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Factors Affecting the Digital Transformation Process of Deep Water Seaports in Vietnam

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Thesis for a Master of Business Administration (UAS) Degree

The Degree Programme of Digital Business and Management

Vaasa 2023

DEGREE THESIS

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Degree Programme and place of study: Master of Business Administration, NOVIA University of Applied Sciences, Vaasa

Specialization: Digital Business and Management

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Title: Factors Affecting the Digital Transformation Process of Deep Water Seaports in Vietnam

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Date: 17.11.2023 Number of pages: 73 Appendices: 1

Abstract

Seaports play a critical role in the transport and logistics chain by providing some core services such as cargo handling, warehousing, and storage for a diversified range of customers including shipping lines, freight forwarders, logistics companies, and cargo-owners. In the digital age of Industry 4.0, digital transformation is a must for the existence and development of all types of businesses including seaport sectors.

Focusing on four main deep water seaports: Gemalink, TCIT, TCTT, and SSIT which are considered the main nodes for international sea transport in Vietnam, this study investigates the influencing factors of the digital transformation process in the context of Technology – Organization – Environmental (TOE) framework. To achieve the research objectives, semi-structured interviews with 8 experts were conducted and a quantitative research method was performed through 216 online survey questionnaires within these seaports. Research results found that 8 influencing factors: Security and privacy (T), Compatibility (T), Strategy (O), Human resources (O), Structure (O), Customer demand (E), Government policy (E), and COVID-19 pandemic (E) in which Government policy is the most influential factor to the digital transformation process in deep seaports. Based on these factors, the author proposed some solutions as managerial implications to help port operators, port authorities and port management succeed in their digital transformation projects.

Language: English

Key Words: Digital transformation, digitalization, Vietnam deep water seaport, logistics

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1. Introduction

The global economy is always moving and constantly changing from time to time, today businesses are facing numerous challenges and rapid changes in the business environment. Especially, a variety of new ecosystems and business models have appeared simultaneously due to the huge effect and rising penetration of the Fourth Industrial Revolution that creates new challenges and opportunities for each business worldwide. Fierce competition in the digital age forces companies to continuously innovate and improve to meet the changing customers' requirements and the economy. Anything that can be digitalized will be digitalized (Negroponte, 1995). It is imperative and inevitable for all businesses across all industries to implement technologies or emerge digital opportunities for their business models. Today's organizations that are slower in deploying digitalization and technologies may lead to lower productivity, loss of competitive advantage, and being eliminated from the competition and the market (Lim, 2019, p. 27). Transforming business operations by using digital technologies is one of two core activities for leading companies to succeed in digital transformation (Berman, 2012). Digitalization will help business entities improve productivity, create a brand reputation, enhance operations, and advance customer experience and engagement (Schreckling & Steiger, 2016, pp. 12-13) to meet customers' increased expectations and satisfaction, thereby boosting more profits.

In recent years, the wave of high-impact digital technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), Cloud computing, Blockchain, and Big data analytics profoundly affected economies, societies, sectors, businesses, and even individuals. It can be said that today's digital transformation is not only a trend but also an indispensable part as it gradually plays a vital role in all human activities. According to the report carried out by McKinsey & Company for the European Commission, digital technologies are estimated to contribute €2.2 trillion to the cumulative additional GDP (14.1% increase in total amount compared to 2017) in 28 European countries (including the United Kingdom) by 2030 (McKinsey & Company, 2020).

Digital transformation in Vietnam has also received special attention from the Government, the local authorities, and business owners over the past time. The decision "National Digital Transformation Program through 2025, with orientations toward 2030" No. 749/QD-TTg approved by the Vietnam Prime Minister on June 03, 2020 emphasized the importance of

fostering digital transformation and developing the economy driven by science, innovations, and creativity for a target to become a prosperous digital country pioneering in new technologies and models in 2030 (The Prime Minister of Vietnam, 2020). This decision also focused on some main sectors that need to be prioritized for implementing digital transformation including healthcare, education, the financial-banking, agriculture, transport and logistics, etc. Vietnam transport and logistics services is one of eight critical sectors named by the Prime Minister for enhancement of digital transformation. The smart traffic systems will be developed by transforming the logistics infrastructure (e.g. seaports, inland ports, airports, railway systems, etc.) and establishing new platforms with digital technologies to increase productivity and efficiency. Among logistics infrastructures in Vietnam, seaports are vital traffic node points for the customs clearance, import, and export of goods carried by sea. Therefore, enhancing port compatibility and technical advancement of seaports by digital technologies is the main goal for improving the effectiveness of the overall sea transportation process as well as the whole national logistics system.

1.1 Justification for the study

The continuous and rapid development of digital technologies has been fostering incredible movement and changes in human life and all business activities in recent years. This has been called Digital Transformation (Trierveiler, Sell, & Santo, 2019). Especially, the outbreak of the Covid-19 pandemic worldwide at the end of 2020 has caused many unprecedented disruptions and changes to every aspect of our daily lives as well as all business activities. Disruption of the global supply chain during this time caused a serious impact on the logistics sector in Vietnam. Severe congestion of cargoes at seaports interrupted all import-export and trading activities, thereby adversely influencing Vietnam's economy. From this reality, there is an urgent need for Vietnam to transform a traditional business model into a digital model to adapt to the current situation.

However, the implementation of digital transformation in all countries worldwide is facing many certain difficulties. It is even much more difficult and challenging for developing countries like Vietnam compared with other developed countries. Vietnam enterprises in general and logistics corporations in particular, are confronted with many outstanding problems needed for the digital transformation process such as the shortage of human

resources to conduct digitalization activities, weak technology infrastructure platforms, a lack of mindset for digital transformation due to the long-term effects of traditional business activities, and even organizational culture change. These issues have been remaining huge challenges for Vietnam's economy and businesses to adapt to this new practical and indispensable experience.

Possessing the advantage of a long coastline of over 3,260 kilometers and being located near the international and regional maritime routes, Vietnam is favorable for developing the maritime sector (shipping, export-import, and trading) and relevant logistics industries, especially port systems which are considered one of the strengths of Vietnam's economy. Especially, after becoming a member of the World Trade Organization in 2007, Vietnam has gradually transformed the marine sector to bring its national economy to the world. Therefore, seaway and inland waterway transport systems play a critical role in the country's socioeconomic development. Seaport systems are considered a traffic hub and an important link in the transport chain (Behdani, Wiegmans, Roso, & Haralambides, 2020), especially deep water ports. With a favorable geographical location with a depth from 14m to 16m and well-equipped with the most modern facilities, Vietnam's deep water seaports play a role as international transshipment ports are able to handle large vessels such as large container ships, Roll-on/roll-off (RORO) ships, and bulk carriers. The increasing demand for direct-service cargo transportation by sea and many large container vessels being built in recent years has promoted the expansion of deep water container seaports at some locations, particularly in Southern Vietnam at the busiest Cai Mep-Thi Vai complex (Ba Ria-Vung Tau province) to meet this demand. Realizing the importance of digital transformation activities and their effect on port operations and throughput productivity, many fostered solutions for port digitalization have been proposed. To be successful in the implementation of digital transformation, however, seaports should overcome many challenges as well as find out some factors that can be obstacles during this process.

In the above context of practical requirements, the need for digital transformation and its application plays a vital role in the existence and development of seaports in Vietnam, especially deep water seaports which are considered the main nodes for international transport. This study will determine some main factors that affect the digital transformation process of deep water seaports, then suggest some practical solutions to help port operators, and the port's board of management timely transform the business

model to meet the current increasing demand of customers as well as the sustainable development needs of the business in the future.

1.2 Research questions

Same all other sectors in the economy of a country, specific industries like seaports in Vietnam must also implement digital transformation as an inevitable need in the digital age. To succeed in this process, therefore, the main target of this study is to discover the main factors affecting the digital transformation process of deep seaports in Vietnam. The first research question (RQ) focuses on identifying the factors, the second one on the influential level of these factors, and the final RQ closes in on managerial implications for port operators:

RQ1: What are the main factors that affect the digital transformation process of deep water seaports in Vietnam?

RQ2: How do these main factors influence on the digital transformation process of deep water seaports in Vietnam? Which factor is the most influential?

RQ3: What are the managerial implications for the port operators and the port's board of management to succeed in digital transformation?

1.3 Research objectives

This thesis aims to determine the main factors that affect the digital transformation process of deep water seaports in Vietnam. Based on discovered factors, the author will suggest some practical solutions as managerial implications that help the port operators, and the port's board of management timely make decisions in fostering digital transformation for effective operations.

RO1: To determine the main factors that affect the digital transformation process of deep water seaports in Vietnam.

RO2: To determine the influential level of these factors on the digital transformation process of deep water seaports in Vietnam and identify the most influential factor.

RO3: To suggest some practical solutions as managerial implications for the port operators and the port's management board to succeed in digital transformation.

1.4 Delimitation of the study

This thesis scope is affected by certain delimitations. As implication by the topic and the above research questions, the study exclusively focused on the deep water seaports in Vietnam. Specifically, the scope of this research concentrated in detail on the Southeast region, considered Vietnam's major economic zone. Besides, this region also gathers many deep water seaports, especially Cai Mep-Thi Vai deep water ports cluster located at the mouth of Thi Vai river and Cai Mep river in Ba Ria-Vung Tau province. To support the thesis, four deep water seaports in this zone were chosen as the main research objective, including **GEMALINK** International Port, TAN CANG - CAI MEP International Terminal (**TCIT**), TAN CANG - CAI MEP THI VAI Terminal (**TCTT**) and SP-SSA International Terminal (**SSIT**).

The combination of qualitative and quantitative methodologies was used as the main research method for this study. There was also a limitation in the number of experts participating in the interviews in qualitative research when this project only interviewed 2 experts for each of the 4 targeted deep seaports. In addition, the survey questionnaire in the quantitative research focused only on surveying employees working in the offices of these seaports. Workers working directly in specialized and specific areas such as dry storage, cold warehouses, and equipment repair workshops at these seaports were difficult to approach, thereby, not considering as respondents to the questionnaire survey of this study.

2. Literature review

This section reviewed the theoretical framework as the basis of the study. It examined the literature on digital transformation through the hierarchy and some typical concepts from different perspectives by previous researchers. The literature on seaports, deep water seaports,, and digital transformation in this sector were also discussed. Based on a careful examination of the empirical literature on digital transformation in the context of TOE model, the conceptual research framework was proposed. Besides, various findings about factors influencing the digital transformation process and the research gap were highlighted.

2.1 Literature on digital transformation

The explosion in digitalization of the economies of many countries worldwide has been highlighting the vital role of digital transformation and how it can help organizations stay competitive in the global market (Kraus, et al., 2021). In recent decades, globalization has put high pressure on and forced organizations to rapidly change to adapt to the new competitive digital business environment in Industry 4.0. Digitalization has created many challenges and obstacles for organizations to survive and develop in the digital age. To overcome these challenges and obstacles, organizations need to demonstrate their capabilities in all business aspects as well as digital readiness (Machado, et al., 2019). However, not all businesses are aware of the vital role of digitalization. Some organizations are realizing the need for digitalization and its essential role, but some lack sufficient knowledge on how to initiate digital transformation (Von Leipzig, et al., 2017).

Digital transformation roots originated in the 1980s and early 1990s by many researchers when they analyzed the influences of applying Information Technology (IT) on the structures, innovation, and performance of organizations (Plekhanov, Franke, & Netland, 2022). With the support of computers, technologies, and the popularity of the Internet (Chatfield & Andersen, 1997), the outstanding IT-enabled transformation of some businesses was recognized during the 1990s, especially IT-based businesses (Markus & Benjamin, 1997). The continuous development of IT systems over the years and the adoption of IT in every discipline make the necessary demand for digital transformation

research across most businesses, economic, and management fields (Plekhanov, Franke, & Netland, 2022).

In recent years, there has been a wide range of studies focusing on digital transformation in many areas with different approaches. However, there is still no standardized definition that can cover the entire concept of digital transformation (Kraus, et al., 2021). It is mostly expressed by individuals, organizations, and businesses based on their own development orientation. From the perspective of a country like Vietnam, digital transformation is basically defined as the use of data and digital technology to change all aspects of socioeconomic life in a comprehensive way (The Prime Minister of Vietnam, 2020). Therefore, it is clear that digitalization is a wide-ranging activity and can reach not only the micro-level at the enterprise or an organization but also the macro-level of a nation. Research on digital transformation has also been conducted extensively around the world. According to Demirkan and his associates, digitalization or digital transformation refers to an accelerating transformation phenomenon that is based on digital advances to apply to business activities, processes, and business models (Demirkan, Spohrer, & Welser, 2016, pp. 14-18). In the research paper of Hess and his associate (2016), there is the same opinion as Demirkan when Hess also mentioned an important feature of digital transformation in applying changes in digital technology so that new business models can be developed, thereby creating new products to meet customer demands or applying digital advances in transforming the organizational structure, process, and workflow towards automation. Digital transformation, in other words, can be defined as an integration of digital technologies into business activities that lead to critical changes in its operations and bring value to customers (Mićić, 2017). According to Mićić, the application of digital technology is based on the development of many different types of technologies including telecommunication networks, computing technology, and software engineering. In contrast to the above definitions, Siebel's book titled "Digital Transformation: Survive and Thrive in an Era of Mass Extinction" (2019) has deeply focused on providing the concept of digital transformation by specifically indicating technology applications that are necessary for digitalization such as Cloud Computing, Big Data, Internet of Things (IoT), and Artificial Intelligence (AI). It implies that the impact of digital transformation is extremely wide and can lead to different perspectives and approaches for each type of business during this changing process.

There is a distinction between the definition of digital transformation and digitization (Kraus, et al., 2021, p. 4) and digitalization concepts (Shehadeh, Almohtaseb, Aldehayyat, & Abu-AlSondos, 2023). The clear distinction between these definitions is described in **Figure 1** by the hierarchy of digital transformation (O'Leary, 2022), in which the activities move from the simple and easy level (digitization) to the more difficult level (digitalization) and the most complex and difficult level for execution (digital transformation). However, some research described the same concept between digital transformation and digitalization (Hagberg, Sundstrom, & Egels-Zandén, 2016) (Hess, Benlian, Matt, & Wiesböck, 2016) (Parviainen, Tihinen, Kääriäinen, & Teppola, 2017). Research from Hess and his associates described "digitization" as the conversion of information from analog data to digital form or machine-readable format as well as the use of information technologies for processes' automation (Hess, Benlian, Matt, & Wiesböck, 2016). Digitalization focuses on information processing and using digital data analysis for workflow improvement through the automation of existing processes (Monton, 2021). Digitalization relates to a socio-technical process to which digitizing techniques are applied (Heilig, Lalla-Ruiz, & Voß, Digital transformation in maritime ports: analysis and a game theoretic framework, 2017). Research by Kraus and his associates describes digitalization as the improvement of specified processes within an organization, whereas the digital transformation process is a broader concept that relates to changes arising from digital technologies (Kraus, et al., 2021), encompasses various businesses, and systems, and allows the group of all types of digital solutions and digitalization (Vrana & Singh, 2021). According to the Organization of Economics Cooperation and Development (OECD), digital transformation is considered "the economic and societal effects of digitization and digitalization" (OECD, 2018).

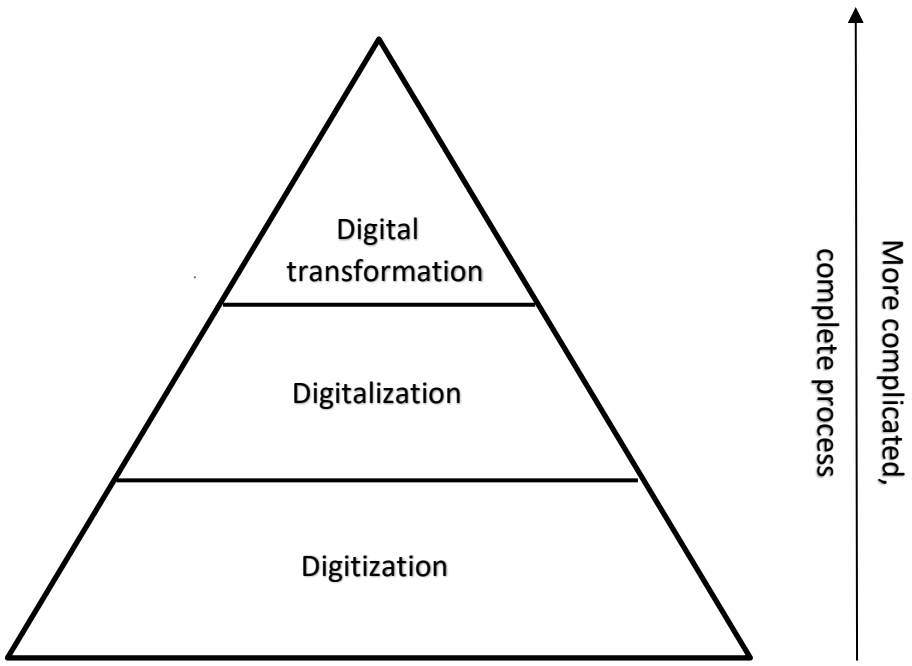


Figure 1. Digital transformation hierarchy (O'Leary, 2022)

Thanks to the grounded theory of Wolfswinkel and his associates (2013), a conceptual framework of digital transformation was developed and described as a process in which organizations or businesses use digital technologies to transform their value-creation process and react to any changes occurring in their environment (Vial, 2019). Besides processes, digital technologies can help organizations and businesses to create new business models or upgrade the current ones to a higher level (Loebbecke & Picot, 2015) as well as support the organizational structures and resources transformation (Frank, Dalenogare, & Ayala, 2019). Almost all aspects of modern organizations could be influenced by digital technologies (Beverungen, Muller, Matzner, Mendling, & Vom Brocke, 2019) such as production, managerial strategy (Warner & Wager, 2019), and relationships with customers, suppliers, and partners (Majumder, Gupta, & Paul, 2022). The term "transformation" refers to considerable changes that comprise the realization and understanding to take necessary action when businesses are approaching new technologies (Singh & Hess, 2017).

