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# The impact of the digital maturity level on port operations in Africa

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# THE IMPACT OF THE DIGITAL MATURITY LEVEL ON PORT OPERATIONS IN AFRICA

By

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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.

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(Date):20TH SEPTEMBER 2022
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Supervised by:
**.....**

Supervisor's affiliation**.....**

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# Abstract

Title of Dissertation: **The Impact of the Digital Maturity Level on Port Operations in Africa**

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Digital maturity refers to the level or capacity of an organization to transform and embrace technology for it to remain competitive. It has both a technological and managerial component. Previous research has shown more digitally mature organizations usually outperform their competitors on many aspects, including financial performance. Other benefits include increased productivity and efficiency, reduced costs and environmental sustainability. Digital maturity in the shipping and Port domains are largely unexplored.

The aim of this study is to ascertain the impacts of digital maturity levels on port operations in Africa. The study employed the use of a novel digital maturity model that was developed for the maritime transport industry to establish the level of digital maturity of the various players. The researcher used both interviews as well as questionnaires to collect data aligned to the dimensions of the digital maturity model. A total of 43 respondents drawn from 7 ports of Africa participated in the study; 7 via interviews and 36 via online questionnaires. The respondents were further asked to identify the digital platforms and technologies in use at their Ports, their impact, challenges and how these challenges can be overcome.

The findings of the study showed that, according to the respondent's perceptions, the Ports and Port users in Africa are generally at the structured stage of digital maturity. However, the Port user organizations had a higher maturity level and were advancing into the Integrated level. Whereas integrated port community and single window systems have been fully embraced, the level of use of digitalized Port equipment remains low in Africa. In addition, some of the ports have invested in block-chain, IOT and advanced analytics technologies to some extent while higher level technologies such as AI, Mass and Robotics have very limited application. The use of digital platforms and technologies has increased levels of efficiency, reduced vessel turnaround times and reduced the use of paper in organizations.

The major challenges associated with digitalization were mainly human-related than IT related. There is a great need to prioritize, fully engage and train the human resource when introducing digitalization programs to reap the benefits of digitalization. In addition, raising the collaboration with key stakeholders and with other Ports that have invested in digitalized equipment and systems would be beneficial to Ports in Africa. Lastly, investment in cyber-secure systems and cyber-security awareness levels remains key as the level of cyber threats within the maritime transport industry has increased four-fold in recent times.

**KEYWORDS**: Assessment, Digital Maturity, Performance, Port Operations, Port choice, Transhipment, Digitalization

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# List of Abbreviations

| | |
|---|---|
| ACT | Automated Container Terminal |
| AI | Artificial Intelligence |
| COMESA | Common Market for Eastern and Southern Africa |
| EAC | East African Community |
| FAL | Convention on Facilitation of International Maritime Traffic |
| GTO | Global Terminal Operator |
| ICT | Information and Communications Technology |
| IPMS | Integrated Port Management System |
| KPA | Kenya Ports Authority |
| KPI | Key Performance Index |
| OECD | Organisation for Economic Co-operation and Development |
| PCS | Port Community System |
| SWS | Single Window System |
| TEU | Twenty Equivalent Unit |
| TFA | Trade Facilitation Agreement |
| UNCTAD | United Nations Conference on Trade and Development |

# Chapter 1 Introduction

## 1.1 Background

The port facilities, shipping lines, the clearing and forwarding agencies, and connective road and rail networks all need to exchange data to move a consignment between jurisdictions for efficient movement of cargo to be achieved (Balcı, 2021). In addition, one of the world's leading classification society and leading advisor for the maritime industry have stated that "the transition towards automation and digitalization is speeding up in the maritime industry". Digital technologies are being used to enhance organizational competitiveness, improve operational efficiency levels as well as move the industry to realize the goal of zero emissions by 2050 (DNV, 2020).

Digitalization can be referred to as the use of digital technology to transform the way business is operated. Most of the existing literature indicate that digitalization within the operations of a business has a positive impact on its performance. The digital transformation era has seen many of the operations, processes and facilities within container shipping being digitalized. Digitalization has translated into various benefits which include increased integration with various stakeholders such as customers and suppliers as well as improved performance and efficiency levels (Balcı, 2021).

Organizations need to have a digital strategy in place as they embark on their digitalization journey (Westerman, 2017). A digital strategy defines the short and long term initiatives expected to transform the organization's product offerings as well as create value (Lipsmeier et al., 2020). While one of the aims of digitalization and electronic data exchange is to speed up the processes in Port, the importance of engagement with multiple key stakeholders for successful transitions and its implementation cannot be ignored (IAPH, 2020).

Further, digital maturity refers to an organization's capacity to transform and embrace technology in order to remain competitive. It also describes the achievements an organization in terms of transformation. Digitally mature organizations usually outperform their competitors on many aspects, including financial performance. Digital maturity and digital transformation are often used interchangeably (Teichert, 2019).

The Associated British Ports annual review 2022 report on embracing innovation and sustainability indicates that investments in digitalization and sustainability measures in Wales yielded some benefits. These benefits include increased visibility and insight, streamlined and safer operations in port and fuel efficiency. Further, a reduction in fuel consumption by 95% on some of their port equipment has contributed to reduction of carbon emissions. However, these investments have come with a huge infrastructural cost of approximately £50 million since 2019 (ABP, 2022). In addition, digitalization increases the systems vulnerability to cyber-attacks (Kosiek et al., 2021) and in 2020, cyberattacks in the maritime industry increased by 400 percent (Alamoush et al., 2021). In July 2021, a cyber-attack on Transnet National Port Authority's systems paralyzed the operations in four major ports in South Africa (Reuters, 2021).

