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Digital transformation for maritime logistics capabilities improvement: cases in Indonesia

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Abstract

Purpose – The authors have faced rapid technological developments over the past few years. Still, the authors face challenges of maritime supply chain inefficiency, high costs and the low competitiveness of Indonesian ports. In line with the flow of this research, the purpose of this paper is to conceptualise best practices to improve port connectivity, which impacts improving maritime logistics capabilities in Indonesia that are relevant to the current situation.

Design/methodology/approach – The authors utilise surveys and interviews as a data collection method, where several sources were actors in the maritime logistics industry. The authors also use secondary data from the Ministry of Transport of the Republic of Indonesia, online databases as well as trade magazines and newspapers. This paper conducts a multiple case study and principal component analysis (PCA) to meet the research objectives.

Findings – The intention to use port digitisation services will increase if the perceived usefulness of the service also increases. Also, if the negative coefficient of user trust rises, it will bring a very sharp decrease in customers' intentions to use. Furthermore, the high estimated value of context indicates that users expect to have a good experience using the application and bring benefit to their business.

Originality/value – Based on the authors' knowledge, there has been no review about port digitalisation, specifically in Indonesia. The authors initially provided best practices to improve port connectivity, which can impact improving maritime logistics capabilities.

Keywords Digitalisation, Port, Technology acceptance model, Survey, Emerging country

Paper type Research paper

Nomenclature

AI	Artificial Intelligence
AIS	Automatic Identification System
ASD	Arrival and Ship Departure
BUP	*Badan Usaha Pelabuhan* (Port Business Entity)
DITLALA	*Direktorat Lalu Lintas dan Angkutan Laut* (Directorate of Traffic and Sea Transportation)
FVUA	Foreign Vessel Usage Approval
INSW	Indonesia National Single Window
IoT	Internet of Things
IIoT	Industrial Internet of Things
KBN	*Kawasan Berikat Nusantara* (National Bonded Zone)
LCL	Less Container Load
LSOP	Linear Ship Operation Plan
LUWP	Loading and Unloading Work Plan
MCC	Marine Command Centre
MSAL	Motion Sports Approval Letter
NLE	National Logistic Ecosystem
NPWP	*Nomor Pokok Wajib Pajak* (Tax Identification Number)
PNBP	*Penerimaan Negara Bukan Pajak* (Non-Tax Revenue)

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SAL	Sailing Approval Letter	SIUPAL	*Surat Izin Usaha Perusahaan Angkutan Laut* (Sea Transportation Company Business License)
SAN	Ship Arrival Notification	SMD	Ship Mooring Determination
SANFA	Ship Agency Notification Foreign Affairs	UPP	*Unit Penyelenggara Pelabuhan* (Port Management Unit)
SIOPSUS	*Surat Izin Operasi Perusahaan Angkutan Laut Khusus* (Special Sea Transportation Company Operation Permit)	VTS	Vessel Traffic Service

1. Introduction

Digitisation is a common thing nowadays. New terms, such as Big Data, Internet of things (IoT), cloud computing, to regulatory changes to adapt to the times, are unavoidable. They must be adopted immediately because they simplify the course of an activity, increase effectiveness and efficiency, not only in terms of time but also costs (D'Amico *et al.*, 2021), increase flexibility and streamline communication because of the integrated system. In Indonesia itself, the adoption of digitalisation is also proliferating, as has happened in other countries. One of them is in maritime activities, which are vital for an archipelagic country such as Indonesia (Amin *et al.*, 2021). The warehousing, handling and manufacturing activities are underway and re-export activities and other crucial activities occur. Thus, it is not surprising that in 2014, the president of the Republic of Indonesia advanced a vision called the "Global Maritime Nexus", which aims to overcome and embrace Indonesia's geography as an asset, not a burden (CSIS, 2014).

Maritime transportation is essential in global activities, especially for an archipelagic country like Indonesia. The port is a trade facilitator and provides value-added activities through the provision of employment opportunities related to research and development (Wahyuni *et al.*, 2019). Dwarakish (2015) added, port growth and development could encourage increased trading activity, increased supply and additional foreign reserves to lower commodity prices in order to reflect the overall economic condition (Tu *et al.*, 2018). Therefore, the adoption of digitalisation or digital transformation should be one of the main ingredients in the maritime logistics activities in Indonesia.

However, as a country that claims to be called the "maritime state", container port traffic in Indonesia is ranked seventh, below Malaysia's (ranked fourth) and Singapore (ranked second). According to the 2017–2018 Global Competitiveness Report, Indonesia is ranked fifth in the ASEAN region in terms of infrastructure quality, behind Singapore, Malaysia, Brunei Darussalam and Thailand. In addition, infrastructure and international shipping get a relatively low rating. Carruthers (2016) even mentions that bottlenecks at Indonesian ports affect 24–26% of total Gross domestic product (GDP). Furthermore, the Indonesia Global Competitiveness Index (CEIC) was reported at 64,629 in 2019, down from 2018, in which was at 64,935. Indonesia still lost to Thailand (68,112) and Malaysia (74,602). According to the Ease of Doing Business Index (2019), Indonesia is ranked 73. Even though it has increased, it is still below Vietnam (70), Brunei Darussalam (66), Thailand (21), Malaysia (12) and Singapore (2). Indonesia's Logistics Performance Index (LPI) (2.89) experienced a slight increase from 2016 to 2018, but is still below Vietnam (3.01), Thailand (3.14), Malaysia (3.15) and Singapore (4.06). Concomitantly, practice in the field shows that logistics costs are also quite expensive.

Indonesia has great potential to create a more efficient supply chain, reduce costs significantly and accelerate the competitiveness of Indonesian ports (Wahyuni *et al.*, 2019). Indonesia has four (four) Free Trade Zones and Indonesian Free Ports in Batam, Sabang, Bintan and Karimun – in which workmen can carry out activities without obstacles by the customs authorities through the policy of eliminating customs and excise as well as non-tariff and tax barriers. In addition, Indonesia has the *Kawasan Berikat Nusantara (*KBN): this infrastructure supports economic development by using the location to increase export-oriented processing industries that receive special incentives, exemption from import duties and other state levies. Besides, the concept of maritime logistics is listed in the blueprint for developing the national logistics system (*Sistem Logistik Nasional* or Sislognas) and the idea of the archipelago pendulum or sea highway.

However, this has not gone smoothly and there are still some obstacles to the process. This issue leads to significant inefficient supply chains (e.g. Parola *et al.*, 2021), high costs and the low competitiveness of ports, which are caused by the unequal transformation of digitalisation in every corner of the country (Tijan *et al.*, 2021), leading to the low quality of connectivity for each actor in it. These problems are deepened by several factors, such as logistics integrators having to go through several permits for each activity, Foreign Direct Investment (FDI) restrictions weakening the flexibility to set up integrated logistics providers, the prevalence of tickets for transportation operators and monopolies for certain main activities.

These problems result in information asymmetry, encouraging the emergence of moral hazards and opportunistic behaviour. Information asymmetry causes the institutions/institutions not to be strong enough, thus creating inefficiencies in various fields (Junarsin *et al.*, 2021). As a result, competitiveness is low, and Indonesia does not realise the expected targets/impacts. To the best of our knowledge, there has been no research that combines multiple case studies and principal components analysis (PCA) methods in industrial maritime, specifically in Indonesia. Nguyen *et al.* (2022) added there is a lack of research that empirically examines how factors would contribute to enhancing the performance of maritime firms. Based on the description above, we can pose two big questions in this research. First, how is it possible to improve the efficiency of the maritime supply chain, reduce costs significantly and have an impact on increasing the competitiveness of ports in Indonesia? Second, what are the best steps that industry players and policymakers should take in the short, medium and long term to make this happen?

Departing from the questions mentioned earlier, this paper is structured as follows. Section 1 introduces the problem and purpose of this study. Section 2 outlines the conceptual framework of this research. Section 3 explicates the research methods. Section 4 presents the findings, while section 5 analyses and discusses our findings. Finally, section 6 concludes the study and provides theoretical and practical implications.

