An Exploratory of Factors Influencing of Digital Technology Adoption in Thai Maritime Industry: Perspective of Thai Shipowners

Atcharaporn Janmethakulwat and Bundit Thanasopon
School of Information Technology, King Mongkut's Institute of Technology Ladkrabang, Thailand

Keywords: Digital Technology, Maritime Industry, Thai Shipowner, Technology Adoption, TOE Framework.

Abstract: This study addresses a literature gap in the maritime sector concerning the slow adoption of digital technology by Thai shipowners to drive sustainable organizational development. Understanding the determinants of digital technology adoption is crucial. Thus, this study examines the adoption process of digital technology in Thai shipowners at the firm-level, specifically focusing on the perceived influence of technology, organization, and environment. The study employs an exploratory approach and utilizes in-depth case studies to build theory. The findings suggest that factors such as improved organizational efficacy, reduced operational expenses, enhanced internal and external communication, top management support and commitment, plan maintenance monitoring, documentation, compliance with legal, regulatory, and policy requirements, and social pressure positively influence the adoption of digital technology in Thai shipowners.

1 INTRODUCTION

The term digital transformation refers to organizational changes brought about by digital technologies that result in the redefinition of existing business capabilities, processes, and relationships. Changes can be seen in business models and how organizations create, deliver, and capture value (Kleppe and Nortvedt 2020). Reshaping business models through the adoption and use of digital technologies creates a setting within the organization and its environment in which new possibilities are enabled, and value is made (Tijan et al. 2021). Integrating and utilizing new digital technologies is one of the most difficult challenges businesses face today. Maritime transport is an essential mode of international trade that is digitizing and undergoing digital technology at varying rates in different domains. Shipping, as a component of the logistics chain, is a volatile industry characterized by technological immaturity and impending regulatory changes (Zaman et al. 2017).

Digitalization and digital disruption have already begun to impact the maritime industry, affecting operations and strategy, resulting in more unique and successful business models. Innovative technological applications, particularly in the marine industry, can provide economic and societal value (Gavalas 2020). As a result, the current phase of digital technology is focused on adopting new digital technologies to improve vessel measurement, monitoring, and control. This can include advanced data preprocessing and analysis to extract information and knowledge in planning and decision support systems. However, the success of digital technology depends not only on the use of cutting-edge technologies and methods but also, most importantly, on the adaptation of organizational aspects. The specific management issue is that the barriers to technology adoption among maritime industry players in Thailand are poorly understood, limiting the naval sector's ability to achieve national sustainable development. The use of current technologies is one of the most critical issues in the digital technology of the marine industry in developing countries (Yang 2019).

Although several studies focus on digital technology adoption, there is no comprehensive study on the digital technology adoption, especially in the scope of Thai shipowners. To address the literature gap, this study aims to better understand technology adoption in Thai shipowners using The Technology, Organization and Environment Framework (TOE framework), as well as Institutional Theory.

Janmethakulwat, A. and Thanasopon, B.
An Exploratory of Factors Influencing of Digital Technology Adoption in Thai Maritime Industry: Perspective of Thai Shipowners.
DOI: 10.5220/0012035100003467
In *Proceedings of the 25th International Conference on Enterprise Information Systems (ICEIS 2023) - Volume 2*, pages 669-677
ISBN: 978-989-758-648-4; ISSN: 2184-4992

2 CONCEPTUAL INSIGHTS FROM PRIOR STUDIES

2.1 The Fourth Industrial Revolution Becomes Maritime 4.0

According to the Global Maritime Forum's Annual Summit 2019, the world is experiencing the so-called Fourth Industrial Revolution. The first three industrial revolutions were propelled forward by mechanics and mass production, electricity and mass production, and electronics and automation. The Fourth Industrial Revolution is defined by cyber-physical systems and interconnectedness. The Fourth Industrial Revolution is fueled by a number of critical technologies, including advanced robotics, 3D printing, autonomous cars, artificial intelligence, segmented/virtual reality, and digital breakthroughs such as finance and blockchain. Along with several benefits such as increased connectedness and efficiency, the Fourth Industrial Revolution also introduced considerable uncertainty and worry.