Table 1. Concepts of Digital transformation compiled and summarized by the author

Source	Definition of digital transformation
(European Parliament, 2019)	Refers to the integration of digital technologies such as IoT, cloud computing, blockchain, and digital platforms and the influence of these new technologies on society.
(Westerman, Calméjane, Bonnet, Ferraris, & McAfee, 2011)	The utilization of new technologies to improve the performance of organizations.
(Schwertner, 2017)	The use of digital technologies in organizations for building new processes, business models, software, and systems. The final result is to improve competitive advantage, get more revenue, higher efficiency, and bigger market valuation.
(Fitzgerald, Kruschwitz, Bonnet, & Welch, 2014) ; (Horlacher, Klarner, & Hess, 2016); (Singh & Hess, 2017)	The application of new digital technologies to enhance major business, improve customer experience, and streamline operations with new business model creation. New technologies can be social media, mobile, analytics, or embedded devices.
(Ismail, Khater, & Zaki, 2017)	A process in which multiple new digital technologies are used by organizations to reach superior performance and sustainable competitive advantage. Many business dimensions are transformed during this process such as business model, customer experience, operations, networks, and human resources.
(Liu, Chen, & Chou, 2011, p. 1728)	Refers to the transformation in organizations where there is the integration of both digital technologies and business processes.

(Nwankpa & Roumani, 2016)	Refers to changes that are driven and built on a foundation of digital technologies.
(Stolterman, Fors, & Truex, 2004)	Includes the changes associated with the use of digital technologies in all aspects of human society.
(Clohessy, Acton, & Morgan, 2017)	A process in which the business model of a company is changed by digital technologies. This will lead to changes in products, organizational structure, and processes.
(Notteboom, Pallis, & Rodrigue, 2022, p. 155)	The integration of digital technologies or information technologies into business processes. This results in notable changes in business operations as well as new values for customers are created.

Over the last two decades, digital transformation topic has received increasing and significant attention in research by many researchers. **Table 1** summarizes some typical concepts of digital transformation during this period. In general, these authors have different aspects and perspectives on digital transformation, however, they all have the same orientation by using new digital technologies to improve organizational performance, enhance customer experience, and create new business models. For the digital transformation process to be successful and bring positive outcomes, organizations must focus on several factors that can hinder or affect the execution of the transformation (Vial, 2019).

2.2 Seaport and deep water seaport

It cannot be denied that the maritime industry plays a vital role in the world trade history. With the role of promoting global economic activities and growth, the maritime industry is considered “the first and primary facilitator of world trade” as well as “the first truly global industry” (Maria G., 2015). Indeed, if anyone desires to deeply understand how effective the global economy is or monitor the growth rates, production, and employment of a region or a nation, he simply needs to check out how seaports work.

The concept of a port (or a seaport) appeared quite early with the formation and development of the maritime industry. Along with the expansion of sea transportation and increasingly close labor cooperation, seaport definitions are gradually upgraded from time to time. There are many different definitions of seaport till now. The general concept of ports can be seen as a place where there is a transfer of cargo and passengers to and from waterways and shores (Wayne K., 2009). In another conventional perspective, port refers to a transit area or a gateway through which cargo and passengers move from and to the sea (Notteboom, Pallis, & Rodrigue, 2022). Ports can be cargo ports, passenger ports, or a combination of cargo and passenger ports. However, most major and typical seaports that have a critical impact on global trade are cargo ports. There are many types of cargo, comprising general cargo, bulk cargo, containers, and project cargo. The prominent type of cargo or specialized type of cargo handled by a port will describe that cargo port's type. According to the Britannica Dictionary, a port is simply defined as a place where ships stop to load or unload/discharge the cargo as well as a shelter for ships during a storm. Martin Stopford, who is the author of a famous textbook "Maritime Economics", described seaports as "a geographical area where ships are brought alongside land to load and discharge cargo – usually a sheltered deep-water area such as bay or river mouth" (Stopford, 2009). Besides loading and unloading cargo, seaports also refer to a place for storage, receipt and delivery of cargo by inland transport as well as all business activities connected to sea transport (Nijdam & Horst, 2018).

It is obvious to notice the important functions of seaports through the above definitions. The main function of a seaport relates to the handling and providing services to both ships and cargo in the port as summarized in **Figure 2**. Some core services are provided by ports to ships such as: towing, berthing, repairing, and maintenance services.

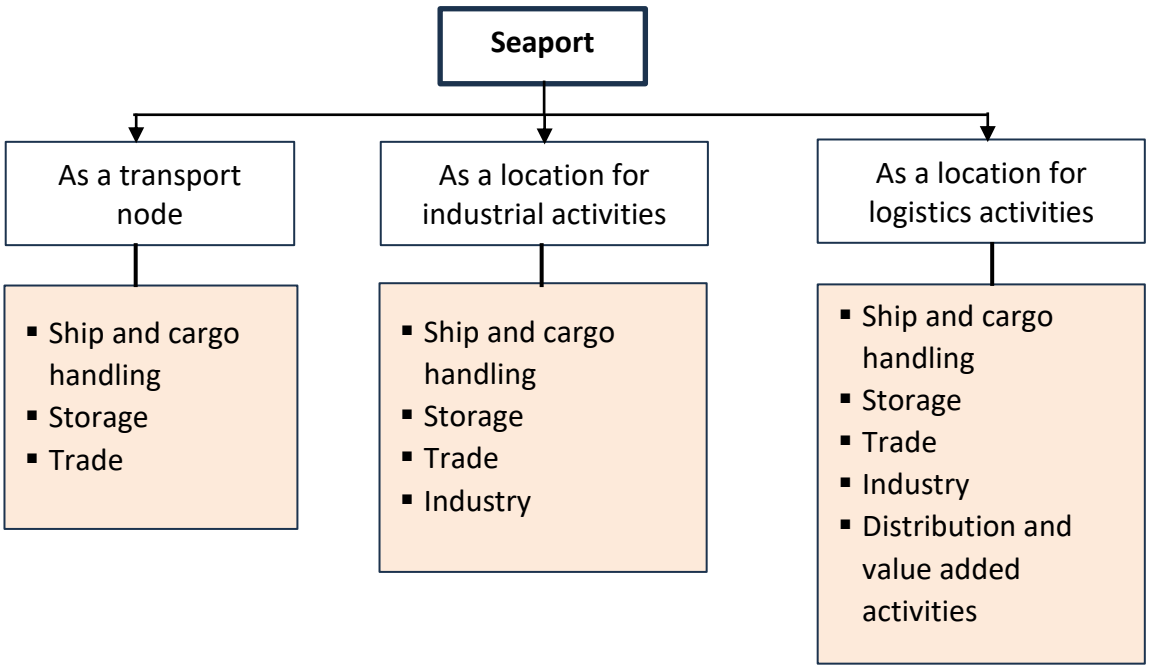


Figure 2. Main functions of a seaport (Nijdam & Horst, 2018)

For import and export cargo, ports provide loading/unloading service, transportation, and some logistics activities including storage services, warehousing, packing and packaging, labeling, consolidation, deconsolidation, etc. Besides, ports are also important nodes in transportation networks (Wayne K., 2009) or transport chains (Nijdam & Horst, 2018). Most seaports focus on cargo to a large extent, therefore, a node in this case is a center location where there is an emanation of cargo movements and the interaction between ocean and inland transport systems (Wayne K., 2009). Moreover, a node is also a convergent place for various transport modes such as railway, airway, roll-on/roll-off, and highway.

Due to the essential roles of seaports in both industrial and logistics activities, seaports can also be defined from a supply chain perspective as “a functional and spatial clustering of activities directly or indirectly linked to transportation, transformation, and information processes within global supply chains” (Notteboom, Pallis, & Rodrigue, 2022). Theo Notteboom and his associates also define seaport with the combination of geographical and functional elements as shown in Figure 3. While logistics nodes and industrial nodes define the functional elements of a seaport, location and site determine its geographical elements. Site refers to the physical characteristics of a seaport and location relates to the relative position of this seaport with other ports through its hinterland and shipping networks.

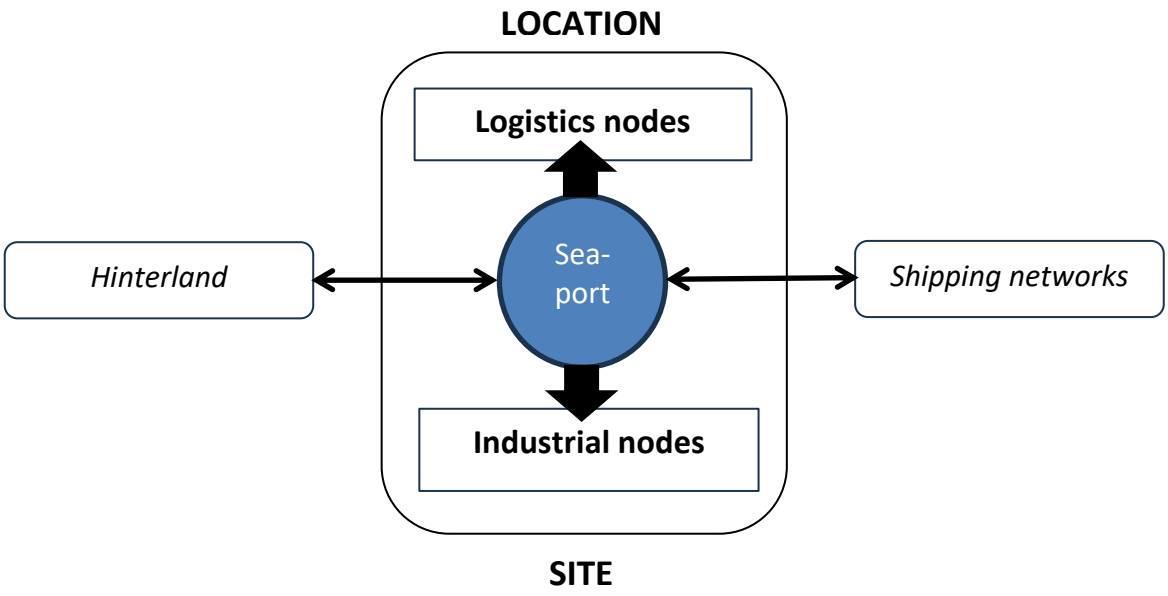


Figure 3. Definition of seaport with geographical and functional elements (Notteboom, Pallis, & Rodrigue, 2022)

The current trend of the global maritime industry is rapidly moving in the direction of huge vessels and deep water seaports. Large maritime carriers, especially containerships have witnessed a dramatical growth from the Early Containership in 1956 with a capacity of 500-800 TEU (TEU is the acronym for **T**wenty-foot **E**quivalent **U**nit - it is the unit of measurement of capacity of a twenty-foot container in length) to Ultra Large Container Ship and Megamax Ship (which are considered *economical vessels*) with the total of 25,000 TEU in capacity recently (Jean-Paul, 2020). This promotes the emergence and mandatory development of deep water seaports worldwide. Deep water seaport is also referred to as "deep seaport" or "deep water port". From the name and nomenclature of the deep water seaport, it can be suggested that this kind of seaport differs from regular seaports in respect of the depth of the water. The deeper the water of the port, the higher capacity ships the port can accommodate.

There are several descriptive definitions of deep water seaport. According to the US Deep Water Port Act 1974, under Title 33 of U.S. Code § 1502 (9), deep water port is defined as "any fixed or floating man-made structure other than a vessel, or any group of such structures, that are located beyond State seaward boundaries and that are used or intended for use as a port or terminal for transportation, storage, or further handling of oil or natural gas for transportation to or from any State." (US-DWPA, 1974). It has not been a general definition for deep water seaport due to some specifications following the US

statutory. However, this definition emphasizes the location of deep seaport beyond seaward boundaries. Another research paper from García underlines any ports that have the draft both in the entrance channel and in the terminal area exceeding 13.72m, can be qualified as deep water seaports (García, 2013). The draft means the vertical distance from the water surface to the bottom of the sea. This concept shows another aspect of deep water seaport in terms of its capability for large vessels to berth, especially the depth of the vessels' draft. It underlines the fact that, for a large and heavily loaded ship to be able to access the deep water seaport, the draft of this port must be higher than the draft of a ship under normal natural conditions.

In general, a seaport with a favorable geographical location and artificial or natural capacity that can accommodate large vessels in terms of depth of draft and cargo handling operation qualifies as a deep water seaport (Emeka, 2020, p. 5).

2.3 Digital transformation in port operations

Digital transformation plays a vital role in all business operations. According to the research of Ustundag and Cevikcan, the transformational era we are living in is totally different from other eras, it not only brings changes in fundamental business processes but also highlights the concept of intelligent interactive products expressed through business models (Akdil, Ustundag, & Cevikcan, 2018). Therefore, it is clear that digital transformation is inevitable and essential for all individuals, businesses and even governments.

For all businesses in general, enterprises can reduce operational costs through the process of digital transformation. Besides, the increasing use of digital solutions helps businesses gain higher competitiveness, increase profits and productivity as well and minimize human errors (Salkin, Oner, Ustundag, & Cevikcan, 2018). Digital transformation contributes the success not only in the manufacturing sector but can also bring a competitive advantage for service-based organizations (Shehadeh, Almohtaseb, Aldehayyat, & Abu-AlSondos, 2023). Like many service sectors of the economy, the maritime and logistics industries in general, and port and shipping operations in particular have also been influenced by digital transformation. In the digital era, service reliability is not only evaluated by the diversity of services that a business delivers to the customer but also by how efficient, convenient, and consistent these services are (Notteboom, Pallis, & Rodrigue, 2022, p. 156). The

implementation of new strategies and business models, as well as new data solutions between relevant organizations including seaports and their logistics providers or supply chain partners can become a significant challenge for seaports. The support of IT systems and digital innovations highly affects almost all aspects of port operations and the transportation process. Heilig and his associates indicated three generations of digital transformation in seaports starting from paperless procedures to automated procedures and finally to smart procedures (Heilig, Schwarze, & Voss, 2017). Another research from Heilig and his associates named *"Digital transformation on maritime ports: Analysis and a game theoretical framework"* also analyzed the development of digital transformation at seaport as well as highlighted the current opportunities and obstacles relating to digital transformation implementation (Heilig, Lalla-Ruiz, & Voß, 2017).

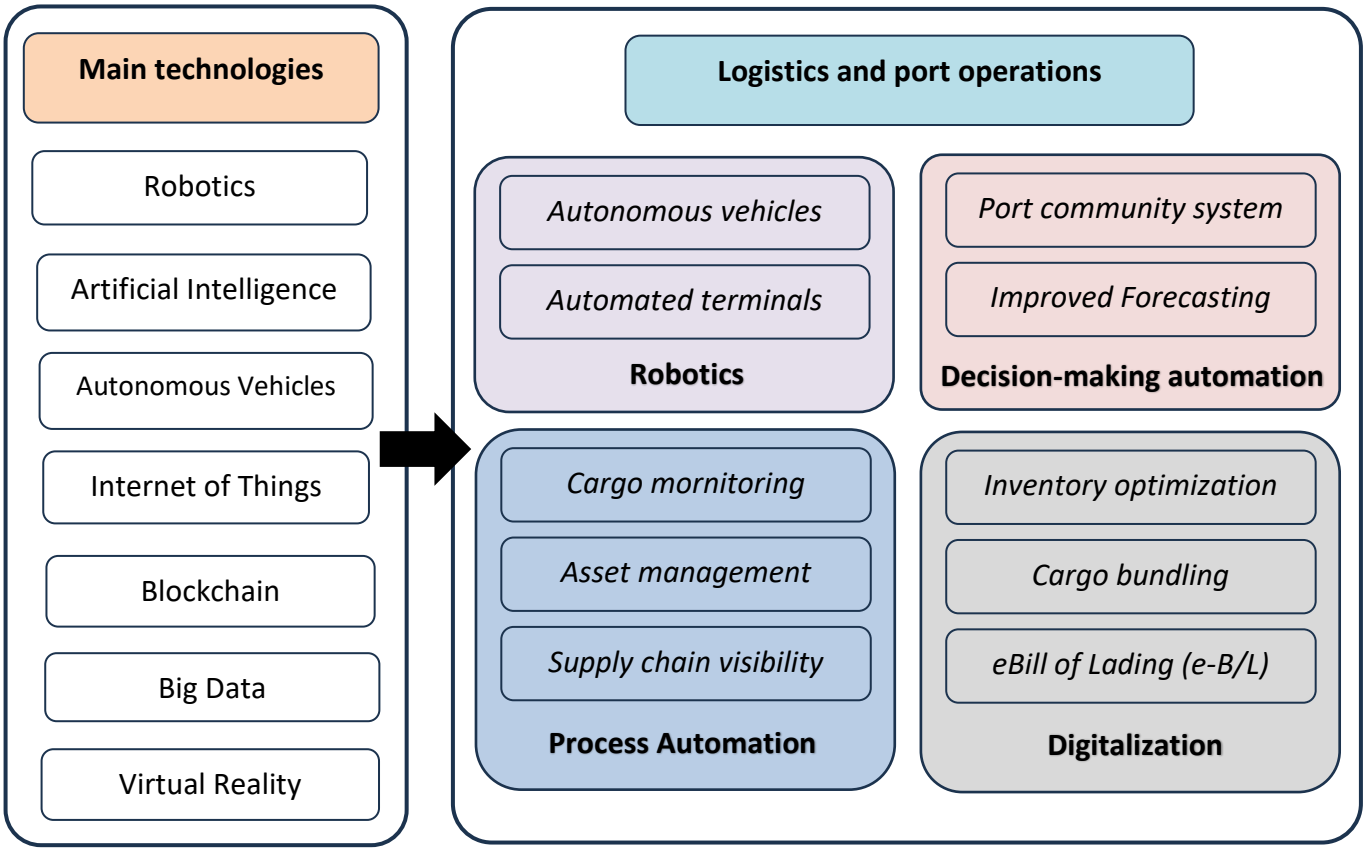


Figure 4. Main technologies integrate into logistics and port operations (Notteboom, Pallis, & Rodrigue, 2022, p. 158)

Four main categories of digital technologies and automation integrated into logistics and port operations comprise Robotics, decision-making, process automation, and digitalization as shown in **Figure 4.** Streamlined operation is one of the notable advantages of Robotics automation in ports. Up to over 90% of all workloads are autonomously

performed with the diversified implementation of Robotics-based automation in some of the important processes and systems in container terminals for equipment that handled container such as automated mooring systems, and automated ship-to-shore cranes (Notteboom, Pallis, & Rodrigue, 2022). Intelligent robotics, smart cranes equipped with advanced sensors and cameras, and Automated Guide vehicles (AGVs) are utilized in terminals to handle the real-time movement of the containers in port such as loading, unloading, lifting, and stacking the containers on vessels or within container yards.