## 1.2 Problem Statement

Ports across the world have continued to invest in digitalization. According to Philipp(2020), the ports of Antwerp and Rotterdam in Europe have invested heavily in digital technologies such as Block-chain and Internet of Things (IoT). Utilizing these digital technologies has improved process optimization and enhanced security as well as sustainability in these ports. On the other hand, smaller ports have limited awareness of Industry 4.0, Block-chain and IoT and its benefits. Further, when it comes to investing, developing and implementing innovative technologies, ports normally "*follow"* the leading global transport and logistics companies. They must apply the new digital technology solutions so as to integrate in the global supply chains otherwise they are likely to lose their competitive advantage (Philipp et al. 2018).

The Port of Busan which currently handles approximately 22million TEUs per annum launched a plan in November 2020 to increase its overall capacity by investing in smart technologies (Port, 2021). On the other hand, the Pasir Panjang Terminal in Singapore is one of the leading automated terminals in the world whose operations are enabled by remote-controlled gantry cranes as well as automated guided vehicles. Singapore Port's leadership as a transhipment hub is a result of its geographical location, relatively higher productivity and efficient terminal operations, as well as its connectivity to global liner networks. All these unique features give it momentum to increase its market share (Munim et al., 2021).

In Africa, an example of a port which has completely digitalized the import and export formalities is the Tangier Med Port. Since 2021, operators at this Port are now required to electronically submit all their documents through the online Port Community system. The port is offering training sessions and support to their customers since they are still in the transition phase (TMPA, 2021). In addition, the port successfully facilitated the world's first digitally controlled port arrival in conjunction with Hapag Lloyd and the Anglo-Eastern Ship management. The Kobe Express, with a carrying capacity of 4, 612 TEUs, docked safely at the Tanger Med on 25th June 2021 using the Wärtsilä Navi-Port system having sailed in from Cartagena (Port, 2021b).

Despite the great strides made in the developed countries as noted above, many smaller and middle-sized ports have limited knowledge and application of digital technologies (Philipp et al. 2018). Further, digitalization is associated with many benefits as well as a myriad of challenges. This study therefore seeks to find out the level of digital maturity of Ports in Africa and if this has had any impact on port operations. This study involved respondents from various ports in Africa and bearing in mind the differing understanding when it comes to measuring performance across the Ports, the researcher opted to use subjective data.

## 1.3 Aim and Objectives of the study

The aim of this study is to ascertain the impact of digital maturity levels on port operations. To achieve this aim, the following are the objectives: -

1. To establish the Port Authorities and Port users' perception of the impact of digitalization on port operations in the Africa region.
2. To interrogate the level of digital maturity of the Port Authorities and Port users using subjective data.
3. To find out the major challenges encountered, and opportunities identified by the stakeholders at the different stages of digital maturity.

## 1.4 Research questions

1. How do the Port Authorities and Port users perceive the impact of digitalization on port operations in the Africa region?
2. What is the level of digital maturity of the Port Authorities and Port users in their perspective?
3. What are the major challenges encountered and opportunities identified by the stakeholders at the different stages of digital maturity?

## 1.5 Limitations

The study had a number of limitations namely: -

i) The digital maturity model was being applied and tested for the first time in this study. The model was developed specifically for use by shipping and Ports as there were none existing in literature addressing this industry. The use of the model has been critiqued and duly justified in the next chapter and the researcher notes that there is room for further improvement of the model dimensions in future studies.

ii) A high level of unwillingness of some respondents to participate in the research. In addition, the respondents who wilfully participated sighted

issues of confidentiality regarding how their organizations share data with third parties hence were reluctant to provide key quantitative data. Further, most data on port performance in the region covered by the study is not published in the public domain.

iii) This study focussed on the perceptions of users on digital maturity levels and the perceived impact, which are likely to be biased. This subjectivity means that digital maturity rating level and impact generated for the various organizations may be higher or lower than it would be if more empirical data was used.

iv) The small sample size was another limitation as the study covered 7 ports and attracted a total of 43 respondents. The respondents' views from the ports represented with regard to certain aspects may differ widely and the small sample may not necessarily be representative of the entire region.

## 1.6 Scope and delimitation

The scope of this study was selected Ports within Africa. Respondents were drawn from the North, South, East and Horn of Africa regions and from a diverse group of persons. The Port users who were invited to participate included Port authorities and terminals, shipping agents, transport and logistics companies, customs, freight forwarders, government agencies, importers and exporters.

This was done to get a broader perspective from key stakeholders on the impact of digital maturity on the Port operations. The researcher believed that the diversity of participants would yield interesting perspectives, which would provide insight to the Policy makers and business owners as well as contribute to literature on digital maturity and its impact within the maritime sector.

## 1.7 Structure of the Dissertation

The rest of the paper is organized as follows. The literature review in Chapter two focuses on the background of digitalization and digital maturity and the associated benefits and challenges; its impact on various operations in Ports; as well as an evaluation of digital maturity model adopted in the study. Chapter three details the research methodology and methods used in this study and provides an overview of the data collection and data analysis methods. Chapter four presents the findings and analysis of the data while Chapter five focusses on the discussion of the findings. The conclusion and recommendations for Ports, Port users and other stakeholders as well as suggestions of areas for future research are duly captured in Chapter six.

