. The first one is scalability as blockchain networks need to efficiently handle the vast volumes of data and high transaction frequencies inherent in maritime operations(Irannezhad, 2020). The next big challenge is integration with existing IT systems, to align with the current methods and follow best practices and protocols. Additionally, blockchain requires solid IT support for decentralized networks and a mechanism for verifying transaction information at

multiple nodes. Overcoming these technological barriers is critical in unlocking blockchain's full potential when it comes to improving supply chain transparency and efficiency in the maritime industry (Liu, Zhang and Zhen., 2023).

The major economic implications of blockchain in maritime logistics consist of massive costs in kick-starting the implementation together with recurrent costs for maintaining the blockchain system. Nevertheless, potential benefits of financial investments consist in obtaining drastic decreases in transaction costs, optimization of business processes, and enhancement of protection against cyber threats. Thus, the breakthrough in maritime business is in long-term benefits traceable to automation and security as provided by the blockchain technology this paper seeks to establish (Irannezhad, 2020). Another reason that complicates the adoption of blockchain is the issues related to the regulatory environment of the sector. There are issues on compliance with International Maritime Laws, data privacy laws and legal issues of implementing blockchain in digital documents and contracts. Policies across the different regions are also dynamic and pose challenges to adoption because while changes in legal requirements areunderway, the maritime entities already in operation should continue their operations legally while adopting the change (Nisar, et al., 2024).

The case of Maersk Line working with IBM demonstrates the issues and opportunities of implementing blockchain in the context of international shipping. Maersk Limited, a global container ship operator, experienced challenges in monitoring and authenticating shipments in all participants of the supply chain. Maersk intended to increase more transparency together with cutting paperwork processes that in turn caused more delays and mistakes. However, the adoption of the blockchain platform was problematic because it had to be implemented into the existing IT systems leading to compatibility problems with the older systems and using different formats in organizational members' data storage and processing. The case points to the technological issue of systems integration and the degree of system modernisation required to unlock blockchains ability to impact positively on the efficiency of maritime logistics (DiGregorio, Nustad and Constantiou., 2017). Similarly, the Port of Rotterdam recently started planning to deploy blockchain for container logistics to enhance the efficiency and openness of its terminal operations. Rotterdam being the largest port in Europe wanted to increase efficiency and visibility of containers within the port and minimize bureaucratic procedures (Wagner and Wisnicki., 2019).

Various factors like initial investments and costs in building up blockchain infrastructure, and other recurrent costs were some of the economic barriers identified. Furthermore, managing the.

legal requirements such as GDPR in Europe increased the legal challenges that involve professional adaptation of blockchain solutions to address the measures of data privacy (Peel, 2019). These examples explained how the maritime stakeholders deal with technological, economic, and legal factors when implementing blockchain and indicated the challenges and opportunities of integrating new technologies into existing maritime systems. These case studies example show the immense technological, economical, and regulatory barriers maritime logistics companies experience when attempting to adopt blockchain technology. They underline the urgency of creating more effective solutions concerning the issues of the scaling, integration and business compliance with the help of blockchain technologies in global supply chains. Overcoming these challenges will enable maritime stakeholders to achieve improved transparency, efficiency and competitive advantage in the context of a dynamics and complex industry environment.

Key Debates and Controversies

Controversies in shipping and transportation industry with regard to adopt blockchain range from technological aspects for instance infrastructural enhancements to system implementation. From the economic perspective, there is discussion of the cost of investment at the beginning as compared to the benefits and the use of ROI in the environment. Controversies arising from them are on the observations of international standards and local laws that may dictate the operations of the business in digital transactions and data privacy. Possible issues of scale are related to the capacity of blockchain networks to manage the number and velocity of transactions that define large shipping industry. Interoperability challenges relate to how to integrate blockchain networks with existing maritime IT systems since this will be essential in determining the effectiveness of the implementation of block chain based solutions in the supply chain of the maritime industry.

Gaps in Existing Knowledge

Although there is a growing body of literature on blockchain solutions in supply chains, its applicability to the maritime sector remains somewhat unexplored. The literature on how block chain resolves compliance, scalability and inter-operability problems specific to maritime logistics is scarce. That is why it is important to fill such gaps to enhance the existing knowledge and better implement the blockchain solutions in the context of the needs of the maritime industry.

