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Digital readiness of container terminals for digital technology adoption: a case study of Vietnam

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WORLD MARITIME UNIVERSITY

Malmö, Sweden

DIGITAL READINESS OF CONTAINER TERMINALS FOR DIGITAL TECHNOLOGY ADOPTION – A CASE STUDY OF VIETNAM

By

ANH TUAN VU

Vietnam

A dissertation submitted to the World Maritime University in partial fulfilment of the requirements for the award of the degree of

MASTER OF SCIENCE

in

(SHIPPING MANAGEMENT AND LOGISTICS)

2022

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Declaration

I certify that all the material in this dissertation that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the University.

(Signature): .... (Anh Tuan Vu)

(Date): 20/09/2022 ....

Supervised by: Associate Professor Gang Chen

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Anh Tuan Vu

Abstract

Title of Dissertation: **Digital readiness of container terminals for digital technology adoption – A Case study of Vietnam**

Degree: **Master of Science**

In Vietnam, most container terminals have not even gone through the digital transformation process. Port operators have little knowledge about digitalization because of the defective material about the digital readiness level of ports. Ports must understand their digital readiness level to utilize their resources for successful digital transformation. Therefore, the study aims to explore the current research about the digital readiness of container terminals and create a digital readiness model to assess the level of digitalization in container terminals based on previous studies, research and expert knowledge. Based on literature, a digital readiness model is proposed consisting of five dimensions with 15 sub-variables supporting the dimension: "Data formation, Asset connectivity, Planning processes, Performance measurement and Security control". The developed digital readiness model can support the process of setting up the long-term investment for the digital transformation of the port. Then, the paper will provide insight into case studies of two container ports in Vietnam about different perceptions of port operators and stakeholders about the digital readiness model of the container terminal. Each manager has a different rating on their port based on the model, indicating the asynchronous connection among departments in the terminal due to the disparity of knowledge in digitalization. As a result, top management must establish a two-way relationship between the operational and management system to solve the problem of de-synchronization for a successful digital transformation.

KEYWORDS: maritime, container terminal, port industry, digitalization, digital readiness, digital maturity, digital transformation.

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List of Abbreviations

AGVs	Automated Guided Vehicles
AI	Artificial Intelligence
AIS	Automatic Identification Systems
ASC	Automated Stacking Crane
CFS	Container Freight Station
CMIT	Cai Mep International Terminal
CRM	Customer Relationship Management
DRIP	Digital Readiness Index for Ports
DT	Digital Transformation
EDI	Electronic Data Interchange
GMD	GEMADEPT Corporation
GPS	Global Positioning System
IoT	Internet of Things
IT	Information Technology
KPI	Key Performance Indicator
OCR	Optical Character Recognition
PCS	Port Community's System
PMI	Project Management Institute
QC	Quay Crane
RD	Research Databases
RFID	Radio-Frequency Identification
RTLS	Real-Time Locating Systems
SCM	Supply Chain Management
STS	Ship-to-Shore
TEU	Twenty-foot equivalent unit
TOS	Terminal Operation System
VTS	Vessel Traffic Services

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1. Chapter One: Introduction

1.1 BACKGROUND

The pace of digital transformation and digitization in the maritime sector, a crucial transportation route for international trade, varies across different sectors (Sanchez-Gonzalez et al., 2019). As a link in the logistical system, ports lack knowledge, appropriate initiatives, and strategies for a successful digital transformation (Gausdal et al., 2018). And digitalization is a future with these rapid changes in technology acceleration (Amankwah-Amoah et al., 2021). Most of the visible changes in terms of digitalization are E-learning and E-commerce – which are booming in Asia, with a share of consumer spending per capita reaching 3.6% in 2020. In the 21st century, with the new concept of industrial 4.0, digital transformation is a complex challenge for all companies. Different industry sectors like supply chain, mining, construction, and aviation also accelerate digitalization. Hence, applying digital technology in all aspects of business is a risk for the company to seek a new competitive advantage (Schwertner, 2017). With this acceleration, company can blind investing in technology without knowing how to distribute their resources and the fundamental of technology adoption. By looking at the digital readiness of one company, researchers can address challenges when applying the digital transformation process. Therefore, understanding the motivation behind the digital transformation process is crucial for a company.

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Commented [GC4]: How should I understand this logic? ‘Different sectors accelerate digitalization’, yes it is true, but why does it make technology application a risk?

However, the digitalization concept is only being discussed and researched in the general context, and it is different regarding various types of business models. Digitalization and IT system implementation are essential aspects of maritime transport, particularly port development (Heilig et al., 2017). As an essential part of maritime transport, where most activities are challenging to adopt digital transformation, Container terminal infrastructure is the key to promoting the development of logistics services, with more than 90% of cargo volume going by sea (Selkou & Roe, 2004). Digital transformation affects various aspects of port operations (Paulauskas et al., 2021), including port business, activity management and planning, commercial and support services, client contact, navigation, etc. There are numerous benefits for the port to implementing digital solutions, such as: increasing their productivity and sustainability, reducing costs and operational time, refining the information stream and decision-making process, lessening documents in operational procedures related to sustainability policy, and decreasing the negative impact of maritime transport on the environment in ports and port areas, as well as boosting innovation. Therefore, the port must continuously grow and adapt to the situation to meet the market's demand. As a result, digital transformation is one of the developments of a process that port operators can consider to acclimate.

To understand the digital transformation processes of the port, it is necessary to conduct research based on the digital readiness model. Port needs to measure its digitalization status because its competitive advantage will be improved if these technologies are adopted earlier than its rivals. By searching the keywords "Port Digital", and "Container terminal Digital Maturity", there are only 39 articles related and for "Digital Readiness", there are 114 articles related in the Web of Science database. However, among all those articles, previous studies about the digital readiness of container terminals are minimal and not well-known to researchers though many container terminals are successfully in digital transformation. In this case, critical issues of the thesis will be addressed in this paper: creating a digital readiness assessment model based on the research's conduction from different authors and sources; applying it to the case study in Vietnam container terminal; identifying the difference of perception between port operators and stakeholders on the digital readiness model in the container terminal.

1.2 PROBLEM DESCRIPTION

1.2.1 Port operators' awareness of Digital Transformation

The port is commonly known as a node of maritime transport in the supply chain network. Ports and the shipping industry have become the backbone of the global economy (Carballo Piñeiro et al., 2021). Even though most international ports globally have realized the importance of digitalization in the company, the level of knowledge among the port people or the motivation behind the story remains indefinite. There are some efforts in researching the digital transformation in the port industry but only a few successes in providing a sufficient understanding of the industry. Also, researchers identified barriers such as lack of awareness about the potential of digitalization in the maritime industry, an inability to digitalize infrastructure, and an unqualified workforce that could lead to a lack of digital transformation research in the port industry (Tijan et al., 2021).

1.2.2 Issues on the digital readiness in port

Corporate developments can be optimized through the process of adopting technology efficiency. Container terminals must understand where they are in digital transformation (digital readiness) and assess their digitalization status by a set of variables to acquire a significant competitive advantage through adopting digital technologies ahead of their competitors. The phrase "digital readiness" refers to an organization's ability to adapt technology advancements to market developments to remain competitive. The majority of research undertaken on digital transformation or digitalization and digital readiness also appear to be studied, according to the literature (Eremina et al., 2019). Other researchers have also found evidence that digitally matured businesses outperform their competitors on various financial metrics (Teichert, 2019).

These developments demonstrate how technology has become a facilitator in developing new, value-added solutions that genuinely solve real-world problems. The technology is readily available, inexpensive, and available in large quantities. The Internet of Things (IoT), big data, blockchain, and artificial intelligence (AI) have all been buzzwords in recent years, with the latest hypes following each other quite quickly. 'The digital twin' is the most recent addition to this grouping. Although these technologies offer significant opportunities to the industry, particularly the logistics industry, there are few explicit success stories or large-scale implementations. Some may point to the logistics industry's conservatism, but others may question the actual business case for these technologies. Many vendors can provide help with the implementation of these technologies. Does this imply that we are no longer confronted with challenges?

On the contrary, there is a lot of work ahead of us to use digital technologies in such a way that they genuinely serve the goals of ports and terminals. I have attempted to pinpoint the main dimensions to create the digital readiness model in this paper based on previous studies, research and expert knowledge.

1.2.3 The gaps in the digital readiness model in the port industry

An exhaustive search of the bibliographic references has been done to address the present state of the study on the digital readiness of container terminals. The search's scope included both indexed academic journals found in the more pertinent Research Databases (RD), such as multidisciplinary platforms (Web of Science, SCOPUS, Mendeley, Science Direct, Google Scholar, JournalSeek, JSTOR, and ResearchGate), as well as a thorough search of websites for Port Operators and Maritime Organizations and para-academic magazines published by Project Management Institute (PMI). The search is conducted using terms related to the key phrase, such as "Digital Readiness", "Port digitalization", and "Digital Maturity", as well as background descriptions related to the port industry.

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According to the literature, organizations are speeding up their implementation of digital transformation technologies. Academic explorations of the terms "digitalization" and "digital transformation" turn up thousands of results from a variety of fields (Eremina et al., 2019); (Sanchez-Gonzalez et al., 2019); (Thordsen et al., 2020). This suggests that scholars continue to look at digitalization and digital transformation topics. When studying the latter notions, we similarly notice the typical application of the "digital maturity" term in literature. As important as digital maturity has become in recent years, the validity and appropriateness of the digital readiness level of ports remain limited. According to the literature, many digital maturity measuring methodologies or models are essentially generalized – however, few findings on the digital readiness of container terminal sectors.

Therefore, main ports must deal with new digital technology (Philipp, 2020). It is critical to figure digital readiness levels of a container terminal. As a result, in this research, we will look into how to address the digital readiness of a port, as well as develop a model that will be suitable for measuring digital maturity level and recommendations for ports in Vietnam to assess digital readiness in the port sector.

1.3 Objectives

The study's first aim is to find the current stage of research on the digital readiness of the port sector. Secondly, the research paper will conduct a digital readiness model for container terminals. Hence, identify the critical challenges of port digitalization. Based on the findings, this research paper will give recommendations for container terminals, in general, to investigate their current requirement to shift to digital technology or not.

