

Digital Transformation in Maritime Supply Chains: A Systematic Review of DIS Platforms

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Abstract - Digital transformation plays a key role in improving information sharing and information processing in supply chains. Specifically, maritime supply chains require numerous data and document exchanges and can significantly benefit from digital information sharing (DIS). This notable potential has attracted attention and has resulted in a growing number of studies on blockchain platforms, cloud-based platforms, and other digital technology platforms. However, DIS adoption and execution is a complex process as it depends on various success factors and barriers and affects numerous capabilities and performance outcomes. Moreover, various information systems and management theories can be utilised to underpin these relationships. Our study aims to conduct a systematic literature review that uncovers dynamic capabilities, barriers, enablers and outcomes of DIS with blockchain and cloud-based platforms, illustrates the relationship between them, and discloses methods and theories applied in supply chains. We discuss different use cases of blockchain and cloud-based platforms for DIS in various business functions in supply chains. Particularly, we reveal six DIS-powered capabilities, five performance outcomes improved by the DIS, eight main barriers, and nine enablers of DIS implementation. The lack of theoretical underpinning and causal empirical studies is identified as an important gap in the literature. This study also presents precise future research directions that can help address these gaps

Keywords— Digital transformation, Supply chain management, Blockchain technology, Cloud-based platforms

I. INTRODUCTION

The continuous pursuit of improvement necessitates efficiency in handling information, transactions, and cargo within supply chains (SC)[1]. The ongoing wave of technological advancements and integration sets the stage for digital transformation, a crucial vehicle for achieving continuous improvement objectives across all SC functions [2]. Digital platforms play a pivotal role in facilitating digital

transformation, serving as the foundation for information sharing. Given the intricate and dynamic nature of supply chains with multiple stakeholders, Digital Information Sharing (DIS) platforms, backed by blockchain and cloud technologies, prove invaluable for sharing, exchanging, and processing information within operational, financial, customer relationship, and sustainability functions of SCs[3].

In the context of a maritime supply chain, which encompasses interconnected value chains in maritime services and transshipment functions, numerous independent actors such as shipping companies, ports and terminals, customs, shippers, hinterland operators, forwarders, waterways and navigation authorities, inland logistics, financial institutions, and government agencies are involved[4].

A plethora of monetary transactions and data exchanges, including bookings, confirmations, information processing, shipment tracking, collaboration, customs clearance, payment tracking, taxing, product authentication, customer services, emission reporting, and regulation compliance, are inherent in supply chains[5].

Understanding the capabilities and enablers and their relationship to digital information sharing is crucial but may not be sufficient[6]. Adoption barriers persist due to various factors[7]. The complexities and trade-offs involved in DIS-related barriers, enablers, capabilities, and performance outcomes add layers of intricacy. DIS has the potential to enhance various supply chain capabilities, subsequently improving diverse supply chain performance outcomes. Various information technology and management theories can be employed to underpin these relationships.

Despite the multitude of potential theories and relationships, research in this area faces several gaps. Barriers, enablers, and performance outcomes are often studied in isolation within relevant SC literature. A holistic view that uncovers and relates all these elements is lacking[8]. This study aims to bridge these gaps by providing a systematic literature review (SLR) of digital information sharing, particularly with cloud-based and blockchain-based platforms in supply chains, focusing on maritime domains. The study aims to identify enablers and barriers to DIS adoption, reveal the capabilities and performance outcomes enhanced by DIS implementation in maritime SC, map the theories and methods used in the state-of-the-art, and suggest future research directions considering the identified gaps and relationships[9]. The contribution of this study lies in advancing operations and supply chain management literature, particularly within the maritime industry[10-13]. It is relevant to studies exploring the adoption of blockchain and cloud-based information sharing in SC operations, offering insights applicable to information systems research. The review is the first to approach DIS in maritime supply chains through an operations and supply chain management lens, covering capabilities, success factors, barriers, and theories employed.

Noteworthy platforms such as AWS Supply Chain, CargoX, Flexport, GSBN, Maersk Spot, Maersk Flow, Oracle Transportation Management EDI, OneTouch EDI, SAP Shipment EDI, Wave BL, and T-Mining provide DIS solutions, claiming contributions to operational, financial, sustainability, marketing, and security performance. However, the effectiveness of digital platforms depends on the organization's establishment of routines, procedures, and collective activities (capabilities) that mediate the impact of digital information sharing on company performance.

II. Methodology

Phase I involves three key steps: defining the research aim and questions, developing the review protocol, and establishing inclusion and exclusion criteria. The research aim and questions are determined in Step 1, outlined in the Introduction. Step 2 involves selecting the database, defining appropriate keywords, and devising search strategies. In this study, the Scopus database is utilized for article selection, employing a "title, abstract, and keyword" search.

Different keyword selection criteria are specified for the first and second research objectives in Phase I. The collected articles contribute to achieving the third and fourth research objectives, respectively.

Phase II comprises selecting relevant research articles (Step 4), conducting quality assessments (Step 5), and analyzing relevant data (Step 6) within the systematic literature review (SLR). Title and abstract analyses are conducted to select pertinent research articles, focusing on empirical-based and conceptual articles to uncover conceptual developments in information sharing through digital platforms in maritime SC. Duplicate articles are eliminated at this stage. Following this step, 43 and 36 articles are retained for RO1 and RO2, respectively. Step 5 involves examining all articles to determine if they answer the research questions, resulting in the removal of 20 articles. A total of 59 articles are used for the SLR.