Some core decisions related to port operations such as stowage planning, container positioning in the yard and on vessels, transportation scheduling or empty container forecasting can also be made, monitored and optimized by the implementation of digital technologies. Besides, the cargo handling process can be automated with these technologies. One notable example is a gate process in container ports, automated technologies are integrated such as vehicle detection and container identification, radiation scanning for the recognition of cargo inside the containers, driver identification, and route monitoring of the vehicle within the container terminal (Notteboom, Pallis, & Rodrigue, 2022). Some internal processes in the container ports including container inspection, customs clearance, tracking position of an empty and full container, etc. can be autonomously performed with the support of Optical Character Recognition (OCR) and Radio Frequency Identification (RFID) technologies.

Furthermore, digitalization in port operations significantly reduces the reliance on paper-based processes and facilitates the adoption of digital documentation systems such as electronic Bill of Lading (E-B/L), and electronic Delivery Order (E-D/O). Blockchain and Electronic Data Interchange (EDI) technologies are implemented to ensure the seamless, security and transparency of data sharing and communication between port authorities and shipping lines, logistics providers, and customers, minimize manual errors, and eliminate unnecessary paperwork.

It is undeniable that digital transformation through new technologies has delivered numerous advantages to all types of business sectors in general and maritime industries in particular. The implementation of digital transformation has become more necessary than ever, especially in seaports, shipping companies, and logistics corporations. With digital technology adoption, risks and costs can be highly reduced while on-time delivery and

customer prestige are considerably improved. Therefore, these corporations can overcome obstacles, maintain competitive advantages, and accelerate their operations in the digital era.

2.4 Current situation of Vietnam seaports in digital transformation

According to approval No. 749/QD-TTg of the Vietnam Prime Minister (2020), the logistics industry in general and shipping, port operations, and forwarding services in particular is considered one of eight important sectors that need to be prioritized in fostering digital transformation. Besides, the logistics report of the Vietnam Ministry of Industry and Trade (Ministry of Industry and Trade of VietNam, 2022) also emphasized the urgent need for advancing digital transformation in the seaport industry. It is extremely difficult for many large seaports, especially some deep-water seaports in the Cai Mep - Thi Vai cluster in the Southern area of Vietnam which are considered the largest seaports in Vietnam with a total area of over 48 ha (Saigon Newport Corporation, n.d.) to control and monitor all types of cargo, vehicles coming and leaving these ports as well as customs process management without the support of digital transformation. The booming of COVID-19 pandemic has caused a negative impact on Vietnam's economy but it is considered one of the important factors in accelerating the digital transformation process for many sectors including seaports. The manual handling of a variety of complex and diverse goods through the ports together with many documents from customs clearance and related parties result in high pressure and risks in port operations. According to the statistics from the Vietnam Maritime Administration, the Vietnam seaport system stretches across the country and it is formed with a total of 34 seaports, 296 berths and wharves with 96 km length overall (Vietnam Maritime Administration, n.d.). The implementation of digitalization or proper investment in IT applications, however, has not received any special attention from seaports up till now (Ministry of Industry and Trade of VietNam, 2022). The slow in applying digital technologies in seaports is caused by many significant reasons such as high investment costs, lack of infrastructure, the risk of business data leakage, shortage of human resources as well as knowledge and skills of modern technologies and equipment (VCCI, 2021).

Saigon Newport was the first corporation in the South that implemented an electronic port (E-port) application in Vietnam in early 2017. This successful project, which marked the first milestone of the Vietnam seaport industry in implementing digital transformation,

supports customers relating to declaration procedures in loading and unloading containers as well as fee payment in a time-saving, convenient, and cost-cutting manner (TCIT, n.d.). With the easy interface of this application, it takes customers just one to two hours only by internet connection phone to complete the transaction for their export/import cargo including e-customs clearance without coming directly to the port. According to the interview with a representative from TCIT, made by the author as one step in this thesis, AI technology has been gradually implemented in all ports of Saigon Newport group to enhance the experience and care to customers and partners.

In the North of Vietnam, Hai Phong Port which is the largest seaport cluster in this area, has also applied new software such as E-port, Terminal Operating System (TOS), smart gate system, and Management Information System (MIS) to control the movement and storage of various types of cargo within specified terminals and port. The application of these software in this port significantly promotes customer service, resulting in an increase of more than 30% in the proportions of volume and revenue for this enterprise (HAI PHONG PORT, 2022).

In the Fourth Industrial Revolution, the port operation and management will become easier and more professional in a cost-effective manner with the equipment of digital and intelligent technologies. Besides, these technologies can upgrade service quality to a higher level, strengthen and optimize processes between port operators, cargo owners and transport/logistics service providers. Challenges from the COVID-19 pandemic are also fostering automation in the logistics and seaport sectors. Therefore, sooner or later, the digital transformation of seaports in Vietnam is inevitable in the digital era.

2.5 Review of the empirical literature

Digitalization plays a vital role in every aspect of our life, therefore, research in this area has received special attention and interest from many scholars and researchers all over the world. Considering the keys to successful digital transformation in businesses, the research of Danielle Clark reveals four main factors including the work improvement process, human resources, workflows through the Internet, and the flexibility that directly contribute to the success (Danielle, 2019). With the same research goal as Danielle Clark, however, Blake Morgan explores that digital transformation within small and medium-sized enterprises

(SMEs) is affected by eleven factors comprising customers; organizational structure; change management; leadership intentions; technology; data integration; logistics – supply chain; data security; products/goods development; digitization of data and process; and personalization (Morgan, 2020). Also in SMEs, Eller and her associates discovered that information technology, employee skills, and digital strategy of SMEs will have a positive effect on their digital transformation process (Eller, Alford, Kallmünzer, & Peters, 2020). A highlight from another study by Swen and Reinhard (2020) considered a clear long-term business strategy, the role of the managers, human resources, and information technology as critical determinants for digitalization in organizations. Meanwhile, a research team of Reis J. and associates used three groups comprising technology, organization and society to classify and explain the meaning of digital transformation as well as some major challenges (Reis, Amorim, Melão, & Matos, 2018). According to their study, social media and embedded equipment reflected the technology group while new business model implementation and changes to current processes related to the organizational group.

Focusing on Technological factors in maritime transport sectors, the final report from the Digital Transport and Logistics Forum (2018), and research of (Legner, et al., 2017) identified that digital security and compliance influence the success of the digital transformation. Besides, Schumann and his associates also emphasized that investing in appropriate technologies suitable to the corporation's business models, the compatibility and integration between multiple information platforms (Junge, 2019) will bring the success to transformation process, improve data exchange, especially create new value for businesses, reduce costs and increase productivity (Schumann, Baum, Forkel, Otto, & Reuther, 2017). Moreover, the five-dimension model of the digital readiness of container ports in Vietnam including data formation, asset connectivity, planning processes, performance measurement, and security control was also discussed (Tuan, 2022). This indicates that the availability of digital data will also affect the digital transformation process of seaports.

Relating to Organizational factors, current business models should be changed with the new business models (Osmundsen, Iden, & Bygstad, 2019) in maritime logistics (Fruth & Teuteberg, 2017), transport industry (Genzorova, Corejova, & Stalmasekova, 2019) and seaports (Jovic M. , Tijan, Aksentijevic, & Cisic, 2019) during the process of implementing the digital transformation, associated with appropriate business strategies (Osmundsen,

Iden, & Bygstad, 2019) (Wang & Mileski, 2018) to maximize innovation and stay competitive in the market. The new business model of seaports is considered “smart ports” (Jovic M. , Tijan, Marx, & Gebhard, 2020). For human resources, the success of digital transformation needs new roles of leadership (Vial, 2019) (Wang & Mileski, 2018) with clear vision (Larjovuori, Bordi, & Heikkila-Tammi, 2018), leaders’ capabilities (Verina & Titko, 2019) and digital leadership skills (Boneva, 2018) as well as the investment of knowledge on digitalization for all employees and managers within organization (Verina & Titko, 2019). It shows that the strategy, business processes, human resources, and readiness for changes (Boneva, 2018) are factors from the organization itself that highly influence the digital transformation process of a business. Moreover, the research from Muhammad and Anton (2022) indicated that there is a positive impact of three factors including the ability to adapt to the enterprise, the allocation of corporate resources, and the innovative ability of the digital application in logistics enterprises.

Hartl and Hess (2017) believe that the mutual trust between organizations and partners is one of the environmental factors that contribute to the success of digital transformation. Fruth and Teuteberg (2017) emphasize the importance of realizing stakeholders’ needs and expectations, which play a key role in the success. Besides, regulations/policies or support from the Government or State (Hanna, 2018) relating to seaports, logistics, and maritime industry will also encourage and impact the process of the transformation (Digital Transport Logistics Forum, 2018) (Legner, et al., 2017).

Zhu Kevin and his associates discovered determinants of digital transformation adoption of European corporations (Zhu, Shutao, Sean, & Kenneth, 2006) by applying the influence model of three different elements of the TOE (Technology – Organization – Environment) analytical framework (Tornatzky & Fleischer, 1990). This author group determined four main variables that impact digital transformation in the TOE framework including technological capacity (T), organizational size (O), competitive pressure (E), and partners’ readiness (E). Hwang and his associates, with the same TOE research framework applied to the supply chain in the semiconductor industry, indicate that the compatibility (T), complexity (T), organizational resources (O), innovation (O), Government regulations (E), competitive pressure (E), and customer demand (E) (Hwang, Huang, & Wu, 2016).

The study of Nuraan and Osden (2020) also discovered the main factors influencing the digital transformation in the retail supply chain using the TOE framework. The result from their paper indicated these main factors including the IT infrastructure (T), new technologies (T), organizational characteristics (O), strategies (O), competitiveness (E) and Government regulations/policies (E). Besides, the research also concluded the higher impact of technological factors than the remaining two-group factors.

While there are numerous global research relating to digitalization and digital transformation worldwide, local studies on digital transformation in Vietnam are still relatively limited, almost these research papers in this area just apply to general businesses, and not many in-depth articles on a specific sector, especially in logistics and maritime sector. Until now, hardly has published research on digital transformation in seaports or the shipping industry been done in Vietnam, even in the Vietnamese language. The study of Chu, Ba Quyet (2021) is considered a rare research when he came to explore the factors affecting the success of the digital transformation of import-export businesses in Vietnam based on the TOE framework. **Table 2** shows the summary of some typical research that used TOE model to investigate the main factors influencing the digital transformation of organizations:

Table 2. Typical research using the TOE model compiled and summarized by the author

Source	**TOE model**		
	Technological factors	*Organizational factors*	*Environmental factors*
(Zhu, Shutao, Sean, & Kenneth, 2006)	technological capacity	organizational size	competitive pressure; partners' readiness
(Hwang, Huang, & Wu, 2016)	compatibility; complexity	organizational resources; innovation	Government regulations; competitive pressure; customer demand

Nuraan and Osden (2020)	IT infrastructure; new technologies	organizational characteristics; strategies	competitiveness; Government regulations/policies
Chu, Ba Quyet (2021)	Digital process; Information security and privacy; availability of information technology and data infrastructure	Strategy; Human resources; business processes; organizational structure	customer demand; logistics and customer support; Government support
Mai, Liem and Hoang (2022)	technologies	leadership; human resources; workflow; business strategy	competitiveness
(Viet & Quoc, 2023)	information technology	manager roles; human resources; cost	support services

Contrary to the research of Chu Ba Quyet, the research of group authors Mai, Liem and Hoang (2022) has analyzed the main factors affecting the digital transformation in telecommunication enterprises in Ho Chi Minh city, Vietnam. They proposed a model of the digital transformation process affected by five factors including leadership, human resources, technology, workflow and business strategy (Mai, Liem, & Hoan, 2022). Besides, in another recent local research, factors including the manager role, information technology, human resources, cost, and support services are identified as the main factors influencing the digital transformation in Vietnam logistics enterprises (Viet & Quoc, 2023).

Moreover, under the affection of Covid-19 pandemic, (Tripathi, 2021) categorized 8 factors that influence the digital conversion process of enterprises in the post-COVID-19 pandemic, comprising employee health and safety, virtual collaboration, remote working, business resilience and recovery, business process automation, technology readiness and, cybersecurity risks into three groups human, organization and technology.

TOE framework is proven to play a vital role in technological innovation studies worldwide. According to Baker (2011), all three elements of the TOE framework are applied to

influence technological innovation. TOE has also been extensively used in a wide range of innovative technology studies to explore factors affecting organizational adoption of augmented reality in e-commerce (Chandra & Kumar, 2018) or to investigate determinants of digital transformation (Fu & Lee, 2021). Moreover, this framework has also been successfully applied to identify the factors influencing digitalization in the maritime transport sector (Edvard, Jovic, Aksentijevic, & Pucihar, 2021). In Vietnam, the application of the TOE framework in studying the factors affecting digital transformation is relatively limited, except for the research (Chu, 2021). Especially, there has not been any research in Vietnam applying this framework to Logistics, shipping and port sectors. This causes a big gap in academic research. Moreover, many recent prior studies using the TOE framework ignored the impact of the COVID-19 pandemic on the digital transformation process. In the study (Giao, 2020), he emphasized the COVID-19 pandemic has no connection to the digital transformation theoretically, however, the outbreak of this pandemic highlights the need for digital technologies and contributes to accelerating digitalization in all fields, especially some important sectors that need to prioritize digital transformation including seaport as mentioned in Decision No. 749/QD-Ttg 2020 (The Prime Minister of Vietnam, 2020). On this basis, together with the consultant with experts at seaports, I will consider the impact of COVID-19 as one influencing factor that belongs to the Environmental context.

From the solid theoretical basis and the reliability of empirical results of prior studies, therefore, the TOE framework is totally suitable for studying the factors that affect the digital transformation process in deep water seaports in Vietnam. Using the TOE framework and considering the impact of COVID-19 as one of environmental factors, this research attempts to fill the above-mentioned research gap in both theoretical and practical directions.

2.6 Conceptual research framework

To reach the target of this study, an organizational level of technology adoption framework called Technology – Organization – Environment (TOE) will be applicable for finding the main factors affecting the digital transformation process of deep water seaports in Vietnam. TOE framework describes three main group factors (three contexts or three categories) including the Technological context, the Organizational context, and the Environmental context (Tornatzky & Fleischer, 1990) that affect the process of the digital

implementation and technological innovation of an organization. The specific variables in each of the three contexts are flexible and not specified in the TOE framework, therefore, the researchers are allowed to revise and modify this framework to be suitable for the research fields and its objectives (Huang, Yang, & Zhang, 2022) (Zhao, Wang, Feng, & Zhang, 2021).

Based on careful examination of the factors found in prior studies and published research results mentioned in the empirical literature (section 2.5), and some research that employs the TOE framework, a proposed model for this research as **Figure 5** is constructed and will be used to examine technology application and the influence of technological, organizational, environmental factors in seaport scenarios in Vietnam.

Any internal and external technologies relevant to an organization can be grouped to the first of the TOE framework as Technological (T) context. T factors refer to how organizations make their decisions to adopt technology based on the availability of technology. Tornatzky and Fleischer (1990) emphasized the main factor in the decision to implement technological innovation based on the fit between the currently existing technology in an organization and the newly aimed technology. In the context of this study, Technological context comprises security and privacy, compatibility and the readiness of digital data and technology. There are 3 hypotheses proposed in the T context including:

H1: Security and privacy has a positive influence on the digital transformation process of deep seaports.
H2: Compatibility has a positive influence on the digital transformation process of deep seaports.
H3: The readiness of digital data and technology has a positive influence on the digital transformation process of deep seaports.