1.4 Outline of the thesis

The dissertation contains five chapters. The first chapter will introduce the thesis, including the research background and objectives. The second chapter will have a literature review on digital maturity and digital readiness in the port industry. The third chapter will be the paper's methodology, including the model structuring method and case study analysis. The fourth chapter will analyze the case study of ports, including the Cai Mep International Terminal and GEMADEPT Corporation. The last chapter summarises the paper and gives some suggestions for future research.

2. Chapter Two: Literature Review

2.1 Development of Container terminal systems

Regional multimodal intersections of international supply networks are container terminals. They operate in a setting of complex infrastructure, commercial activity, and rules. Ports have come under growing pressure to improve their performance in light of the economic, environmental, energy, and operational issues that impact their sustainability as the world economy demands maritime transit.

There are two types of terminals: “Free port is within coastal often protected waters with a land bridge and closed port is frequently opened deep water exposed to the elements with no land bridge. Although each terminal performs a different purpose, they all share facilities managed by port authorities or third parties” (Barnes, 2013). A small portion of the port’s definition is referred to as a terminal in the transport industry. People carry out practical tasks at terminals, such as managing freight, transporting, packaging, etc. In contrast to airports, which are onshore facilities, seaport terminals must also contain deep water and berths.

Each terminal’s container terminal architecture will have a unique layout that best fits its geographical area. Establishing a structure also depends on the company’s strategy and long-term goals. However, most terminals have a typical design, such as the situation for essential facilities depicted in Figure 1 below.

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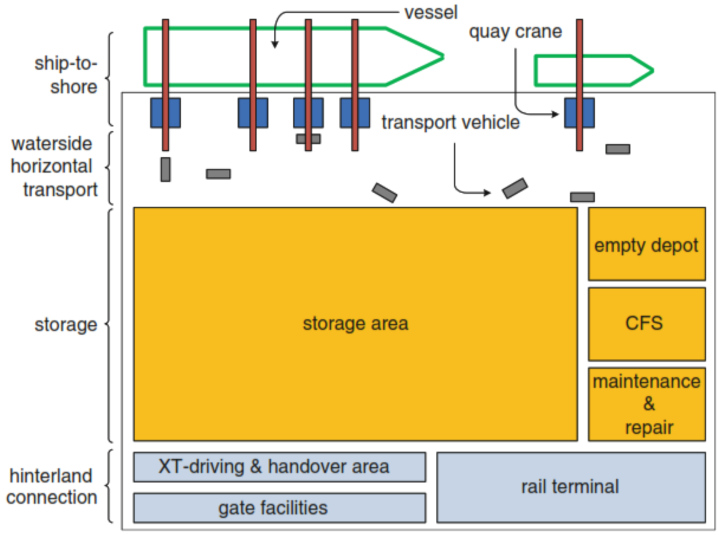

Figure 1: The structure of the container terminal system

Source: Container Terminal Logistics

A container terminal, in general, is an open system that generates material flow through two external interfaces. The QC is the piece of equipment responsible for boarding and offboarding goods. The four primary sectors that make up the common terminal are the ship-to-shore system, transport system, storage system, sometimes known as a container yard, and hinterland connection system.

Millions of containers are handled annually by a significant terminal (Drewry, 2011). In 2013, container terminals in Shanghai handled more than 33.8 million TEU, compared to more than 11.6 million TEU handled by terminals in the Port of Rotterdam (Port of Rotterdam Authority, 2014). More area is required for the associated supply chain activities since several containers must be temporarily stacked. Container port operators have had to construct more high container stacks due to a lack of available space. The size of ships has also increased during the past few decades, as have the port call sizes. Compared to the first-generation ships, which had a capacity of roughly 400 TEU, the largest Post-Panamax ships can carry about 18 000 TEU.

Shipyards are planning even larger ships. Only ports with the appropriate draft, terminals with wide enough gantry cranes, competent material handling equipment, and hinterland connections can accommodate large ships. As a result, fewer ports are visited, and the drop size per terminal is larger. Also, larger ships stay in port longer than smaller ships. For instance, a 4000 TEU Panamax ship spends only 17% of its roundtrip time in port, but an 8000 TEU ship spends 24% of that time (Midoro et al., 2005). $20 000 to $25 000 is spent per day on an idle 2000 TEU ship (Agarwal & Ergun, 2008). Container terminal managers are constantly searching for innovative technologies and methods to efficiently handle all the containers coming into and leaving their facilities.

2.1.1 First generations (from the 1960s to 1980s): Paperless procedures

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Containerization and intermodal transportation began to significantly alter pre-existing transportation networks in the 1960s, transforming them into integrated transportation systems (Hayut, 1981). Significant decreases in transportation costs were made possible by the exponential rise of container shipping, especially throughout the 1970s and 1980s, which resulted in continuously rising container volumes. It was necessary to ensure adequate information flows in addition to focusing on cargo flows because third-generation ports play a critical role in connecting transportation networks and port community participants. Though, it is well established that using conventional paper-based techniques to organize the flow of information is labour-intensive, costly, and error-prone.

However, the implementation of EDI systems required port actors to make significant investments in suitable IT installations and equipment, share information, and modify individual procedures accordingly. As a result, to meet the new standards for creating inter-organizational networks, actors first had to convert internal IT. Actors could thus once more acquire competitive advantages at the local port level by implementing the necessary functionality early on and integrating internal data and procedures. To properly utilize external data, actors had to interface internal systems with external systems and modify internal processes. Still, Port community systems (PCS) quality and accessibility at ports are believed to be crucial factors in determining competitiveness and sustainable expansion (Wiegmans et al., 2008). As is evident now, the port community's willingness to collaborate and exchange pertinent information was crucial to the digital transformation's success.

2.1.2 Second generation (the 1990s – 2000s): Automated procedures

Developed information management, such as Terminal Operation System (TOS) and Port Community's System (PCS), laid the groundwork for the port's container handling processes, especially in container terminals, in the 1990s and 2000s. Laser technology laid the groundwork for automated and safer handling options in container terminals in the early 1990s (Heilig et al., 2017). The ECT Delta Terminal in Maasvlakte Rotterdam (Netherlands), inaugurated in 1993, was the first contemporary automated container terminal. It developed automated guided vehicles (AGVs) and automated stacking cranes (ASC) to handle transports between the dock and container stacks and inside the container stacks. This considerable shift toward automated container terminals requires seamless connectivity between the automated handling equipment and the TOS containing all work orders.

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During the mid and late 1990s, the trend of using IT as a foundation to further automate and raise the visibility of port operations persisted. To increase the effectiveness and security of port operations, automatic identifying technologies, such as radio-frequency identification (RFID), real-time locating systems (RTLS) and positioning technologies like the global positioning system (GPS), were presented around the middle of the 1990s. The first optical character recognition (OCR) systems were introduced to help inspection processes in the late 1990s. For example, to detect container problems, image-based damage assessments were frequently combined with the capacities of laser and video technologies (Heilig & Voß, 2017). OCR systems had to be installed in the gate area as part of this. To track vehicles and avoid collisions, automatic identification systems (AIS) were used in the late 1990s. This was advantageous for other information systems as well. Vessel Traffic Services (VTS) is one such system that port authorities employ to track and manage vessel traffic. At the same time, the ongoing expansion of container shipping appeared to have reached the capacity of specific major ports, creating significant traffic issues. The ever-increasing vessel sizes that caused peak loads for hinterland transit were one of the contributing causes. Initiatives were created to suggest strategies for tackling those potential difficulties, and the state enacted regulations. The first solutions to the severe traffic issues were introduced at the beginning of the twenty-first century. For instance, the creation of the first truck appointment system at the Los Angeles/Long Beach ports in the USA began in 2002 in response to state legislation intended to lessen truck queues at terminal gates (Giuliano & O'Brien, 2007). By requiring appointments, extending gate hours, and charging more for container moves during regular hours, the primary goal was to move drayage truck operations to off-peak hours. The evolution of drayage processes once more required new information systems.

Additionally, to enable features like prior identification checks, the terminal operators urged the drayage companies to outfit their vehicles with RFID tags (Hakam & Solvang, 2012). The Container Terminal Altenwerder (CTA) was built at the Port of Hamburg, Germany, in 2002 due to rapid advancements in automated container terminal construction. This was a significant step toward automated container terminals, which might result in fewer staffing needs and better equipment usage.

In conclusion, the second wave of digital port transformation focused on integrating terminal equipment and the terminals' IT infrastructure to assist the automation of terminal operations. In the first phase, terminal operators implement new handling technology (such as AGVs and ASCs) that enable autonomous cargo handling in designated terminal regions. However, control software's design and development significantly impacted automated terminals' productivity(Heilig et al., 2017), not simply influenced by those automated technologies. Even though the creation of control software falls under the category of localized exploitation, it is still required to interface it with the terminal's TOS to collect and update relevant data, such as work orders and status, as necessary.

As a result, we note that the prior generation of digital transformation established the framework for internal information flows that were later leveraged to increase internal integration with terminal equipment. Affected business processes must be modified to present that new knowledge and attain the anticipated efficiency successfully. In this regard, the automation of current procedures necessitated significant adjustments to organizational practices. The distribution of information to support particular terminal activities was a significant development, and IT must be coordinated with these procedures and information management must be appropriate. Additional controls and inspections must be implemented to ensure the efficiency and security of those semi-automated processes.

2.1.3 Third generations (the 2010s – today): Smart Procedures

The third generation of digital transformation is currently under way and primarily focuses on actively measuring, controlling, and assisting port operations in conjunction with port communities. Whereas the first and second generations of digital transformation mainly focused on laying the groundwork for better information flows in terminals and port communities, enabling and improving terminal automation, trading, and interaction between various actors in a local or global context, the third generation of digital transformation is currently underway. This includes "smart" technologies for managing and monitoring port infrastructure (based, for instance, on actuators and sensors), mobile technologies for supporting active communication between actors, and information platforms for supporting real-time information sharing, coordination, and cooperation between actors. The new strategies may also impact how specific actors behave and make decisions; these actions may need to be modified to meet the demands of managing port-related issues, including rising traffic and environmental issues. By functioning as a port's information integrator and supplier, ports are progressively expanding the scope of their core commercial operations due to digital technologies and information systems.