# Chapter 2 Literature Review

## 2.1 Introduction

The purpose of this section is to review and discuss relevant literature on digitalization, automation, digital maturity, digital maturity models and assessment of digital maturity. In addition, the review and discussion will include the impact of digitalization and digital maturity on different aspects across various industries, as well as the envisioned opportunities, associated benefits and challenges. Further, the digital maturity model to be applied in this study will be introduced, discussed and critiqued. Lastly, literature covering aspects of port operations and performance indicators will also be reviewed.

## 2.2 Digitalization and its impact in Ports

The use of digital technology to transform the way business is operated is one way of defining digitalization. The container shipping industry has seen many of its business processes, operations and facilities being digitalized in this digitalization age. As indicated in existing literature, digitalization of its operations and processes has had a positive impact on its performance and efficiency levels as well as improved its integration with various stakeholders such as customers and suppliers (Balcı, 2021).
In addition, software driven automation and control systems not only improve data safety in operations but also enhance data driven decision making processes (Marine digital, 2021). The introduction and use of UNCTAD's Trade information Portal (TIP) in Kenya simplified trade procedures, reduced costs for traders by $482 and reduced waiting time by 110 hours (UNCTAD, 2021).

Another emerging economy in Africa whose Ports have embraced digitalization is Ghana. In their study of Ghana's paperless port digital transformation, Senyo et.al, (2021) notes that over that last three decades, the government has been in the fore-front of transforming the ports. Their digitalization journey began in 1986 with the

implementation of an automated system for customs data with limited data sharing. By 2016, additional platforms such as an integrated single window system TRADENET, department and agencies system (e-MDA), integrated customs management systems as well as the Pre-Arrival Assessment Reporting Systems (PAARS) had been introduced. With these digitalized platforms and systems in place, the ports reduced paperwork significantly, improved collaboration among government agencies and with all their stakeholders, reduced the time taken to clear cargo from port and avenues for corrupt practices as well as facilitated increased collection of tax revenues.

In 1992, the first automated container terminal (ACT), the Europe Container Terminals Delta Terminal in Rotterdam was officially opened. According to (Kon et al., 2020), the benefits of the ACT technology by container terminal operators include increased productivity and efficiency, reduced costs and environmental sustainability. Since the volume of seaborne trade is expected to grow, the need for automated container terminals is inevitable and adoption of this technology by the major container terminals is expected to happen soon. The terminals that are not yet automated may be interested in identifying the real benefits of adopting this technology to assist them in making the decision on whether to invest in automated technology. Kosiek et al., (2021) project that ports will be automated, electrified, and use smart energy systems in the near future. The new technologies could contribute to shorter handling time in Port terminals. Adoption of such innovations have made Singapore stand out as a leading transhipment port.

Despite the discussion on accelerated automation and digitalization in the maritime sector and its purported benefits, the findings of a study done by International Transport Forum ITF (2021) indicated that only 53 container terminals are automated to a certain degree, which represents approximately 4% of the global container terminal capacity. Most of the automated container terminals are in Asia (32%), Europe (28%), Oceania (13%) and the United States (11%), majority of whom are the

greenfield terminals. The automated systems are mostly deployed in the yards and no terminal has completely automated their quay cranes. In addition, they concluded that automated ports are generally not more productive compared to conventional ones. Other factors such as the geographical location, port size, port organisation and specialisation are the major determinants of port performance as opposed to automation and digitalization. Further, the comparatively high capital costs of automation infrastructure compared to the benefits do not make for a compelling case. Whether automation has led to lower overall cost is likely to be location-specific and depends on the local labour costs as well as extent to which manual port labour has been replaced by machines (ITF, 2021).

Lastly, as organizations embark on their digitalization journey, they need to have a digital transformation strategy or simply a digital strategy in place. As re-iterated by Westerman (2017), the most important aspect to focus on in digital transformation is not the "digital" part but rather the "transformation" element. This is because technology's value is achieved by carrying on business in a different way that is enabled by technology. For instance, e-commerce platforms are not about the internet but rather enable organizations adopt diverse ways of selling their products. Analytics on the other hand is not about the algorithms used but assist organizations understand their customer better, optimize processes as well as come up with more suitable product offerings. A digital transformation strategy for the purposes of this paper is a company's overall vision in the context of digitalization, including measures to achieve it. The strategy defines both short and long term initiatives that are expected to transform the organization's product offering and create value (Lipsmeier et al., 2020).

## 2.3 Challenges in Digitalization

The digitalization process is not just a technological issue but also an institutional human resource one (IAPH, 2020). A change management process must address all the challenges simultaneously. The study carried out by Balci (2021) ranked

organizational and collaboration resources as the most critical resources necessary for a successful digitalization process of container shipping services to achieve a competitive advantage. The International Transport Forum, ITF (2021) stated that whereas port automation projects generate social conflicts, there are instances where unions, port authorities and terminal operators cooperate constructively and agree on acceptable conditions for all parties before rolling out automation projects. The results of yet another study indicated that when a digital vision is shared by top management, adequately communicated within the organization and employees' are empowered with training in digital skills, the digital maturity is higher (Salviotti et al., 2019).