According to World Economic Forum research by 2022, 42% of essential skills required for most occupations will change, with an increasing demand for critical, analytical, and creative thinking, technological design, programming, leadership, system analysis, emotional intelligence, and complex problem-solving. Leaders in the Fourth Industrial Revolution are concerned about the future of business, and leveraging data. Sharing data can help resolve operational inefficiencies in the marine sector and accelerate industry development. In an increasingly digital and networked world, there is a rising demand for reliable communication and information-sharing routes. The maritime industry is particularly prone to weak data and document management, complicated regulatory requirements, money laundering and fraud, and insufficient traceability. Sullivan et al. 2020 state that the marine sector is building collaborative platforms to extend the life of vessels via the use of linked digital capabilities. The Fourth Industrial Revolution and Maritime 4.0 share many parallels, notably in terms of technology. The distinction, however, is in the manner in which each of the technologies interacts and overlaps with one another across numerous sectors of the marine industry. Maritime 4.0 refers to the integrated use of digital processes and technologies in the design, development, building, operation, and maintenance of ships as displayed in Figure 1 (Papageorgiou 2020).

Overall, both industry 4.0 and maritime 4.0 represent the next phase of industrial and maritime evolution, respectively, and share several similarities in terms of the technologies and approaches they use to achieve their goals.

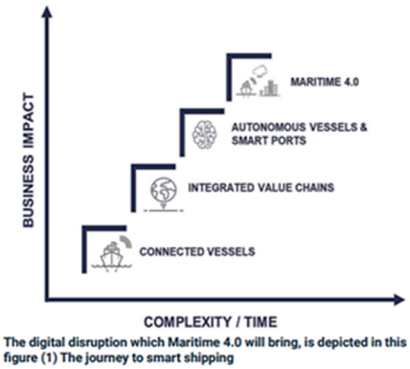

Figure 1: The journey to intelligent shipping (Papageorgiou, 2020).

2.2 Digitalization and Advancements in the Maritime Industry

The maritime transport sector faces several challenges in adopting digital technology. Firstly, there is often a lack of leadership, as management tends to take a conservative approach and resources are limited. Although technologies like Blockchain and autonomous shipping can foster digital technology adoption, many employees and managers are resistant to change and lack awareness of how digital technology can positively affect the business (Bajpai 2021).

Secondly, the utilization and ownership of data presents a challenge. Data confidentiality has become increasingly important for services such as predictive maintenance, use tracking, route planning, and resource planning (Gavalas 2020). However, various parties may have an incentive to withhold specific facts from other business participants, and data ownership is frequently contested. A comprehensive legal assessment of data flows is often critical for data-intensive services and business models, especially when the organization has a strong interest in protecting secrecy.

Thirdly, cyber-security is a major concern. IT-intensive activities create new security zones when plates, containers, and other items are linked. Protection receives a new layer of cyber-security to prevent unauthorized third parties from accessing critical sensors and controllers via existing interfaces and network connectivity. Applying cyber-security measures can be problematic due to existing safety and security requirements and updates to associated legislation (Gavalas 2020).

Fourthly, regulatory issues pose a challenge. Unlike industries such as manufacturing or retailing, maritime transportation operations are inextricably linked to global economics and politics. Moreover, the sector's operations are governed by national and international laws (Zeng et al. 2020).

Fifthly, International laws and conventions such as UNCLOS, SOLAS, COLREG, and MARPOL may affect the permissibility of certain technologies, particularly those used on uncrewed vehicles (Ikpogu 2021).

Finally, the lack of digital skills and a qualified labor force in the maritime transport sector. This problem is expected to worsen as new technologies require the development of new skill sets and technological expertise. To address this challenge, cooperation between universities and the corporate sector is needed, including investment in knowledge, new study and training programs, and other measures to ensure an adequate human resource pool for the continued development and application of innovations in the maritime transport sector (Van Dyk and Van Belle 2019).