This is why a new generation of entirely automated (remote-operated) quality control systems was created. These QCs have two trolleys, each transporting two or even three TEUs simultaneously. Some QC designs include trolleys that can rotate 90 degrees or shuttles on the boom to speed up horizontal handling. We go through alternate concepts where the QCs spread out over an indented berth or float on the water to provide temporary artificial space in the section on stacking area operations. The present models may need to be modified to accommodate these innovations because the new designs have higher capacities and can be used more flexibly than classic QCs. For instance, Xing et al. (2012) analyze the issue of dispatching AGVs in container terminals fitted with tandem lift QCs, necessitating the simultaneous readiness of two AGVs for container unloading. A mixed-integer linear programming model is utilized to formulate the problem, and a decomposition method is employed to resolve it. Dry testing of equipment control rules, remote quay crane control, and stack storage techniques are all made possible by new terminal emulation systems that leverage terminal operating systems for input control. For instance, the emulation tool CONTROLS (for CONtainer TeRminal Optimised Logistics Simulation) was created by Boer & Saanen (2012). A TOS supports all fundamental operations of a terminal, such as equipment control, gate management, quayside planning, vessel planning, and yard planning. Emulation enables the user to test the actual TOS without running the danger of adversely affecting actual operations.

2.2 Digitalization in port

The forthstage of evolution has begun for container terminals, which are now distinguished by their digital transformation and adherence to Industry 4.0 standards (de la Peña Zarzuelo et al., 2020). Digital transformation (DT) is a young technological trend that is more customer-focused and strategy-oriented. Implementing cutting-edge digital technologies alters an organization's procedures and infrastructure (Pihir et al., 2018). There is no acknowledged definition of "digital transformation," according to Schallmo et al. (2017). Also, Shuo Ma (2020) quote that the advent of digital transformation is the biggest shift in maritime history. Significant changes are anticipated to entirely transform the industry from its historical image, similar to any other revolution. Digital transformation research has generated several diverse findings over the last 20 years. The number and variety of research have sharply increased in recent years due to the Digital transformation field’s fast growth, but a thorough analysis is still lacking (Zhu et al., 2021).

According to some academics, the marine sector is slow to adopt new technologies and may even be averse to doing so (Inkinen et al., 2019). As technology advances, productivity increases, and digitalization transforms industries like sea transportation and business practices (Ma, 2021). Matt et al. (2015) describe the transformation in the organizational context as a strategic and structural "fundamental shift" that has an influence. Digital transformation is essential for creating new company structures and preventing them from becoming outmoded (Nerima & Ralyté, 2021). Previous research demonstrates that digital transformation is a continuous process. It is a comprehensive methodology for directing business entities toward new tactics for heightening hierarchical exhibits by enhancing the authority's potency and vigour and creating fresh business models (Pihir et al., 2018).

Additionally, digital transformation addresses the fundamental shift in all business areas, creating a new ecosystem where innovation creates and distributes value to partners, enabling entities to respond to the more quickly changing environment (Williams et al., 2019). According to Salviotti et al. (2019), to successfully handle the digital transformation measures, entities must promote digital abilities and reform their cultures to ensure the successful adoption and usage of digital technology. Additionally, developing a particular configuration of digital capabilities results in a high level of digital maturity. Therefore, it is crucial to classify the dimension to identify the digital transformation.

Container terminals are virtual nodes in the sea-land transportation systems, and deeper integration into supply chains improves their functionality (Mańkowska et al., 2020). Therefore, the advantages of port digitalization are equally crucial for improving the performance of the entire supply chain (di Vaio & Varriale, 2020). Container terminals presently use various IT systems, both standalone ones and those incorporated within intricate IT architecture (Lepekhin et al., 2020). It should be noted, too, that the extent of digitalization at ports varies. Systems for measuring port efficiency have been created (Marlow & Casaca, 2003). Container terminals look for procedures adopted by other ports and proven effective in enhancing port operations and the efficiency of sea-to-land transportation while preparing for future development. These enhancements frequently deal with the safety of maritime transport and ports' desire to draw cargo flows and customers, promote port services, and provide other crucial amenities for current and potential cargo owners and shipping businesses (Talley, 2006). It is decisive to remember that individual ports can have trouble implementing and maintaining a suitable degree of digitalization. This could be due to various issues, including a lack of available financial, technical, and human resources (Paulauskas et al., 2021).

Finding logical solutions for developing digital systems may benefit from evaluating the level of digitization of ports as nodes of sea-land transport networks. Additionally, it offers the chance to analyze how different ports operate and select those without practices that might be adopted by other ports (el Imran & Babounia, 2018). The move to a "smart" or "digital" port is a challenging task (Buck et al., 2019). Digitalization will ultimately raise operational effectiveness and productivity, boost safety, lower emissions, and enhance sustainability (del Giudice et al., 2021). However, adverse effects of digitalization are expected to surface in the early stages. Inkinen et al. (2019) claim that the processes and operations in port communities are frequently highly conservative when it comes to implementing and gathering data-driven operation solutions.

Depending on their size, ports have varying degrees of digitalization. Large ports frequently have access to more resources and typically participate more actively in development initiatives and cooperative research and innovation projects (e.g. European H2020 programs). It is not surprising that they frequently have a higher level of digitalization than smaller ones. Small ports may be highly specialized or only serve a small number of clients, making specialization a significant factor. Three generations of digital transformation at ports have been identified by (Heilig et al., 2017) as follows: paperless procedures, automated procedures, and intelligent procedures. The adoption of Internet of Things (IoT) and artificial intelligence (AI) solutions, which are frequently referred to as "smart" procedures, has been the most significant current development since the 2010s till now. However, they agree that there are differences in the degree of digitalization amongst ports. Unfortunately, in far too many (port) situations, "becoming digital" entails making minor changes in the first place, such as switching to paperless processes. These are the first steps toward digitization, but too often, especially with small ports, the first early adoption level is satisfied (paperless procedures).

2.3 The connection between digital readiness, digital maturity and digital transformation

Maturity frameworks identify components of an efficient framework and capture how digital systems advance from conception through execution to effect (Khanbhai et al., 2019). It demonstrates how well-equipped a group or country is to fend off upcoming change (Kutnjak et al., 2020). A relentless, persistent path to change in a rapidly evolving digital world is known as “digital maturity” (Salviotti et al., 2019). Digital Maturity illustrates an organization’s readiness and capacity to adapt and use innovative technology following market trends (Eremina et al., 2019).

Along with implementing IoT 4.0, its self-measurer includes multidisciplinary activities, with technology-related elements arguably the main areas of interest for businesses. Researchers consistently contribute to advancing the theory and comprehension of current digital knowledge (Ryan et al., 2020). According to Salviotti et al. (2019), Digital Maturity refers to how firms strategically strategies to adapt dependably to ongoing digital transformation. Deal with the digital expectations for customers, representatives, and partners and demands by implementing digital innovations by altering the business’s scheme, workers, culture, and design. Digital maturity is the ability to adapt to a context where technology is developing swiftly. The measurement of an organization’s digital maturity is an essential step in the digitization interaction because the goal of digital transformation is to achieve a level of digital maturity that is acceptable given the advancements and challenges presented by the digitization of the area in which the association operates. Every field of endeavour and even every type of company is directly affected by the advantages and challenges of digital transformation. Each may need a specific digital maturity model (Nerima & Ralyté, 2021). Previous research shows that most current models portray a fragmented view of digital maturity, that social factors reflecting technological culture are not systematically integrated, and that digital maturity systems specific to some service ranges are not adequately addressed (Teichert, 2019).

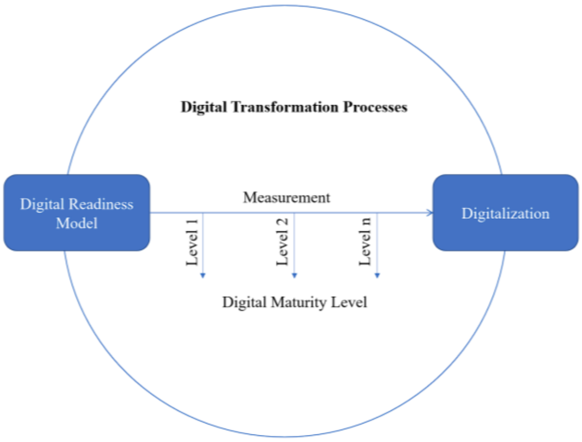

Figure 2: Relationship between Digital Readiness and Digital Maturity

Source: Developed by author

The degree of digitalization attained by a substance is determined by how well its digital measurements have been integrated into its construction (Nerima & Ralyté, 2021). Every stage of the conveyance contact may now be calibrated thanks to digital maturity. Additionally, digital maturity describes the current state of transformation activities that have already been successful and its readiness for additional digital advances. The purpose of digital transformation is to integrate the whole business area and create new value for the business by using digitalization. Meanwhile, digitalization is the end of the digital transformation process. It processes all information and advances workflows by systematizing existing procedures. Digitalization is used to achieve various objectives, including improving operational effectiveness, lowering costs, eliminating human error, and facilitating data analysis. Through digitalization, businesses can develop new revenue streams and provide value. But digital transformation is unique and different across businesses. To apply digitalization, companies require a digital readiness model to measure the capability of the business before taking any further decisions about digital transformation, primarily to pursue the road of digital transformation and regularly assess their performance (Genzorova et al., 2019). As a tool to measure the readiness level of a firm to digitalize, the digital readiness model is an initial step in digital transformation. While digital maturity, according to Teicher (2019), reflects where a business is in its digital transition. According to Schallmo et al., 2020, there has been a substantial amount of study on digital maturity, focusing on advanced skills in the 22 digital management and business indicators.