2. Theoretical background

2.1 Port digitalisation: the current debate

Digital transformation is an evolutionary process that relies on capabilities and digital technology to create or change business processes, operational processes and customer experiences to create new value (Morakanyane *et al.*, 2017). Thus, digital transformation comes from the impact of using a combination of digital innovations that change the structure, values, processes, positions or ecosystems within organisations and the environment outside organisations (Hinings *et al.*, 2018).

The digitisation of the delivery aspect results in new business logic. New business models need digitisation to enhancing the success of the business itself (Mosconi *et al.*, 2019), as well as for economic and social value creation. Various information technology applications have been used, such as decision support systems for optimising shipping operations, information systems for port logistics support, tools for policymakers using contemporary digital technologies. There are orthogonal or interrelated information technology applications, including the Internet of ships and sea services, IoT, AI (autonomous vessels and smart shipping), blockchain (Ahmad *et al.*, 2021; Lambourdiere and Corbin, 2020; Czachorowski *et al.*, 2020) for maritime logistics and trade. Consequently, optimising digital transformation is pronounced as a solution to overcome the main problems in maritime logistics in Indonesia.

Digital technology can be applied to facilitate the flow of goods, information (Haralambides, 2019) and financial resources – physical flow, documentation flow and financial flow – which lead to port operational efficiency (Adabere *et al.*, 2021). The first cluster concerns digital technology that supports physical flow or cargo flow. We can apply digital technology to ensure cargo handling efficiency, better capacity management and reduced processing time (Ellingsen and Aasland, 2019). The second cluster focuses on document flows that involve exchanging many physical documents. The next group relates to the flow of financial resources. Therefore, port digitalisation will lead to extend productivity (Simoni *et al.*, 2022) and streamline financial operations (D'Amico *et al.*, 2021) all while increasing transparency and risk management.

As a change, digital transformation also takes time, which is a challenge in transformation (Vairetti *et al.*, 2019; Carlan *et al.*, 2017). In general, several challenges in digital transformation need to be identified. These challenges including digital culture and mindset, the curse of resources and the ability of regulators to adapt to technological changes, will later determine how the implementation of digital transformation will go in the future.

Capgemini (2017) states that culture and innovation is the biggest challenge in digital transformation. So it is essential to encourage digital culture as the first step in digital transformation. Digital culture is more than just working with digital devices (Carlan *et al.*, 2017). It goes beyond digital tools into skills, environments and artefacts that evolve to provide relevant information and facilitate routines. In addition, digital culture can accelerate work by breaking down hierarchies, encouraging innovation. It enables organisations to develop a workplace that motivates members to try new things while enhancing organisational learning, attracting new-age talent and retaining the current workforce.

Another challenge in digital transformation is the resource curse. Resources are frequently mismanaged. This occurs because of several factors (Senyo *et al.*, 2021; Aiello *et al.*, 2020) In addition, natural resources usually create inter-community conflicts (Collier, 2007) because several groups and factions fight for their share; even the ambitions of the people and the government can conflict with each other. It is also exacerbated because the relationship between the abundance of natural resources and slow economic growth is empirically proven. Nguyen *et al.* (2022) added that there is a lack of research that empirically examines how factors would contribute to enhancing the performance of maritime firms.

The final challenge in digital transformation is the readiness of regulators, where there is usually a paradox regarding innovation and regulation. Regulatory, legal and policy change are linked to data in future maritime networks (Sys and Vanelslander, 2020). On the contrary, Carlan *et al.* (2017) stated that regulation has not been examined as a facilitator or barrier. Fragmented regulation can limit access and hinder innovation. At the same time, the government is under extreme pressure from market leaders who want to level the playing field. In addition, technology can truly bring a myriad of benefits but also comes with harmful risks and facilitates crime, such as terrorist activity, drug trafficking, smuggling and cyber-attacks. Based on this, several principles guide the future of regulation, including adaptive regulation, regulatory sandbox, outcome-based regulation, risk-weighted regulation and regulation of cooperation (collaborative rule).

2.2 Technology acceptance model (TAM)

According to the TAM, user acceptance of each technology is determined by perceived usefulness (PU) and perceived ease of use (PEU). PU is defined as the degree to which an individual believes that using a particular system will improve performance. PEU is defined as the degree to which an individual believes that using a specific system is free from physical and mental effort (Davis *et al.*, 1989; Davis, 1993). TAM shows that the intention to accept technology is determined directly by attitude, PU and PEU. TAM is the method where an individual's choice to use technology determines actual application use and attitudes towards technology influence intention (Davis *et al.*, 1989; Venkatesh *et al.*, 2012). Yang (2019) further examines the utilisation of TAM theory to the intention to use (ITU) blockchain. In this paper, TAM theory will structure the research process and help improve understanding of the acceptance and use of technology developed by DITLALA. Individual factors such as age, gender and technology skills are external variables in this study. We assessed the system's content and service benefits for PU. Application functionality describes the PEU of the system. The attitude towards the technology consists of using the system, satisfaction and experience of benefits from using the service.

3. Methodology

A suitable methodology is essential to ensure that research objectives are achieved and that research questions are answered thoroughly. In general, this study will involve several actors, such as industry players and policymakers related to maritime logistics in Indonesia, to explore specific insights and findings in line with the research questions (research objectives 1 and 2). The sample will be selected to represent the population of maritime logistics actors in Indonesia. The data collection method was carried out through surveys for quantitative data needs and interviews for qualitative data needs with several sources, such as actors in the marine logistics industry and policymakers, as well as by the direct observation of actors and by extracting secondary data.

The data collection and analysis results mentioned above will also answer the third research objective. To minimise bias, we reduce research risk (spectator's account) and improve research quality; this activity will follow a structured research protocol (Creswell, 2003). This research aims to gain an in-depth, comprehensive, specific and relevant understanding of the aims and objectives. We used PU and perceived convenience factors influenced by various external variables such as education level (Burton-Jones and Hubona, 2005). We also gather variables about factors such as gender (Venkatesh and Morris, 2000; Venkatesh *et al.*, 2012) and organisational features, such as training in computer use (Venkatesh *et al.*, 2012).

TAM theory is widely used in research contexts and several types of technology applications (Chau and Hu, 2001; Lee *et al.*, 2006; Raitoharju, 2007; Yarbrough and Smith, 2007). TAM explains the technology acceptance factors that we can transfer to different user populations and different types of technology.

To deepen our understanding of the research context, this research uses multiple case studies. Using multiple case studies allows a study to engage in cross-case comparisons, thus leading the researcher to achieve a higher level of external validity. According to Yin (2013), the results and evidence from the application of multiple case study designs are more convincing, so this design is stronger than single case study designs and multiple case studies are needed to provide an appropriate level of generalisation (Eisenhardt and Graebner, 2007).

Furthermore, to analyse the statistical data of respondents related to the acceptance of digitalisation carried out, this study uses the PCA method to examine which factors correlate with one another in terms of utilising digital port services. PCA is also known as an unsupervised learning that learns patterns from unlabelled data (Liu *et al.*, 2022).

4. Tales from the field

4.1 Overview of the World's ports

In the early stages of analysing multiple case studies, this study tries to compare the situation between world-renowned ports. The aim is to comprehensively understand the state of the world's major ports and explore what kind of digitalisation these ports are implementing using thematic data analysis.

Table 1 shows the mapping of digitisation that has been carried out in several world-renowned ports. The table maps out the diversity of capabilities possessed by each port, the problems they face and details of the digitalisation that has been implemented, up to the expected targets for its implementation. Digitisation is certainly a solution to solving existing problems, which are also detailed in Table 1.

In Table 1, digitisation ultimately pursues effectiveness and efficiency and also helps to resolve the problems in each port. More deeply, the digitisation solution that is carried out revolves around how to create an integrated system that shortens the bureaucracy, can be monitored remotely and at any time, is fully or partly automated and, of course, is safe from the threats of crime and technical problems. In the end, the presence of a management information system is the key to the implementation of digitisation.

Based on the results of the case studies that have been carried out, another emphasis on digitisation is strongly influenced by technological advances, which are becoming standard operators of communication protocols, as in the study conducted by Figueroa-Lorenzo *et al.* (2020) regarding the industrial Internet of things (IIoT). In other contexts (other industries), the implementation has also been carried out, which is called smart manufacturing (Ding *et al.*, 2020; Wu *et al.*, 2017).