The International Association of Ports and Harbours (IAPH) recently undertook a global ports survey on the level of implementation of electronic data exchange between ships and ports to conform with the IMO FAL mandatory requirements while identifying the main barriers to implementation. The findings, as published in a report, indicated that only 30% of the Port Authorities and Operators sampled had operationalized the electronic data exchange systems by October 2020 (IAPH, 2020). Further, the two main barriers to implementation that were rated as "highly challenging" were multi-stakeholder collaboration and the legal framework. The aim of the electronic data exchange is to speed up the processes in Port, and these findings also highlight the importance of engagement with multiple key stakeholders for successful transitions.

Further, in his study on how the COVID-19 pandemic is driving or constraining the digitalization of businesses around the globe, Amankwah et al. (2021) contend that the pandemic is the ''great accelerator''. The COVID-19 pandemic has effectively fast-tracked the world in embracing emerging technologies, leading to transformations in how and where work is done. Adoption of emerging technologies has faced resistance from both employers and employees and may negatively impact employee well-being and possibly the future of work (Amankwah-Amoah et al., 2021). The theme of managing people through periods of transition to digital technology is a common

challenge that managers must address in organizations. Automation and digitalization, generally create fear of job losses, particularly the lower cadre jobs. However, higher generation technologies such as artificial intelligence, robotics and drones have been projected to threaten the more highly skilled jobs (Mullins, 2016).

## 2.4 Organizational culture and change management in digitalization

A system of shared meaning held by members that distinguishes their organization from others is referred to as organizational culture. It has various components but with regard to digitalization, a key characteristic is that of the degree to which the organization encourages its employees to innovate and take risks. It comes as no surprise therefore that the most innovative organizations have a more open, collaborative, unconventional and accelerating culture (Judge & Robbins, 2017).

Change is inevitable and digitalization represents a force of change in an organization. Change in organizations is managed by change agents, whose role is to guide the organization as it adapts to the changing environment as well as seek change in employee behaviour (Judge & Robbins, 2017). Resistance to change by people in organizations occurs naturally when they are either satisfied with status quo, threatened by the change or are not aware of the advantages of the change. Senior management may choose to employ sanctions or coercive power to force the desired change or can find evidence to convince the opposing groups that the change will indeed fit their interests. Additionally, more participative approaches to problem solving as well as effective consultative and negotiation mechanisms from the onset favour the change process in organizations. Further, the required key human, technological and material resources must be procured for the benefits of change to be realized (Cole, 1995). Further, some employees may perceive some aspects of change as threatening and the level of stress this causes may eventually lead them to quitting the organization. Research shows that individuals with a positive change orientation are less likely to perceive change as threatening (Judge & Robbins, 2017).

Previous research suggests that neglect of the human dimension of change often leads to technological failure. This may be because of failing to consider ergonomic concerns, consulting with users or even training users in the new technologies. These failures have particularly been noted in large, public-sector projects. For instance, the failure of an electronic patient record system introduced by NHS Trust North Bristol in 2012 was attributed to among other factors, inadequate preparation and lack of staff training and sufficient engagement with the project. Incidentally, it has also been established that users of new technology are less likely to be engaged at the adoption stage but heavily engaged at the operationalization or implementation stages. The benefits attributable to involving workers in decision making at the adoption stage included the ability to take care of different concerns raised as well improved skills utilization. User involvement is an inherently political process as it reduces the level of resistance thus managers needed to decide on the extent of this involvement (Mullins, 2016).

## 2.5 Digital Maturity

Digital maturity is defined as "the status of a company's digital transformation" (Chanias & Hess, 2016). Teichert (2019) states that digital maturity has both a technological and managerial component. When organizations possess a strong digital foundation and understanding of how to utilise it to achieve a strategic advantage, then they are considered to have reached the highest digital maturity level.

Similarly, Josimovski et.al (2017) look at digital maturity as a point in between digital intensity and intensity of management transformations. Digital intensity has been defined as the level of investment in technology applications to transform company operations while the intensity of management transformation refers to how much an organization invests in leadership capabilities required to ensure it actually attains its vision of digital transformation. This concept combines both the technological and leadership capabilities (Josimovski et.al, 2017).

On the other hand, Salviotti et al. (2019) argues that the way organizations systematically plan to adjust to digital change and actually roll out innovations within its entire business is digital maturity. It requires aligning of an organization's strategy, culture and workforce to address the digital expectations of all their stakeholders and is a continuous adaptation to an ever-changing digital landscape. Since the digital landscape is dynamic, the level of maturity cannot be static therefore organizations need to assess this over time.

### 2.5.1 Digital Maturity models

Organizations strive towards achieving a desired state of digital maturity. However, digital maturity is not constant and it keeps evolving with time. Digital transformation on the other hand involves the use the technology to radically improve a company's performance. Digital transformation is indispensable when organizations achieve certain digital maturity levels. Therefore, digital maturity models are designed to assist organizations take a comprehensive approach to transformation (Josimovski et.al 2017) and enable businesses measure their degree of digital transformation (Rakoma, 2021).

To support managers in assessing their organization's digital maturity levels, various authors have developed different models that mostly use linear scales. For instance, according to Berghaus & Back (2016), there are five linear digital maturity stages namely promotion, creation and building, commit to transform, user centeredness and data driven enterprise. On the other hand, others have proposed one dimensional digital maturity model based on six successive stages and three digital maturity arch-types namely newbies, beginners, and pioneers (Lichtblau et al. ,2015). Remane et al. (2017) suggests that organizations follow linear digital maturity paths along four archetypes namely digital novice, vertical integrator, horizontal integrator, and digital champion.