Terms	Definition	Similarity
Digital Maturity	Digital maturity, according to Teicher (2019), reflects where a business is in its digital transition and describes the current state of digital transformation activities that have already been successful or in progress.	It "*illustrates an organization's readiness"* and capacity to adapt and "*use innovative technology following market trends" by using measurements with different parameters* (Eremina et al., 2019).
Digital Readiness	The degree to which an organization has the resources to manage and adapt to the digital transformation process is referred to as its level of digital readiness. It is a metric used to assess how prepared an organization is.	"*As a tool to assess the readiness level of a firm to digitalize by measuring different dimensions.*"
Digital Transformation	Creating new business processes or altering current ones using digital technologies to meet shifting market and company demands.	"*using technologies to meet changing business and market requirements."*

Table 1: Definition and Similarity of Digital Terms

Source: Developed by author

More specifically, digital readiness and maturity can be the same in specific content; the definition and similarity of those terms can be illustrated in Table 1.

Usually, people get confused when using “maturity” and “readiness” terms. For example, digital maturity relates to the ability to adapt to the digital culture of the business. In the exact definition, digital readiness is also related to the ability to adapt to the digital culture of the business. The difference between the two terms is that digital maturity measures the level of digital after adopting the technology, software, or even culture. On the other hand, digital readiness measures the level of digital transformation before going through the digital transformation process. Moreover, Digital readiness is the level of readiness or the ability of an organization’s workforce to transition into a digital business using software and technology. Meanwhile, Digital Maturity measures an organization’s ability when using digital technology to create value for their business. Therefore, digital readiness cannot be a part of digital maturity because digital readiness is an initial step for a company to produce a digital maturity level.

However, those two definitions can be the same in some cases. For example, in technology, to assess a company's readiness level, the company already applied some digital technologies that are a minimum requirement to be measured. Therefore, the maturity level of a company could be the same as the readiness level because it uses the same parameters. Also, the readiness model tries to evaluate the possibility of a firm transforming digitally. At the same time, digital maturity is understanding a firm’s current level through some particular dimension. With this understanding, the relationship between those three terms: “digital maturity”, “digital readiness”, and “digital transformation”, can be shown in Figure 2.

2.4 Mechanisms of Adopting Digital Infrastructures Transformation at Port

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One of the processes in a concrete system that gives it its characteristics is called a generative mechanism. Examples include cell metabolism, interneuronal connections in the brain, work in offices and factories, laboratory research, and legal disputes (Bunge, 2004). In this vein, identifying what is a digital infrastructure is, in part, the goal of our research question of what factors contingently induce the evolution of digital infrastructure. According to previous literature evaluations, this is a crucial problem for advancing the field's study (see Bygstad, 2008), not least by emphasizing the underlying processes that result in observable events.

First, the mechanics of the digital infrastructure are self-reinforcing (Hanseth et al., 2003). A self-reinforcing mechanism feeds back on itself repeatedly. Infrastructures are challenging to regulate for practical and financial reasons since control over them is frequently shared among several entities. It partially depends on feedback loops that are independent of the control of any one stakeholder (Hanseth & Braa, 2000). Technology and diffusion studies are well-versed in the self-reinforcing phenomenon (Katz & Shapiro, 1985). It is crucial in comprehending organizational stability and change (Sydow et al., 2009). Second, the components of the digital infrastructure are composites. Situational mechanisms (macro-micro level), action-formation mechanisms (socio-technical action), and transformational mechanisms are three different types of mechanisms that are connected (micro-macro level) (DeLanda, 2006). Macro-micro mechanisms explain how the infrastructure permits and restricts its many components. For instance, the Internet's infrastructure has provided independent entrepreneurs with hitherto unimaginable opportunities for innovation, provided they adhere to established interfaces (Hanseth & Lyytinen, 2010; Zittrain, 2006). "How a particular combination of individual needs, beliefs, and action chances generate a specific action" is explained by action-formation mechanisms. (Hedström & Swedberg, 1998). Following in our footsteps, Silicon Valley's online business owners demonstrate fresh ways of learning through the development of innovative paths. (Hagel et al., 2010). Emergent behaviour, or how diverse elements combine to produce an outcome at a macro level, is explained by micro-macro mechanisms. To wrap up our example, we can say that developing an innovation path results in new services and products that support the Internet as a foundation for innovative activity. Third, although most research on mechanisms mainly focuses on the social (Hedström and Swedberg 1998), technology is necessary for digital infrastructures. Technology actively contributes at the structural and action levels (Volkoff et al., 2007). The mechanism is created by the interaction of social and technical components. Critical realism has aided in our exploration of several problems that put our conception of digital infrastructure to the test.

In particular, Henfridsson & Bygstad (2013) highlight three self-reinforcing mechanisms (adoption, innovation, and scaling) that serve as causal powers in digital infrastructure evolution. Digitalization in ports can be divided into three stages if a container terminal functions as a typical firm. The first stage is the “adoption” of technology. The port will apply the digital infrastructure by either investing in buying services and infrastructures or developing a new infrastructure based on existing technologies. The second stage can be identified as “innovation” when the company self-reinforces its infrastructures by recombining resources. The last stage will be “scaling”, when ports expand their network by developing comprehensive technology systems that connect internal and external customers for collaboration. In this paper, we try to apply the adoption theory to the infrastructure digitalization of container terminals and determine the digital readiness of container terminals in the “adoption” stage.

2.5 Dimension of the digital readiness model

The use of new digital technologies to better measure, monitor, and control port operations is a significant focus of the present phase of digital transformation. One example of this is using real-time operational data to predict future events. This may need advanced pre-processing and data analysis to extract information and knowledge that can be used in sophisticated planning and decision-support systems. However, according to the notion that “digital technology is a means, not an end”, the success of digital transformation resides not only in the use of cutting-edge technologies and processes but also particularly in the adaptation of organizational factors (Heilig et al., 2017).

The existing research about digital readiness mainly served the needs of manufacturing sectors. These are the most beneficial sectors when applying digitalization. Therefore, defining a model that supports the industrial sector’s digitalization is reasonable. Since manufacturing companies are the primary target group in the framework of Industry 4.0, the majority of digital and Industry 4.0

readiness indices and maturity models on the micro-level that have been established in theory and practice aim to evaluate the performance of these businesses (Philipp, 2020). In other research about digital readiness, four scenarios that a Swedish manufacturing company executed served as the basis for the analysis and evaluation of a conceptual readiness framework for digital organizational readiness (MacHado et al., 2020). According to (Schumacher et al., 2016), maturity assessment is used to capture the as-it-is state while the maturing process, whereas readiness assessment is applied *"(...) before engaging in the maturing process*". According to early research, digital readiness/maturity models typically do not distinguish between these two categories. There is a need to fill this gap by offering doable first actions to improve digital organizational readiness (Machado et al., 2019).

In this regard, two research questions come to mind: (1) What prerequisites must an organization meet to be digitally ready? (2) What is the plan for enhancing organizational digital maturity in preparation for digital transformation? Results from earlier studies, which were both influenced by Becker's procedure (Becker et al., 2009) for creating maturity frameworks, were used to support the development of the conceptual frameworks. Becker's procedure includes a systematic literature review, a review of existing models, expert interviews, conceptual modelling and validation, and field testing. Only the first framework, digital organizational readiness, was evaluated in this phase for its usefulness, usability, and utility (does the framework give a practical step toward solving the problem it is intended to solve) as well as its viability (can it be followed?). From the manufacturing sector, Machado et al. (2019) identify five dimensions to assess a firm's digital readiness: Organization and Governance, Digital Strategy and Business Model, Connectivity and IT Architecture, Manufacturing Systems and Technology, and Data Collection and Analytics. However, from this view, we can understand that the author looks at the technology aspect when building a digital readiness model. Another paper also suggests the exact dimensions of the banking sector's Management system, Business processes, Human resources, Using of Data, and Enterprise architecture (Stoianova et al., 2020). Hence, we can understand how researchers develop those dimensions to assess a firm's digital readiness.

However, a minimal paper about digital readiness for the port industry exists. For example, Philipp suggested using the digital readiness index for ports (DRIP) and did so for five particular container terminals (Philipp, 2020). To determine the digital condition of container terminals, a digital auditing tool has been developed (Philipp et al., 2019). Based on the studies, it was impossible to identify a single model that container ports could accept with confidence as either generic or specific. A total of 20 digital readiness models can be analyzed, and various model dimensions are present. The digital readiness model dimensions are so heterogeneous that a total of 114 dimensions were found by thoroughly examining the current digital readiness models. A model can have up to 10 dimensions, with 1 being the minimum. Several authors repeated specific aspects in their readiness models, but this recurrence was only slight (Soomro et al., 2020). All the dimensions taken from the current digital-ready models are shown in Table 2.

Digital Readiness Model	**Dimension**	**Source paper**
Digital Readiness Index for Port (DRIP Matrix)	Management, Human Capital, Functionality, Technology, Information	Philipp, R. (2020)
Digital Index for Port (DIP)	Technology, Port promotion materials, Port organization, Human factors	Paulauskas, V., Filina-dawidowicz, L., & Paulauskas, D. (2021).
Industry 4.0 Model	Strategy, Leadership, Customers, Products, Operations, Culture, People, Governance, Technology.	Schumacher, A., Erol, S., & Sihn, W. (2016).
Digital Readiness of Swedish Organizations	Culture, Technology, Organization, Insights.	Ertan, J. 2018
SMART PM Digital Readiness Framework	Strategy, Operations, Data Collection, Connectivity, Governance.	Machado, C. G., Winroth, M., Carlsson, D., Almström, P., Centerholt, V., & Hallin, M. (2019).
Readiness Assessment Tool	Leadership roles, Governance Structure, Team Heterogeneity, Performance Measurements, Process	University of Cambridge & HCL Technologies

	and Routines, Digital Building Blocks, Architecture Roadmaps, Formulation Process, Strategy Content, Perceived Value.	
Digital Readiness model for SMEs	Strategy, Partner interface, Processes, Employees, Technologies, Customer interface, Product & services.	Schallmo, D., Lang, K., Hasler, D., & Ehmig-Klassen, K. (2020).
10 Pre-requisites for Smart Terminals	Assets Connectivity, Human Connectivity, Realtime control, Continuous Performance, Training and Certification, Cybersecurity.	Saanen, Y. (2019).
Readiness Level based on Cronbach's Alpha Test	Leadership, Customer, Human Resources, Innovation culture, Management tools, Process control, Performance measurement, Strategy, Innovation.	Hoa, N. T. X., & Tuyen, N. T. (2021)
Pooling of digital readiness model dimensions	Infrastructure, Culture, Tools, Skills	Soomro, M. A., Hizam-Hanafiah, M., & Abdullah, L. (2020)

Table 2: Existing digital readiness model dimensions

Source: Developed by author

The thesis continues the investigation described in these studies and wants to create a methodology that will allow for a thorough evaluation of the degree of digitization in container terminals. According to the performed literature research, only a limited amount of concerns with evaluating ports' levels of digitization have been examined, and no studies demonstrate a methodology for doing so. This study area still needs to be developed to make it easier to adopt digital solutions in container terminal operations. Decision-making tools also need to be provided. Therefore, closing this gap and creating a suitable methodology is essential.