In widespread use, digitalisation forces the actors and stakeholders to continuously increase their awareness of cutting-edge technologies, which are the main facilities for the adoption, implementation and diffusion of technology into their activities (Queiroz *et al.*, 2019). Based on the results of the theme drawing, digitisation is supported by the adoption of hardware that supports the performance of adopting companies. One of them is a machine tool similar to that introduced by Liu *et al.* (2022), one expected to have high levels of accessibility, connectivity, intelligence, adaptability and autonomy. Specifically, this also applies to the activities of world-renowned ports, as previously stated. The practice of digitisation depends closely on technological progress, especially on the advancement of machine tools.

4.2 INAPORTNET

INAPORTNET is an internet-based electronic service information system. This system is centralised and integrated with operational service standards, useful for serving ships and goods activities at the port. This web-based application system is used for port operational activities that collaborate with all stakeholders at the port. INAPORTNET has been implemented in 76 ports by 2021 (Kemenhub, 2021). This figure has increased compared to the previous year; it is known that there are 53 ports that use this application. The following is the timeline for the development of INAPORTNET in Indonesia.

(1) 2016: INAPORTNET is applied in four major ports. Development is still limited in Makassar, Belawan, Tanjung Priok and Tanjung Perak.

(2) 2017: A total of 12 ports, including developments in class 1 and class 2 ports, are added.

Table 1. Digitalisation initiatives along with the issues faced in ports around the world

No.	Port name	Number of docks	Pier length (km)	Rank	Volume (million TEU)	Cases	Issue	Digitalisation solution	Target
1	Port of Singapore	85	>21.1	2	N/A	Shorten the bureaucracy	Long bureaucratic and administrative chains can lead to inefficiencies in building other integrated systems	digitalPORT@SG™ (Portal for Onestop Regulatory Transactions)	Enabling more efficient, seamless and integrated port services, and will pave the way for further digitisation with one-door/window services
2	Port of Tanjung Pelepas, Malaysia	14	5.04	19	12.5	Blockchain	Not only a fully integrated system, transparency, and security are also crucial aspects of digitisation	*TradeLens*	Give the port a secure and collaborative digital tool that enables viewing of millions of shipping events and documents and helps simplify the process
3	Port of Laem Chabang, Thailand	12	4.5	20	7.55	Enterprise Resource Planning	Information system to integrate and automate business processes related to aspects of operations in the company concerned and demanded in today's era	Container Terminal Control System (CTCS), Corebis	CTCS keeps track of all services performed on every container handled at the terminal. CTCS manages orders, releases, work orders and fixed orders, gate operations, container tracking, exception handling, management reporting and communications
4	Port of Tanjung Priok, Indonesia	>113	>2	23	6.17	Information sharing, system integration	Lack of availability and access among the players will make inefficiencies and lower productivity and non-minimised operating costs	*Indonesia Gateway Master Terminal*, Reception Facility, Delivery Order	Front end operating system for port services at each port. This product is a multiprocessing terminal operating system

(*continued*)

No.	Port name	Number of docks	Pier length (km)	Rank	Volume (million TEU)	Cases	Issue	Digitalisation solution	Target
5	Port of Shanghai, China	49	13	1	43.5	Remote control centre in real time	Problem monitoring and real-time problem reporting, as well as reconfiguring transportation routes	Huawei's Port Intelligent Twins	Help ports support better workforce structures, ensure higher efficiency and lower costs, and enable safer port operations
6	Port of Busan, Korea	45	30	6	21.59	Acceleration Digitisation	Accelerate the digitisation of facilities to increase competition	AI, 5G, blockchain, and big data technology	Development of a data system for the intelligent maintenance of port facilities and to secure the basis for using data that can be used for the long-term plan of port facilities maintenance
7	Port of Rotterdam, The Netherlands	123	89	10	14.35	Hard Infrastructure	Improve efficiency and overall operations	Autonomous ships	Create digital twins of ports to track ship movement, infrastructure and weather, geographic, water data, where the digital replica will help the port to improve overall operations

(*continued*)

Table 1.

No.	Port name	Number of docks	Pier length (km)	Rank	Volume (million TEU)	Cases	Issue	Digitalisation solution	Target
8	Port of Jebel Ali, Dubai	>28	N/A	11	>22.4	Logistics infrastructure	Technologically advanced logistics infrastructure empowers users to continue operations efficiently and reach global markets. Eighteen modules will leverage core competencies and port operational assets	Zodiac Terminal Operating System	This internal integrated system consists of 18 units, including crane automation systems, berth planning. The system also manages rail and Inland Container Depots (ICD) and provides full fleet management. It controls the container to transport station
9	Port of Antwerp, Belgium	N/A	150	14	12.04	SMART-port	Cooperation with various external partners is needed to build a manned and autonomous equipment network. In addition, the general function of drones is to inspect, monitor, and monitor existing infrastructure	Drones	Large and complex port areas become safer, smarter and more efficient. In addition, this tool is expected to complement management, incident related, berthing management, and detection of oil spills as well as floating waste
10	Port of Los Angeles, US	25	69.2	17	9.2	Port Optimiser™	Provide better planning and allocation of resources, especially during a cargo boom	Control Tower Horizon	Changing conditions at the port, and the algorithm continuously updates cargo volumes. This tool also serves to improve forecasts over time and issue volume updates for the next six months, on a monthly basis

Table 1.

(3) 2018: INAPORTNET is applied to goods at five additional ports. This includes the development of a goods module in five ports. In addition, integration is carried out with Terminal Operation System (TOS) and Pelindo HUB.

(4) 2019: This application is extended to 16 ports, including the addition of class 3 ports.

(5) 2020: This application is extended to 21 ports and additions are held in classes 3 and 4 as well as port management unit (UPP) and additional port business agency (BUP) modules.

(6) 2021: The application is extended to 22 ports, addition of classes 3 and 4 as well as UPP, integration with navigation as well.

The purpose of developing the INAPORTNET application is to reduce the intensity of face-to-face contact, increase the smooth flow of goods at the port, reduce logistics costs and manage data accurately. Accurate data can be a more valid source of shipping and manifestation information. In addition, this application supports time transparency measures for the service tariffs charged. Speed is a relevant measure for digitisation, because INAPORTNET can cut operational time, which used to be one to three days – now it is only 30 min.

First, INAPORTNET is useful for creating ship news. At this stage, shipping agents and loading and unloading companies are tasked with inputting data. After that, the incoming data will be checked by the port and port authorities regarding the feasibility and safety of the ships (Kharizsa, 2021). After we gather cleaner data, the required documents related to ship docking will be sent to other users, such as the BUP, and other information can be downloaded by the user. We, as users, can access documents, including ship arrival notification (SAN), sailing approval letter (SAL), motion sports approval letter (MSAL), ship mooring determination (SMD), loading and unloading work plan (LUWP) and arrival and ship departure (ASD). The achievement targets formulated by the Ministry of Transportation for the logistics mission are divided into four major points. First, get the goods quickly and precisely. This includes the right amount, on time, affordable cost and profit contribution to logistics service providers. Second, excellent service, fast and effective communication, and transparency of transportation services. The second thing is the main focus of the Ministry of Transportation. The third point focuses on smart logistics, which means the IoT, the Internet of service and the Internet of people. The fourth point is related to logistics components, such as transportation, information, warehouse (inventory), reverse logistics and distribution of goods.

The elements in INAPORTNET need to be adjusted with outside parties in their implementation. External integration is carried out in order to produce harmonious patterns and functions. There are four forms of integration within INAPORTNET for the surrounding ecosystem. For example, the Ministry of Transportation collaborates with Indonesia National Single Window (INSW) in developing the National Logistic Ecosystem (NLE). In addition, there is a cooperative relationship between the Ministry of Transportation and the Directorate General of Budget (DJA) –Ministry of Finance regarding non-tax revenue (PNBP) and tax identification number (NPWP) payment bills. Then, tug-of-war activities and port service calculations are carried out together with the BUP. Most recently, DITLALA will integrate data between INAPORTNET and the Ministry of Energy and Mineral Resources, related to mineral and coal data.