Overall, the barriers to digital technology adoption can vary depending on the industry, organization, and specific technology being adopted. It is important for organizations to carefully consider these barriers and develop strategies to overcome them to ensure successful digital technology adoption.

3 THEORETICAL FOUNDATIONS APPLIED TO RESEARCH

3.1 Technology, Organization and Environment Framework (TOE Framework)

The Technology, Organization and Environment Framework (TOE framework) was developed in 1990 by Tornatzky and Fleischer. It identifies three aspects of an enterprise's context that influence the process by which it adopts and implements a technological innovation: technological context, organizational context and environmental context see in Figure 2. The term technological context refers to both internal and external technologies that are significant to the company. This includes current practices and equipment internal the firm, as well as the set of available technologies external to the firm. Organizational context refers to descriptive measure about the organization such as scope, size, and managerial structure. Environmental context is the area in which as firm conducts its business, its industry, competitors, and dealings with government (Tornatzky et al. 1990).

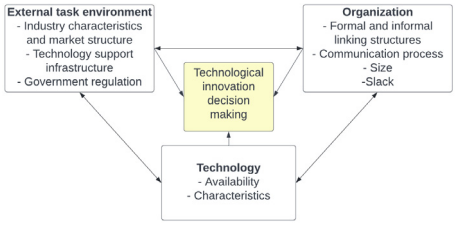

Figure 2: Technological, organizational, and environmental framework (TOE framework) (Tornatzky and Fleischer, 1990).

TOE was employed as the theoretical basis in their study to investigate the adoption factors of inter-organizational information booking system. The research provides a comprehensive understanding of the adoption behavior relating to technological innovation in the maritime supply chain. They found that not only the factors such as relative advantage, ease of use, firm size, and top management support but technology adoption in maritime supply chain is also influenced by other salient factors such as industrial characteristics, information confidentiality, supply chain partners' power, governmental power, and ownership structure. Moreover, digitalization and many technological advances provide opportunities for stakeholders in the supply chain to improve efficiency, enhance productivity, and reduce the impact caused by environmental uncertainty (Zeng and Pawar 2020).

Ikgapu 2021 also supported that the new technology requires four factors to ensure its success in digital era of shipping; the factors include technology availability, organizations expected, environment and favorable policies and security of technology infrastructure.

3.2 Institutional Theory

According to the institutional theory, organizational decisions are not driven purely by rational goals of efficiency, but also by perceived social pressure and the influence of cultural factors and concerns for legitimacy. Institutions are transported by cultures, structures, and routines and operate at multiple levels. According to perceived social pressure and influence, firms become more similar as a result of isomorphic pressures and legitimacy pressures (DiMaggio and Powell 1983). This suggests that firms within the same field tend to become homologous over time, as

competitive and customer pressures motivate them to repeat industry leaders. Several recent research on e-commerce or EDI dissemination and assimilation have used an institutional perspective. It's documented that mimetic, coercive and normative institutional pressures existing in an institutionalized environment may influence organizations' predisposition toward an IT-based interorganizational system (Teo et al. 2003). Mimetic pressures occur when businesses adopt a competitor's approach or innovation. Coercive pressures are a group of formal or informal forces exerted on organizations by other organizations upon which the previous organizations depend. Normative pressures are generated by dyadic partnerships in which organizations communicate information, regulations, and standards. Sharing these norms through relational channels amongst members of a network facilitates consensus, which, in turn, increase the strength of those norms and their potential influence on organization behavior (DiMaggio and Powell 1983).

Unlike other industries such as manufacturing or retailing, the activities of the maritime transportation industry are closely related to global economics and politics. Moreover, the activities within the industry are also affected by the governmental regulations from different countries. Therefore, the perceived social pressure and influence becomes the driving force to examine as another one factor which influencing on intention to digital transformation adoption besides perceived near-term consequence and perceived ease of use.