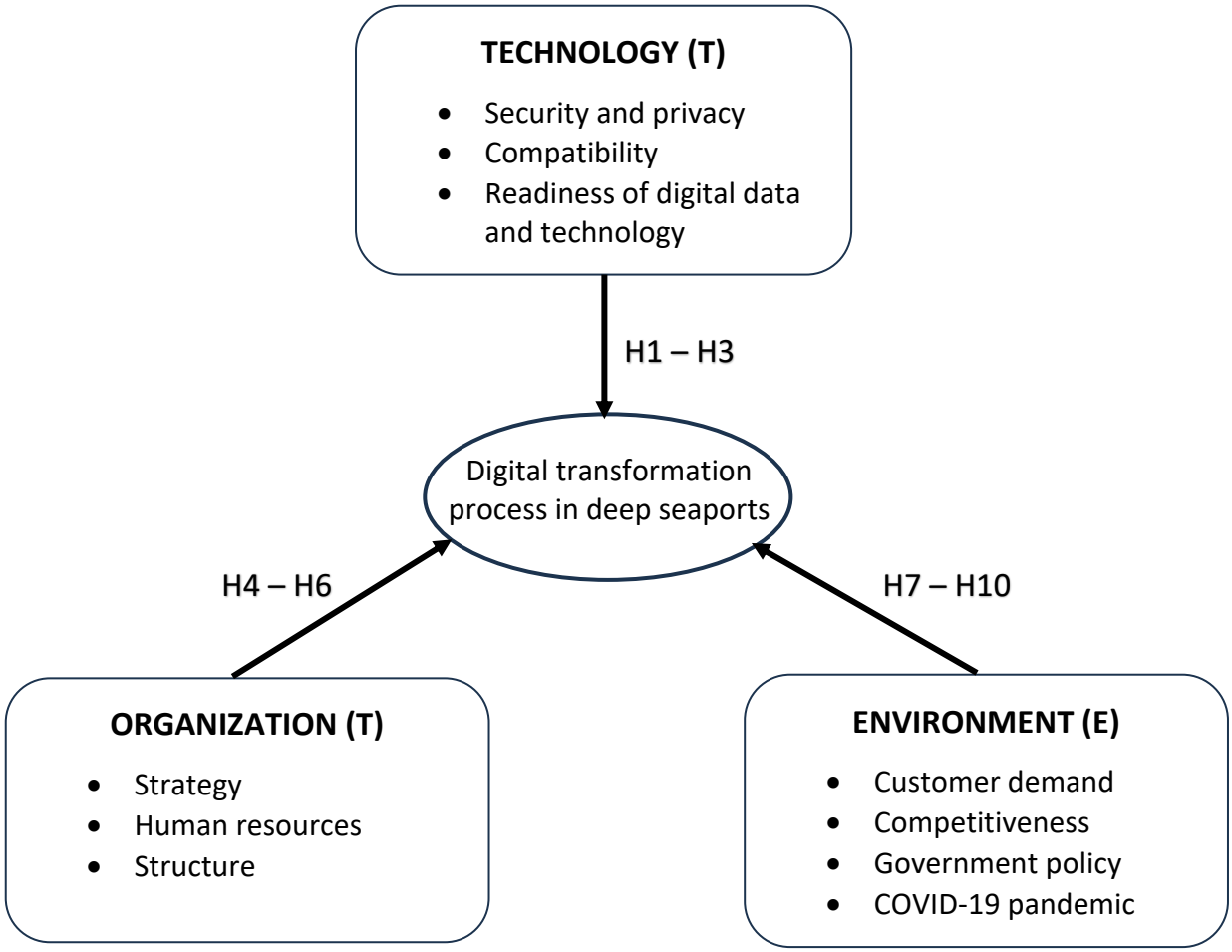


Figure 5. The research model proposed by the author basing on TOE framework

The second context of the TOE model is the Organizational (O) context. It includes many different characteristics of an organization. Relating to this study, organizational strategy, human resources and structure will be considered with 3 hypotheses:

H4: Organizational strategy has a positive effect on the digital transformation process of deep seaports.

H5: Organizational human resources has a positive impact on the digital transformation process of deep seaports.

H6: Organizational structure has a positive impact on the digital transformation process of deep seaports.

The last context of the TOE model is the Environmental (E) factors related to influences coming from outside of the organization such as the industrial environment, pressure from competitors when this organization adopts with new digital technology. In this research

context, customer demand, competitiveness, Government policy and the COVID-19 pandemic. For seaports, customer demand in this case can be considered the request for changes coming from import/export enterprises, shipping lines, logistics corporations and forwarders who are directly or indirectly related to seaport operations. There will 4 hypotheses under E-context including:

H7: Customer demand has a positive effect on the digital transformation process of deep seaports.

H8: Competitiveness has a positive effect on the digital transformation process of deep seaports.

H9: Government policy has a positive effect on the digital transformation process of deep seaports.

H10: The COVID-19 pandemic positively fosters the digital transformation process of deep seaports.

3. Methodology

This section focuses on the location of this study and explains how the target of the thesis can be reached through a step-by-step research design. Besides, the method of data collection and data analysis techniques were also discussedd.

3.1 Location of the study

As mentioned in the research title, only deep water seaports in Vietnam are the main research objects of this study. Other seaports in Vietnam that have not met the criteria of deep water seaports are not considered in the research scope of this study.

According to Decision 1579/DQ-TTg of the Vietnam Prime Minister (2021), a master plan for Vietnam's seaport system development from 2021 to 2030, with a vision to 2050 was issued and approved. The Decision indicated the seaport system as an essential part of maritime and socio-economic infrastructure in Vietnam and emphasized the priorities for investment.

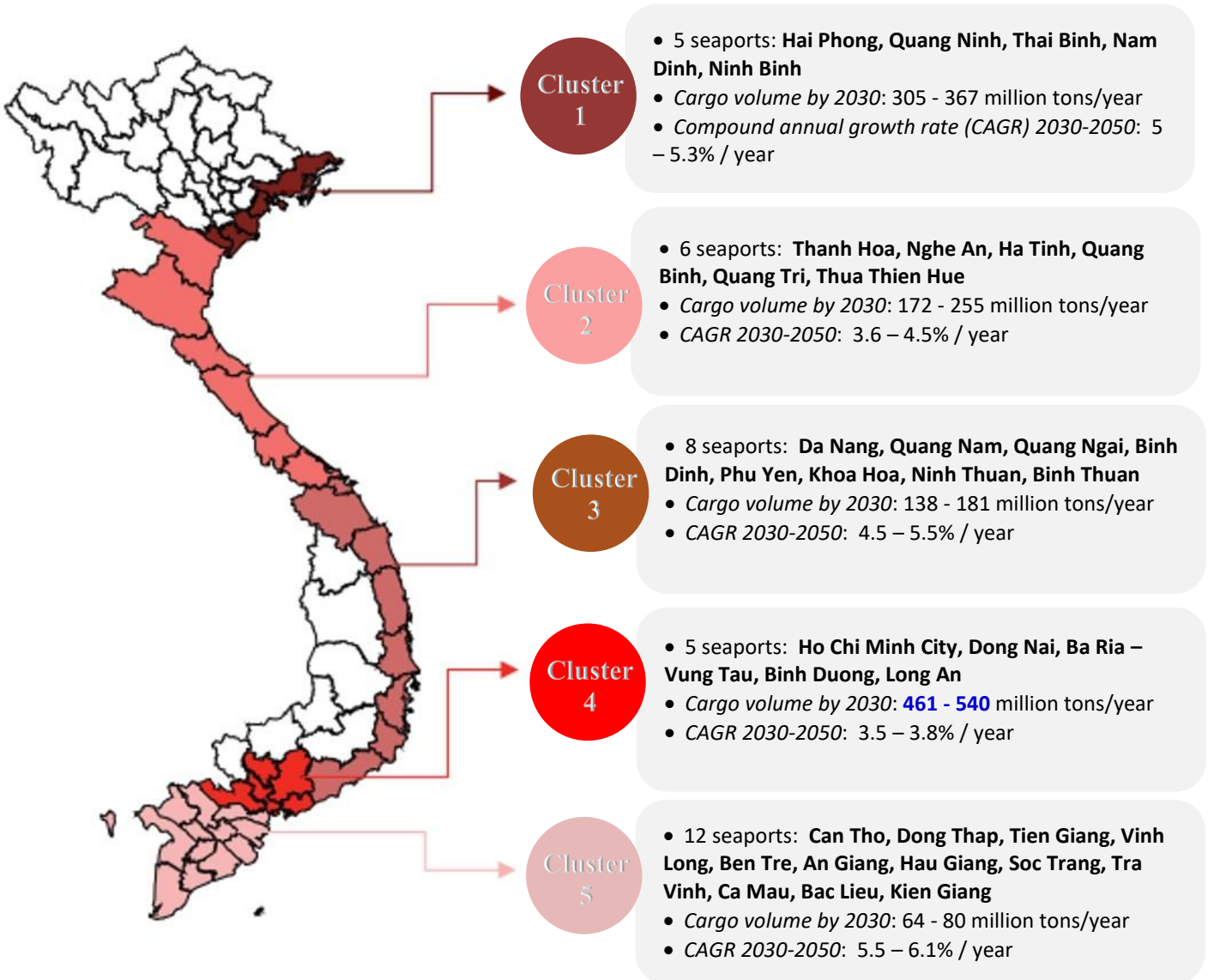


Figure 6. Targets of five major seaport clusters in VietNam to 2030, with a vision to 2050 (*Source*: Decision No. 1579/ QD-TTg **(The Prime Minister of Vietnam, 2021)**)

Figure 6 illustrates five major seaport clusters in Vietnam with prospect cargo volume for each cluster by 2030 according to the Decision No. 1579/QD-TTg. Cluster 4 is considered the most important seaport group in Vietnam with the highest prospect of cargo by 2030. This cluster gathers many large seaports in Ho Chi Minh City and international deep water seaports in Cai Mep Thi Vai (Ba Ria - Vung Tau). Due to the vital roles of deep water seaports in the development of seaport systems as well as Vietnam's economy, this research will focus on 4 main largest deep water seaports located in Cai Mep Thi Vai area (Ba Ria – Vung Tau province), they are:

- ***GEMALINK International port***: this container port is a joint venture invested between GEMADEPT Corporation (Vietnam) – 75% and the world's leading partner in port operation - CMA Terminals (France) – 25%. This port has been officially put into operation since Jan. 19th, 2021 after finishing construction phase 1. Phase 2 is planned to be completed by the end of 2023, at this time, this seaport will possess 72 hectares of an area together with the most modern European standard facilities and equipment. With such outstanding advantages, this seaport become the largest seaport in Cai Mep – Thi Vai and the transshipment hub in the region (Gemalink, n.d.).

- ***TAN CANG – CAI MEP International Terminal (TCIT)*** was established in 2009 as a joint venture between Saigon Newport Corporation which is the biggest container terminal operator in Vietnam and three famous, prestige partners including Mitsui O.S.K. Lines (Japan), Wan Hai Line (Taiwan) and Hanjin Transportation (Korea). The port officially started its operation from Jan. 2011 (TCIT, 2021).

- ***TAN CANG – CAI MEP THI VAI Terminal (TCTT):*** together with TCIT, TCTT is also one subsidiary in deep seaport groups invested and operated by Saigon Newport Corporation. This port was put into operation on Feb. 24, 2016 (TCTT, n.d.).

- ***SP-SSA International Terminal (SSIT):*** was established in 2006, it is a joint venture between SSA Marine with headquarters in Seattle, USA (50%), Saigon Port (38.93%) and Vietnam Maritime Corporation – VIMC (11.07%). The terminal is able to handle a diverse commodity range such as bulk cargo, project cargo, steel, agricultural products and containerized shipments (SSIT, n.d.).

Table 3. General information of 4 objective deep seaports in Cai Mep - Thi Vai area

(*Source*: compiled by the authors from official website and brochure of each seaport)

	SSIT	**TCTT**	**TCIT**	**GEMALINK (phase 1)**
Total Area (*hectares*)	60.6	48	55	72
Depth alongside (*m*)	16.5	17	16.8	16.5
Channel depth (*m*)	14	14	14	14
Total berth length (*m*)	600	600	890	1,500
Capacity (*thousand TEUs*)	1,100	1,500	2,400	1,500
Number(s) of container terminal	2	1	3	1
Vessel capacity accommodation (*Tonnage*)	167,000	160,000	160,000	200,000

3.2 Research design

Researchers can use either qualitative or quantitative research methods or even hybrid methodologies for their research. Referring to this thesis, the combination of qualitative and quantitative methods (hybrid methodologies) will be used as the main methodology to ensure the clarity and reliability of the research problem. Based on the extensive literature review from both international studies and national studies, some digital transformation influence factors in deep water seaports will be identified and gathered under three different groups of the TOE framework. A qualitative research method was conducted through an online semi-structured interview with a total of eight managers as experts from different departments in 4 targeted deep water seaports to define:

(1) The general overview of the current situation in the digital transformation of each seaport.

(2) the relevance of the influence factors to the digital transformation process of each seaport.

(3) The difficulties and obstacles that may happen during the implementation process of digital technologies.

(4) The basis for developing interview questions, evaluating the model and scale as well as for the managerial implication suggestions.

Based on the model and the interview, a questionnaire was designed and an online survey was conducted. Finally, the research model will be validated by the quantitative research method through the statistical software SPSS to define the final factors influencing the digital transformation in deep water seaports. **Figure 7** indicates the step-by-step process of this study to achieve the research objectives.

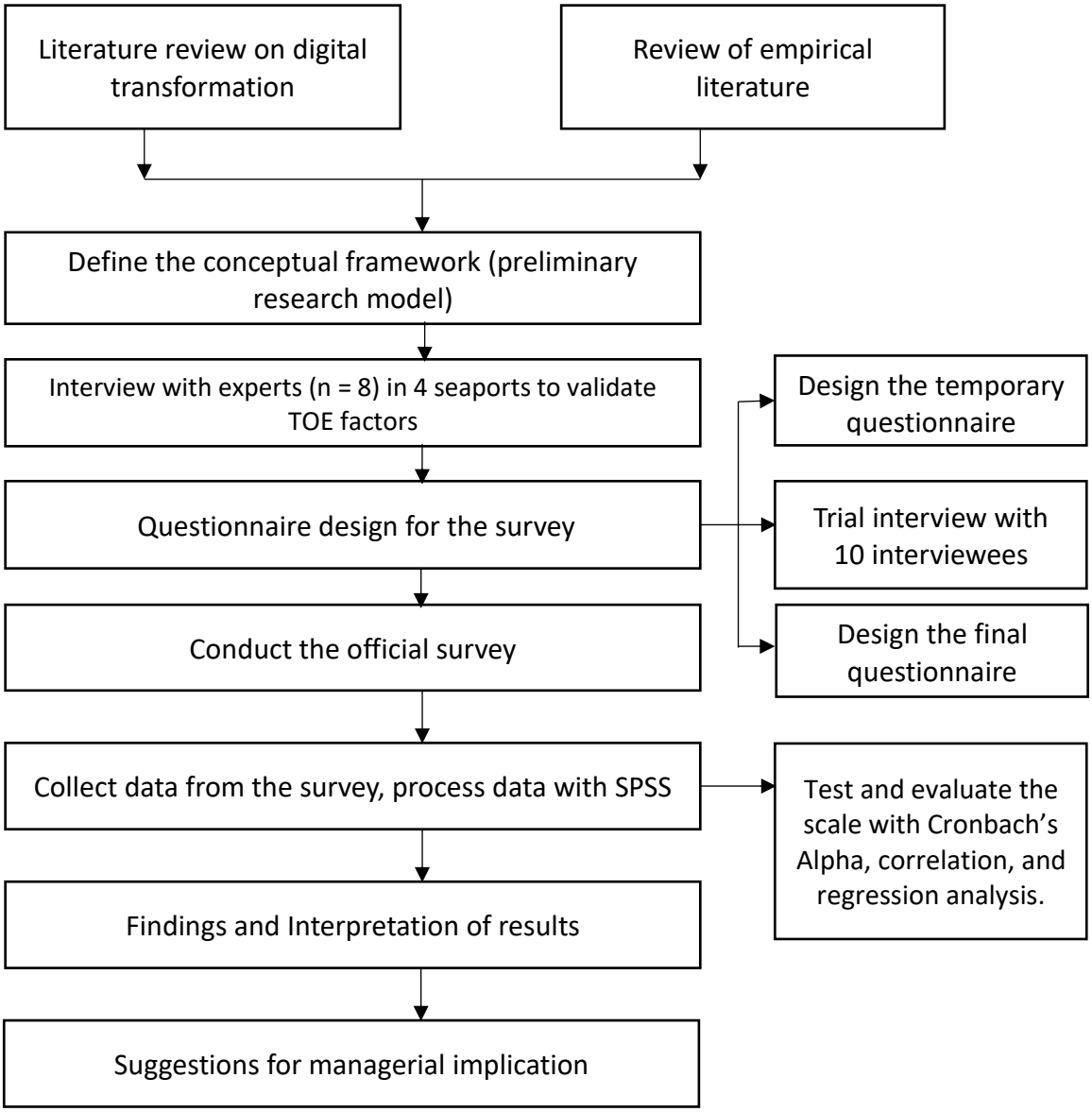


Figure 7. The overall research design for the thesis proposed by the author

3.3 Method of data collection

To ensure the reliability of the results for the research, the author surveyed employees working in 4 targeted deep seaports. Closed-ended questionnaires were used to collect data from respondents. The survey was conducted through Google Forms and questionnaire submissions were collected. A conventional method was used for sample selection, the author also considered the balance of gender, age, job position, and department that is appropriate to the contexts in this study.