Remittances Review
June 2024,
Volume: 9, No: 3, pp. 71-88
ISSN : 2059-6588(Print) | ISSN 2059-6596(Online)

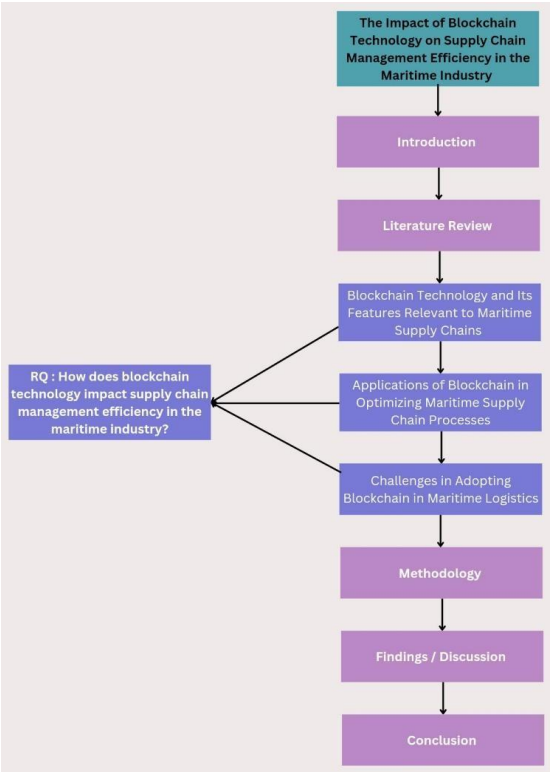
3. Research Methodology

Research Design

In order to accomplish the purpose of this study, a qualitative research was conducted, with the goal of identifying data pertaining to the effects of blockchain technology on supply chain management performance in the maritime sector. Conducting of secondary research was employed to gather data and literature that would explain how blockchain is currently employed in the realm of maritime logistics. It allowed to integrate information received from various cases, reports, and other articles (Palinkas, et al., 2015).

Research Method

The research technique applied in this particular study was the literature review. This quantitative research based study therefore started by searching for articles, industry reports, and case to assess the possibility and potential of applying blockchain technology within the context of Maritime Supply Chain Management. The type of methodological decision allowed collect the received informationand to receive a comprehensive view of potential the further application and development ofblockchain concerning the maritime sector(Hennink, Hutter and Bailey., 2020).



Research Approach

This is why this research used the exploratory research paradigm to highlight the fact that

Structure of the Paper

blockchain implementation in the maritime logistics industry is complex and constantly evolving. The use exploratory research design was informed by the need to determine what is already known in the literature about blockchain technology and productivity in the supply chain (Hunter et al., 2019). Therefore, the study's aim was to analyse and find useful data from variousperspectives and sources regarding the transformation of function and operation of the maritime supply chain via application of blockchain.

Data Collection

The method adopted in this research for the purpose of data collection were mainly the secondary research whereby the researcher sourced data from Peer reviewed articles, academic journals, and trade magazines, cases and other literature sources (Johnston, 2014). The selection of the sources has been made based on the topic in focus and how best it can assist in understanding the usefulness and the application of blockchain in regards to maritime logistics. Information relevant to the research objectives was only obtained after making a comparison of the data of the two studies.

Ethical Considerations

In this research, ethical consideration was focus on protecting the sources of the secondary data that would ensure proper and accurate enquiry. The criterion of credibility, validity and relevance of the data to the Research questions were used to assess all the accumulated sources. Other policy relating to absence of plagiarism and citing the original rights and authors was also observed during the study process. The study therefore complied with ethical uses of secondary data by observing appropriate research ethic in the writing of results (Jol and Stommel., 2016).

4. Findings

The findings of this study highlight how the use of blockchain technology enhances the functionality of managing a maritime supply chain. A deeper evaluation of the case studies and existing literature shows that the integration of blockchain has positively impacted the transparency and performance of the maritime logistics operations. Even if the control discussed above is increased, the implementation of the blockchain by Maersk Line together with IBM and

the initiatives of the Port of Rotterdam showed the dramatic shift in visibility and the level of process optimization. Besides, these innovations have addressed challenges such as fraud and making errors, and have enhanced stakeholders' confidence (Jovic, et al. , 2020).