4 RESEARCH DESIGN AND METHOD

4.1 Research Method

This exploratory study was positioned within an interpretive research paradigm. To answer the research questions, we collect data from three shipowners in Thailand. Evidence from the in-depth cases is used to build theory. A multiple-case study method is used to explore the relationships between factors influencing adoption. A qualitative case study method is appropriate because the aim of this study is to generate fresh and deeper insights into the factors influencing digital technology adoption relating to Thai shipowners. Please note that, this paper is a preliminary study. The results obtain will be used to frame our future interviews as we plan to collect more cases. The qualitative insights obtained from the case studies will be used to build a research model which will be confirmed by a large-scale survey.

4.2 Data Collection

The following stages were followed with regard to the identification of interviewees with knowledge relating to digital technology in the maritime industry. Thai shipowners firms were contacted and the focus of the study was discussed. If the maritime firm had been engaged in the adoption of digital technology, the key participants were identified. Additionally, the snowball method was used to generate additional respondents from the cases. Semi-structured interviews were conducted with the management level in three shipowners located in Thailand. In total, six executive managers from the three firms were interviewed. To ensure accurate information was provided, the participants were assured that their names and the companies' names would not be disclosed. The demographic profiles of the cases are summarized in Table I. Each interview lasted from fifty to sixty minutes. Interviews were recorded and then instantly transcribed. The validity and reliability of the presented responses were considered. In addition, internet and archival materials were combed through for information on each company. The latter information was then triangulated with the interview-gathered information. The responses of multiple responders from the same company were triangulated.

Table 1: The demographic profiles of the Thai shipowners.

Case	Profiles of the Thai Shipowners company				
	Founded	Listed company	Business Type	No. of vessels	No. of employee
A	1989	Yes	Bulk Carrier, Cement Carrier	38	906 pax
No. of respondents /Position/Working experience		A1	Training Instructor Manager		27 y
		A2	Technical Manager		24 y
B	2015	Yes	Marine Petroleum Transportation	20	423 pax
No. of respondents /Position/Working experience		B1	Chief Financial Officer		30 y
		B2	Chief Technical Officer		41 y
C	1992	No	Marine Petroleum Transportation	13	265 pax
No. of respondents /Position/Working experience		C1	Technical Manager		24 y
		C2	HSSEQ Manager & DPA		12 y

4.3 Data Analysis

Analyses were conducted on adoption narratives. All management responses were transcribed the day following each interview. The most frequently reported characteristics impacting adoption were discovered after comments were consistently categorized. Within-case analysis and cross-case analysis were undertaken iteratively. Data were compared with existing theory and the data was allowed to talk. Several propositions were derived from the interviewers' comments.

5 ANALYSIS AND DISCUSSION

The combined analysis from literature review and semi-structured interviews revealed eleven factors as driving the digital technology adoption in Thai shipowners which shown in Table II.

Table 2: Summary of the digital technology adoption.