The official survey was conducted by online questionnaire through Google Forms from Oct. 22, 2023 to Oct. 31, 2023 and 221 submissions from respondents were collected. However, only 216 valid samples were used for data analysis.

3.4 Data analysis techniques

Based on the data collected, the author conducted descriptive statistics, tested and evaluated the scale, and analyzed the correlation. Statistical Package for Social Sciences (SPSS) software was used to make statistics and analyze the factors influencing the digital transformation in deep seaports in Vietnam. The important level of factors was evaluated based on a 5-point Likert scale and the average score of relevant questions in the questionnaire. The average scores are the basis for ranking factors and finding the most influential factor.

4. Empirical findings

In this section, some influencing factors are revealed not only through the semi-structured interview with experts at seaports in qualitative research but also through the responses from survey questionnaires in quantitative research. The analysis of data are clearly explained and presented through descriptive statistics, Cronbach's alpha measurement, correlation table. Results from regression formula discover the factors affecting the digital transformation process at deep seaports.

4.1 Qualitative research and interview findings

The semi-structured interview was conducted via an online platform with two experts in each seaport, a total of eight experts from different backgrounds within four targeted seaports. Due to the differences in operational policies and business strategies, interviews had to be performed separately for each seaport. As mentioned in 3.2, the purpose of the interview is to get a general overview of the current situation as well as to identify the influencing factors in the digital transformation of each seaport. Moreover, the valuable responses from these experts can be considered the basis for developing a questionnaire design of quantitative research. These semi-structured interviews started on Aug. 14, 2023 and finished on Aug. 30, 2023. Six experts in 3 seaports: Gemalink, TCIT, and TCTT participated directly via online meeting platforms (Google Meet) lasting around 30 minutes on average per seaport, while the remaining two target experts of SSIT were unable to join the meeting due to their business trips abroad. Therefore, the author approached each expert of SSIT by phone call and collected the responses accordingly.

Five in-depth interview questions were posed to these specialists including:

1. What are some main digital technologies that have been implemented in your seaport?

2. Why did your seaport decide to choose this digital technology? (Technology / Organization / Environment)

3. What are the main factors that affect the implementation of new technologies at your seaport? (Technology / Organization / Environment)

4. What is (are) the investment policy (policies) of your port on digital technologies?

5. In order for smooth operation in implementing digital technologies, what does your seaport need?

Table 4. Job position and years of experience of interviewees

No.	*Deep seaports*	*Job position*	*Years of professional experience*
(1)	**GEMALINK**	Planning Manager	6
(2)		Specialist in Documentation Department	3
(3)	**TCIT**	Head of Planning and operation	8
(4)		Head of human resources	6
(5)	**TCTT**	Head of Sales & Marketing	5
(6)		Specialist in IT department	4
(7)	**SSIT**	Deputy General Manager	12
(8)		Head of Operational department	8

Table 4 summarizes the job position and the years of professional experience of each interviewee in this stage. Figures relating to years of experience in this table indicate that all participants in the interview have had certain professional experience, sufficient knowledge, skills as well as a deep understanding of the seaport industry in general and the specific fields they are working in particular. These experts were intentionally selected in many different departments to collect diverse perspectives relating to the context of digital transformation at deep water seaports. From the participants' answers, **Table 5** summarizes the current digital technologies that these 4 seaports are implementing in their port operations.

Table 5. Current digital technologies at 4 seaports

(Source: summarized and developed by the author based on the interview)

Name of deep seaport	**Current implementing digital technologies**
Gemalink	Terminal Operating System (TOS); Smartport; Rivergate
TCIT	E-port; E-customs; E-Invoice; Electronic Delivery Order (E-D/O)

TCTT	E-port; E-customs; E-Invoice; E-D/O
SSIT	E-port, E-customs

Gemalink port has been officially put into operation in Jan. 2021 and is considered the most modern deep seaport in Vietnam. The equipped cutting-edge technology of Gemalink makes it different from other deep seaports. Besides, these technologies can ensure smooth cargo handling processes and efficient operations, especially its unique collaborative platform Rivergate.

"Rivergate is a platform to coordinate and collaborate with barges. It helps to transform the barge planning and handling process into an efficient transparent and intuitive endeavor. Before the barges even leave the upstream of Inland Clearance Depot (ICD), the operators from all parties can easily see, communicate, and exchange necessary information via a common platform which better facilitates collaboration." described by Interviewee No. (1)

To reduce the large number of customers coming directly to the seaport, queuing up to wait for documentation and invoice payment procedures, Smartport technology was officially deployed in Apr. 2022 at Gemalink. Smartport technology and application are fully integrated functions of E-port, E-customs, E-invoice. Interviewee No. (3) emphasized "*Besides current technologies, the application of **IoT** in monitoring and controlling the temperature of reefer containers will be soonest deployed at TCIT".*

"The automation process is becoming more and more popular within businesses in Industrial Revolution 4.0, especially in seaports where many unexpected incidents and unforeseeable accidents can occur to workers, therefore, some steps in port operation of TCTT will be automated.", stated interviewee No. (6) in TCTT.

When asking for the main reasons or drivers for digital transformation with the above digital technologies, most of the answers from experts aim at the desire to optimize port productivity, enhance operational efficiency, and reduce downtime of their seaports.

"In the past, at a time when digitalization had not yet been deployed in our seaport, there were large numbers of documents from stakeholders we had to store in our warehouse such as shipping documents, cargo (loading/unloading) documents, import/export invoices, customs documents, etc. Such work not only costs us a lot of money for storage but also

carries many potential risks. In addition, anytime trouble happened, it took us a lot of time to find the documents we needed. And, digitalization can help us overcome all these problems.", said by Interviewee No. (7).

"Thanks to digitalization, we can access information anywhere and at any time. With the increase in data security and privacy, the fear of information leaks will be highly reduced.", explained by Interviewee No. (2).

"Digitalization can help us get further information and be more proactive in making decisions. All decisions from management can be made faster and more accurate thanks to the clear and timely report from system." Interviewee No. (8)

"Digitalization reflects the development of the seaport, upgrades its values in the industry, and enhances customer service capabilities. Customer requests are faster processed with the assistance of digital technologies. Reaching new customers and understanding their demands as well as taking care of previous customers become more simple thanks to supporting digital applications.", Interviewee No. (5)

Relating to the main factors that affect the success of implementing digital transformation in deep seaports, most experts acknowledged that they need time to evaluate the effective level of technology investments, therefore the success of digital transformation cannot be evaluated immediately. In the organizational context of seaports, human resources, and corporate strategy were frequently mentioned and discussed in the interview and were considered the fundamental factors impacting their success in the conversion process. The young and dynamic employees could quickly adapt to new environments and apply digital technologies to their operations. On the contrary, some employees, who are relatively older and have less capability to absorb new technologies, often need additional training to promote the application of digital technologies in their businesses. Besides the ability to absorb technology, the employee's attitude to accepting new technology also affects the success of transformation process as well, according to experts. Due to the direct impact of new technologies on daily working habits, some employees in seaports are unpleasant to co-operate, this could cause many difficulties for seaports during the promotion and deployment process of new technologies. **Table 6** summarizes some core answers from participants and reveals some factors affecting the digital transformation process in 4 deep seaports.

Table 6. Main factors influencing digital transformation in deep seaports

(Source: summarized and developed by the author based on the interview)

Factors	Interview findings	Interviewee
Technological factors (T)		
Readiness of digital data	*"Data is the most fundamental in all operation activities in business, from the basic data on the number of vessels arriving and leaving at our ports, the amount of imported and exported cargo to some complex and statistical data on the port's throughput, revenues, expenses, etc. Once data is insufficient, the digitized process cannot be successful."*	(2)
	"In order to deploy digital transformation in seaport, the database must be ready. Our seaport has been put into operation since 2006, some processes in our seaport from then until now still use manual operations, data is stored discretely, not systematically. Currently, we are having the database digitized step by step for our next digitalization plan."	(8)
Organizational factors (O)		
Human resources	*"Humans are the most important factor in digital transformation. We are impossible to deploy transformation once people are not ready to change. It isn't easy to get acquainted with the new systems, especially for elder employees."*	(4)
	"There are more than half of the employees working in our seaport with the age of over 40 or even older. Changing their working routine with new technology is really a big challenge for us. We, the Board of management, of course, will have some appropriate policies to encourage them to follow in	(7)

	case of digitalization deployment, however, it will take a lot of time."	
Environmental factors (E)		
Government regulations & policy	*"Many decisions were signed and approved by our Government relating to digital transformation, and the maritime industry also receives a lot of attention from the National State in this activity. However, this process needs to be synchronized with infrastructure development."*	(3)
Customers' demand	*"Our seaport has applied digital technologies such as Smart Port application, tracking software to look up the exact location of the containers in the container yard, Electronic documents (E-B/L, E-customs, E-D/O), etc. in order to make it more convenient for customers. Better serving customers is the main target of digital transformation."*	(5)
Covid-19 pandemic	*"The COVID-19 pandemic is considered an essential driver and core catalyst in accelerating the digital transformation process in seaports. Thanks to some implemented digital applications pre-covid, we could overcome this challenge and back to the "New Normal". Realizing the vital role of digitalization in preventing business disruption, we are also rapidly promoting further digital transformation activities at our port."*	(5)

The summary of responses from the experts in the interview for questions 2. and 3 above reveal that the digital transformation of deep seaports will be affected by some main factors including security and privacy; the readiness of digital data; strategy; human resources; Government regulations & policy; Customers' demand and COVID-19 pandemic. Based on the proposed research model (Figure 5) and quantitative research method, it will

help identify specific factors and their level of influence on the digital transformation process in 4 deep seaports.

4.2 Quantitative research and findings

The interview with 8 seaport experts combined with some relevant previous studies on digital transformation can help the author identify and propose a model of influencing factors as Figure 5. Based on that, the author defined 10 independent variables that have an impact on digital transformation process (as a dependent variable), built the appropriate scales for each variable, and designed a temporary questionnaire for a survey. First, the temporary questionnaire was used for a trial interview with 10 interviewees, mainly managers from these seaports to get their comments and corrections. Then, the final questionnaire was used for the official survey. Based on the data collected, SPSS software version 23 was used for data analysis and interpretations.

4.2.1 Scales and samples

4.2.1.1 Scales

Scales of variables will be evaluated based on the 5-point Likert scale from 1 (*Strongly Disagree*) to 5 (*Strongly Agree*). Table 7 describes details of the encoding and appropriate scales used for each variable.

Table 7. Summarize of encoding and scales used for all factors in the research model

Factors		*Code*	*Scales*	*Source*
T - context	Security and privacy	**T.SECUR**		
		T.SECUR_1	All data and information uploaded to the system over the Internet is verified for reliability and accuracy.	(Chu, 2021)
		T.SECUR_2	Only authorized users are responsible for uploading all data and information in the system over the Internet.	
		T.SECUR_3	All data and information uploaded over the Internet is always kept secure and confidential.	
		T.SECUR_4	Employees in your seaport ensure the confidentiality of the business when exchanging information over the Internet.	
	Compatibility	**T.COMPA**		
		T.COMPA_1	The information technology system in your seaport allows you to access sources of information outside of your organization.	(Fu & Lee, 2021)
		T.COMPA_2	Accessing and exploiting data over the internet is supported by the corresponding software(s).	
		T.COMPA_3	Your organization has a suitable and specialized department that supports connecting and using external information sources.	
	Readiness of digital data and technology	**T.READI**		
		T.READI_1	Work data can be easily accessible through a connection to the internet system in your seaport.	(Chu, 2021)
		T.READI_2	The data source that your seaport accesses over the internet is suitable for the work needs.	Proposed by the author

		T.READI_3	Access to necessary information over the Internet is available at competitive costs.	(Chu, 2021)
		T.READI_4	Your seaport can easily access new digital technologies.	
O - context	Strategy	**O.STRAT**		
		O.STRAT_1	Leaders and managers of your seaport have knowledge about digital transformation.	(Mai, Liem, & Hoan, 2022)
		O.STRAT_2	Your seaport has planned and built a development strategy for digital transformation.	
		O.STRAT_3	Your seaport has recently implemented digital transformation process.	
		O.STRAT_4	Your seaport's digital transformation strategy is consistent with its development strategy.	
	Human resources	**O.HUMAN**		
		O.HUMAN_1	Employees in your seaport have knowledge about digital transformation.	(Chu, 2021)
		O.HUMAN_2	Employees in your seaport deeply understand the digital transformation strategy of your organization.	
		O.HUMAN_3	Employees in your seaport are conducting a digital transformation process.	
		O.HUMAN_4	Employees in your seaport are proactive in the digital transformation process.	Proposed by the author
	Structure	**O.STRUC**		
		O.STRUC_1	All departments in your seaport are built and structured appropriately with the digital transformation process.	(Chu, 2021)
		O.STRUC_2	It is necessary to implement the digital transformation process within the size and scope of your seaport's operations.	

		O.STRUC_3	Your business structure is flexible with the digital transformation process implementation.	
E - context	Customer demand	**E.CUSTO**		
		E.CUSTO_1	Customers desire your seaport to implement digital transformation to serve them better.	(Chu, 2021)
		E.CUSTO_2	The digital transformation process makes the transaction and working process with customers more convenient.	
		E.CUSTO_3	The digital transformation implementation helps customers cut costs compared to current traditional processes.	Proposed by the author
	Competitiveness	**E.COMPE**		
		E.COMPE_1	Other deep seaports have a higher level of digital transformation than your seaport.	(Fu & Lee, 2021)
		E.COMPE_2	Digital transformation implementation helps your seaport become more competitive in the sector.	
		E.COMPE_3	Digital transformation implementation is a prerequisite for the survival and development of your seaport.	
	Government policy	**E.GOVER**		
		E.GOVER_1	The Government encourages the implementation of digital transformation in your seaport.	(Nuraan & Osden, 2020)
		E.GOVER_2	The Government has financial policies to support the digital transformation process of your seaport.	
		E.GOVER_3	The Government has issued legal policies for the digital transformation process.	Proposed by the author
	COVID-19 pandemic	**E.COVID**		

		E.COVID_1	The COVID-19 pandemic influences the digital transformation process of your seaport.	Proposed by the author based on the interview
		E.COVID_2	The COVID-19 pandemic is a driver in fostering the digital transformation process of your seaport.	
		E.COVID_3	The COVID-19 pandemic has changed the digital transformation strategy of your seaport.	
DIGITAL TRANSFORMATION PROCESS IN DEEP SEAPORTS **(DT_PORT)**		DT_PORT_1	The digital transformation process brings benefits to your seaport.	(Chu, 2021)
		DT_PORT_2	The digital transformation process brings benefits to all employees in your seaport.	
		DT_PORT_3	The digital transformation process promotes business activities in your seaport.	Proposed by the author based on the interview
		DT_PORT_4	The digital transformation makes your seaport's leaders feel more secure and satisfied.	

4.2.1.2 Samples

To ensure the reliability of the results for the research as well as reach the target of the study, the author took samples from employees working in 4 targeted deep seaports. A conventional and non-probability sampling method was used for sample selection, based on personal relationships as well as considering the balance of gender, age, job position, and department that is appropriate to the contexts in this study. The survey was conducted by online questionnaire through Google Forms from Oct. 22, 2023 to Oct. 31, 2023 and the submissions from respondents were collected.

There were a total of 221 collected responses during this time, however, five of them were invalid due to lack of information. Thus, 216 valid samples were used for data analysis. In the book *Multivariate Data Analysis* (1998), Hair and his associates emphasized the need for at least 5 samples for each survey question to be successful in Exploratory factor analysis (EFA). For regression analysis, (Green, 1991) determined the sample size based on $N \geq 50+8p$ (where p refers to the number of predictors or independent variables in the model). Back to this thesis context, at least 190 (38*5) samples are needed according to Hair's research and $N \geq 130$ based on Green's study. Therefore, 216 samples are appropriate for this thesis.

4.2.2 Descriptive statistics

The descriptive statistics in **Table 8** illustrate the main features of the sample collected from the official survey. The majority of employees working in seaports are male, therefore, there is a relative difference in the ratio of gender between males and females in the survey results. The male respondents constitute 63.9% of total responses while the figure is only 36.1% for females. Relating to the age, the proportion of survey respondents aged between 30 - 40 accounts for 41%, and this figure is 30.1% for the age from 40 to 50. The years of working reflect the professional experience of employees in seaports. The relevant data in Table 8 indicates most of the surveyed employees have working experience when 40.3% of the total samples from 2-5 years of working, and 32.9% from 5-10 years. For working departments, the highest proportion relates to port planning and operating department when it constitutes 33.3% of total responses, next is sales and customer services departments with 26.4%. The proportion of 20.4% belongs to other departments in

seaports such as: Financial departments, Accounting Department, Commercial Department, etc. Three departments including human resources, technical departments and the Board of directors account for approximately 20% of the total number of respondents from the survey. There were no significant differences in the number of survey participants regarding the place of working in 4 main deep seaports.