However, that is not all that blockchain has to do with the aspect of transparency, though it is understood primarily as visibility. Through maintaining an open digital record of all the activities that are recorded in the block chain all stakeholders are assured of the accuracy of the records made and documented on block chain. This capability has helped drastically in the tracking of cargo and shipment through realization of the statuses and conditions of the consignment.Measures of the validity of the papers can now be settled immediately, thereby enhancing the operations of customs procedures as well as the general supply chain. This transparency is important in meeting the set regulatory standards and increasing the accountability curve across the maritime sector (Jeppsson and Olsson. , 2017). Apart from transparency, the use of blockchain has enhanced the tracking system along the maritime supply chain management. Since it records every transaction involving a good from its source to its ultimate destination, using a blockchain provides an exact and smooth view on the location of products in global supply chains. The objective of this capability is to ensure that the quality standards and regulations concerning the production are met in addition to enabling effective management of resources and inventory. The solutions of using blockchain for improving traceability show thatit helps avoid possible logistic risks and problems thus ensuring an effective supply chain (Sunny, Undralla and Pillai., 2020).

Furthermore, blockchain with integrated smart contracts has been adopted to improve automation of maritime logistics. Smart contracts trigger operations based on pre-programmed parameters with less need for middlemen and the reorganization of such tasks as payment and cargodelivery. This automation also helps in uplifting transaction speeds and reduces concerns such asdisputes and expense. Blockchain has revolutionized the normal supply chain processes by increasing automation and efficient decision-making processes within the supply chain network (Perkusic, Jozipovic and Piplica. , 2020). However, the study identifies the following barriers of using blockchain in maritime logistics even with developed technologies. There are still challenges like where scalability can be a problem and integration with other systems. Furthermore, professionalism and experienced support necessitate huge expenditure, particularly

in this case whereby the application of block chain incurs both initial installation costs and recurrent costs. Another challenge related to regulation is adherence to the international maritime laws as well as compliance with data privacy regulations which also becomes a hindrance towards the adoption of the technology (Liu, Zhang and Zhen. , 2023).

In summary, based on the analysis of the presented challenges and opportunities, it is essential to conclude that blockchain technology has significant potential to increase transparency, traceability, and automation of maritime supply chains where implementation of the technology is feasible but depends on the overcoming of the current technological, economic, and regulative barriers. The case studies and the result discussed in the paper reveal the opportunities and challenges of using the blockchain in traditional maritime environment and create the foundation for creating the innovative and highly effective supply chain systems in the future.

5. Conclusion

In conclusion, this study has highlighted how blockchain technology can revolutionalise the maritime supply chain management. With increased understanding, accountability and efficiency Blockchain has revolutionized the Logistics operations worldwide and minimized fraudulent activities. Literature review and case studies have proved that along with easing paperwork Blockchain integration in maritime logistics has also strengthened the confidence of its users due to the transaction records which are not altered.

Going forward the importance of blockchain within the context of maritime is significant. The favorable impact of the technology for cost and efficient operations can be seen through its automation feature explored by smart contracts. The future works in the blockchain technology have to emphasize on the development of its efficiency, integration with the current organizational IT systems, and understanding issues related to the legal frameworks for its adoption. These challenges and future work makes blockchain useful for the maritime industry tohave a more efficient and reliable supply chain worldwide.

References

Attaran, M. And Gunasekaran, A., 2019. Applications of b technology in business: challenges and opportunities.

Ahmad, R.W., Hasan, H., Jayaraman, R., Salah, K. And Omar, M., 2021. Blockchain applications and architectures for port operations and logistics management. Research in Transportation Business & Management, 41, p.100620.

Czachorowski, K., Solesvik, M. And Kondratenko, Y., 2019. The application of blockchain technology in the maritime industry. Green IT engineering: Social, business and industrial applications, pp.561-577.

Chen, H., 2020. Using Blockchain for improving communication efficiency and cooperation: the case of port logistics.

Carlan, V., Coppens, F., Sys, C., Vanelslander, T. And Van Gastel, G., 2020. Blockchain technology as key contributor to the integration of maritime supply chain?. In Maritime supply chains (pp. 229-259). Elsevier.