While various terms exist, this paper will use the digital readiness assessment model. The adjective digital purposely targets senior executives whose primary focus is strategic planning for digital transformation initiatives. As previously stated, this paper aims to provide measurement dimensions of digital readiness for a container terminal that will be a valuable evaluation tool for ports' digital transformation efforts.

3. Chapter Three: Methodology

3.1 Formulation of Research questions

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Creating research questions is crucial for all disciplines, not only the one in which this study is undertaken, to conduct a systematic, transparent, rigorous literature review. Before beginning, the literature study must identify pertinent research questions containing the eligibility requirements and search techniques (Lim et al., 2019). We used the CIMO (Context, Intervention, Mechanism, and Outcome) approach to determine the critical components of this study (Pilbeam et al., 2019).

CIMO Approach:

- C – Status of research on digital readiness
- I – Application of the existing digital readiness assessment model in the port industry
- M – Models of digital readiness assessment appropriate for the port sector
- O – Outcomes of implementation of digital readiness assessment models.

3.2 Study searching and selection

We will locate pertinent prior and current studies in this area to address the research issues outlined in the following part. We will name the databases and search terms employed to find reliable and pertinent material.

Criteria for document selection were devised to use a systematic literature review technique to address the research issues. The selection criteria are established during a crucial stage of study planning. With the duration of this dissertation in mind, we devised our selection criteria. To complete this study, the following selection criteria have been established. The three main phrases, “Digital Maturity”, “Digital Readiness Model”, and “Measurement”, should be the emphasis of the articles. Additional supplementary keywords were identified: “Port” OR “Container Terminal” OR “Digital Readiness Assessment” OR “Digital Readiness Evaluation” will be used to create search strings. The keyword structure in Table 3 below shows the practical search terms, secondary search terms, and search strings that were utilized to look for the literature under evaluation:

Search terms and strings used	
Primary terms	**Secondary terms**
Digital Readiness Digital Readiness Model Measurement	Port Container Terminal Digital Transformation Digitalization
Search Strings	
“Digital Readiness” and “Port” or “Container Terminal” and “Digital Transformation” or “Digitalization”	
“Digital Readiness Model” and “Port” or “Container Terminal” and “Digital Transformation” or “Digitalization”	
“Digital Measurement” and “Port” or “Container Terminal” and “Digital Transformation” or “Digitalization”	

Table 3: Search Keywords and Search Strings.

Source by author

In terms of data collection, three internationally renowned databases from which data was taken. We used databases from “SCOPUS”, “Mendeley”, “WebofScience”, “Science Direct”, “Google Scholar”, “JournalSeek”, “JSTOR”, and “ResearchGate” which are well-known and often used by researchers, practitioners, and academics. The position or ranking in the volume of high-quality papers and abstracts indexed, as well as the complete document access, served as the foundation for our choice of these databases. These databases also contain pertinent profile information for the area we have chosen. We also checked reference lists to ensure that our literature review included everything. Data can be gathered from journals, conferences, proceedings, books, and theses, according to Gebayew, Hardini, Panjaitan, et al. (2018), but for our review, we only gathered pertinent papers from journals. We have reduced the number of papers that need to be synthesized because obtaining data might be somewhat tricky (Aromataris & Pearson, 2014). Information from the carefully chosen articles will be used as the primary data in the synthesis (Okoli & Schabram, 2010).

3.3 Digital readiness evaluation model

Models for evaluating the readiness of container terminal digital transformation create variables depending on expert consultation and academic researchers. Five dimensions with 16 observable variables were chosen. The research panel includes academics, system developers for intelligent production, and equipment manufacturers. This model differs from earlier models in that the assessment model contains aspects for data formation, assets connectivity and planning processes. Since these factors still constrain many container terminals, they must be evaluated to determine how well they can sustainably and methodically transition to intelligent operation (Axmann & Harmoko, 2020). According to the analysis, the various models share some dimensions, some of which are used independently and others in combination. A methodology for evaluation dubbed the Port Digital Scorecard (PDS) is offered to analyze how far along a port is in the process of becoming more digital. Based on three major pillars - management, human capital, and technological ecosystem - the model conceptualizes the level of digitalization maturity in ports (Cheng et al., 2022). There is no standard terminology for the many dimensions, and using words with similar meanings leads to misunderstandings among the dimensions that refer to the same things. As a result, we have divided combined aspects and noted those with a single meaning (such as "human capital, human resources, or people"). The latter allows us to determine that the "proper model" for container terminals should have these 5 dimensions (Data formation, Asset’s connectivity, Planning processes, Performance measurement, and Security control). This model is not the final one; it requires further assessment and will be tested for accuracy, dependability, and trustworthiness in subsequent studies.

3.3.1 The model

Based on the literature review, we identified the dimensions and sub-dimension for the model. The digital readiness model is developed by comparing existing models and research, as listed in Table 2 and based on studies of the port industry, which are key factors correlated to changes in port structure. In Table 2, we can see some essential listed dimensions repeated through studies and research:

"Management", "Processes", and "Technology". These dimensions can be adapted to the port industry. However, the port industry is quite a different sector compared to others. Therefore, the dimensions need to include "Data" as one dimension because data is the initial factor in the digitalizing container port. "Strategy" is also an excellent dimension to measure, especially for port operators in Vietnam.

Moreover, it needs to be divided and separated with sub-dimension for better evaluation. For example, "Technology" is ubiquitous. Digitalization at ports is not only about the level of technology and automated systems but also about the level of understanding of digitalization among employees. When applied to the container port, it has to be specific, such as the level of automation crane and how well the equipment linked among the systems can measure it. This can refer as the connectivity of assets. Therefore, the model is quantitative since it should be used to grade or be a guideline for the company's digital transformation.

Furthermore, each dimension will include a scale from zero to five to evaluate each dimension's readiness level. The total outcome score will be the average score of the table. The higher the score, the better readiness of a port.

To help customers or future users understand the leading indicators to watch for under each dimension, the model developed in Figure 3 is further detailed in tabular form.

Dimensions	Digital readiness levels						
		5	**4**	**3**	**2**	**1**	**0**
Data formation	Data Availability						
	Data quality						
	Data Accessibility						
	Data transformability						
Asset connectivity	Physical assets connectivity						
	Human assets connectivity						
	Cross-channel integration						
Planning processes	Strategic planning						
	Tactical planning						
	Operational planning						
	Planning system						

Performance measurement	Integrated Real-time measuring KPI system						
	Operational disturbance level						
	Level of application of measurement tools						
Security control	Cyber security tools						
	Process of monitoring						

Figure 3: Dimensions and variables to measure digital readiness level of container terminal

Source: Developed by author

The suggested model has five dimensions followed by 16 variables to asset it on a scale from five to zero (with five being the highest score and zero being the lowest score), which indicates the level of the digital readiness of each variable. The core of a group of characteristics that digitally powered container terminals are expected to display at a defined level of maturity for each dimension included in the model.

3.3.2 Dimensions

The dimensions of the proposed model for the container terminal are explained below:

1) Data formation:
    a. Data Availability: The availability of data stored in the port. It determines the level or extent to which data is readily used and what essential IT and management procedures, tools, and technologies are needed to allow, monitor, and constantly make data available. The data must be sufficient for the company to transform into automated systems.
    b. Data Quality: To confidently use corporate data in operational and analytical applications, measuring data quality is essential. Only reliable data (daily collection data) can support precise analysis, which can support reliable business decisions. Port operators can consider various data properties when determining the appropriate context and measurement strategy for data quality, including accuracy, relevance, timeliness, and completeness of the data. Then, by identifying the

process of collecting the data, which is manually or automated, we can adjust the level of data quality.

c. Data Accessibility: The level of data useability within your company is known as data accessibility. This means that data is not just accessible but also useable by any means of the technology-supporting system, even by those with little to no prior expertise using data.
d. Data transformability: The ability of raw data can be transformed into report data or data that can be analyzed and story-telling supporting the decision-making management level. For example, weather forecast, STS maintenance time, etc.

2) Asset connectivity:
    a. Physical assets connectivity: Although terminals are a collection of valuable assets, intelligent control cannot be implemented without real-time information on the assets (location, status, technical state, etc.). Control both asset deployment and maintenance needs. The application of technology, such as different types of sensors, GPS systems, and machine-bound PLCs, enables asset connectivity. This necessitates a high degree of device standardization. Essential tools like version control, remote updating, and device health checks are also indispensable.
    b. Human assets connectivity: Connectivity to the human assets in the field is just as crucial as connectivity to the physical assets, and operators need real-time access to central data to ensure people are kept out of harm's way (think of location detection or proximity sensors) as well as information in real-time to perform actions efficiently (updated loading list, reefer (un)plugging list, etc.). Instead, people are dispatched to gather information and record it on paper for later processing. This is when smartphones can be used to access nearly everything, allowing operators to receive visual information immediately while freeing up their hands (Saanen, 2019).

c. Department connection connectivity: The inter, multi-linkage among departments in the terminal regarding data, information, and operation process. The internal IT systems presence any helpful to this linkage. For example, information from the business department is present in a form that the financial and technical departments can understand.