Table 8. Descriptive statistics

Samples		Frequency	Percentage
Gender	Male	138	63.9%
	Female	78	36.1%
Age	< 30	18	8.3%
	30 - 40	90	41.7%
	40 - 50	65	30.1%
	> 50	43	19.9%
Place of working	GEMALINK	59	27.31%
	TCIT	53	24.54%
	TCTT	56	25.93%
	SSIT	48	22.22%
Years of working	Less than 2 years	42	19.4%
	2-5 years	87	40.3%
	5-10 years	71	32.9%
	More than 10 years	16	7.4%
Deparments	Board of directors	7	3.2%
	Sales & Customer Services	57	26.4%
	Human resources	22	10.2%
	Port planning & operating	72	33.3%
	Technical Department	14	6.5%
	Others	44	20.4%

4.2.3 Cronbach's alpha measurement for reliability assessment

Cronbach's alpha is used to measure and assess the reliability or the internal consistency of a set of scales. The scale is considered reliable when:

(1) Cronbach's alpha measurement is higher than 0.6 and it is usually acceptable between 0.6 and 0.8 (Cronbach, 1951);
(2) The corrected item-total correlation higher than 0.3 (Hajjar, 2018).

- *Security and privacy* **(T.SECUR)***:*

Table 9. Table of reliability and item-total statistics for T.SECUR from SPSS

Reliability Statistics	
Cronbach's Alpha	N of Items
.841	4

Item-Total Statistics				
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
T.SECUR_1	10.68	4.397	.697	.788
T.SECUR_2	10.71	4.652	.686	.795
T.SECUR_3	10.73	4.421	.684	.794
T.SECUR_4	9.89	4.198	.642	.817

Based on Table 9, the Cronbach's alpha is 0.841 > 0.6 and the value of the corrected Item-total correlation of each observed variable is higher than 0.3. Therefore, the scale of T.SECUR is reliable.

- *Compatibility* **(T.COMPA):**

Table 10. Table of reliability and item-total statistics for T.COMPA from SPSS

Reliability Statistics	
Cronbach's Alpha	N of Items
.799	3

Item-Total Statistics				
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
T.COMPA_1	6.60	1.656	.622	.753
T.COMPA_2	6.56	1.670	.640	.731
T.COMPA_3	6.41	1.862	.681	.698

In Table 10, the Cronbach's alpha is 0.799 > 0.6 and the value of the corrected Item-total correlation of each observed variable is higher than 0.3. Therefore, the scale of T.COMPA is reliable.

- *Readiness of digital data and technology* **(T.READI):**

Table 11. Table of reliability and item-total statistics for T.READI from SPSS

Reliability Statistics	
Cronbach's Alpha	N of Items
.729	4

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
T.READI_1	11.35	4.806	.635	.601
T.READI_2	11.49	4.744	.596	.621
T.READI_3	12.27	6.123	**.277**	.795
T.READI_4	11.43	4.684	.595	.621

In Table 11, the Cronbach's alpha is 0.729 > 0.6 but the value of the corrected Item-total correlation of T.READI_3 is lower than 0.3. Therefore, T.READI_3 will be removed.

Table 12. Table of reliability and item-total statistics for T.READI from SPSS (after removing T.READI_3)

Reliability Statistics	
Cronbach's Alpha	N of Items
.795	3

Item-Total Statistics				
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
T.READI_1	8.11	3.165	.622	.738
T.READI_2	8.25	2.912	.660	.697
T.READI_4	8.19	2.924	.633	.727

After removing T.READI_3, the value of Cronbach's alpha is 0.795 > 0.6 and the values of the corrected Item-total correlation of the rest observed variables are higher than 0.3 as shown in Table 12. Then, the scale of T.READI is now reliable.

- *Strategy* **(O.STRAT):**

Table 13. Table of reliability and item-total statistics for O.STRAT from SPSS

Reliability Statistics	
Cronbach's Alpha	N of Items
.844	4

Item-Total Statistics				
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
O.STRAT_1	9.88	6.214	.681	.802
O.STRAT_2	9.77	6.458	.696	.796
O.STRAT_3	11.31	6.492	.630	.825
O.STRAT_4	10.50	6.595	.720	.788

In Table 13, the Cronbach's alpha is 0.844 > 0.6 and the value of the corrected Item-total correlation of each observed variable is higher than 0.3. Therefore, the scale of O.STRAT is reliable.

- *Human resources* **(O.HUMAN):**

Table 14. Table of reliability and item-total statistics for O.HUMAN from SPSS

Reliability Statistics	
Cronbach's Alpha	N of Items
.800	4

Item-Total Statistics				
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
O.HUMAN_1	9.87	4.160	.651	.730
O.HUMAN_2	10.51	5.404	.584	.777
O.HUMAN_3	11.63	4.542	.606	.753
O.HUMAN_4	9.94	3.866	.660	.730

In Table 14, the Cronbach's alpha is 0.800 > 0.6 and the value of the corrected Item-total correlation of each observed variable is higher than 0.3. Therefore, the scale of O.HUMAN is reliable.

- *Structure* **(O.STRUC):**

Table 15. Table of reliability and item-total statistics for O.STRUC from SPSS

Reliability Statistics	
Cronbach's Alpha	N of Items
.819	3

Item-Total Statistics				
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
O.STRUC_1	8.15	3.113	.694	.736
O.STRUC_2	7.35	2.917	.653	.770
O.STRUC_3	7.44	2.666	.680	.747

In Table 15, the Cronbach's alpha is 0.819 > 0.6 and the value of the corrected Item-total correlation of each observed variable is higher than 0.3. Therefore, the scale of O.STRUC is reliable.

- *Customer demands* **(E.CUSTO):**

Table 16. Table of reliability and item-total statistics for O.CUSTO from SPSS

Reliability Statistics	
Cronbach's Alpha	N of Items
.845	3

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
E.CUSTO_1	6.50	2.363	.722	.778
E.CUSTO_2	6.56	2.573	.740	.758
E.CUSTO_3	6.47	2.725	.679	.815

In Table 16, the Cronbach's alpha is 0.845 > 0.6 and the value of the corrected Item-total correlation of each observed variable is higher than 0.3. Therefore, the scale of E.CUSTO is reliable.

- *Competitiveness* **(E.COMPE):**

Table 17. Table of reliability and item-total statistics for O.COMPE from SPSS

Reliability Statistics

Cronbach's Alpha	N of Items
.801	3

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
E.COMPE_1	7.38	2.618	.667	.710
E.COMPE_2	6.69	2.343	.625	.761
E.COMPE_3	7.25	2.663	.659	.719

In Table 17, the Cronbach's alpha is 0.801 > 0.6 and the value of the corrected Item-total correlation of each observed variable is higher than 0.3. Therefore, the scale of E.COMPE is reliable.

- *Government policy* **(E.GOVER):**

Table 18. Table of reliability and item-total statistics for O.GOVER from SPSS

Reliability Statistics

Cronbach's Alpha	N of Items
.783	3

Item-Total Statistics				
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
E.GOVER_1	6.61	2.453	.607	.728
E.GOVER_2	7.29	2.847	.633	.701
E.GOVER_3	7.44	2.591	.634	.692

In Table 18, the Cronbach's alpha is 0.783 > 0.6 and the value of the corrected Item-total correlation of each observed variable is higher than 0.3. Therefore, the scale of E.GOVER is reliable.

- *COVID-19 pandemic* **(E.COVID):**

Table 19. Table of reliability and item-total statistics for O.COVID from SPSS

Reliability Statistics	
Cronbach's Alpha	N of Items
.767	3

Item-Total Statistics				
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
E.COVID_1	7.67	2.250	.631	.655
E.COVID_3	7.38	2.040	.591	.703
E.COVID_2	8.08	2.309	.585	.704

Table 19 shows the Cronbach's alpha is 0.767 > 0.6 and the value of the corrected Item-total correlation of each observed variable is higher than 0.3. Therefore, the scale of E.COVID is reliable.

- *Dependent variable*: **DT_PORT**

Table 20. Table of reliability and item-total statistics for DT_PORT from SPSS

Reliability Statistics	
Cronbach's Alpha	N of Items
.767	4

Item-Total Statistics				
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
DT_PORT_1	10.09	2.931	.521	.735
DT_PORT_2	10.04	2.761	.603	.693
DT_PORT_3	10.11	2.710	.549	.722
DT_PORT_4	10.19	2.604	.599	.694

Table 20 shows the Cronbach's alpha is 0.767 > 0.6 and the value of the corrected Item-total correlation of each observed variable is higher than 0.3. Therefore, the scale of dependent variable DT_PORT is reliable.

4.2.4 Correlation analysis

Correlation analysis is used to explore the correlations and describe the strength of the relationship between two variables. In the context of this thesis, the Pearson correlation coefficient (r) was utilized to measure and assess the linear correlations. (Pallant, 2016, p. 150) indicates that the Pearson correlation is designed for interval-level (continuous) variables. When Pearson r reaches the value of 1 or -1 which is called perfect correlation, in this case, the value of one variable can be exactly determined basing on the value of the second variable (Pallant, 2016, p. 150). On the other hand, there is no relationship between two variables when the value of Pearson r is zero.

Table 21 illustrates the Pearson correlation analysis, the results of sig. (2-tailed) between independent variables and the dependent variable is all lower than 0.05. Therefore, all independent variables in the model are correlated with the dependent variable (DT_PORT). Especially, there is a strong relationship between Government policy (E.GOVER) and Digital transformation process in deep seaports (Pearson r = 0.606).

Table 21. The Pearson correlation coefficient analysis (summarized from SPSS)

Correlations											
	DT_PORT	T.SECUR	T.COMPA	T.READI	O.STRAT	O.HUMAN	O.STRUC	E.CUSTO	E.COMPE	E.GOVER	E.COVID
DT_PORT	1	0.371	0.294	0.444	0.534	0.527	0.510	0.488	0.516	0.606	0.448
T.SECUR	0.371	1	0.302	0.294	0.239	0.187	0.140	0.176	0.268	0.151	0.127
T.COMPA	0.294	0.302	1	0.204	0.180	0.128	0.024	0.153	0.151	0.171	0.095
T.READI	0.444	0.294	0.204	1	0.359	0.290	0.304	0.251	0.360	0.326	0.081
O.STRAT	0.534	0.239	0.180	0.359	1	0.299	0.325	0.278	0.261	0.277	0.164
O.HUMAN	0.527	0.187	0.128	0.290	0.299	1	0.384	0.261	0.340	0.282	0.215
O.STRUC	0.510	0.140	0.024	0.304	0.325	0.384	1	0.318	0.289	0.340	0.228
E.CUSTO	0.488	0.176	0.153	0.251	0.278	0.261	0.318	1	0.491	0.404	0.258
E.COMPE	0.516	0.268	0.151	0.360	0.261	0.340	0.289	0.491	1	0.417	0.321
E.GOVER	0.606	0.151	0.171	0.326	0.277	0.282	0.340	0.404	0.417	1	0.372
E.COVID	0.448	0.127	0.950	0.081	0.164	0.215	0.228	0.258	0.321	0.372	1

4.2.5 Regression analysis

According to Hair J.F and his associates (2010), the regression analysis describes the strength of linear relationships between many independent variables and one dependent variable. Moreover, this technique can also be used to measure the importance of independent variables (Hair, Black, Babin, & Anderson, 2010).

The sig. value of F-test in ANOVA for this model is $0.000^b < 0.05$ thus, the regression model is appropriate. Besides, the adjusted R^2 value in the model summary is 0.692, which means all predictors (independent variables) in the regression affect 69.2% to the change of the dependent variable (DT_PORT).

Table 22. Coefficients Table (summarized from SPSS)

Coefficients								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	T.SECUR	0.093	0.033	0.119	2.843	0.005	0.816	1.225
	T.COMPA	0.072	0.032	0.093	2.283	0.023	0.867	1.153
	T.READI	0.041	0.029	0.063	1.413	0.159	0.715	1.399
	O.STRAT	0.139	0.028	0.216	5.003	0.000	0.767	1.304
	O.HUMAN	0.133	0.030	0.194	4.474	0.000	0.759	1.317
	O.STRUC	0.099	0.029	0.152	3.424	0.001	0.726	1.378
	E.CUSTO	0.066	0.032	0.096	2.095	0.037	0.682	1.467
	E.COMPE	0.053	0.034	0.075	1.561	0.120	0.618	1.617
	E.GOVER	0.176	0.032	0.255	5.510	0.000	0.668	1.497
	E.COVID	0.124	0.032	0.164	3.882	0.000	0.802	1.247

a. Dependent Variable: DT_PORT

Based on Table 22, two variables T.READI and E.COMPE are non-significant because their sig. values from t-test (0.159 and 0.120) are higher than 0.05. The rest independent variables (T.SECUR, T.COMPA, O.STRAT, O.HUMAN, O.STRUC, E.CUSTO, E.GOVER and E.COVID) are statistically significant when their sig. values are all lower than 0.05.

The VIF (Variance Inflation Factor) values in Table 22 of all independent variables are all lower than 2, therefore, no multicollinearity among these variables in this multiple regression model.

Table 23. Hypothesis testing results

Hypothesis		Standardized Coefficients Beta	Sig. values from t-test	Results
H1	Security and privacy has a positive influence on the digital transformation process of deep seaports	0.119	0.005	Accept
H2	Compatibility has a positive influence on the digital transformation process of deep seaports	0.093	0.023	Accept
H3	The readiness of digital data and technology has a positive influence on the digital transformation process of deep seaports	0.063	0.159	Reject (sig. > 0.05)
H4	Organizational strategy has a positive effect on the digital transformation process of deep seaports	0.216	0.000	Accept
H5	Organizational human resources has a positive impact on the digital transformation process of deep seaports	0.194	0.000	Accept
H6	Organizational structure has a positive impact on the digital transformation process of deep seaports	0.152	0.001	Accept
H7	Customer demand has a positive effect on the digital transformation process of deep seaports	0.096	0.037	Accept
H8	Competitiveness has a positive effect on the digital transformation process of deep seaports	0.075	0.120	Reject (sig. > 0.05)
H9	Government policy has a positive effect on the digital transformation process of deep seaports	0.255	0.000	Accept
H10	The COVID-19 pandemic positively fosters the digital transformation process of deep seaports	0.164	0.000	Accept

The sig. value of each variable from the t-test shown in the coefficients table **(Table 22)** is the basis for testing the hypothesis. Two independent variables T.READI and E.COMPE are non-significant, so they have no influence on the dependent variable (DT_PORT). Two

hypotheses corresponding to these 2 variables will be rejected from the model. Therefore, 2 factors: Readiness of digital data and technology (T) and Competitiveness (E) are not considered influential factors in the digital transformation of deep seaports in Vietnam.

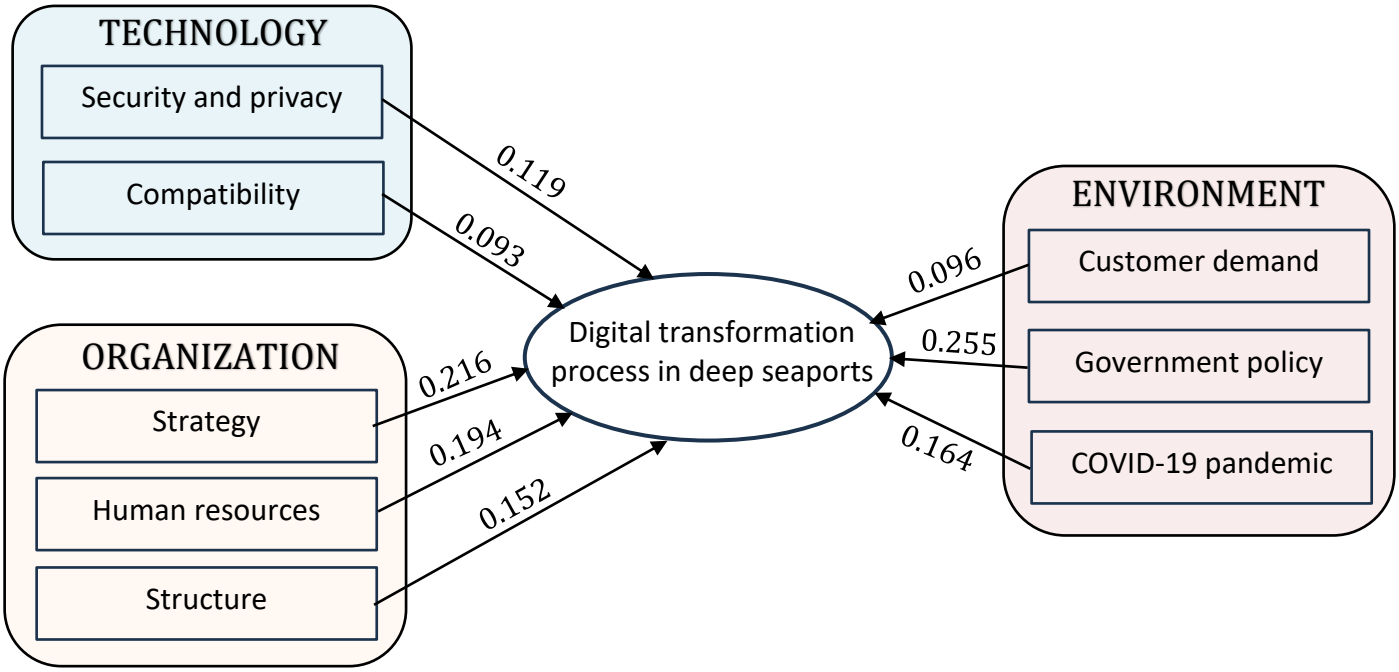
Based on the Standardized Coefficients Beta values from **Table 22**, the Standardized regression formula is formed as follow:

DT_PORT = 0.255***E.GOVER** + 0.216***O.STRAT** + 0.194***O.HUMAN** + 0.164***E.COVID** + 0.152***O.STRUC** + 0.119***T.SECUR** + 0.096***E.CUSTO** + 0.093***T.COMPA** + ε

5. Key findings

Through the semi-structure interview with 8 experts as well as a survey with 216 employees working in 4 deep water seaports including Gemalink, TCIT, TCTT, and SSIT in Cai Mep Thi Vai area, Ba Ria Vung Tau province, Vietnam, the analysis of the survey results discovered 8 main factors that have a positive effect to the digital transformation process in the context of TOE framework as shown in Figure 8.