Dutta, P., Choi, T.M., Somani, S. And Butala, R., 2020. Blockchain technology in supply chain operations: Applications, challenges and research opportunities. Transportation research part e: Logistics and transportation review, 142, p.102067.

Di Gregorio, R., Nustad, S.S. and Constantiou, I., 2017. Blockchain adoption in the shipping industry. A study of adoption likelihood and scenario-based opportunities and risks for IT service providers, Copenhagen Business School, Number of STUs, 272.

Farah, M.B., Ahmed, Y., Mahmoud, H., Shah, S.A., Al-Kadri, M.O., Taramonli, S., Bellekens, X., Abozariba, R., Idrissi, M. And Aneiba, A., 2024. A survey on blockchain technology in the maritime industry: challenges and future perspectives. Future Generation Computer Systems.

Gurtu, A. And Johny, J., 2019. Potential of blockchain technology in supply chain management: a literature review. International Journal of Physical Distribution & Logistics Management, 49(9), pp.881-900.

Hennink, M., Hutter, I. And Bailey, A., 2020. Qualitative research methods. Sage.

Hunter, D., McCallum, J. And Howes, D., 2019. Defining exploratory-descriptive qualitative (EDQ) research and considering its application to healthcare. Journal of Nursing and Health Care, 4(1).

Irannezhad, E., 2020. Is blockchain a solution for logistics and freight transportation problems?. Transportation Research Procedia, 48, pp.290-306.

Johnston, M.P., 2014. Secondary data analysis: A method of which the time has come. Qualitative and quantitative methods in libraries, 3(3), pp.619-626.

Jol, G. And Stommel, W., 2016. Ethical considerations of secondary data use: What about informed consent?. Dutch Journal of Applied Linguistics, 5(2), pp.180-195.

Jovic, M., Tijan, E., Zgaljic, D. And Aksentijevic, S., 2020. Improving maritime transport sustainability using blockchain-based information exchange. Sustainability, 12(21), p.8866.

Jeppsson, A. And Olsson, O., 2017. Blockchains as a solution for traceability and transparency.

Li, L. And Zhou, H., 2021. A survey of blockchain with applications in maritime and shipping industry. Information Systems and e-Business Management, 19(3), pp.789-807.

Li, K., Gharehgozli, A., Ahuja, M.V. and Lee, J.Y., 2020. Blockchain in maritime supply chain: A synthesis analysis of benefits, challenges and limitations. Journal of Supply Chain and Operations Management, 18(2), p.257.

Nisar, U., Zhang, Z., Wood, B.P., Ahmad, S., Ellahi, E., Ul Haq, S.I., Alnafissa, M. And Fathi Abd-Allah, E., 2024. Unlocking the potential of blockchain technology in enhancing the fisheries supply chain: an exploration of critical adoption barriers in China. Scientific Reports, 14(1), p.10167.

Peronja, I., Lenac, K. And Glavinovic, R., 2020. Blockchain technology in maritime industry. Pomorstvo, 34(1), pp.178-184.

Perkusic, M., Jozipovic, S. And Piplica, D., 2020. The need for legal regulation of blockchain and smart contracts in the shipping industry. Transactions on Maritime Science, 9(02), pp.365- 373.

Peel, J., 2019. The GDPR: The biggest threat to the implementation of blockchain technology in

global supply chains. UMKC L. Rev., 88, p.497.

Palinkas, L.A., Horwitz, S.M., Green, C.A., Wisdom, J.P., Duan, N. And Hoagwood, K., 2015. Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. Administration and policy in mental health and mental health services research, 42, pp.533-544.

Surucu-Balci, E., Iris, C. And Balci, G., 2024. Digital information in maritime supply chains with blockchain and cloud platforms: Supply chain capabilities, barriers, and research opportunities. Technological Forecasting and Social Change, 198, p.122978.

Sunny, J., Undralla, N. And Pillai, V.M., 2020. Supply chain transparency through blockchain-based traceability: An overview with demonstration. Computers & Industrial Engineering, 150, p.106895.

Wagner, N. And Wisnicki, B., 2019, November. Application of blockchain technology in maritime logistics. In DIEM: Dubrovnik International Economic Meeting (Vol. 4, No. 1, pp. 155-164). Sveuciliste u Dubrovniku.