Theme	Main Finding	Case
Technological-related criteria		
Availability of access to digitalization	Easier access from around the world	A1, A2
Organizational-related criteria		
Improved organizational efficiency	1. Increased Operational Efficacy and Reactivity 2. Cost optimization	A1, B1, B2, C2
Reduced operational expenses	1. Cost savings on operations due to the optimization of processes and staff 2. Decrease in fuel prices 3. Decrease in expenditures related to procedural delays	A1, A2, B1, B2, C1, C2
Cargo Management Productivity	1. Cost reduction for freight storage 2. Cargo damage and theft estimation using data-driven analytics	B2
Data Analytics for management	1. Ability to concentrate on one's own main business strategies 2. Better asset management insights	B1, B2
Better Internal and external communications	1. Connectivity of the head office 2. 24X7 connectivity 3. Online virtual meetings, training, and conferences 4. Multiple, inexpensive communication methods 5. Interactive between onshore and offshore 6. Real-time information for shipowners to enable risk management	A1, A2, B1, B2, C1, C2
Top management support and commitment	1. Top management support can help to get the necessary resources (facility, capital, IT, and human resource) and then achieve the benefits of digitalization adoption 2. 2. Self-efficacy and set up KPI to measure the successful implementation	B1, B2, C1, C2
Plan maintenance monitoring & Unplanned situation	1. A notification when it's time for maintenance 2. Improved contingency plan for an unplanned situation 3. Guideline or generate for a routine job	A2, B1, C2
Documentation	1. Reduced paperwork improves productivity and response times. 2. Decreased transaction and enforcement expenses 3. Sending electronic certificates and documents	A1, A2, B2, C1
Environmental-related criteria		
Legal, Regulatory, & Policy requirements	1. Managing dynamic government, IMO, inter-financial policies 2. Regulations using ship data to navigate and labor policy	A1, A2, B1, B2, C1, C2
Social pressure influence	1. Improved competitiveness 2. Developed into the same industry standard	A1, B1, B2, C1

5.1 Technological-Related Criteria

One factor identified under the technology theme is the availability of access to digitalization and only Case A mentioned this factor. Easier access from around the world and automatic system updates are the main findings of this theme.

Availability of Access to Digitalization

The availability of the technical infrastructure, such as broadband internet access and reliable power, necessary to support the use of digital technology. Case A reported that the digital technology will be easier to access vessels from around the world. They are the international fleet, the real-time information for shipowners to enable risk management is most required. "*In addition, the ship in the middle of the sea had poor communication. The signal is transmitted via satellite phone calls, which are expensive and unstable. Data may be delayed and error, and errors must be improved. Currently, this operating system is designed to provide mobile phone users on board which is more stable and cost-effective. which before that would only get the content of the news But nowadays, it can be sent as a picture that makes the information clear, accurate, and real-time*".

From the evidence, we found only this one technology factor, while, in organizational and environmental context, we found eight and two factors respectively. Moreover, the technological factor is found in Case A only. This is a surprise when compared with the literature conducted in other industry settings.

This discussion suggests the following proposition:

P1: The technological-related critical is not the main driving force for Thai shipowners to adopt digital technology.

5.2 Organizational-Related Criteria

The large number of criteria highlighted by participants indicated that organizational considerations were dominating in their opinion when assessing the implementation of digital technology within the Thai shipowners company.

Improved Organizational Efficacy

Improved organization efficacy is one of the criteria that three cases mentioned. Organizational efficacy can be improved through digital technology adoption in several ways. Case A and B reported that they can also provide new and improved tools for communication and collaboration, which can help to increase productivity and reduce the time required to complete projects.

"When I was a crewman the crew member on the vessel around 24-25 people, but now it's 21-22 people, some vessels have 20 people, like the vessel has a new system. that is easy to operate, easy to maintain plus which will not be used by many people. The company, therefore, they don't want to use a lot of people, they reduce the number of people and do cost optimization".

In addition, Case C supported that digital technologies can provide organizations with access to new data sources and analytics tools such as dashboards in ERP systems, which can be used to make data-driven decisions and improve the overall decision-making process. "*Suppose in the future we want to see almost everything of ship equipment in a running ship. We will be able to access to new data sources to check everything how the device will be, how the dashboard cycle is, what temperature, and how's the oil level. I ensure that technology must the key to supporting the requirement*".