An exploratory study carried out by Remane et al. (2017) on digital maturity in

traditional industries portends that the linear arch-types aid in understanding the firm's current positioning and its potential need for action. However, it disagrees with the notion in most classifications that suggest that firms follow linear paths to reach the stage of total transformation. This oversimplification may lead to wrong management decisions. They argue that it is not be desirable for organizations to attain a state of ultimate digital transformation, as most linear digital models suggest. Instead, digital transformation is context-specific and normally takes peculiar paths. The perspective of firms taking different paths to digital maturity will be more useful to managers.

Their proposed framework has two dimensions to assess digital maturity namely digital impact and digital readiness. Digital impact is the effect of digital transformation on a firm while digital readiness is the firm's state of preparedness to embrace digital transformation. The study further combines these two dimensions with empirical analysis and derives five digital maturity clusters that consist of employees' level of ICT skills, the firm's IT budget, the size of the organization as well the firm's profitability level. In yet another study, Philipp (2020) developed a digital readiness index and applied it to selected ports and based on the indexing result were able to establish their current positioning. Based on each port's unique classification, strategic recommendations can be made to move them towards a smart port (Philipp, 2020). However, existing literature lacks models that assist in assessing the digital performance of ports. When an assessment tool is missing, it is not possible to establish the digital status or maturity level of a Port as well as come up with a digital transformation strategy.

### 2.5.2 Digital maturity model in shipping

As far as it has been established in existing literature, none of the digital maturity models have specifically been used in shipping and Ports. In this study, we will use the following model developed by Rakoma (2021) to assess the digital maturity levels of the port community partners.

*Figure 1: Digital Maturity model in shipping adapted from Rakoma (2021)*

| Digital Maturity model for Shipping | | | | | | |
|---|---|---|---|---|---|---|
| **Dimensions** | **DIGITAL MATURITY STAGES** | | | | | |
| | **User driven(5)** | **Integrated (4)** | **Structured (3)** | **Emergence (2)** | **Limited(1)** | **Absence(0)** |
| **Business Culture** | | | | | | |
| **Technology use** | | | | | | |
| **Customer relationship** | | | | | | |
| **Strategy** | | | | | | |
| **Human resource** | | | | | | |
| **Governance & Leadership** | | | | | | |
| **Operational process** | | | | | | |
| **Infrastructure** | | | | | | |

Rakoma (2021) considered an '*appropriate model'* for shipping as one that incorporated eight (8) dimensions and six (6) digital maturity stages. The 8 dimensions are operational processes, business culture, customer relationship, technology use, strategy, governance and leadership, infrastructure and human resource. A brief description of the model's 8 dimensions is provided below:

*Table 1: Dimensions of the Digital maturity model*

| | |
|---|---|
| *Business culture:* | Alludes to the organization's beliefs and practices that guide the interactions between management, its employees and other stakeholders. The culture plays a role in supporting and enhancing the process along the proposed digital maturity mechanism. |
| *Technology use*: | Addresses the technological abilities that enable innovation, planning and implementation to support the day-to-day activities of the companies. |
| *Customer relationship:* | Focuses on digital integration of customer interface in the way products and services are offered and delivered by the company. |
| *Operational Processes:* | Involves the process of identifying, examining and ameliorating processes that exists within the business for performance enhancement. This is done with the objective of meeting the high level of standard of practice and improving the quality and the customer and end-user experience. |
| *Strategy*: | Represents the direction a company will take to establish new competitive edge through digital means, and the strategies it will adopt to achieve their objectives. |

| | |
|---|---|
| *Infrastructure:* | Focuses of advanced technologies in systems (deployed digital technologies) that enhance safety, security and efficiency as well as allow for interoperability and sharing of data to improve the customer's experience. |
| *Human Capital*: | Focuses on processes that require technologies such as mobile, analytics and cloud to be exploited to make human resource efforts inclusive, effective and efficient. |
| *Governance and Leadership*: | Focuses on establishing accountability and decision making based on digital transformation and adoption of advanced digital technologies. It includes the decisions about security, privacy, data credibility and integrating digital transformation capabilities of the company and its stakeholders. |

He argued that the shipping industry is part of the supply chain ecosystem and that these eight dimensions accommodate all the players in this ecosystem. The 5 digital maturity stages used to measure the degree of maturity along the 8 dimensions have been elaborated in the table below.

*Table 2:Digital maturity rating key adopted from Rakoma (2021)*

| **Rating** | **Meaning** | **Digital maturity stage** | **Characteristics** |
|---|---|---|---|
| 5 | Exceptional | User driven | Digitalization level is habitual and reproducible; Organization uses highly scientific digitalization techniques and systems |
| 4 | Very good | Integrated | Digitalization permeates throughout the entire organization. It is also comprehensive, pervasive, and universally applied. |
| 3 | Good | Structured | Existence of clear, different and partly systematic methods of digitalization within the organization. Most of the key processes and systems are digitalized whereas some are not. |

| | | | |
|---|---|---|---|
| 2 | Fair | Emergence | Use of digitalization within the organization is visible and promising; Inconsistent understanding of digitalization within the organization; Existence of inefficiencies in digitalized systems |
| 1 | Poor | Limited | There is a very low level of awareness and interest in digitalization; Digitalization efforts are uneven and haphazard; Lack of allocation of sufficient resources for digitalization |
| 0 | Non-existent | Absence | Lack of awareness of digital transformation; Digital adoption is missing |