Figure 8. Validated research model



Besides, the results from regression analysis and Figure 8 also discovered that the Government policy is the most influential factor for the success of the digital transformation of deep seaports in Vietnam. Besides, organizational strategy for implementing digital technologies as well as organizational human resources also have a great influence on this conversion process. The COVID-19 pandemic is obviously considered a vital driver in accelerating the speed of the digitalization process in deep seaports.

The Government policy as well as the support from the Government plays an essential role in the success of the digital transformation at seaports. Besides Decision No. 749/Qd-TTg was issued in 2020, the Prime Minister should issue some technology policies to help

seaports increase their capability in the transformation process. Besides, policies on transport infrastructure investment should also be considered and enforced by the Government. Regarding financial policies related to digital transformation, especially in logistics and seaport sectors, the Government should consider some regulations on tax exemptions or some special preferential tax policies for seaports that are proactively in the process of digitalization. On the one hand, this will help seaports that are ongoing in their digital transformation process reduce costs. On the other hand, it will encourage other seaports to accelerate the process of digitalization.

Relating to the strategy, the port operators or port management should be more proactive in learning and grasping the contents of digital transformation including hardware, software, costs, functions, and transformation trends as well as an appropriate business model to ensure their seaports transform in the right direction with effectiveness. Deep seaport operators should build a strategic development roadmap for digital transformation in each stage with specific goals to become Smart seaports in the near future. During the implementation process, it is necessary to ensure the feasibility and establish a timeframe to keep up with each stage in the conversion process.

Human resources also plays a vital role in the success of the digitalization at seaports. *"To meet the digital transformation needs in the coming times, some leaders in our port have been trained about digitalization knowledge in the Netherlands and some developed countries."* said Interviewee No. (5) of TCTT. Obviously, some leaders of seaports have in-depth knowledge about digital transformation. However, many employees working in these seaports do not have much knowledge about this issue according to the results from the survey. Therefore, some basic and advanced training courses on digital transformation for all employees in seaports are necessary for them to quickly adapt to a new digital environment. Port management or port operators should have some appropriate policies to encourage long-time and elder employees to change their daily habits and strictly follow in case of digitalization deployment. For the transformation process to be synchronous and unified across all departments within seaports, the board of management should be determined to force employees to comply requirements of organizations.

Seaports are a service industry that ensures the loading, unloading, and movement of goods together with relevant logistics activities. Any disruptions in seaport operations,

especially deep seaports, will greatly affect the import and export volume of one country, thereby causing a negative impact on the economy. The COVID-19 pandemic is a valuable lesson for seaports in fostering the digital transformation. More applications and operating software should be deployed to help employees work remotely and flexibly, ensuring smooth operations together with high security and privacy. Moreover, all planned digital transformation projects within 4 seaports need to be deployed as soon as possible during this time, this can help seaports maintain their operations and overcome challenges in case of any unexpected incidents like the COVID-19 pandemic.

Relating to organizational structure, results from the survey show that departments in seaports have not been built and structured effectively and compatibly with the digital transformation process when the average point for this question (O.STRUC_1) is only 3.32 of 5.0. Currently, most departments are organized in a traditional way, which can cause disruption and slowness in implementing digital transformation. To be able to succeed in deploying new digital technologies, port operators should consider to re-structure the departments of seaports towards an active and simple way. Some processes need to be simplified, unnecessary procedures and documents should also be minimized to reduce risks and costs.

Security and privacy factor is considered one of the most important factors in implementing digitalization in seaports. During the transition process to upload data into the system over the internet, the accuracy of the data must be ensured and authorized through the responsible employee, especially some data relating to the customer, description of cargo, vessel and berth details. The leaks of customer information, cargo and documentation can lead to the loss of goods. Therefore, the security authentication steps should be deployed in some different methods so that the risks of leaking data, improper use or data theft can be avoided.

Digital transformation not only brings benefits to organizations and enhances their positions in the market but also helps businesses to serve customers better. All manufacturing or service business activities create value for customers and the same for seaports. Customer demand is also one of the main factors that influence the digital transformation process in seaports, therefore, understanding customer needs and minimizing costs and time for customers relating to any procedures with seaports is

necessary. This can be proved by some current software and digital technologies at 4 targeted deep seaports such as E-port, E-Manifest, E-D/O, Smart ports, etc. Besides individual customers, however, shipping lines, logistics corporations, and forwarding companies are also important customers of seaports. Thus, any digital implementation or transformation projects of seaports should consider the two-way relationship between these types of customers and seaports. To avoid some difficulties and obstacles that customers can face due to the inaccessibility of the digital platform, port operators should conduct market surveys and research, as well as collect opinions and responses from relevant stakeholders and customers. Through analyzing the results, the port authorities will have a general overview of their customers' desires before making decisions on digitalization deployment.

6. Conclusion

With the combination of qualitative research method with expert interviews and quantitative research method within 4 deep seaports at the Cai Mep – Thi Vai cluster in Ba Ria Vung Tau province including Gemalink, TCIT, TCTT and SSIT, this study reveals 8 main factors influencing the digital transformation process in seaport sectors in Vietnam by applying the influence model of three different contexts (TOE). These factors include Security and privacy (T), Compatibility (T), Strategy (O), Human resources (O), Structure (O), Customer demand (E), Government policy (E) and COVID-19 pandemic (E). The result obtained from this study can fill the big gap in academic research on digital transformation issues by applying TOE model framework to explore influencing factors in seaport sectors, especially in Vietnam.

Besides, this study also found that Government policy is the most influential factor in transformation decisions in deep seaports. In addition, organizational strategy and human resources also have a strong impact on this transition process. The COVID-19 pandemic is considered the core driving force to accelerate digital conversion. The research findings provide the implications to help the Government identify the influence of State policies on the digital transformation of seaports. The Government needs to promote the implementation of digital transformation Decision No. 749/QD-Ttg as well as issue some additional policies on transportation infrastructure, encouraging seaports for digital

transformation by considering some regulations on tax exemptions or applying some special preferential tax policies.

6.1 Limitations of the study

All research objectives have been achieved, however, there are still two limitations of this research:

- Although deep seaports are the main subject, the study only focuses on 4 of 6 deep seaports in Cai Mep Thi Vai cluster, Ba Ria Vung Tau province in Southern Vietnam. Another deep seaport TAN CANG – HAI PHONG International Container Terminal (TC-HICT) in Nothern Vietnam is also not considered the targeted seaport for this research.

- Due to the time constraints, there is also a limitation in the sample size in this study compared to the total number of employees working in each deep seaport. The actual sample size meets the requirements and standards for reliability in data analysis, however, more survey samples can result in a higher level of confidence about influencing factors.

6.2 Suggestions for future research

Based on the limitations of the study, some suggestions are proposed for future research in terms of digital transformation within seaports:

- Expanding the research scope and research objects: not only in deep seaports, but future research also can aim at smaller (non-deep) cargo seaports in southern, central, and northern regions in Vietnam.

- Increasing the sample size for each seaport as well as considering further factors that can influence the digital transformation process such as investment costs or cultural readiness for change in organizations.

REFERENCES

Akdil, K., Ustundag, A., & Cevikcan, E. (2018). Maturity and Readiness Model for Industry 4.0 Strategy. i *Industry 4.0: Managing The Digital Transformation* (ss. 61-94). Springer, Cham, https://doi.org/10.1007/978-3-319-57870-5_4.

Baker, J. (2011). The Technology–Organization–Environment Framework. *University of Hamburg, DOI: 10.1007/978-1-4419-6108-2_12*.

Behdani, B., Wiegmans, B., Roso, V., & Haralambides, H. (2020). Port-hinterland transport and logistics: emerging trends and frontier research. *Marit Econ Logist 22, 1–25 (2020) https://doi.org/10.1057/s41278-019-00137-3*.

Berman, S. J. (2012). Digital transformation: opportunities to create new business models. *Strategy & Leadership, Vol. 40 Issue: 2, pp.16-24, doi: 10.1108/10878571211209314*.

Beverungen, D., Muller, O., Matzner, M., Mendling, J., & Vom Brocke, J. (2019). Conceptualizing smart service systems. *Electronic Markets, 29(1), https://doi.org/10.1007/s12525-017-0270-5*, pp 7-18.

Boneva, M. (2018). Challenges Related to the Digital Transformation of Business Companies. *Innovation Management, Entrepreneurship and Sustainability (IMES)* , 101–114.

Chandra, S., & Kumar, K. (2018). Exploring factors influencing organizational adoption of augmented reality in e-commerce: Empirical evidence using technology-organization-environment model. *Journal of Electronic Commerce Research 19(3)*, 237-265.

Chatfield, A., & Andersen, N. (1997). The impact of IOS-enabled business process change on business outcomes: Transformation of the value chain of Japan airlines. *Journal of Management Information Systems 14(1), https://doi.org/10.1080/07421222.1997.11518152*, 13-40.

Chu, B. Q. (2021). A research to explore the factors affecting the success of businesses digital transformation in Vietnam. *Banking Science & Training Review. ISSN 1859 - 011X; https://hvnh.edu.vn/tapchi/vi/thang-10-2021/chu-ba-quyet-nghien-cuu-kham-pha-cac-nhan-to-anh-huong-den-chuyen-doi-so-thanh-cong-cua-doanh-nghiep-o-viet-nam-566.html*.

Clohessy, T., Acton, T., & Morgan, L. (2017). The impact of cloud-based digital transformation on ICT service providers' strategies. *Bled eConference, Bled, Slovenia*, pp. 111-126.

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika volume 16, https://doi.org/10.1007/BF02310555*, 297–334.

Danielle, C. (2019). Keys to Successful Digital Transformation.

Demirkan, H., Spohrer, J. C., & Welser, J. J. (2016). Digital Innovation and Strategic Transformation. *IT Professional (18:6)*.

Digital Transport Logistics Forum. (2018). *Towards paperless transport within the EU and across its borders.* Retrieved from https://eufordigital.eu/wp-content/uploads/2020/01/executive_summary1_reading.pdf

Edvard, T., Jovic, M., Aksentijevic, S., & Pucihar, A. (2021). Digital transformation in the maritime transport sector. *Technological Forecasting & Social Change 170. 120879, DOI:10.1016/j.techfore.2021.120879*.

Eller, R., Alford, P., Kallmünzer, A., & Peters, M. (2020). Antecedents, consequences, and challenges of small and medium-sized enterprise digitalization. *J. Bus. Res. 112*, 119–127.

Emeka, C. (2020). Deep seaports development and the Nigerian Economy: Prospects and challenges.

European Parliament. (2019). *Digital transformation.* Retrieved from https://www.europarl.europa.eu/RegData/etudes/BRIE/2019/633171/EPRS_BRI(2019)633171_EN.pdf

Fitzgerald, M., Kruschwitz, N., Bonnet, D., & Welch, M. (2014). Embracing digital technology: A new strategic imperative. *MIT Sloan Management Review, 55(2), 1.*

Frank, A. G., Dalenogare, L. S., & Ayala, N. F. (2019). Industry 4.0 technologies: Implementation patterns in manufacturing companies. *International Journal of Production Economics 210 (1), https://doi.org/10.1016/j.ijpe.2019.01.004*, pp 15-26.

Fruth, M., & Teuteberg, F. (2017). Digitization in maritime logistics - What is there and what is missing? *Cogent Business & Manage. 4 (1), 1411066, https://doi.org/10.1080/23311975.2017.1411066*.

Fu, Y., & Lee, Y.-C. (2021). Investigating determinants of digital transformation: Empirical evidence from Chinese companies. *THE JOURNAL OF ASIAN STUDIES, DOI: 10.21740/jas.2021.08.24.3.113*.

García, B. A. (2013). Ports: Definition and study of types, sizes and business models. *Journal of Industrial Engineering and Management, doi:10.3926/jiem.770*.

Gemalink. (u.d.). *Overview of Gemalink*. Retrieved from https://gml.gemadept.com.vn/: https://gml.gemadept.com.vn/overview-4798/index.html

Genzorova, T., Corejova, T., & Stalmasekova, N. (2019). How digital transformation can influence business model, Case study for transport industry. *Transportation Research Procedia, Vol. 40, https://doi.org/10.1016/j.trpro.2019.07.147*, 1053-1058.

Giao, P. H. (2020). Digital transformation: Nature, practice and application. *PetroVietnam Journal 12, https://doi.org/10.47800/PVJ.2020.12-02*, 12-16.

Green, S. B. (1991). How Many Subjects Does It Take To Do A Regression Analysis. *Multivariate Behavioral Research, Vol. 26 No. 3*, 449-510.

Hagberg, J., Sundstrom, M., & Egels-Zandén, N. (2016). The digitalization of retailing: An exploratory framework. *International Journal of Retail & Distribution Management, 44(7)*, p 694–712.

HAI PHONG PORT. (2022). *Annual report 2022.* HAI PHONG Port.

Hair, J., Anderson, R., Tatham, R., & Black, W. (1998). *Multivariate Data Analysis, 5th edition.* New Jersey: Prentice Hall.

Hair, J., Black, W., Babin, B., & Anderson, R. (2010). *Multivariate Data Analysis - 7th edition.* New York, USA: Pearson.

Hajjar, S. T. (2018). Statistical analysis: Internal-consistency reliability and construct validity. *International Journal of Quantitative and Qualitative Research Methods Vol. 6, No.1*, 46-57.

Hanna, N. (2018). A role for the state in the digital age. *J. Inno. and Entrepreneurship 7(1), https://doi.org/10.1186/s13731-018-0086-3.*

Hartl, E., & Hess, T. (2017). The Role of Cultural Values for Digital Transformation: Insights from a Delphi Study. *Proceedings of the 23rd Americas Conference on Information Systems, Retrieved from https://pdfs.semanticscholar.org/0637/ef47694073848b3e5292fc5cb91bb65f2c66.pdf.*

Heilig, L., Lalla-Ruiz, E., & Voß, S. (2017). Digital transformation in maritime ports: analysis and a game theoretic framework. *SPRINGER NETNOMICS: Economic Research and Electronic Networking volume 18; https://doi.org/10.1007/s11066-017-9122-x*, 227–254.

Heilig, L., Schwarze, S., & Voss, S. (January 2017). An Analysis of Digital Transformation in the History and Future of Modern Ports. *Proceedings of the 50th Hawaii International Conference on System Sciences.* Hawaii, HI, USA.

Hess, T., Benlian, A., Matt, C., & Wiesböck, F. (2016). Options for formulating a digital transformation strategy. *MIS Quarterly Executive, 15(2)*, 123–139.

Hess, T., Matt, C., Benlian, A., & Wiesböck, F. (2016). Options for formulating a digital transformation strategy. *MIS Quarterly Executive, 15(2)*.

Horlacher, A., Klarner, P., & Hess, T. (2016). Crossing boundaries: Organization design parameters surrounding CDOs and their digital transformation activities. *Americas Conference of Information Systems, San Diego, CA*.

Huang, Z., Yang, Y., & Zhang, F. (2022). Configuration Analysis of Factors Influencing Port Competitiveness of Hinterland Cities under TOE Framework: Evidence from China. *Journal of Marine Science and Engineering 10(10), 1558; https://doi.org/10.3390/jmse10101558*.

Hwang, B.-N., Huang, C.-Y., & Wu, C.-H. (2016). A TOE Approach to Establish a Green Supply Chain Adoption Decision Model in the Semiconductor Industry. *Sustainability 2016, 8(2), 168; https://doi.org/10.3390/su8020168*.

Ismail, M. H., Khater, M., & Zaki, M. (2017). *Digital business transformation and strategy: What do we know so far?* Retrieved from https://cambridgeservicealliance.eng.cam.ac.uk/resources/Downloads/Monthly%20Papers/2017NovPaper_Mariam.pdf

Jean-Paul, R. (2020). *The Geography of Transport Systems (Fifth Edition).* New York:: Routledge.

Jovic, M., Tijan, E., Aksentijevic, S., & Cisic, D. (2019). An overview of security Challenges Of Seaport IoT Systems. *42nd International Convention on Information and communication technology, Electronics and microelectronics*, ss. 1571-1576.

Jovic, M., Tijan, E., Marx, R., & Gebhard, B. (2020). Big data management in maritime transport. *J. Maritime and transport science 57 (1)*, 123-141.

Junge, A. (2019). Digital transformation technologies as an enabler for sustainable logistics and supply chain processes – an exploratory framework. . *Operations & Production Management 16 (3)*, 462–472.

Kraus, S., Jones, P., Kailer, N., Weinmann, A., Chaparro-Banegas, N., & & Roig-Tierno, N. (2021). Digital Transformation: An Overview of the Current State of the Art of Research. *SAGE Open, 11(3), https://doi.org/10.1177/21582440211047576*.

Larjovuori, R.-L., Bordi, L., & Heikkila-Tammi, K. (2018). Leadership in the digital business transformation. *Proceedings of the 22nd International Academic Mindtrek Conference, https://doi.org/10.1145/3275116.3275122, Finland.* 212–221.