Reduced Operational Expenses

Three case shipowners have improved the process through digital adoption. Reduced operational expenses are one of the forces for digital adoption. To reduce operational expenses, the shipowners utilized digital technologies to cost savings on operations due to the optimization of processes and staff, decrease in fuel prices, decrease in expenditures related to procedural delays, and decrease in unexpected accident. The Chief Technical Officer of Case B has strongly remarked that digital technology can allow cost savings on operations due to the optimization of processes and staff and improve profitability. "*We thought that if we put the data in the computer, we will be able to reduce the calculation time from 20 minutes, it will be only 5 minutes, we save 10 minutes, 1 year we use to run 300 trips, 300 trips multiplied by 10 minutes, is 3000 minutes. It made the run from 300 become 302 trips, assuming the number of trips increased that we earn more money. From saving only 10 minutes per day, only 10 minutes per trip, resulting in 2 additional trips, we thought that the 2 trips were worth the cost of a computer of 60,000 baht.*"

Case A also supported that the digital technology can be used to practice navigation skill. "*We bought that simulation software, and we have the size data of the different types of marines that we have that we can use to practice what you need to do when marines enter different areas."*

Better Internal and External Communications

As the maritime business is known to operate 24 hours a day, communication between land and sea is important. In the past, communication had to wait for ships to dock in order to send messages. But nowadays, digital technology is helping to make operations between land and sea more efficient. Especially, the Training Instructor Manager of Case A remarked that the pandemic Covid-19 reshape the meeting and training pattern. Crew can train when they operate on vessels and the quality of training is higher than traditional training. "*Our attitude changed after we started training online for a while, we felt that it was not bad. Now, at the same time, we feel that it's easier to keep eye contact or look at the body language of the participants. I feel that it's not bad, it's good*."

Case B and C focused on noon report and crews can create purchase requisitions and then receive goods once the vessels arrived at the destination port without any delay.

Top Management Support and Commitment

Case A and B mentioned that top management plays a crucial role in innovation by establishing the necessary atmosphere and making decisions that facilitate the successful generation and use of knowledge (Al Shaar et al. 2015). *"Just like the top management himself, he had already gone to new Main Engine technology training section. The dealer gave him a free seat and he try to go to training. After going to training, the top management told me to*

change to new Main Engine technology. I mean, it's up to the top management."

Case B and C also mentioned about the important of top management support *"Top management policies must be clear. Then there is clear communication with the employees. We will measure the digital technology usage by KPI and monitor what changes and what the result will be. They can assist in obtaining the necessary resources and reaping the benefits of digitalization adoption."*

Plan Maintenance Monitoring & Unplanned Situation

Plan maintenance system (PMS) for maritime refers to the process of regularly scheduled and systematic inspections, repairs, and upgrades to the equipment and systems used in the maritime industry. Case A and C reported that the automatic PMS can help to reduce the risk of equipment failure and prevent safety incidents. *"As for the PMS, I was able to draw out which ones were overdue, which ones were due, which had to be done. It can be retrieved using very little time. Then come to consider choosing which system or equipment to do PMS and then order to the ship that this one is close to having to do PMS or this is immediate to be done. It was able to plan and it wasn't as hard as before."*

Case B and C supported the theme that technology can play an important role in supporting unplanned situations in various industries, including the maritime industry. By providing real-time data and analytics, digital technologies can help organizations quickly assess the situation and make informed decisions to respond to unplanned events, such as unexpected weather conditions, equipment failures, or security incidents.

"…because navigation has to look at the geography as well for example it might encounter a typhoon now that is strong, so we need a technology tool to detect conditions such as wind conditions, sea waves conditions."

Respondents from Case A and C were more expected to decrease an unexpected accident. Unforeseen accidents can continue to occur and affect shipowners in terms of both crew and hull costs. "*Today we have sensors on the bridge. Most of the accidents will happen when the boatman may fall asleep. This system will have a camera mounted on the bridge and track the movement of the people in the bridge and let the AI teach it that if the person stays still for more than the specified seconds. This is one thing that uses technology to help reduce accidents.*"

Documentation

The adoption of technology is closely related to the concept of a paperless environment. Paperless refers to the use of digital technologies to replace traditional paper-based processed, which can increase efficiency.