3) Planning Processes: Each extension is planned as needed, without consideration for the overall picture. Buildings in awkward locations, height disparities, light poles, highways with illogical routing, and other issues are typical. Of course, not everything can be considered, but we may look farther ahead and create a robust master plan that, to a considerable extent, withstands a change in circumstances. Maintaining a constant measurement, analysis, and action cycle is essential so the learning cycle can also respond to changes. Operational strategies will probably need to be changed in response to variations in volume, dwell times, truck patterns, or even the introduction of a new vessel service. The key to modelling is keeping track of changes that have been made. Most strategy adjustments take the impact over a longer time frame (usually more weeks than days). There will also be simultaneously cyclical, independent influencing variables like seasonal trends. Modelling may greatly assist these evaluations and serve as a reference point for future choices. Also, modelling must be able to learn from the past and modify itself through time.

4) Performance Measurement: The effectiveness of the operation should be monitored closely and continuously. Then, and only then, can one correctly pinpoint what causes the peaks and valleys in performance? For instance, monitoring STS production alone does not give enough information. The circumstances influencing the performance must also be gathered for a complete picture to emerge. It is vital to monitor variables, including yard occupancy, gate volume, driving distances, and the number of ineffective moves. Preferably, the measurement should be conducted automatically. The key questions are: What are the assets doing, how many moves are the crane

performing, and how far are they going in a shift? As the third component that can explain performance, all data on operational disruptions must be acquired.

5) Security Control: Today, a terminal must have a secure cybersecurity system. A significant amount of data is exchanged with numerous other parties. In such a situation, there is a high chance of obtaining malware, viruses, or the like and distributing it to others. Additionally, the enormous value of the items in containers makes them a highly sought-after target for hackers. It is not a far-fetched idea to find the correct container, stuff it with expensive goods like electronic devices or fragile luxury goods, and arrange a fraudulent delivery. Consequently, cybersecurity must be a regular operation.

3.3.3 Readiness levels

Table 4 shows the readiness levels and phases used to assess the level of readiness concerning the abovementioned parameters.

3.3.4 Measurement parameters of readiness levels

To measure the readiness level of the container terminal, we assess the state of digital readiness at the port. Six stages make up the framework: Absence (S0), Limited (S1), Emergent (S2), Structured (S3), Integrated (S4), and User-driven (S5). In the framework of this study, the steps are described. The readiness stages are shown in Table 4.

Stage	Context
Absence (S0)	❖ Digital adoption is missing ❖ No awareness of the digital transformation
Limited (S1)	❖ Low level of interest in digital transformation ❖ Insufficient resources for digital readiness
Emergent (S2)	❖ Digital readiness is visible and increase ❖ Inconsistent understanding among employees ❖ Inefficiencies
Structured (S3)	❖ Different and partially systematic perspectives and methods of digital transformation
Integrated (S4)	❖ Inclusive, persistent, and widespread application of Digital resources

User-driven (S5)	❖ Recognized methods and repeatable scientific or systematic digital techniques

Table 4: Digital readiness levels

Source: Developed by author

3.3.5 Result of the model

The model aims to represent a container terminal's level of digital readiness at a specific time in the future. It also provides a glimpse of what a fully functional container terminal would look like. Nevertheless, the model does not provide the "most optimal manner" to move up the readiness scale. Furthermore, it does not imply that all container terminals must have level 5 capability. It is an execution paradigm in which the levels represent the execution level, all other things equal. The model should represent the same result as what the interviewees answered. With the application of the model, port operators can optimize their processes, hence increasing the scale level of dimensions and being capable of shifting to digitalization.

3.4 Limitation

The findings of just one article indirectly related to port support this hypothesis (Philipp, 2020b). To the best of our knowledge, neither academic research nor models of digital readiness for container ports existed when this study was conducted. These conclusions are supported by open-access literature. Access to pertinent research articles on the subject may be blocked. As a result, the scant research findings suggest that the field of port research into digital readiness is still in its early phases. Further research must be done to lay the groundwork for exploring digital readiness and creating models for container ports.

A significant obstacle for the reviewer was a lack of appropriate and pertinent data. We could not gain a deeper grasp of the application of the digital readiness model in the container terminals sector since we could only find one article about the industry and this study. The time allotted for this research study was insufficient to allow for the model's construction and testing of its applicability, leaving only room to identify the pertinent features and suggest further modelling through future investigations. Another drawback is that the research only looks at Vietnam port's case study and interview, which produces less accurate results. As a result, desk research methods are employed instead.

4. Chapter Four: Case Study of Ports in Vietnam

Our in-depth case study investigation at container ports in Vietnam produced the impression of the digital readiness model. Vietnam's container terminals are more likely to be less developed compared to other regions. To receive a significant benefit for the dissertation, we chose two ports that had just been opened and had fewer than ten years old. Other ports will have less idea about digital readiness and cannot fulfil the data for the dissertation. To support this theoretical investigation, we interviewed various staff members from various departments at ports to solve the issue and put the model into action. However, the dissertation will be a guideline for other ports to consider digitalization as a strategic plan soon. We anticipated a set of different perceptions by which the digital readiness model could be understood to produce successful outcomes. To investigate these issues further, we conducted a case study of two ports of digital infrastructure from interview to analysis.

The first selected port is Cai Mep International Terminal (CMIT), one of the largest container ports in Vietnam, established as a joint venture between the Vietnam-based Saigon Port, Vietnam Maritime Corporation and APM Terminals. And the second container port in the case study is GEMALINK, established as a joint venture between the Vietnamese company GEMADEPT Corporation and the French company CMA Terminals (CMA CGM Group). GEMALINK is the new greenfield container terminal in the same region as CMIT. Both ports have the same infrastructure level but differ in development history. CMIT was born earlier, approximately ten years older than GEMALINK. Therefore, it can be indicated that the perception of the two ports might be different regarding the advancement of knowledge.

4.1 Interview participants

The interview process started in July 2022 and was completed in August 2022 with the interviews of 10 managers from various backgrounds within two ports. All meetings were one-stage and lasted, on average, 50 minutes, with only a handful lasting longer. Seven in-person interviews were conducted via online platforms, while the remaining geographically unavailable respondents were contacted by phone and email and provided their responses. There was no other individual there as the interviews were conducted one-on-one.

To shorten the name and job position title of the interviewees, we will use a coding process as shown in the following table:

	Job Position	Coding
CMIT	Head of Operational	PM1
	Head of IT	PM2
	Deputy Chief Financial Officer	PM3
	Head of Government Relations and Corporate Affairs	PM4
	Head of Sales and Marketing	PM5
GEMALINK	Specialist in Business Development	PM6
	Specialist in External relations & Marketing	PM7
	Specialist of Technical	PM8
	Specialist of CSCC	PM9
	Specialist of Innovation and Research	PM10

Table 5: Interviewee's coding process

Source: Developed by author

Commented [GC12]: Table 5 and Table 6 in combination release some personal information, which could be part of personal privacy. Please consider anonymizing it.

Commented [TV13R12]: I have asked the interviewees about the personal privacy that included in the research, they are fine with the table. Also, it is needed to show their background and experience in order to have better picture of why there is such a gap between employees.

4.2 Interview findings

Interviewees have an average of five to fifteen years of work experience with various backgrounds, as shown by the demographics in Figure 4. The level of knowledge on digitalization of interviewees scored from 1 to 5 (with 1 being the lowest and 5 being the highest) based on their answers. From the background of participants, we can see the wide range of backgrounds with different levels of knowledge on digitalization. It is indicated that most port managers with IT backgrounds will have the highest knowledge of digital infrastructure at the port. Followed by technicians and marketing personnel, which can point to the fact that the engineers and marketing personnel at the port are highly digitally understanding because their work requires sufficient digital literacy. From there, they can execute digital transformation in the port, synchronize the system and people, and provide customer information. Also, we can see that the year of experience does not correlate with the level of knowledge on digitalization. This can be explained that the newcomers to the port industry emphasize digitalization more and understand the benefit of digital transformation at the port. The disparity of knowledge in digitalization can cause issues when implementing the digital transformation strategy for the port.

	Background	No. Year of experience	Level of knowledge on digitalization	The most important dimension	Who benefits the most from digitalization at the port?
PM1	Business Management	12	4	Human assets	Stakeholders
PM2	IT Infrastructure	7	5	Data formation	Customers
PM3	Accounting Financial	8	2	Data formation	Stakeholders
PM4	International Business	5	3	Data formation	Stakeholders
PM5	Marketing Strategy	5	4	Human assets	Customers
PM6	International Business	9	3	Performance measurement	Stakeholders
PM7	Maritime Affairs	5	3	Human assets	Customers
PM8	Technician	14	4	Level of automation	Port Operators
PM9	Public Relation	6	2	Human assets	Customers
PM10	IT Developer	8	5	Data formation	Port Operators

Table 6: Interviewees' background on digitalization

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Source: Developed by author

From the participants' answers, we acknowledge that digital readiness measurement shows businesses the motivation and the right time to deploy digital and technology solutions. This can help plan implementation in phases, by areas or synchronously, according to necessary conditions. And what is enough to make among all the dimensions in the model? Also, most believe that the most critical dimension is the human factor. However, the principal reason can be grouped into those answers from interviewees:

"Human assets are the most important. When the team (people) is not ready to change, all the other things are not available to deploy. Employees fear the lack of synchronization with stakeholders, fragmented, patchy technology, and the old system overriding the new system. Therefore, it is hard to get acquainted with the new systems. It is difficult to change their habits. Some employees feel uncomfortable changing to digital technology due to corruption." (PM1)

"For Vietnam's port system, digital transformation is still a big obstacle in investment and, above all, the human factor. Employees feel difficult to accept change, replaced by machine tools. Generally, more than half of the staff working at the Ports are 40 years of age or older. Thus, changing their habits and preparing them for new technology is very difficult and expensive for businesses. Of course, top management has foresight towards the future and people. However, in this industry, in Vietnam, there is still a shortage of human resources for digital transformation, so not many ports are ready for digital transformation today." (PM7)

On the other hand, port managers are also concerned about data formation dimensions, which can be listed as data availability and quality. According to respondent PM2, he said:

"Data is the most important. When the data is insufficient, lacking, or of poor quality, the data will be fragmented and cannot be digitized. Since then, digital transformation will be difficult due to insufficient data availability and not enough information to provide a complete operation model for the port based on good to normal and worst scenarios. Currently, at ports in Vietnam, it is the most difficult to collect data for digital transformation because all data before the 2000s is manual and incomplete. It is challenging to build a comprehensive model of Port operation." (PM2)

"From a financial perspective, data is fundamental. Digitization brings many benefits to finance and accounting, from storing documents and documents through live signatures and documents to making cash payments instead of transfers requires a lot of time. Many people still face many risks of accuracy, costly in terms of space and time to store documents. In particular, Covid-19 is a catalyst to accelerate the digitization process. Digitization as the lifeline of businesses during the Covid-19 period to avoid business interruption when most have to work remotely" (PM3).