Since the formation of the INAPORTNET application, the scope of development has expanded. This is manifested in the number of applications in more and more areas. Furthermore, it is manifested in the integration and collaboration with the DJA to verify the report (*Bentuk Usaha Tetap* (BUT) or Permanent Business Establishment/*Laporan Hasil Verifikasi* (LHV) or Verification Result Report) and the integration with automatic identification system (AIS)/vessel traffic service (VTS) marine command centre (MCC) at the Directorate General of Sea Transportation. Another function that was expected to be carried out in 2021 is tracking the ship's position, then tracing up to the last 100 h of ship movement, making notification port boundaries for notifications of ships going in and out of the port. Furthermore, DITLALA also develops in-house navigation systems on the INAPORTNET system, such as the VTS PNBP report module and local port VTS PNBP approval. Finally, from the SIMLALA, which we will describe below, it is hoped that in 2021, they will be able to visualise the ship's berthing. The shortcomings and challenges in implementing this information system, among others, are provided in Table 2 as follows.

4.3 SIMLALA

Sistem Informasi Manajemen Lalu Lintas Angkutan Laut (Marine Transport Traffic Management Information System) or SIMLALA is an online naval traffic permit service application (Kemenhub, 2021). The business processes carried out include online applications and centralised data storage. In particular, the final product of this application is technical licencing, ship shipping approvals and administrative completeness. SIMLALA has been operating since March 1, 2012. SIMLALA has 12 main features to support service users: sea transportation company business license (SIUPAL), special sea transportation company operation permit (SIOPSUS) services, ship specifications, linear ship operation plan (LSOP), ship agency notification foreign affairs (SANFA), opening branch offices, adding cargo, omissions and divisions, monitoring service progress and adding ports.

As for some of the progress felt after developing the SIMLALA application, the government has announced the ease of change, maintenance and integration of INSW. In addition, one of the advantages of SIMLALA is the ease of processing, more precisely, the ease of submitting requests online. Users do not have to come to the Ministry of Transportation's head office to make a request. In addition, this application does not consume a lot of paper, because submissions through the online system minimise document printing and repetition. Furthermore, users can download the results directly. Payments can be made anywhere, with any media that has collaborated with the DJA –Ministry of Finance. In the end, users can find out where the position of the uploaded document is, so the ease of this process will result in the expected data transparency. This will greatly reduce the gaps in corrupt practices and unnecessary levies, commonly known as illegal levies.

SIMLALA continues to support the formation of a NLE, the challenges are related to managing:

(1) Permits to operate foreign and domestic ships,

(2) Ship agents,

Table 2.
Weakness and challenges in implementing INAPORTNET

Aspects	Weakness and challenges
Human Resources	The desire for change and high reluctance is a big challenge when it comes to implementing this system in the ministry
Regulation	Fundamental support related to regulation is a part that can protect every decision or movement taken. The faster or easier it is to change a rule that applies, the more difficult this system is to implement
Commitment	The implementation of this application really needs support in the form of commitment from every line, meaning that support is needed from the highest to the lowest ranks
Sustainability	This includes the consistency of relevant stakeholders, how the aspects of supervision in the field, sustainable integration with outside parties and others
Collaboration	Differences in viewpoints and master data held between institutions will make cooperation or collaboration difficult to realise

(3) Ship safety certificates (company security officer, ship security officer, etc.),

(4) The route or routes of the ship, and

(5) The estimated time of ASD.

Both INAPORTNET and SIMLALA are a form of sustainable development expected by the Directorate of Traffic and Sea Transportation (DITLALA) under the Indonesian Ministry of Transportation. However, several ports in other countries have implemented open data systems. Available data are defined as data that is available and can be freely accessed (related to information) that machines can read. This openness of data enables software development and applications for partners and external users at the port (Inkinen *et al.*, 2019).

Inkinen *et al.* (2019) added the most relevant resource to use when deciding to disclose data is information related to port transportation infrastructure. Therefore, the Ministry of Transportation is expected to continue supporting this Crusade with up-to-date technological advances advancing exponentially. For example, ports need to observe technology trajectories and create scenarios related to the context of port digitisation (Brunila *et al.*, 2021; Inkinen *et al.*, 2021). In addition, these digitisations need to be balanced with digital empowerment. Digital empowerment can determine the scope of digitisation that the port has carried out. Digital empowerment is defined as the ability to participate in processes of continuous growth and change (González-Cancelas *et al.*, 2020). In this context, the appropriate actors, both government and ports, need access to information and resources to make the right decisions for all stakeholders.

4.4 SITOLAUT

Sistem Informasi Tol Laut (Marine Highway Information System) or SITOLAUT is an application based on an integrated information system of various government and private agencies in ensuring the implementation of the objectives of the marine highway program, which is one of the national priority programs. In other words, SITOLAUT is a system to accommodate and monitor logistics management and distribution to regions in Indonesia. It is expected to be a solution to the inequality in prices for basic goods and other important goods in the archipelago. In particular, the outermost, frontier, remote and border (*tertinggal, terpencil, terluar, dan perbatasan* or 3TP) areas is where the use of SITOLAUT can be useful both in reaching and distributing, ensuring the availability of goods and reducing price disparities, as well as improving connectivity and delivery of basic and essential goods (*Bahan Pokok dan Bahan Penting* or Bapokting).

It is hoped that the existence of SITOLAUT will make it easier for the community and related stakeholders to access sea toll services, because it provides a logistics distribution tracking system from suppliers to resellers that can be accessed by users or stakeholders based on their access rights, providing information on the disparity in the price of goods between purchase and sale. Sales from the sea toll distribution program are in the form of report data that can be monitored by the government, and the SITOLAUT application can be adjusted and made easier according to the conditions and needs of various stakeholders. In addition, SITOLAUT also has several new features, including being integrated with DAMRI (*Djawatan Angkoetan Motor Repoeblik Indonesia* or Indonesian bus operator), payment integration through Bank Rakyat Indonesia's Virtual Account (BRIVA) and BRI Store, an LCL feature, enabling route creation and adding additional hubs and spoke ports, as well as allowing for scheduling ship orders.

In general, SITOLAUT is not yet perfect and will continue to be developed over time, coupled with equitable distribution of application utilisation throughout the archipelago. Therefore, it is possible that later, there will be the latest additional features in the SITOLAUT application. This is also in line with the dissemination of the use of the application, which also continues to be voiced, given that Indonesia often experiences gaps in information absorption and the readiness of the parties who must be involved. However, apart from that, the presence of SITOLAUT should aim to provide several benefits, including:

(1) Providing media to all entities (consignees, shippers, suppliers, resellers and shipping operators) to be able to transact in the goods and livestock sea highway program with a system that has been designed according to the regulations made by the regulator.

(2) Provide a tracking system for all transactions carried out by all entities of the sea goods/livestock highway and can be easily monitored.

(3) Providing transaction information in the form of reports on the delivery of goods and livestock, such as manifests, shipping orders, release orders and other reports.

(4) Being easy to use, because it is designed according to the needs of various stakeholders.

4.5 SIJUKA

Sistem Persetujuan Penggunaan Kapal Asing (Information System for Approval of Use of Foreign Vessels) or SIJUKA is an application that follows the presence of the previous SITOLAUT, which is also an information system-based application. In addition, SIJUKA is also one of the development modules of SIMLALA, which is a web-based approval service, which is expected to accommodate time efficiency and transparency in submitting the Foreign Vessel Usage Approval or *Persetujuan Penggunaan Kapal Asing* (PPKA) (Thenniarti, 2020).

SIJUKA was officially launched at the end of 2021, which also indicates that the system is still in the early socialisation stage, so not much information can be obtained from user experience. In other words, the utilisation of SIJUKA cannot be said to be maximal, so it is possible it will encounter several obstacles on a small, medium and large scale in the future, as well as technical and non-technical obstacles.

We also consider that the application in question is the starting point of the digitisation stage: users at this early stage can actively provide feedback and assessments of the application. Developers are now able to provide maximum service to the running of the application, because it will later become an application with a crucial function. To achieve this, the steps taken are to ensure the absorption of information from socialisation to potential users throughout the archipelago and ensure that all parties are ready to switch to using an online-based system.