Three case shipowners reported that in the maritime industry, many of the tasks that were previously performed on paper such as payroll, purchase requisition, and classification certificates and now digital technology makes paperless. *"I think it's a policy from the company in order to find a system that will support all of the paperwork. In the past, we would have paper in the payroll section, in the provision section, in the weekly report section, and in the PMS section, it's all spread out, it's all paper."*

Case C refers that *"The main factor that we can touch on is the cost of operating in various sections. When we use technology, many costs are reduced. For example, when we try to go paperless, of course, the cost of using paper in our work is reduced."*

The evidence from the cases suggests the following proposition:

P2: Organizational-related factors are the main drivers of digital technology adoption in Thai shipowners.

P3: The organizational-related criteria are improved organizational efficacy, reduced operational expenses, better internal and external communication and top management support and commitment, and documentation.

5.3 Environmental-Related Criteria

There are two factors were identified under the environment theme. Legal, regulatory, & policy requirements, and social pressure influence.

Legal, Regulatory, and Policy Requirements

Normally, International Maritime Organization (IMO) specifies which types of ships must be equipped with what kind of digital technology. The legal, regulatory and policy requirement is very important for the maritime industry which is completely agreed upon in the three cases. Case C is the local trade shipowner and installed only the digital equipment which required by the marine department, but the technical manager of Case C plan to trade international voyage so the vessel has to be inspected and install more digital equipment such as ECDIS to comply with the international maritime regulation. *"We must strictly follow the IMO's regulations. Is*

there any additional equipment to be installed? What equipment do we have to invest in? We must make it comply with international maritime regulations."

Case A and B are listed companies, and both are international trade. They have been the requirement of the regulation since building a new vessel at the shipyard. *"When building a new vessel, you will have to look at all the regulations put in. Not that the current regulations put in all. You have to look in the next 2-5 years to see what regulations will come in. We have to install them in from now on. Otherwise, it will be a waste of time to call the vessel in the dock to install new regulations."*

Social Pressure Influence

According to the research evaluation, firms become more similar due to isomorphic pressures and legitimacy pressures caused by perceived social pressure and influence (DiMaggio & Powell, 1983). As a result of competition and customer pressures, organizations within the same industry tend to grow increasingly similar over time. "*In the past 10 years, there are many companies that do not focus on developing technology, either shut down or have few jobs. Perhaps the shipowner had ordered the vessel to go to an anchor point that had a lot of petroleum ships. It's parked there. There is no work for a week or only runs one way. Or run only 2 times a month, it has been greatly affected in the present."*

Case B also mentioned that the company cannot grow and get a competitive advantage without technology. *"We also have to be ready in terms of finance and continue to progress by using technology to help us because if we want to grow without technology to help me, in this era all over the world has used digital technology systems."*

The evidence from the cases suggests the following proposition:

- P4: Concerning external environment, legal, regulatory, & policy requirements is a key factor to digital technology adoption in Thai shipowners.
- P5: In Thai marine time industry, digital technologies are adopted with the aim to reduce the company's social pressure impact and demonstrate its commitment to sustainability, which result in improved reputation and competitiveness.

6 CONCLUSIONS

This study aims to gain a deeper understanding of the digital technology adoption process from the organizational level's perspective and to explain these findings using existing innovation adoption theories. The investigation and integration of the technology, organization, and environment framework and institution theory indicated that perspectives on the innovation adoption process are susceptible to change. This is a preliminary study in which the researcher especially plans to collect more data from more cases and a follow-up large-scale survey to confirm the identified adoption factors. Case evidence highlights that the main drivers of digital technology adoption in the maritime industry are improved organizational efficacy, reduced operational expenses, better internal and external communications, top management support and commitment, plan maintenance monitoring & unplanned situation, documentation, legal, regulatory, & policy requirements, and social pressure influence. We also found that technological drivers/barriers are less important comparing to the other two context, namely organizational and environmental.

The result suggests that policymakers and industry associations should promote digital technology adoption in the Thai maritime industry by educating shipowners on the benefits. Shipowners should invest in training their employees on digital technologies and involve their top management in the adoption process to drive digital transformation. Integrating digital technology into existing organizational structure can improve organizational efficacy and reduce expenses. Additionally, shipowners should collaborate with other stakeholders to create a supportive ecosystem and address social pressure to facilitate digital technology adoption.