#### 2.5.2.1 Critiquing the Model

Existing digital maturity literature has models with 4-5 dimensions and as such, 8 dimensions in a digital maturity model is on the higher side. Looking at it critically, technology use, operational processes, infrastructure and customer relationship dimensions overlap and can be consolidated. This is because technology is used to improve overall operational processes which is geared towards customer satisfaction. On the other hand, long, unreliable processes may be an indicator low levels of technology use. Similarly, infrastructure looks at advanced technologies that enhance safety, security and efficiency and allow for inter-operability and sharing of data to improve the customer's experience. Further, governance and leadership and strategy dimensions can also be consolidated. Strategy emanates from governance and leadership and is more of an over-arching item that guides the organization on its journey towards digital transformation. Thus, consolidating some of these dimensions would enhance the model and make it easier to apply. Lastly, the six (6) digital maturity stages are in line with the existing literature and are both distinctive and easy to understand.

Finally, in line with the above critic, this study will apply this model with a slight adjustment on the Customer and Infrastructure dimensions, which will be merged. The

rest of the dimensions will remain as is when assessing the digital maturity levels since the survey included all the players in the maritime industry.

### 2.5.3 Impact of digital maturity

The effect of digital transformation on various firms differs. A study investigating the digital maturity level of retail companies within distribution in Sweden categorised the digital maturity level of the country's largest retailers as either adopters or collaborators. The major benefits arising from using digital tools included cost efficiency, accuracy in delivery, ease in traceability, improved lead time and shelf availability (Tavakoli & Mohammadi, 2017).

Another study done on the impact of digital maturity revealed that companies that had a higher level of digital intensity were better at generating income. Additionally, they also exceeded the average performance of the industry by up to 9% in terms of employee incomes and fixed asset management. Their profit margins and net incomes were between 9% to 26% higher than their industry average. Digital transformation translates into operational efficiency as automating processes with the various stakeholders provides for better customer experience with lower costs. In addition, through creation of more personalized customer propositions and new digital services, long-term customer value is created (Josimovski et.al, 2021)

Digital technologies have of late increasingly received attention in the maritime industry as players seek to improve process optimization enhance security and sustainability. Examples of ports that have invested heavily in digital technologies such as Blockchain and Internet of Things (IoT) include Antwerp and Rotterdam in Europe. (Philipp, 2020).

Despite the gains and new opportunities that come along with digitalization, it has its fair share of disadvantages. Digitalization comes with huge infrastructural cost and inherently heightens the vulnerability of the systems to cyber-attacks. (Kosiek et al., 2021). The Notpetya malware attack cost Maersk an estimated $250 million loss in

2018 (Carballo Piñeiro et al., 2021) while in 2020, cyberattacks in the maritime industry increased by 400 percent (Alamoush et al., 2021). Cimpanu (2020) noted that CMA CGM and Mediterranean Shipping Company fell victim to cyber security crimes in 2020 while Morgan (2020) estimates that by 2025, the annual cost of cybercrimes would be approximately usd 10 trillion. Given the global nature of the maritime industry, there is need to urgently prioritize cybersecurity measures as its impact on the global supply chain has huge ramifications (Caponi & Belmont, 2015).

According to the 2021 Annual report of the Maritime Transportation System information sharing and analysis centre (MTS-ISAC), attacks targeting the operational technology systems in ports increased by 900% over the past three years (MTS, 2021). In July 2021, the ports of Cape Town, Ngqura, Port Elizabeth and Durban in South Africa suffered a cyber-attack on Transnet National Port Authority's systems. which paralyzed their operations. Transnet had just embarked on a Smart Port programme with Durban Port as a pilot (Reuters, 2021). More recently in January 2022, oil facilities in Belgium's ports including the Port of Antwerp became victims of hackers, disrupting the operations in the oil market (Euronews, 2022).

To assist ports establish the operational, commercial and financial impact of a cyber-attack, the International Association of Ports and Harbours (IAPH) recently launched its cybersecurity guidelines. The development of these guidelines followed concerns raised by stakeholders about the increased cyber threats within the maritime industry over the past four years. The guidelines will go a long way in helping top level managers in ports assess their level of preparedness to prevent, halt as well as recover from cyber-attacks. Incidentally, no port is immune to cyber-attacks regardless its level of digital adoption. Moreover, the digital divide across global players, the centrality of the maritime industry in global trade and necessity of information exchange among various players exposes all ports and port communities to cyber risks (IAPHCSG, 2021).

Lastly, although most organizations invest heavily in cyber-security, this does not absolve them from being victims of cyber-attacks. However, just like any other good

risk management strategy, having a secure system minimizes the likelihood and severity of the attacks.

## 2.6 Port Operations and performance

According to Alderton (2008), the operational functions provided by Ports include pilotage, mooring and tugging activities, use of berths, loading, discharging, storage and distribution of cargo. There are various other services provided for cargo while in port and these include dangerous cargo segregation, customs and documentary control, tallying, marking, surveying among others. Port development across the globe has been influenced by the need to accommodate increasing supply of ship tonnage, increasing ship size as well as specialization in ship types and cargo handling features. (ICS, 2013).