Legner, C., Eymann, T., Hess, T., Matt, C., Bohmann, T., Drews, P., & Ahlemann, F. (2017). Digitalization: Opportunity and Challenge for the Business and Information Systems Engineering Community. *Business and Info. Syst. Eng. 59 (4), https://doi.org/10.1007/s12599-017-0484-2*, 301–308.

Lim, T. W. (2019). Digital Disruptions and the Workplace. *In: Industrial Revolution 4.0, Tech Giants, and Digitized Societies. Palgrave Macmillan, Singapore. https://doi.org/10.1007/978-981-13-7470-8_13*, 163-169.

Liu, D., Chen, S., & Chou, T. (2011). Resource fit in digital transformation: Lessons learned from the CBC Bank global e-banking project. *Management Decision, 49(10)*, 1728–1742.

Loebbecke, C., & Picot, A. (2015). Reflections on societal and business model transformation arising from digitization and big data analytics: A research agenda. *The Journal of Strategic Information Systems, 24(3), https://doi.org/10.1016/j.jsis.2015.08.002*, pp 149–157.

Machado, C., Winroth, M., Carlsson, D., Almström, P., Centerholt, V., & Hallin, M. (2019). Industry 4.0 readiness in manufacturing companies: Challenges and enablers towards increased digitalization. *Procedia Cirp 81*, 1113–1118.

Mai, L. T., Liem, D. T., & Hoan, T. X. (2022). Factors affecting the digital transformation of telecommunication enterprises in Ho Chi Minh city. *International Journal of Applied Science and Engineering Review (IJASER) 3 (3)*, 59-74.

Majumder, M., Gupta, S., & Paul, J. (2022). Perceived usefulness of online customer reviews: A review mining approach using machine learning & exploratory data analysis. *Journal of Business Research, 150,* https://doi.org/10.1016/j.jbusres.2022.06.012, pp 147–164.

Maria G., B. (2015). *Port Management and Operations.* CRC press (Taylor & Francis Group).

Markus, M. L., & Benjamin, R. I. (1997). The magic bullet theory in IT-enabled transformation. *MIT Sloan Management Review 38(2)*, 55-68.

McKinsey & Company. (2020). *Shaping the digital transformation in Europe.* European Union.

Mićić, L. (2017). Digital transformation and its influence on GDP. *Economics, 5(2)*, 135-147.

Ministry of Industry and Trade of VietNam. (2022). *Vietnam Logistics Report 2022.* Ha Noi, Vietnam: Publishing House of Ministry of Industry and Trade.

Monton, A. (2021). Difference and Similarities: Digitization, Digitalization, and Digital Transformation. i *Handbook of Nondestructive Evaluation 4.0* (ss. 1-17). Springer: Berlin/Heidelberg, Germany.

Morgan, B. (2020). Accelerate your digital transformation.

Muhammad; Anton. (2022). Digital transformation for enhancing LSP (logistic service provider) performance. *Proceedings of the 5th International Conference on Family Business and Entrepreneurship.* Milan, Italy.

Negroponte, N. (1995). *Being Digital.* New York, NY: Alfred A. Knopf, Inc.

Nijdam, M., & Horst, M. v. (2018). Port definition, concepts and the role of ports in supply chains. i H. Geerlings, B. Kuipers, & R. Zuidwijk, *Ports and Networks: Strategies, Operations and Perspectives.* Abingdon, Oxon: Routledge.

Notteboom, T., Pallis, A., & Rodrigue, J.-P. (2022). *Port economics, management and policy.* Milton Park, Abingdon, Oxon: Routledge.

Nuraan, D., & Osden, J. (2020). Factors Affecting Digital Transformation in the Retail Supply Chain. *Proceedings of the International Conference on Management, Business, Economics and Accounting (ICMBEA)* (ss. 117–133). Available online http://hdl.handle.net/10566/6884.

Nwankpa, J. K., & Roumani, Y. (2016). IT capability and digital transformation: A firm performance perspective. *International Conference of Information Systems Dublin, Ireland*.

O'Leary, D. E. (2022). Digitization, Digitalization and Digital Transformation in Accounting, Electronic Commerce and Supply Chains. *USC Marshall School of Business Research Paper Sponsored by iORB, No. Forthcoming,* http://dx.doi.org/10.2139/ssrn.4307305.

OECD. (2018). *Going digital in a multilateral world.* Retrieved from https://one.oecd.org/document/DSTI/CDEP/GD(2018)2/en/pdf

Osmundsen, K., Iden, J., & Bygstad, B. (2019). Digital Transformation: Drivers, Success Factors, and Implications. *The 12th Mediterranean Conference on Information Systems (MCIS), https://doi.org/10.1080/10106049.2014.888485*.

Pallant, J. (2016). *SPSS Survival Manual - A step by step guide to data analysis using IBM SPSS (6th edition).* New York, USA: Mc Graw Hill Education.

Parviainen, P., Tihinen, M., Kääriäinen, J., & Teppola, S. (2017). Tackling the digitalization challenge: How to benefit from digitalization in practice. *International Journal of Information Systems and Project Management, 5(1)*, p 63–77.

Plekhanov, D., Franke, H., & Netland, T. H. (2022). Digital transformation: A review and research agenda. *European Management Journal, https://doi.org/10.1016/j.emj.2022.09.007*.

Reis, J., Amorim, M., Melão, N., & Matos, P. (2018). Digital transformation: A literature review and guidelines for future research. i *Trends and Advances in Information Systems and Technologies, volume 16* (ss. 411–421). Berlin/Heidelberg, German: Springer.

Saigon Newport Corporation. (u.d.). *Tan Cang - Cai Mep Thi Vai Terminal*. Retrieved from https://saigonnewport.com.vn/en/port-company/tan-cang-cai-mep-thi-vai-terminal-tctt

Salkin, C., Oner, M., Ustundag, A., & Cevikcan, E. (2018). A Conceptual Framework for Industry 4.0. i *Industry 4.0: Managing The Digital Transformation* (ss. 3-23). Springer, Cham, https://doi.org/10.1007/978-3-319-57870-5_1.

Schreckling, E., & Steiger, C. (2016). Digitalize or Drown. *In: Oswald, G., Kleinemeier, M. (eds) Shaping the Digital Enterprise. Springer, Cham. https://doi.org/10.1007/978-3-319-40967-2_1*, 3-27.

Schumann, C.-A., Baum, J., Forkel, E., Otto, F., & Reuther, K. (2017). Digital Transformation and Industry 4.0 as a Complex and Eclectic Change.

Schwertner, K. (2017). Digital transformation of business. *Trakia Journal of Sciences, 15(1), https://doi.org/10.15547/tjs.2017.s.01.065*, 388-393.

Shehadeh, M., Almohtaseb, A., Aldehayyat, J., & Abu-AlSondos, I. A. (2023). Digital Transformation and Competitive Advantage in the Service Sector: A Moderated-Mediation Model. *Sustainability 15(3), https://doi.org/10.3390/su15032077*.

Siebel, T. M. (2019). "*Digital transformation: survive and thrive in an era of mass extinction".* Rodin Books.

Singh, A., & Hess, T. (2017). How chief digital officers promote the digital transformation of their companies. *MIS Quarterly Executive, 16(1)*, 1-17.

SSIT. (u.d.). *About SSIT*. Retrieved from https://www.ssit.com.vn/

Stolterman, E., Fors, A. C., & Truex, D. P. (2004). Information technology and the good life. i B. Kaplan, D. P. Truex, & D. Wastell, *Information systems research: Relevant theory and informed practice* (ss. 687-693). Kluwer Academic Publishers.

Stopford, M. (2009). *Maritime Economics - 3rd Edition.* Abingdon: Routledge.

Swen, N., & Reinhard, P. (2020). Digital transformation: A review, synthesis and opportunities for future research. *Management Review, 71*, 233–341.

TCIT. (2021). *TCIT Brochure.* TCIT, retrieved from https://www.tcit.com.vn/resources&active=2.

TCIT. (u.d.). *TCIT E-port instruction*. Retrieved from https://tcit.com.vn/uploads/files/ePort_Huong_dan_dang_ky_giao_nhan_container_TCIT_Apr.pdf

TCTT. (u.d.). *Tan Cang Cai Mep-Thi Vai Terminal (TCTT)*. Retrieved from https://saigonnewport.com.vn: https://saigonnewport.com.vn/en/port-company/tan-cang-cai-mep-thi-vai-terminal-tctt

The Prime Minister of Vietnam. (den 03 June 2020). *DECISION No. 749/QD-TTg INTRODUCING PROGRAM FOR NATIONAL DIGITAL TRANSFORMATION BY 2025 WITH ORIENTATIONS TOWARDS 2030*. Retrieved from https://vanbanphapluat.co/decision-749-qd-ttg-2020-introducing-program-for-national-digital-transformation

The Prime Minister of Vietnam. (2021). *Decision No. 1579/QD-TTg dated September 22, 2021 on approving master planning for development of Vietnam's seaport system in 2021 - 2030 period with a vision by 2050*. Retrieved from vanban.chinhphu.vn: https://vanban.chinhphu.vn/default.aspx?pageid=27160&docid=204165

Tornatzky, L. G., & Fleischer, M. (1990). *The processes of technological innovation.* Lexington, MA: Lexington Books.

Trierveiler, H., Sell, D., & Santo, N. D. (2019). The Benefits and Challenges of Digital Transformation in Industry 4.0. *Global Journal of Management and Business Research 19(12)*, 27-40.

Tripathi, S. (2021). Determinants of Digital Transformation in the Post-Covid-19 Business World. *IJRDO - Journal of Business Management, 7(6)*, 75-83.

Tuan, V. A. (2022). *Digital readiness of container terminals for digital technology adoption: a case study of Vietnam.* Malmo, Sweden: World Maritime University Dissertations. 2118. https://commons.wmu.se/all_dissertations/2118.

US-DWPA. (1974). *33 U.S. Code § 1502 - Definitions*. Retrieved from Cornell Law School: https://www.law.cornell.edu/uscode/text/33/1502

VCCI, V. C. (2021). *DIGITAL TRANSFORMATION: Solutions to overcome the Covid-19 pandemic and accelerate for business.* VCCI, retrieved from http://vienptdn-vcci.vn/wp-content/uploads/2020/11/CHUYEN-DOI-SO-DOANH-NGHIEP-TA.pdf.

Verina, N., & Titko, J. (2019). Digital Transformation: A Conceptual Framework. *Contemporary Issues in Business, Management and Economics Engineering,* https://doi.org/10.3846/cibmee.2019.073, 719–727.

Vial, G. (2019). Understanding digital transformation: A review and a research agenda. *Journal of strategic information systems review, Volume 28, Issue 2,* https://doi.org/10.1016/j.jsis.2019.01.003, pp 118-144.

Viet, H. L., & Quoc, H. D. (2023). The Factors Affecting Digital Transformation in Vietnam Logistics Enterprises. *Electronics.; 12(8):1825.* https://doi.org/10.3390/electronics12081825.

Vietnam Maritime Administration. (u.d.). Retrieved from https://www.vinamarine.gov.vn/en/cang-bien

Von Leipzig, T., Manz, D., Gamp, M., Schöttle, K., Ohlhausen, P., Oosthuizen, G., . . . Von Leipzig, K. (2017). Initialising customer-orientated digital transformation in enterprises. *Procedia Manuf. 8*, 517–524.

Vrana, J., & Singh, R. (2021). Digitization, digitalization, and digital transformation. i *Handbook of Nondestructive Evaluation 4.0* (ss. 1-17). Springer: Cham, Switzerland.

Wang, P., & Mileski, J. (2018). Strategic maritime management as a new emerging field in maritime studies. *Maritime Business Review 3(3)*, 290–313.

Warner, K. S., & Wager, M. (2019). Building dynamic capabilities for digital transformation: An ongoing process of strategic renewal. *Long Range Planning, 52(3),* https://doi.org/10.1016/j.lrp.2018.12.001, pp 326–349.

Wayne K., T. (2009). *Port economics.* Abingdon, Oxon: Routledge.

Westerman, G., Calméjane, C., Bonnet, D., Ferraris, P., & McAfee, A. (2011). Digital transformation: A roadmap for billion-dollar organizations. *MIT Sloan Management, MIT Center for Digital Business and Capgemini Consulting*, 1-68.

Wolfswinkel, J. F., Furtmueller, E., & and Wilderom, C. P. (2013). Using grounded theory as a method for rigorously reviewing literature. *European Journal of Information systems (22:1)*, pp. 45-55.

Zhao, Y., Wang, L., Feng, T., & Zhang, X. (2021). A research on the differentiated paths adopted by governments for resumption of work and production in the context of COVID-19. *Sci. Res. Manag. (42)*, 191-200.

Zhu, K., Shutao, D., Sean, X., & Kenneth, K. (2006). Innovation diffusion in global contexts: Determinants of post-adoption digital transformation of European companies. *European Journal of Information Systems 15(6)*, 601-616.

APPENDIX

RESEARCH QUESTIONNAIRE

FACTORS AFFECT THE DIGITAL TRANSFORMATION PROCESS OF DEEP WATER SEAPORTS IN VIETNAM

INTRODUCTION

This survey questionnaire is developed by HUY NGUYEN DANG QUANG who is an MBA student of Digital Business and Management (DBM) at NOVIA University of Applied Science, Finland in order to collect primary data for my master's thesis on title **"Factors affect the digital transformation process of deep water seaports in Vietnam".** I promise that all received information in this questionnaire will only be used for academic purpose and validation of my study result.

Thank you very much for your assistance.

SECTION 1: General information

1. Gender: Male ☐ Female ☐

2. Age: < 30 ☐ 30-40 ☐ 40-50 ☐ > 50 ☐

3. Which seaport are you currently working in?

Gemalink ☐ TCIT ☐ TCTT ☐ SSIT ☐

4. How long have you been working at this seaport?

0-2 years ☐ 2-5 years ☐ 5-10 ☐ > 10 years☐

5. Please select the appropriate departments that you are currently working on:

Board of Directors ☐

Sales & Customer Service ☐

Human resources ☐

Port planning and operating ☐

Technical Department ☐

Others ☐

<u>SECTION 2</u>: Factors influencing the digital transformation process in deep water seaports

Please click that if your answer is:

SD=Strong Disagree (1), D=Disagree (2), N=Neutral (3), A=Agree (4), SA=Strong Agree (5)

No.	Statements	1	2	3	4	5
A.	**TECHNOLOGICAL FACTORS (T)**					
I.	*Security and privacy*					
	All data and information uploaded to the system over the Internet is verified for reliability and accuracy.					
	Only authorized users are responsible for uploading all data and information in the system over the Internet.					
	All data and information uploaded over the Internet is always kept secure and confidential.					
	Employees in your seaport ensure the confidentiality of the business when exchanging information over the Internet.					
II.	*Compatibility*					
	The information technology system in your seaport allows you to access sources of information outside of your organization.					
	Accessing and exploiting data over the internet is supported by the corresponding software(s).					
	Your organization has a suitable and specialized department that supports connecting and using external information sources.					
III.	*Readiness of digital data and technology*					
	Work data can be easily accessible through a connection to the internet system in your seaport.					
	The data source that your seaport accesses over the internet is suitable for the work needs.					
	Access to necessary information over the Internet is available at competitive costs.					
	Your seaport can easily access new digital technologies.					
B.	**ORGANIZATIONAL FACTORS**					
I.	*Strategy*					
	Leaders and managers of your seaport have knowledge about digital transformation.					
	Your seaport has planned and built a development strategy for digital transformation.					

	Your seaport has recently implemented digital transformation process.					
	Your seaport's digital transformation strategy is consistent with its development strategy.					
II.	*Human resources*					
	Employees in your seaport have knowledge about digital transformation.					
	Employees in your seaport deeply understand the digital transformation strategy of your organization.					
	Employees in your seaport are conducting a digital transformation process.					
	Employees in your seaport are proactive in the digital transformation process.					
III.	*Business structure*					
	All departments in your seaport are built and structured appropriately with the digital transformation process.					
	It is necessary to implement the digital transformation process within the size and scope of your seaport's operations.					
	Your business structure is flexible with the digital transformation process implementation.					
C.	**ENVIRONMENTAL FACTORS**					
I.	*Customer demand*					
	Customers desire your seaport to implement digital transformation to serve them better.					
	The digital transformation process makes the transaction and working process with customers more convenient.					
	The digital transformation implementation helps customers cut costs compared to current traditional processes.					
II.	*Competitiveness*					
	Other deep seaports have a higher level of digital transformation than your seaport.					
	Digital transformation implementation helps your seaport become more competitive in the sector.					
	Digital transformation implementation is a prerequisite for the survival and development of your seaport.					

III.	*Government policy*					
	The Government encourages the implementation of digital transformation in your seaport.					
	The Government has financial policies to support the digital transformation process of your seaport.					
	The Government has issued legal policies for the digital transformation process.					
IV.	*COVID-19 pandemic*					
	The COVID-19 pandemic influences the digital transformation process of your seaport.					
	The COVID-19 pandemic is a driver in fostering the digital transformation process of your seaport.					
	The COVID-19 pandemic has changed the digital transformation strategy of your seaport.					
D.	**DIGITAL TRANSFORMATION PROCESS IN DEEP SEAPORTS**					
	The digital transformation process brings benefits to your seaport.					
	The digital transformation process brings benefits to all employees in your seaport.					
	The digital transformation process promotes business activities in your seaport.					
	The digital transformation makes your seaport's leaders feel more secure and satisfied.					