The final step of Phase II involves reviewing and conducting thematic analysis. An initial table is developed, encompassing the purpose, utilized constructs, implemented methods, and adopted theories. A coding scheme is designed to categorize papers and convert the extensive dataset into a digestible and organized format. The coding scheme addresses each research question inductively, encompassing dynamic capabilities, performance outcomes, barriers, enablers, their sub-categories, as well as methods and adopted theories.

A total of 30 downloaded articles focus on blockchain-based platforms, while 29 examine information sharing using other platforms like cloud-based. The framework illustrates enablers and barriers to DIS adoption (RO1) in the upper part, while the lower part depicts capabilities and performance outcomes achievable or improvable through DIS usage (RO2). The framework suggests that DIS adoption depends on enablers and barriers, with positive effects on various dynamic capabilities and performance outcomes.

Smart contracts prove efficient for utilizing DIS platforms, automatically executing applications when predetermined criteria are met, necessitating investments from platform members. Enhancing security becomes crucial with technological advancements, demanding additional investments. Real-time information sharing requires live power, especially in blockchain-based DIS platforms, where creating a new node necessitates significant energy.

Scalability and infrastructure play a vital role in DIS adoption. The inefficiency in document exchanges during transportation can be prevented by DIS platforms, requiring larger-scale adoption within the maritime supply chain. However, this demands investment, updates, and compatibility in technology, posing obstacles, especially for small-scale enterprises operating internationally.

Conservatism within the maritime industry, characterized by slow adoption of new technology and conservative organizational structures, acts as a barrier to DIS platform adoption. Structural characteristics like family-owned businesses, hierarchical structures, and conservative decision-makers impede the decision-making process.

Lack of trust and privacy concerns emerge as barriers, despite indications that DIS platforms are safe. Concerns center around data confidentiality, cyber-attacks, and loss of control. The maritime industry's reliance on information asymmetry and uncertainty contributes to skepticism regarding data security and privacy.

Lack of support from stakeholders is identified as a significant barrier. Stakeholder support is crucial for DIS platform adoption, both among maritime supply chain actors and within organizations. A lack of support is observed in terms of stakeholders not leading or supporting each other in adopting new technology, including ERP systems. Additionally, top management, often skeptical or senior-aged, poses a critical barrier when adopting DIS platforms.

III. Research Directions

Our study provides a thorough exploration of various variables acting as both enablers and barriers to Digital Information Sharing (DIS), the capabilities that can be developed through DIS, and the performance outcomes that can be enhanced either directly through DIS or by mediating the capabilities generated by DIS [14]. The wide array of variables identified opens up numerous possibilities for research models that can be empirically tested [15]. Our research not only highlights the current state of DIS in maritime Supply Chains (SC) but also identifies significant gaps in empirical studies on DIS within this context, emphasizing the need for more quantitative research.

One major research direction is focused on DIS adoption in supply chains, particularly in the maritime industry. Our study underlines the complexity of DIS adoption, influenced by both rational and irrational factors at both organizational and individual levels. Understanding the complexities requires evaluating different information system theories, possibly through a combination of them. The Technology Acceptance Model (TAM) and the Technology-Organization-Environment (TOE) framework have been independently utilized in the existing literature, but their complementary roles should be considered for a more holistic understanding of DIS adoption. Future research could explore the interdependencies between variables, identifying the most influential barriers or root causes and their inter-relationships. Techniques such as Interpretive Structural Modeling (ISM) can be employed to uncover these relationships effectively. Additionally, there is a notable absence of studies focusing on individual perceptions and factors affecting attitudes towards DIS, warranting further investigation through qualitative studies.

Another potential avenue for future research involves the segmentation approach, applying it at the organizational level to understand the varying importance of DIS enablers for different members of the SC[18]. Different segments within industries, such as ports, terminals, shippers, and freight forwarders, may prioritize different capabilities of DIS based on their specific needs and operations[19]. A more granulated approach could also be adopted concerning the type of DIS platforms and the specific purposes for usage. For instance, the adoption attitude of cargo owners may vary based on whether DIS is used for electronic bill of lading, cargo booking, or as an in-house platform versus an industry-wide platform.

The second major research direction involves exploring the role of DIS in dynamic capabilities and performance outcomes. This holistic approach in our study uncovers the intricate relationships between enablers, capabilities, and performance outcomes. Future research can delve into potential relationships, examining additional constructs and uncovering further relationships within the domain of DIS in SCs [16-17]. Our study not only presents current insights but also opens up avenues for empirical testing and exploration of various constructs and relationships in future research endeavors.

IV. Conclusion

The primary aim of this study is to conduct a systematic literature review, examining the capabilities, enablers, and barriers, along with their relationships and contributions to performance metrics associated with digital information sharing (DIS) in maritime supply chain management. The review encompassed 59 peer-reviewed academic articles. The first objective involves identifying and discussing the relationships between enablers and barriers to DIS adoption. Our study identifies eight primary barriers based on the Technology-Organization-Environment (TOE) framework in maritime supply chain management. These barriers encompass adoption costs, scalability and infrastructure issues, conservatism, lack of human resources, knowledge gaps, trust and privacy concerns, absence of regulations, and inadequate stakeholder support. Enablers identified in our study include security enhancements, traceability, transparency, connected supply chain, environmental considerations, reduced lead time, cost reduction, paperless trade, and efficient information sharing.

The second objective focuses on revealing supply chain (SC) capabilities and performance outcomes that can be enhanced through DIS implementation in maritime supply chain management. The review unveils six DIS-powered capabilities: integration, resilience, visibility, optimization, market sensing, and customer relationship management. Additionally, the study indicates that DIS implementation can lead to improvements in operational, financial, sustainability, safety, security, and marketing performance, either through direct impact or mediated by the enhancement of SC capabilities

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