5. Analysis and discussion

5.1 Descriptive analysis

In general, the demographics of the respondents in this study can be seen in Table 3, where the majority of respondents are male (85.2%) and the rest are women. The majority of respondents were aged 36–40 years (25.9%), followed by 31–35 years (22.2%), 41–45 years (18.5%), 46–50 years (18.5%), 21–25 years (7.4%) and 26–30 years (7.4%). The majority of respondents' last education was undergraduate (63.0%), with the majority domiciled in Surabaya (48.1%).

Meanwhile, the majority of industrial sectors/sectors are harbourmaster (18.5%) and cruise (18.5%) and shipping (11.1%), with the majority commodities being general cargo (18.5%) and containers (18.5%). However, 33.3% of respondents did not answer the question asked. This is also the same as the question of monthly turnover, where 40.7% did not fill an answer in and the majority of monthly turnover was greater than Rs 300,000,000.00 (40.7%). The most widely used information system by respondents was INAPORTNET (88.9%), followed by SIMLALA (29.6%), SITOLAUT (14.8%) and SIJUKA (7.4%), with the majority of users having used it for more than one year (85.2%). The majority of respondents in this study claimed to obtain information about

Variable	Items	Frequency	Percentage
Gender	Male	23	85.2
	Female	4	16.7
Age	21–25	2	7.4
	26–30	2	7.4
	31–35	6	22.2
	36–40	7	25.9
	41–45	5	18.5
	46–60	5	18.5
Educational background	Senior high school	3	11.1
	Diploma (D1/D3)	2	7.4
	Undergraduate	17	63.0
	Postgraduate	5	18.5
Place of residence/Domicile	Bitung	7	25.9
	Jakarta	7	25.9
	Surabaya	13	48.1
Industrial sector/Sector	Exlar	1	3.7
	Service	1	3.7
	Kalla Lines	1	3.7
	Agency	1	3.7
	Harbour	1	3.7
	Logistics	1	3.7
	Manadomina Citra Taruna	1	3.7
	Meratus Line	1	3.7
	Staff Operations	1	3.7
	Cruise	5	18.5
	Tanto Line Cruise	1	3.7
	Temas Line Cruise	1	3.7
	Pelni	1	3.7
	Shipping	3	11.1
	Shipping Spil Line	1	3.7
	Harbormaster	5	18.5
	Water transportation	1	3.7
The most transported commodity (some fill more than one type)	Foodstuffs	1	3.7
	Staple	1	3.7
	Production Goods	1	3.7
	Mixture	1	3.7
	Chemical Oil	1	3.7
	Bulk	1	3.7
	General Cargo	5	18.5
	Fish and Wood	1	3.7
	Container	5	18.5
	Coal	1	3.7
	Marine Logistics	1	3.7
	Passenger	1	3.7
	Cement	2	7.4
	Oil	1	3.7
	Not filling	9	33.3
Monthly turnover	<Rp 50.000.000	3	11.1
	Rp50.000.000-Rp100.000.000	1	3.7
	Rp100.000.000-Rp150.000.000	1	3.7
	>Rp300.000.000	11	40.7
	Not filling	11	40.7

(*continued*)

Table 3. Demographic distribution

Variable	Items	Frequency	Percentage
What information system do you use? (can choose more than one)	INAPORTNET	24	88.9
	SIMLALA	8	29.6
	SITOLAUT	4	14.8
	SIJUKA	2	7.4
How long have you used the system?	Between 7–9 months	1	3.7
	Between 10 months and 1 year	3	11.1
	More than 1 year	23	85.2
How do you find out about the service?	Government Circular	22	81.5
	Colleagues/Relations	4	14.8
	Other	1	3.7
How often do you use the service?	Every day	15	55.6
	Several times a week	9	33.3
	Once in a week	2	7.4
	Several times a month	1	3.7
Are you satisfied with the service?	Yes	27	100
	No	N/A	

Table 3.

services through circulars from the government (81.5%) and colleagues/relations (14.8%) and the frequency they used the application was every day (55.6%) and several times a week (33.3%).

5.2 Service acceptance analysis

First, we conducted a normality test. At this stage, an anomaly occurs in the value of the trust aspect or trust. Therefore, the existing values are transformed, in other words, converted into a logarithmic function first. After the transformation or conversion stage, the results of the normality test are shown in the following table.

From Table 4 above, it can be seen that the results of the normality test are adequate and in accordance with the criteria. The following table displays a descriptive statistic related to the transformation with logarithms. Ordinal regression was carried out because the questionnaire distributed to users consisted of questions using a Likert scale. From here, we also obtained information about the goodness of fit of the model that has been built. The model is intended to be used with service acceptance as the dependent variable, and other variables, such as PU, PEU, T, PIC and C as independent variables.

The results in Table 5 show information on goodness-of-fit and how the model meets these criteria. Furthermore, Table 6 regarding parameter estimation, ITU is selected as the dependent variable. The results are displayed in red.

The ordinal regression coefficient can simply be interpreted as a predicted change or an estimate in the logarithm of the probability of the dependent variable being in a higher (as opposed to a lower) group/category (controlling for the remaining independent variables),

	Kolmogorov-Smirnov[a]			Shapiro–Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
log_ITU	0.374	27	0.000	0.701	27	0.000
log_PU	0.220	27	0.002	0.828	27	0.000
log_PEU	0.171	27	0.041	0.845	27	0.001
log_T	0.172	27	0.040	0.888	27	0.007
log_PIC	0.243	27	0.000	0.816	27	0.000
log_C	0.235	27	0.000	0.803	27	0.000

Note(s): a. Lilliefors Significance Correction

Table 4.
Normality test

given a per unit increase in the independent variable. A positive coefficient in the estimate can be interpreted as:

(1) For every one-unit increase in the independent variable, there is a certain amount of predicted increase in the log odds of being at a higher level in the dependent variable. For example, in Table 6, it is shown that there is an estimated 2.132 increase in the PU of the service, that the user's perception of the usefulness of the service will have an effect on increasing the ITU the digitisation service.

(2) This means that, as the value of the independent variable increases, there is a possibility of a decrease at a higher level in the dependent variable.

Estimates or negative coefficients are defined as follows:

(1) For every one-unit increase in the independent variable, there is a certain predictive decrease in the log odds of being at a higher level in the dependent variable. For example, the aspect of user trust in the digitisation of the services offered is negative, at −4.723, so there will be a certain decrease in the prediction of the ITU the service.

(2) This means that as the value of the independent variable increases, there is a possibility of a decrease at a higher level in the dependent variable (See Table 7).

After conducting the analysis and interpretation, generalised linear models were used to obtain the goodness of fit of the built model. From Table 6 above, it can be seen that the ITU port digitisation services will increase if (one of them) the PU of the service also increases, because there is an estimate of 2,132 increases at this level will increase user intentions at the same time. Second, with respect to user trust, when there is an increase from the value of −4.723, it will bring a very sharp decrease in the ITU the service. Furthermore, the estimated value of context (C) is high, meaning that users expect that using the application will be a good experience and bring benefits to their business. In particular, although all variables have an effect, the highest negative value (trust) and the highest positive value (context) need special attention.

Model	−2 log likelihood	Chi-square	df	Sig.
Intercept only	61.191			
Final	21.036	40.155	5	0.000

Note(s): Link function: Logit

Table 5. Model fit information

		Estimate	Std. Error	Wald	df	Sig.	95% confidence interval Lower bound	Upper bound
Threshold	[ITU = 3.00]	35.460	11.804	9.024	1	0.003	12.324	58.596
	[ITU = 3.50]	41.300	13.742	9.033	1	0.003	14.367	68.233
	[ITU = 4.00]	45.627	14.923	9.349	1	0.002	16.379	74.875
	[ITU = 4.50]	47.785	15.488	9.520	1	0.002	17.430	78.140
Location	PU	2.132	2.117	1.014	1	0.314	−2.017	6.280
	PEU	4.279	3.335	1.646	1	0.199	−2.257	10.816
	T	−4.723	3.779	1.562	1	0.211	−12.129	2.683
	PIC	3.698	3.058	1.463	1	0.226	−2.294	9.691
	C	5.294	2.505	4.467	1	0.035	0.385	10.204

Note(s): Link function: Logit

Table 6. Parameter estimation

	Value	df	Value/df
Deviance	21.036	79	0.266
Scaled Deviance	21.036	79	
Pearson Chi-Square	31.806	79	0.403
Scaled Pearson Chi-Square	31.806	79	
Log Likelihood[b]	−10.518		
Akaike's Information Criterion (AIC)	39.036		
Finite Sample Corrected AIC (AICC)	49.625		
Bayesian Information Criterion (BIC)	50.699		
Consistent AIC (CAIC)	59.699		
Dependent Variable: ITU			
Model: (Threshold), PU, PEU, T, PIC, C			

Note(s): [a]. Information criteria are in smaller-is-better form
[b]. The full log likelihood function is displayed and used in computing information criteria

Table 7.
Goodness of fit[a]

5.3 Innovation diffusion analysis

This survey section discusses the perceived benefits of digitising information system services at the Directorate of Traffic and Sea Transportation of the Ministry of Transportation. This research produces a more specific analysis related to the factors of adoption and diffusion of products as well as services. These factors are supported by the theory of diffusion of innovation (Rogers, 1995), which is divided into four factors, including:

(1) The advantages and relative advantages compared to other products and services.