Sorgenfrei (2018) portends that port performance can be measured with a number of indicators, which are normally referred to as Key Performance Indicators (KPIs). These can broadly be categorized into operational, financial, quality, environmental and safety indicators. Examples of some KPIs include throughput, equipment utilization, berthing time, idle time, ROI, terminal profitability, operational efficiency, unproductive time, turnaround time, vessel waiting time, energy consumption per handled unit, carbon footprint per unit, number of road accidents, accidents related to hazardous cargo, among others (Ivan, 2022). KPIs provide port managers with insight into the main operations and have a two-fold role. The first one is to compare actual performance with the set targets and take corrective action while the second one is to observe the performance trends over time. These measures are useful for port planning, forecasting and coming up with investment strategies (ICS, 2013). Port performance is affected by the how well the Port utilizes its resources, from Port infrastructure labour, technology, etc. Further, many technical innovations can have an effect on efficiency and productivity e.g. twin lift moves with a gantry crane and automated guided vehicles not only improve overall productivity but also reduce average cargo handling cost (Sorgenfrei,2018).

# Chapter 3: Data and Methodology

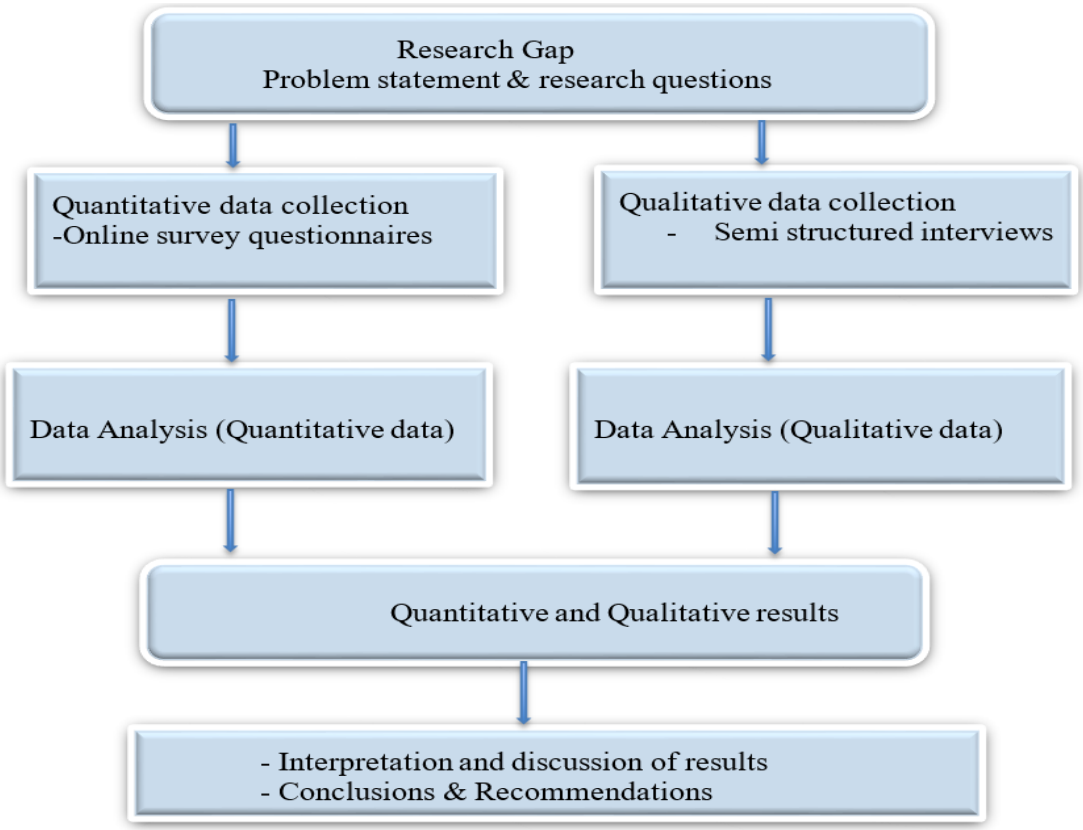
## 3.1 Introduction

The chapter will describe the research methods used for data collection and analysis. It has been structured in sections as follows: - The methodology, research methods, selection of participants, data collection, instrumentation, data analysis, ethical consideration, budget, expected results and key limitations.

## 3.2 Research Methodology

Kothari (2004) describes research methodology as the scientific and systematic way of solving a research problem. The research design on the other hand relates to the criteria that are employed when evaluating social research. It is a framework for generation of evidence that is suited both to a certain set of criteria and to the research question in which the investigator is interested (Bryman, 2012).

*Figure 2: Research Design developed by author*



The research design used in this study was a mixed methodology approach that involved the use of both quantitative and qualitative research methods of data analysis. The quantitative method is more objective as it uses numerical and statistical methods. On the other hand, the qualitative method is more of an interpretative approach.

These methods were chosen by the researcher to have a complete overview of current state of affairs as well as validate the data collected. Questionnaires were easy to administer while interviews were flexible and helped clarify and yield more details on ambiguous issues and capture diverse opinions. In addition, there is limited information around digital maturity in the maritime industry particularly in Africa hence a combination of all the above methods were considered most appropriate for this study.

Further, prior research has revealed the usefulness of subjective measures particularly in matters of organizational change and innovation. However, it is important to note that they are highly susceptible to individual biases. According to Remane et al. (2017) CEOs tend to assess the digital readiness more positively than other survey participants as suggested by the data collected. To reduce the level of bias and assess digital maturity more accurately, the researcher opted to survey multiple interviewees from different cadres in one firm such as clerks, supervisors, managers, and top management.