Therefore, we can conclude that the first dimension, "Data formation", is the most important. Data must be available for use for digital transformation to take place. Because ports still use manual operations, storing data is discrete, not centralized, and incomplete in width and depth. It is tough to implement a digital transformation, taking minimal steps into the database and then applying digital technology to each area.

Primarily, participants in the interview answered in either data or human factors. Some have a different point of view on digitalization, which can be very technical such as PM8. When talking about the model in this research, he states, *"The Port's automation level is the core to assess readiness for digital transformation. We need to consider the degree of automation of Port operation systems. From there, we can assess what stage our port is in of digital transformation. For a container terminal, focusing on equipment and the connection of devices is extremely necessary. The Ports of Hamburg or Rotterdam automation are prime examples of digital transformation. Therefore, it is necessary to assess the degree of automation of a port for the decision to move to digital transformation. In the digital readiness model, physical assets can somehow explain the level of automation of cranes and machines. However, the level of automation needed more than just cranes or mobility vehicles, and it needed cross-linked functional systems."*

Moving to the question related to the benefit of digitalization, 50 per cent of the respondent's state that customers benefit the most from digitalization at the port, and 30 per cent of respondents think that stakeholders, including employees, port users, port operators, and investors, have benefited equally. And the rest think that port operators benefit the most. The answer for digitalization benefit is observable and correlates with participants' most critical factor (human asset – customer). The reason for this can be explained based on the interviewees' answers:

"Of course, the port's customers will be the biggest beneficiaries of digital transformation. Because at present, in Vietnam, automation still has many obstacles and big gaps in the container terminal system. However, digital transformation is a different story. Currently, many ports have applied digital transformation technologies to make it more convenient for customers, for example, RFID technology, customer identification in and out of the port, automatic electronic weighing, tracking software, monitoring the online operation plan such as SMART PORT of GEMALINK, or the online portal to look up container information at the container yard. All of this

digital technology is to serve the customer. Hence, it can be said that the port's digital transformation is due to customers' needs." (PM9)

However, many other managers claim that digital transformation in container terminals benefits all related parties: *"Partners, customers and port internals users have the same benefit. Thank to document processing time, payment is fast, accurate and clear. All can track the processing of a transaction as well as the payment status. There is no waiting time because the people involved can handle it from anywhere instead of waiting to process the work only when they are at the office." (PM3)*. Hence, every party related to the port is known to be beneficial. In the port, the specialized and professional departments and management levels will increase work efficiency and reduce costs and administrative efficiency. In addition to the main customer such as shipping lines, shippers, transport units, support service providers, and state management agencies, because it will increase the efficiency of professional cooperation, information is exchanged quickly and systematized, minimize human errors and directly increase the efficiency of management and planning.

Also, port managers are concerned about evaluating other findings based on this model. The port needs to re-assess the enterprise's financial viability and the general condition of the port industry in Vietnam. These will be essential inputs for a port to consider when or at the appropriate scale of digital transformation.

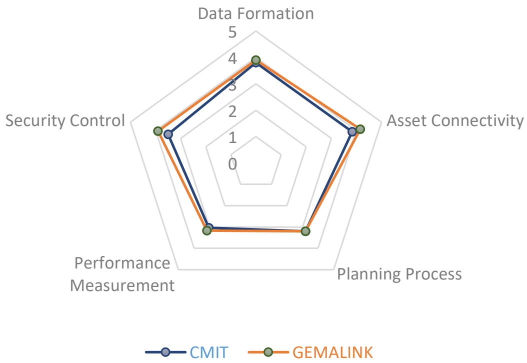

Figure 4: Rating digital readiness based on the model of two selected ports

Source: Developed by author

Both CMIT and GEMALINK have similarities in operational structure and infrastructure level. However, when asked about the level of digital readiness based on the model, each manager has a different rating on their port, indicating the asynchronous connection among departments in the terminal. In Figure 4, their digital readiness evaluation based on the model was decent, with an average point of around 3.5 to 4 (integrated from managers of each port). Yet, their idea about digitalization is little compared to the digitalization at their ports. As a result, Figure 5 shows a knowledge gap between top management (Board of Directors, Chairman, etc.), middle management, and lower rank. Therefore, it indicates that companies at all levels have a distance in the knowledge of digitalization and the prospect of port development. And junior employees cannot see the long-term benefits because of the substantial initial investment. In addition, the dissemination of the vision to the departmental levels is lacking, so employees cannot get an overview of the benefits of digital transformation and the conditions for achieving the goals of digital transformation.

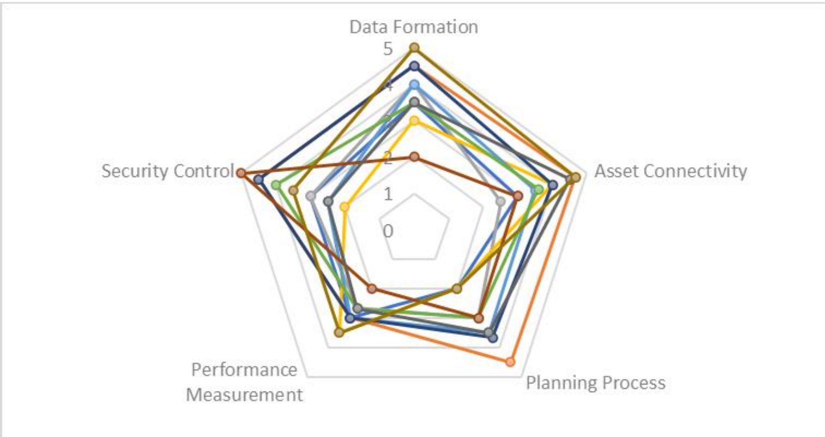

Figure 5: Rating of port managers regarding their digital readiness

Source: Developed by author

Commented [GC15]: Please anonymize.

From the manager's aspect, we can see that digital transformation plays a significant role in helping to improve and accelerate administrative reform, improve the quality of public services and the efficiency of state management, and at the same time create a favourable and advanced business environment for the port enterprises and entities involved in the logistics chain. This is an inevitable trend that needs to be seen in time. However, the current reality in Vietnam is still limited regarding implementation.

4.3 Discussions

4.3.1 Obstacle of the container terminal in Vietnam to digitalize

The digital transformation in ports is essential in Vietnam. Currently, the infrastructure systems of the old ports are individually operated, leading to duplication in the operation process, causing system congestion and inefficient production. Therefore, digital transformation is necessary so that the systems can synchronize and operate smoothly, saving fuel and costs for customers. Therefore, digital transformation is necessary according to the trend. However, there will be many obstacles regarding investment, people, process and data availability. Port operators often forget the early step of transforming manual to digital processes. The initial strategic goal is essential, then adjust the process, and find the software technology to implement. From superior to a lower level, the mindset must be synchronized and transparent, and digital technology must be applied to execute the process.

Most ports in Vietnam have not even gone through the digitization process, so the digital transformation is still quite far away (except for ports with foreign investment or those newly built within 2-3 years or more). In addition, according to the port managers, in terms of physical assets, ports in Vietnam have an unready infrastructure system, leading to enormous investment costs when converting to digital technology. In terms of human assets, port employees are afraid to change, especially for ports with a lengthy operating background in the old way of operation, which will not be willing to change their habits, and do not know how to start the digital transformation because of no specific strategy. Some managers also shared that this is a two-way relationship between the customer and the port due to the lack of synchronization between the operational and management system. Therefore, customers who have not yet converted to digital face difficulties and obstacles due to inaccessibility to the digital platform.

4.3.2 Dimensions of digital readiness model for container terminals

The interviewee's answer analysis needs measurements to perform the digital transformation. However, port managers must first determine how many variables they can evaluate. From there, scale the coefficients of the variables to see which variables are the most important, then understand why each dimension will have different importance for a particular point. In addition, the port needs to be able to answer the following 5 questions:

Commented [GC16]: 5, no?

- ❖ Can the process be digitized? Is the data in a complete form?
- ❖ Are those processes tied together by automation or manual?
- ❖ Is the automatic time less than the manual time? Are the errors more minor after the digitalized process?
- ❖ Are services improved and more satisfied customers?
- ❖ How many percentages for satisfaction rate? Can the service be available 24/7?

As for the planning dimension in a container terminal, automation in strategic planning is currently impossible. However, supporting tools have appeared to help make the most optimal choice for production and business activities. The data and information are collected and processed manually to make reports for business purposes. Therefore, it can be affirmed that the application of digital technologies in the current planning process is not high. For daily operational planning tasks, there is TOS software to support. Depending on the specific characteristics, the ports will determine whether to lease TOS software or buy TOS. For example, a port that chooses to lease TOS software will need fewer initial resources, and OPEX will be small every year. Conversely, if buying or investing in another software, the CAPEX will be high and need many tweaks to fit. Both ports in this study inherit software from APM Terminals and CMA-CGM, so it is much more convenient when implementing digital transformation. Other factors that may affect the digital transformation, such as deep-sea ports, will need to be digitalized due to the needs of foreign customers.