(2) Whether the products and services are simple or complex.

(3) The capability for trial or trialability.

(4) The obviousness of the features and benefits offered.

However, in this study, one of the factors was omitted in the formation of the questionnaire, namely the user's ability to try existing product or service innovations. Therefore, the factors that are considered to play a role include:

(1) The relative benefits are perceived by the user.

(2) The advantages compared to other products and services.

(3) The complexity of the products and services.

(4) The obviousness of the features and benefits offered.

Table 8 shows the results of the correlation analysis using PCA and the varimax rotation method using Kaiser normalisation.

Table 8 shows the value of each item of the devised questionnaire. Statements C3 and C11 were excluded from the analysis because their values did not meet the standard factor loading while the other statement items met the criteria.

From Table 8, it can be seen that the largest average value on the questionnaire is the perception of the superiority of the service product compared to other services or products, at 4.44, followed by a trialability factor of 4.43. This figure supports the finding that port digitisation products and services are expected to be easy to understand and can be tried by potential users first. In line with this, it is clear that the correlation between the factors driving the adoption of port digitisation products and services is positive and quite significant (see Tables 9 and 10.)

Based on the information in Table 10, we found that the compatibility aspect has a high correlation with the observability aspect, which is 0.955 with a significance level of 99%. Complexity has a correlation of 0.891 with the advantages of digitising services compared to other products/services.

5.4 Implications

Based on these results, there are several implications, suggestions and recommendations that can be drawn which are summarised in Table 11.

Furthermore, there are several recommendations for future research. Our study does not distinguish between the information systems for analysis. Thus, focussing on each type of information system could be a possible avenue for future research. This would certainly be useful for gaining deeper understanding of these dynamics, because each type of information system has unique characteristics.

In addition, research similar to this study is still very feasible to carry out using other methods, such as Qualitative Comparative Analysis (QCA), to deepen the findings both qualitatively and quantitatively.

6. Concluding remarks

This study has several conclusions. First, to build ports in Indonesia with high maritime supply chain efficiency, low costs and high competitiveness, digitalisation, which has generally been implemented in several major world ports should be considered a major

Statement	1	2	3	4
C1	0.581	0.477	0.365	0.233
C2	0.538	0.433	0.532	0.332
C4	0.205	0.168	0.602	0.721
C5	0.512	0.402	0.301	0.430
C6	0.710	0.338	0.341	0.371
C7	0.570	0.663	0.203	0.267
C8	0.844	0.261	0.156	0.203
C9	0.578	0.312	0.526	0.406
C10	0.577	0.553	0.430	0.357
C12	0.222	0.446	0.489	0.603
C13	0.565	0.187	0.156	0.690
C14	0.422	0.161	0.733	0.283
C15	0.524	0.220	0.311	0.620
C16	0.320	0.697	0.328	0.429
C17	0.809	0.221	0.304	0.178
C18	0.461	0.414	0.494	0.403
C19	0.354	0.618	0.503	0.318
C20	0.776	0.291	0.285	0.381
C21	0.723	0.483	0.246	0.227
C22	0.693	0.398	0.274	0.370
C23	0.329	0.807	0.304	0.218
C24	0.588	0.436	0.505	0.270
C25	0.553	0.654	0.353	0.290
Mean	4.37	*4.44*	4.01	*4.43*
Std. Deviation	0.62	0.65	0.58	0.64

Note(s): Extraction Method: Principal Component Analysis
Rotation Method: Varimax with Kaiser Normalization
a. Rotation converged in 9 iterations

Table 8. Rotated component matrix[a]

priority. The elements of digitisation include: creating an integrated system; lessening the bureaucracy; having a system that can be monitored remotely and at any time; prioritising automation; being safe from the threat of crime and technical problems. Most ports in Indonesia have actually implemented programs such as these. However, the main barrier to the uptake of such systems is related to the uneven distribution of port development in the country's various regions.

Table 9.
Descriptive statistics

	Mean	Std. Deviation	*N*
relative_adv	4.3678	0.61756	27
Compatibility	4.4444	0.65167	27
Complexity	4.4081	0.58122	27
Observability	4.4281	0.64081	27

Table 10.
Correlation between variables

		relative_adv	Compatibility	Complexity	Observability
Spearman's rho	relative_adv	1.000	0.926**	0.895**	0.907**
	compatibility	–	1.000	0.891**	0.955**
	complexity	–	–	1.000	0.885**
	observability	–	–	–	1.000

Note(s): **Correlation is significant at the 0.01 level (2-tailed)

Table 11.
Implications

No.	Implications
1	Changes in the dynamics of the maritime sector and technological developments require all parties, including the government as regulator and policymaker to acclimate
2	Internal capacity building is necessary so that the government can stand on par with industry – lest the guests are welcomed by the hosts
3	Several digital technologies have developed quite maturely and must be tested in a wider field/sector, for example, the benefit of IoT sensors to monitor government assets/ships/containers
4	Many digital technologies have developed quite maturely and deserve to be tested in a wider field/sector, for example, the use of IoT sensors to monitor government assets/ships/containers
5	From the TAM concept, the intention to use the systems mentioned above will rise and is closely related to the perception of acceptability and trust. Context also plays an important role. Therefore, socialisation needs to be strengthened so that users feel the perception of benefits, believe in the reliability of the system and so that the system will help their business processes
6	From the concept of diffusion of innovation, more users will use digital systems/services if port digitisation products and services are easy to understand and can be tried out first. The compatibility element is highly correlated with the observability aspect, indicating the importance of socialising with (prospective) users by ensuring that the system that has been developed can be observed beforehand but is still compatible with the system they are currently using
7	The variety of available digital service systems, on the other hand, shows that system integration is a very important issue. Separate information systems run the risk of manipulation and moral hazard. The door-to-door integration of data will not only guarantee the reliability of data and information but will also reduce the potential risk of fraud and moral hazards from users
8	To ensure harmonious integration, a digitalisation architecture roadmap is needed at the Ministry of Transportation. This is needed not only to harmonise various systems within the Ministry of Transportation alone, but also to assist the integration process with other ministries and agencies (for example, the Directorate General of Customs and Excise, the DJA, the Ministry of Finance, the Ministry of Energy and Mineral Resources and so on)

Second, the ITU port digitisation services will increase if the PU of the service also increases. Hence, based on the results of the study, it can be concluded that if the consumer value for the application is high, then the customer's ITU it will also be high. Third, the negative coefficient trust variable indicates that when there is an increase, it will bring a very sharp decrease in the number of people with an ITU the service. In other words, there is an increase in distrust that affects the ITU these services. In addition, the high value of the context estimate (C) indicates that users expect to have a good experience as well as bring benefits to their business by using the application.

For the short and medium term, the Ministry of Transportation needs to work with other authorities or regulators to encourage users to make more use of these applications. In addition, the Ministry of Transportation needs to increase user trust by increasing compatibility to reduce system complexity (making it easier for users to use it, making it flow clearly and minimise errors, make it accessible from anywhere, etc.). In the end, the Ministry of Transportation needs to improve the obviousness of the benefits of this system, because based on the PCA variable analysis uptake is highly correlated with the observability of benefits.