A limitation arises from conducting exploratory research in this emerging field. It is essential to clarify that we are aware that only evidence form three cases may not be able to provide a robust conclusion. However, this is just a preliminary study. We plan to collect more data which could result in a different result. Moreover, the researcher is aware that it is not possible to holistically develop a model that applies to every Thai shipowners and their respective needs. Since the research scope is focused on a unit of analysis in Thai shipowners, future research is necessary to investigate the use cases for more vertical areas in the maritime industry. These may include, amongst many categorizations, shipyard, port, ship management, and other transportation industries.

REFERENCES

Yang, C. S. (2019). Maritime shipping digitalization: Blockchain-based technology applications, future improvements, and intention to use. *Transportation Research Part E: Logistics and Transportation Review*, 131, 108-117.

DiMaggio, P. J., & Powell, W. W. (1983). The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields. *American sociological review*, 147-160.

Ikpogu, N. M. (2021). Barriers to Technology Adoption Among Maritime Industry Stakeholders in Nigeria (Doctoral dissertation, Walden University).

Gavalas, P. (2020). Onboard vessels digital disruption through ICT technologies: strategic incentives, anew perils and adoption tendencies. Focusing on the greek maritime shipping sector (Doctoral dissertation, University of Piraeus (Greece).

Tornatzky, L. G., Fleischer, M., & Chakrabarti, A. K. (1990). Processes of technological innovation. *Lexington books.*

Zeng, F., Chan, H. K., & Pawar, K. (2020). The adoption of open platform for container bookings in the maritime supply chain. *Transportation Research Part E: Logistics and Transportation Review*, 141, 102019.

Teo, H. H., Wei, K. K., & Benbasat, I. (2003). Predicting intention to adopt interorganizational linkages: An institutional perspective. *MIS quarterly*, 19-49.

Kleppe, K. M. S., & Nortvedt, B. (2020). Authentic leadership and employee agility in the context of a digital transformation: the roles of employees' fixed digital mindset and affective commitment to change (Master's thesis, Handelshøyskolen BI).

Papageorgiou, M. (2020_. Digital Technology in the Shipping Industry is here, *KPMG for NAFS magazine*, Retrieved on December 04, 2020

Al Shaar, E. M., Khattab, S. A., Alkaied, R. N., & Manna, A. Q. (2015). The effect of top management support on innovation: The mediating role of synergy between organizational structure and information technology. *International Review of Management and Business Research*, 4(2), 499.

Tijan, E., Jović, M., Aksentijević, S., & Pucihar, A. (2021). Digital transformation in the maritime transport sector. *Technological Forecasting and Social Change*, 170, 120879.

Zaman, I., Pazouki, K., Norman, R., Younessi, S., & Coleman, S. (2017). Challenges and opportunities of big data analytics for upcoming regulations and future transformation of the shipping industry. *Procedia engineering*, 194, 537-544.

Bajpai, A. (2021). Drivers and barriers in adoption of digitalization in commercial shipping (ship chartering and ship broking) (Master's thesis, University of South-Eastern Norway).

Van Dyk, R., & Van Belle, J. P. (2019, September). Factors influencing the intended adoption of digital transformation: a South African case study. *In 2019 Federated Conference on Computer Science and Information Systems* (FedCSIS) (pp. 519-528). IEEE.

Sullivan, B. P., Desai, S., Sole, J., Rossi, M., Ramundo, L., & Terzi, S. (2020). Maritime 4.0–opportunities in digitalization and advanced manufacturing for vessel development. *Procedia manufacturing*, 42, 246-253.

Teo, H. H., Wei, K. K., & Benbasat, I. (2003). Predicting intention to adopt interorganizational linkages: An institutional perspective. *MIS quarterly*, 19-49.