For data issues, data can be transformed for analysis, for example, productivity, operational efficiency, vehicle utilization rate, etc. However, some data must be compiled manually, not automatically. The data with enough fields can meet routine reports but must be converted through an intermediate step (Excel) for specific reports, which can be obtained in a specific time frame (12hrs, 24hrs, week, month, year). All employees use the same standard port operation software but separate functions depending on the department/section, and these functions are linked together (some departments do not link together). Vehicles in the port are dispatched and visually displayed for performance management (Real-time), and these vehicles link together in terms of display information to ensure a sequence of operations.

In addition to the above essential variables, both ports are not aware of the importance of cyber security. Through the interview process about the level of security control of the port, most crucial port positions have installed surveillance cameras. However, it is still difficult to control. The process is still incomplete and complicated, causing a lot of trouble and creating obstacles in the operation process. Regarding cyber security, the port does not fully understand the risks and dangers of data theft and data leakage. Although the systems operating at the port are private, none of the systems is used to prevent outside intrusion. It can only be used to monitor, not to prevent, when there is a risk in terms of data.

Since the digital transformation of ports cannot be protected solely by deploying cutting-edge technologies, these five dimensions (data, asset, planning, performance, and security) were added to the digital auditing tool. A sustained development towards an intelligent port depends on the interaction between management practices, staff knowledge and skills, and functioning IT processes and systems with these digital technologies. A thorough information procurement of current digitalization developments must also be ensured. Port representatives can do this to educate themselves and become aware of the potential added value that results from sustainable digital development. Additionally, this guarantees that appropriate actions and investments are identified correctly during the strategic decision-making process. As a result, we can witness that the port has undergone digital transformations. However, this transformation is unevenly applied, and many redundant processes lead to system disturbances. This creates a barrier between employees and technology software.

4.3.3 Limitation of digitalization in the Port industry

From the perspective of port operators, there are some downsides to port digitization. Because of the continuous changing environment, ensuring that data is not disrupted – or even missing – is extremely difficult. Any potential dead zones will prevent ports from efficiently collecting and exchanging information. This is especially problematic for automated ports because, unlike conventional ports, they cannot contain problems at individual functions or process steps, necessitating constant collaboration among activities.

Similarly, the port will require a highly secure and mobile system due to the highly intricate nature of ports, such as the required operational and security roles complicated in the successful shipment movement. With such a complex network required, the initial investment cost of automation is exceptionally high and not reasonable for every port, predominantly those in developing countries. Potential updates must also be considered to ensure that ports can keep up with software advancements. Disregarding these progressions may leave ports vulnerable to cyber security, which could be disastrous.

Furthermore, installing and maintaining an automated port necessitates the development of a new skill set within the port industry. Finding these specialized technicians will be complicated and expensive for ports.

5. Chapter Five: Recommendation and Conclusions

It should be noted that additional internal and external factors may impact the ports' level of digital readiness despite the chosen criteria being researched. The amount and intensity of investments in digitalization, for instance, may be influenced by the financial resources available and the economic climate of a port. As a result, a thorough investigation and potential expansion of the elements affecting these ports' functioning may be considered. Discussions may also include the ports' current technological development status and rate of advancement. It can be challenging to close digital development gaps in ports quickly, and such activities might require time. It seems sensible to use a benchmarking technique to plan upcoming digitalization initiatives. Based on the technique that enables evaluating a port's level of digital readiness, specialized software may be created specifically for such analysis for various ports worldwide. It should be noted that new digital solutions are frequently implemented in port development, which could affect the readiness level for digital technology. Therefore, conducting more research and looking at potential shifts in the ranking of port levels of digitalization is worthwhile.

On the other hand, port managers must have a strategy to exchange information widely to all levels of employees, with a phased orientation so that employees can both understand the benefits of digital transformation and know how to determine for themselves what stage their understanding is currently through a digital readiness assessment model. Along with that, coordinating policymakers in the maritime sector must have beneficial incentives that support the digital transformation of the port industry. Promoting this significant change requires a lot of resources and knowledge. Also, policymakers need to work with port leaders to find solutions to support the port in terms of investment and business knowledge.

Consequently, practitioners, particularly port representatives like port authorities or operators, and researchers, can evaluate the digital performance and readiness of ports through the presented and conceptualized container port digital readiness model in this study. Practitioners can also identify the current strategic positioning of ports in the digital context. Overall, the roadmap for the digital transformation of ports toward innovative port development was established by defining the appropriate strategies concerning the various digital port classifications. In other words, the developed maturity model can support the identification and definition of an efficient and effective strategic direction for setting up the roadmap for the digital transformation of the port. It can also assist port authorities, operators, policymakers, and other port-related stakeholders during decision-making. Even though there have already been researched studies that have focused on these issues, future research efforts should emphasise presenting appropriate use cases because the present study's findings showed that these technologies have not yet been widely adopted and employed in ports. Furthermore, a general methodological constraint is evident due to the shortage of comparative research investigations.

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Appendices

Appendix 1: Sample of semi-structured interview with guiding questions

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a specialized agency of the United Nations

Interviewer Name:

Date of interview:

Research background

The aim of the study is to explore the current research about digital readiness of container terminal and create the digital readiness model to assess the digital maturity level of container terminal based on previous studies, researches and expert knowledge. Then, providing insight case studies about different perception of port operators and stakeholders about digital readiness model of container terminal. understand the different perception of people about digital readiness level in container terminal in Vietnam. Based on the findings, this research paper will give explanations and recommendations for Vietnam container terminal in general to shift to improve their organization for digitalization.

The research comprises two objectives:

a) To create a digital readiness assessment model based on the research's conduction from different authors and sources.
b) To identify the different of perception between port operators and stakeholders on the digital readiness model in container terminal.

Sociodemographic

1) What is your name and role in your organization/company?
2) What is your professional background?
3) How many years have you been in your current job position?

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Question scope (Each question answer from 3 to 4 sentences)

1) Port Digitalization
   - What do you think about digitalization? At what aspect you are talking about digitalization?
   - Who would benefit the most if container terminal becoming digitalize? Why?
   - What is your understanding about this digital material, digital maturity or digital readiness?
2) Digital Readiness
   - In your point of view, is this digital readiness assessment model sufficient enough to determine container terminal readiness level?
   - What could be the obstacle to apply this model into container terminal in Vietnam?
3) Case ports in Vietnam
   - From your aspect, how do you understand the variables of the model?
   - How would you rate each of the dimension in the container terminal?
   - What dimension you believe it is the key to measure digital readiness level at container terminal? And why?

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Appendix 2: Ethics considerations

2.1 Sample of Consent form

WORLD MARITIME UNIVERSITY

Dear Participant,

Thank you for agreeing to participate in this research survey, which is carried out in connection with a Dissertation which will be written by the interviewer, in partial fulfilment of the requirements for the degree of Master of Science in Maritime Affairs at the World Maritime University in Malmo, Sweden.

The topic of the Dissertation is "Digital readiness of container terminals for digital technology adoption – A Case study of Vietnam"

The information provided by you in this interview will be used for research purposes and the results will form part of a dissertation, which will later be published online in WMU's digital repository (maritime commons) subject to final approval of the University and made available to the public. Your personal information will not be published. You may withdraw from the research at any time, and your personal data will be immediately deleted.

Anonymised research data will be archived on a secure virtual drive linked to a World Maritime University email address. All the data will be deleted as soon as the degree is awarded.

Your participation in the interview is highly appreciated.

Student's name	Anh Tuan Vu
Specialization	Shipping Management and Logistics
Email address	w1010331@wmu.se

* * *

I consent to my personal data, as outlined above, being used for this study. I understand that all personal data relating to participants is held and processed in the strictest confidence, and will be deleted at the end of the researcher's enrolment.

Name: ....

Signature: ....

Date: ....

2.2 WMU REC Protocol

WORLD MARITIME UNIVERSITY

WMU Research Ethics Committee Protocol

Name of principal researcher:	Anh Tuan Vu
Name(s) of any co-researcher(s):	None
If applicable, for which degree is each researcher registered?	MSc in Maritime Affairs (Specialized in Shipping Management and Logistics)
Name of supervisor, if any:	Associate Professor Gang Chen
Title of project:	Digital readiness of container terminals for digital technology adoption – A Case study of Vietnam
Is the research funded externally?	No
If so, by which agency?	N/A
Where will the research be carried out?	Malmö, Sweden
How will the participants be recruited?	Selected participants from two ports in Vietnam will be invited
How many participants will take part?	10
Will they be paid?	No
If so, please supply details:	N/A
How will the research data be collected (by interview, by questionnaires, etc.)?	Structured interview
How will the research data be stored?	Data will be stored in both my personal laptop, Onedrive, Google Drive with strong password
How and when will the research data be disposed of?	The data will be deleted upon completion of my MSc study at WMU, degree scheduled to be awarded in Oct 2022.
Is a risk assessment necessary? If so, please attach	No

Signature(s) of Researcher(s): Date: 5th July 2022

Signature of Supervisor: Gang Chen Date: 5th July 2022

Please attach:

- A copy of the research proposal
- A copy of any risk assessment
- A copy of the consent form to be given to participants
- A copy of the information sheet to be given to participants
- A copy of any item used to recruit participants

2.4 WMU REC Approval

16:37, 19/07/2022 World Maritime University Mail - REC DECISION # REC-22-64(M)

WMU WORLD MARITIME UNIVERSITY

VU, Anh Tuan <w1010331@wmu.se>

REC DECISION # REC-22-64(M)

2 messages

Email, PhD <PhD@wmu.se> 8 July 2022 at 09:16
To: Anh Tuan VU <w1010331@wmu.se>
Cc: Gang CHEN <gc@wmu.se>

Dear Anh Tuan Vu,

I am pleased to let you know that the members of the WMU Research Ethics Committee (REC) have now **approved** the research related documents that you submitted to this office on 5th July 2022, concerning your research study involving human participation.

You are now free to start your data collection work in consultation with your supervisor.

With kind regards,

Carla Fischer
REC Secretary
Faculty Support Officer
Research Projects and Doctoral Programs
World Maritime University

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