In the long term, decision makers need to continue to increase capacity and balance the implementation of digital technology in a balanced way with other (more advanced) countries and evenly distribute it throughout Indonesia.

This research is not without its limitations. First, we did not differentiate between each of the information systems for analysis. We know that each of the information systems mentioned above has unique characteristics. Second, we faced difficulties at the end of the year to find respondents who really understood the aforementioned above system. This system is not an application that is known to everyone. In any one particular company/organisation, maybe only one or two people understand the above system. This made it challenging for us to find adequate respondents.

Last but by no means least, digitalisation in the Indonesian maritime sector is rapidly gathering pace. The transition towards digitisation and automation is speeding up, particularly in the last couple of years, to drive competitiveness and enhance operational efficiency. This process also has not been without its difficulties. However, regulators and policymakers must run a tight ship without trying to make waves, nor compromise the extant rules, regulations and restrictions.

References

Adabere, S., Kwateng, K.O., Dzidzah, E. and Kamewor, F.T. (2021), "Information technologies and seaport operational efficiency", *Marine Economics and Management*, Vol. 4 No. 2, pp. 77-96.

Ahmad, R.W., Hasan, H., Jayaraman, R. and Salah, K. (2021), "Blockchain applications and architectures for port operations and logistics management", *Research in Transportation Business and Management*, Vol. 41, 100620.

Aiello, G., Giallanza, A. and Mascarella, G. (2020), "Towards shipping 4.0. A preliminary gap analysis", *Procedia Manufacturing*, Vol. 42, pp. 24-29.

Amin, C., Mulyati, H., Anggraini, E. and Kusumastan, T. (2021), "Impact of maritime logistics on archipelagic economic development in eastern Indonesia", *The Asian Journal of Shipping and Logistics*, Vol. 37 No. 2, pp. 157-164.

Brunila, O.-P., Kunnaala-Hyrkki, V. and Inkinen, T. (2021), "Hindrances in port digitalization? Identifying problems in adoption and implementation", *European Transport Research Review*, Vol. 13 No. 62, pp. 1-10.

Burton-Jones, A. and Hubona, G. (2005), "ACM SIGMIS database: the DATABASE for advances in information systems", *Individual Differences and Usage Behavior: Revisiting a Technology Acceptance Model Assumption*, Vol. 36 No. 2, pp. 58-77.

Capgemini, (2017), “The discipline of innovation–Making sure your innovation center actually makes your organization more innovative”, [Online] [accessed 2021].

Carlan, V., Sys, C., Vanelslander, T. and Roumbouts, A. (2017), “Digital innovation in the port sector: barriers and facilitators”, *Competition and Regulation in Network Industries*, Vol. 18 Nos 1-2, pp. 71-93.

Carruthers, P. (2016), “Two systems for mindreading?”, *Review of Philosophy and Psychology*, Vol. 7 No. 1, pp. 141-162.

Chau, P. and Hu, P. (2001), “Information technology acceptance by individual professionals: a model comparison approach”, *Decision Sciences*, Vol. 32 No. 4, pp. 699-719.

Collier, P. (2007), *The Bottom Billion: Why the Poorest Countries Are Failing and what Can Be Done about it*, Oxford University Press, New York.

Creswell, J. (2003), “A framework for design”, In: *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, SAGE Publications, s.l., pp. 9-11.

CSIS (2014), “Jokowi spells out vision for Indonesia’s ‘global maritime Nexus’”, [Online], available at: https://www.csis.org/analysis/jokowi-spells-out-vision-indonesia%E2%80%99s-%E2%80%9Cglobal-maritime-nexus%E2%80%9D (accessed 2021).

Czachorowski, K., Solesvik, M. and Kondratenko, Y. (2020), “The application of blockchain technology in the maritime industry”, *Studies in Systems, Decision and Control*, Vol. 171, pp. 561-577.

D’Amico, G., Szopik-Depczynska, K., Dembinska, I. and Ioppolo, G. (2021), “Smart and sustainable logistics of Port cities: a framework for comprehending enabling factors, domains and goals”, *Sustainable Cities and Society*, Vol. 69, pp. 1-19.

Davis, F. (1993), “User acceptance of information technology: system characteristics, user perceptions and behavioral impacts”, *International Journal of Man-Machine Studies*, Vol. 38 No. 3, pp. 475-487.

Davis, F., Bagozzi, R. and Warshaw, P. (1989), “User acceptance of computer technology: a comparison of two theoretical models”, *Management Science*, Vol. 35 No. 8, pp. 982-1003.

Ding, H., Gao, R.X., Isaksson, A.J., Landers, R.G., Parisini, T. and Yuan, Y. (2020), “State of AI-based monitoring in smart manufacturing and introduction to focused section”, *IEEE/ASME Transactions on Mechatronics*, Vol. 25 No. 5, pp. 2143-2154.

Dwarakish, G.S. (2015), “Review on the role of ports in the development of a nation”, *Aquatic Procedia*, Vol. 4, pp. 295-301.

East of Doing Business (2019), “Measuring business regulations”, [Online] (accessed 1 January 2022).

Eisenhardt, K. and Graebner, M.E. (2007), “Theory building from cases: opportunities and challenges”, *Academy of Management Journal*, Vol. 50 No. 1, pp. 25-32.

Ellingsen, O. and Aasland, K. (2019), “Digitalizing the maritime industry: a case study of technology acquisition and enabling advanced manufacturing technology”, *Journal of Engineering and Technology Management*, Vol. 54, pp. 12-27.

Figueroa-Lorenzo, S., Añorga, J. and Arrizabalaga, S. (2020), “A survey of IIoT protocols: a measure of vulnerability risk analysis based on CVSS”, *ACM Computing Surveys (CSUR)*, Vol. 53 No. 2, pp. 1-53.

González-Cancelas, N., Molina, S.B., Soler-Flores, F. and Camarero-Orive, A. (2020), “Using the SWOT methodology to know the scope of the digitalization of the Spanish ports”, *Logistics*, Vol. 4 No. 3, p. 20.

Haralambides, H.E. (2019), “Gigantism in container shipping, ports and global logistics: a time-lapse into the future”, *Maritime Economics and Logistics*, Vol. 21 No. 1, pp. 1-60.

Hinings, B., Gegenhuber, T. and Greenwood, R. (2018), “Digital innovation and transformation: an institutional perspective”, *Information and Organization*, Vol. 28 No. 1, pp. 52-61.

Inkinen, T., Helminen, R. and Saarikoski, J. (2019), "Port digitalization with open data: challenges, opportunities, and integrations", *Journal of Open Innovation: Technology, Market, and Complexity*, Vol. 5 No. 30, pp. 1-16.

Inkinen, T., Helminen, R. and Saarikoski, J. (2021), "Technological trajectories and scenarios in seaport digitalization", *Research in Transportation Business and Management*, Vol. 41, pp. 1-11, 100633.

Junarsin, E., Hanafi, M.M., Iman, N., Arief, U., Naufa, A.M., Mahastanti, L. and Kristanto, J. (2021), "Can technological innovation spur economic development? The case of Indonesia", *Journal of Science and Technology Policy Management*. doi: 10.1108/JSTPM-12-2020-0169 (Forthcoming).

Kemenhub (2021), "Sudah 76 pelabuhan gunakan inaportnet, khusus Priok ada penambahan modul", *Ocean Week*, available at: https://oceanweek.co.id/sudah-76-pelabuhan-gunakan-inaportnet-khusus-priok-ada-penambahan-modul/.

Kharizsa, A. (2021), "Sosialisasi peraturan bidang transportasi laut", *Direktorat Jenderal Perhubungan Laut*, available at: https://hubla.dephub.go.id/uppbabang/page/news/read/12004/sosialisasi-peraturan-bidang-transportasi-laut-kembali-di-gelar-di-yogyakarta.

Lambourdiere, E. and Corbin, E. (2020), "Blockchain and maritime supply-chain performance: dynamic capabilities perspective", *Worldwide Hospitality and Tourism Themes*, Vol. 12 No. 1, pp. 24-34.

Lee, H.H., Fiore, A.M. and Kim, J. (2006), "The role of the technology acceptance model in explaining effects of image interactivity technology on consumer responses", *International Journal of Retail and Distribution Management*, Vol. 34 No. 8, pp. 621-644.

Liu, L., Zhang, Y., Hu, Y., Wang, Y., Sun, J. and Dong, X. (2022), "A hybrid-clustering model of ship trajectories for maritime traffic patterns analysis in port area", *Journal of Marine Science and Engineering*, Vol. 10 No. 3, p. 342.

Morakanyane, R., Grace, A. and O'Reilly, P. (2017), "Conceptualizing digital transformation in business organizations: a systematic review of literature", *Bled eConference*, Vol. 21, pp. 1-19.

Mosconi, E., Packmohr, S. and Santa-Eulalia, L.A. (2019), *Making Digital Transformation Real*, Grand Wailea, Maui, HI, pp. 4924-4926.

Nguyen, T.T., Tran, D.T.M., Duc, T.T.H. and Thai, V.V. (2022), "Managing disruptions in the maritime industry–a systematic literature review", *Maritime Business Review*. doi: 10.1108/MABR-09-2021-0072 (Forthcoming).

Parola, F., Satta, G., Buratti, N. and Vitellaro, F. (2021), "Digital technologies and business opportunities for logistics centres in maritime supply chains", *Maritime Policy and Management*, Vol. 48 No. 4, pp. 461-477.

Queiroz, M.M., Pereira, S.C.F., Telles, R. and Machado, M.C. (2019), "Industry 4.0 and digital supply chain capabilities: a framework for understanding digitalisation challenges and opportunities", *Benchmarking: An International Journal*, Vol. 28 No. 5, pp. 1761-1782.

Raitoharju, R. (2007), "Comparing the acceptance of information technology among public and private healthcare sector employees in Finland", *International Journal of Healthcare Technology and Management*, Vol. 8 Nos 1-2, pp. 84-96.

Rogers, E. (1995), "Lessons for guidelines from the diffusion of innovations", *The Joint Commission Journal on Quality Improvement*, Vol. 21 No. 7, pp. 324-328.

Senyo, P.K., Effah, J. and Osabutey, E.L. (2021), "Digital platformisation as public sector transformation strategy: a case of Ghana's paperless port", *Technological Forecasting and Social Change*, Vol. 162, pp. 1-13, 120387.

Simoni, M., Schiavone, F., Risitano, M., Leone, D. and Chen, J. (2022), "Group-specific business process improvements via a port community system: the case of Rotterdam", *Production Planning and Control*, Vol. 33 No. 4, pp. 371-385.

Sys, C. and Vanelslander, T. (2020), "Future maritime supply networks: key issues and solutions", in *In Maritime Supply Chains*, Elsevier, s.l., pp. 261-282.

Thenniarti, D. (2020), “Kemenhub luncurkan Aplikasi SIJUKA untuk Kapal asing”, [Online], available at: https://infopublik.id/kategori/nasional-ekonomi-bisnis/499244/kemenhub-luncurkan-aplikasi-sijuka-untuk-kapal-asing.

Tijan, E., Jović, M., Aksentijević, S. and Pucihar, A. (2021), “Digital transformation in the maritime transport sector”, *Technological Forecasting and Social Change*, Vol. 170, pp. 1-15.

Tu, N., Adiputranto, D., Fu, X. and Li, Z.C. (2018), “Shipping network design in a growth market: the case of Indonesia”, *Transportation Research Part E*, Vol. 117, pp. 108-125.

Vairetti, C., González-Ramírez, R.G., Maldonado, S., Álvarez, C. and Voβ, S. (2019), “Facilitating conditions for successful adoption of inter-organizational information systems in seaports”, *Transportation Research Part A*, Vol. 130, pp. 333-350.

Venkatesh, V. and Morris, M. (2000), “Why don’t men ever stop to ask for directions? Gender, social influence, and their role in technology acceptance and usage behavior”, *MIS Quarterly*, Vol. 24 No. 1, pp. 115-139.

Venkatesh, V., Thong, J.Y. and Xu, X. (2012), “Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology”, *MIS Quarterly*, Vol. 36 No. 1, pp. 157-178.

Wahyuni, S., Taufik, A.A. and Hui, F. (2019), “Revealing Indonesian port competitiveness”, *Infrastructure Investment in Indonesia: A Focus on Ports*, Open Book Publishers, Cambridge.

Wu, D., Jennings, C., Terpenny, J., Gao, R.X. and Kumara, S. (2017), “A comparative study on machine learning algorithms for smart manufacturing: tool wear prediction using random forests”, *Journal of Manufacturing Science and Engineering*, Vol. 139 No. 7, pp. 1-9.

Yang, C.-S. (2019), “Maritime shipping digitalization: blockchain-based technology applications, future improvements, and intention to use”, *Transportation Research Part E*, Vol. 131, pp. 108-117.

Yarbrough, A.K. and Smith, T.B. (2007), “Technology acceptance among physicians: a new take on TAM”, *Medical Care Research and Review*, Vol. 64 No. 6, pp. 650-672.

Yin, R.K. (2013), “Validity and generalization in future case study evaluations”, *Evaluation*, Vol. 19 No. 3, pp. 321-332.

Appendix

Items	Mean	Standard error	Standard deviation	Sample variance	Sum
Perceived usefulness					
B1	4.56	0.11	0.58	0.33	123
B2	4.44	0.14	0.75	0.56	120
B3	4.56	0.10	0.51	0.26	123
B4	4.41	0.15	0.80	0.64	119
B5	4.22	0.16	0.85	0.72	114
B6	4.63	0.12	0.63	0.40	125
Perceived ease of use					
B7	4.44	0.13	0.70	0.49	120
B8	4.48	0.11	0.58	0.34	121
B9	4.37	0.13	0.69	0.47	118
B10	4.37	0.13	0.69	0.47	118
B11	4.59	0.13	0.69	0.48	124
Trust					
B12	4.41	0.11	0.57	0.33	119
B13	4.70	0.12	0.61	0.37	127
B14	4.56	0.11	0.58	0.33	123
B15	4.26	0.14	0.71	0.51	115
B16	4.44	0.12	0.64	0.41	120
B17	4.33	0.13	0.68	0.46	117
B18	4.44	0.12	0.64	0.41	120
Personal initiativeness and characteristics					
B26	4.48	0.12	0.64	0.41	121
B27	4.48	0.13	0.70	0.49	121
B28	4.52	0.12	0.64	0.41	122
B29	4.52	0.12	0.64	0.41	122
B30	4.59	0.11	0.57	0.33	124
B31	4.59	0.12	0.64	0.40	124
B32	4.59	0.12	0.64	0.40	124
Intention to use					
B33	4.63	0.12	0.63	0.40	125
B34	4.52	0.13	0.70	0.49	122
Relative advantage					
C1	4.22	0.14	0.75	0.56	114
C2	4.26	0.14	0.71	0.51	115
C3	4.59	0.11	0.57	0.33	124
C4	4.52	0.13	0.70	0.49	122
C5	4.41	0.13	0.69	0.48	119
C6	4.22	0.15	0.80	0.64	114
Compatibility					
C7	4.52	0.11	0.58	0.34	122
C8	4.52	0.13	0.70	0.49	122
C9	4.41	0.14	0.75	0.56	119
C10	4.37	0.14	0.74	0.55	118
Complexity/simplicity					
C11	4.41	0.12	0.64	0.40	119
C12	4.30	0.13	0.67	0.45	116

(*continued*)

Table A1.
Mean dan standard deviation

Items	Mean	Standard error	Standard deviation	Sample variance	Sum
C13	4.30	0.15	0.78	0.60	116
C14	4.67	0.12	0.62	0.38	126
C15	4.56	0.12	0.64	0.41	123
C16	4.37	0.12	0.63	0.40	118
C17	4.52	0.12	0.64	0.41	122
C18	4.33	0.13	0.68	0.46	117
Observability					
C19	4.44	0.14	0.75	0.56	120
C20	4.37	0.14	0.74	0.55	118
C21	4.37	0.14	0.74	0.55	118
C22	4.52	0.12	0.64	0.41	122
C23	4.48	0.12	0.64	0.41	121
C24	4.41	0.13	0.69	0.48	119
C25	4.41	0.13	0.69	0.48	119

Table A1.

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