## 3.3 Research Methods

According to Oflazoglu (2017), a well-structured questionnaire is the best way of data collection. In order to check on clarity of the questions included in the research instruments; the researcher first conducted a pilot among colleagues working within the Port community. Any questions that were considered ambiguous were re-formulated accordingly whereas explanations and clear instructions were provided to

guide the respondents on the more technical questions. Thereafter, the corrected questionnaires were uploaded onto Google forms and circulated electronically to the respondents. Data collected from the sample were later analysed statistically.

## 3.4 Selection of Participants

The researcher used stratified sampling to select the participants. The researcher targeted both senior and junior officials from the Port, Customs, shipping, export, import and freight forwarding companies to ensure a good cross section of responses.

*Table 3: Selection of Participants*

| **Organization category** | **Participants** | **Method** | **Number of respondents** |
|---|---|---|---|
| Port Authorities/ Ministry: | MD/COO/Harbour masters/ Permanent Secretary/ Head of ICT/ Senior Managers | Interview (Zoom) | 4 |
| | Port clerks/ Supervisors/ Managers | Questionnaires | 16 |
| Shipping lines, Forwarding Agents, Exporters and Importers, Government Agencies | MD/COO/ Head of ICT/ Senior managers | Interview (Zoom) | 3 |
| | Clerks/ Supervisors/Manager | Questionnaires | 20 |
| | | | 43 |

## 3.5 Instrumentation

The researcher carefully developed a questionnaire and interview questions bearing in mind the complex nature of the topic of digital maturity while ensuring the research objectives were achieved. In addition, the researcher appreciated that the targeted respondents would have different backgrounds hence the questions were framed in a simple and user -friendly manner. This was done to ensure the respondents would not be intimidated and could easily respond to the questions. The questionnaire adopted many closed questions and a 5-point Likert scale for the items under investigation that required ranking and measurement; a few multiple-choice questions as well as open

questions that elaborated on some pertinent issues as well as addressed matters of challenges and possible solutions.

The interview questions on the other hand were more open-ended to allow the selected expert respondents share their experience and insight freely. This also allowed the researcher to delve more into areas that required more explanation in line with the respondent's area of expertise.

## 3.6. Data Collection and Analysis

Both qualitative and quantitative data was collected through semi-structured interviews and questionnaires that targeted experts in the maritime field. These methods were selected as they complemented each other and allowed for informed conclusions and recommendations. The interviews were conducted via the Zoom and WhatsApp platforms whereas the questionnaires dispatched via email. Primary data was collected through the questionnaires and interviews with experts selected randomly across regional ports within Africa. Persons working with various port community members such as Ports, shipping lines, customs, freight forwarders, government agencies, importers and exporters were invited to participate in the survey. 36 responses were received from the questionnaires and a total of 7 interviews materialised. Collection of data began in mid-July and was concluded by the end of August 2022.

The data collected from the questionnaires as well as the interviews was coded and analysed in excel. Various descriptive and inferential statistics were generated, and observations made on relationships between the variables. The researcher then presented the results of the analysis and insights in graphs and tables. This process will be discussed in detail in Chapter 4.

## 3.7 Ethical issues

According to Busher & James (2002), respect for both the dignity and privacy of the participants is paramount. Researchers must therefore not only ensure they get informed consent of the participants but must also guarantee to protect their anonymity, confidentiality as well as all the information provided. No identifiable information about the participant's identity was to be disclosed in the study.

In addition, this study involved data collection from people therefore the use of the research instruments was duly approved by the Research Ethics Committee. Since the data collection process was done electronically, consent was marked as mandatory on questionnaire forms distributed to the respondents. In addition, before embarking on the interviews, the researcher requested for and obtained the participants' express consent as well as assured them of anonymity and utmost confidentiality. The researcher noted that this assurance put most of the respondents at ease. The questionnaires and interview questions used in this study have been included in the Appendix section.

## 3.8 Key assumptions and potential limitations

The key assumptions made were that the level of digital maturity may have an impact on both port operational performance and transhipment port choice and that sufficient data would be collected within the allocated timeline.

A potential limitation was the use of a novel model that was being applied for the first time in this study. The use of the model has been justified but as highlighted in the previous chapter, there is room for further improvement in future studies.

Further, due to the low number of respondents (43) and ports (7) surveyed as well as their unique characteristics, some of the results may not be representative of the region.

# Chapter 4 Data Analysis

## 4.1 Introduction

This chapter presents the findings and analysis of the study of the impact of digital maturity level on Port operations and transhipment port choice within selected ports in Africa.

Quantitative data was analysed statistically and presented in a thematic way to ensure that they adequately addressed the research objectives. Observations made in the Likert-scale questions were coded based on the responses to analyse them statistically. The scores with a range of between one (1) and five (5) representing the level of agreement with the statements. The rating of the responses was as follows: - Strongly disagree (1), Disagree (2), Not sure (3), Agree (4), Strongly Agee (5). These responses were linked to the various digital maturity dimensions on a scale of 1-5. The resultant scores were interpreted as follows: Poor (1), Fair (2), Good (3), Very good (4) and Exceptional (5). Further, the researcher equally analysed qualitative data both from the questionnaires and interviews after transcribing then coding the respondent's answers based on the identified common themes, in line with the research questions.

The 5 common themes that were identified are Digital strategy and awareness; Digital Maturity levels of the stakeholders; Digitalization of processes and operations and its perceived benefits; Transhipment port choice and digital maturity level of ports; and Challenges and Opportunities associated with digitalization. These 5 themes will guide the structure of the structure of this chapter.

## 4.2 General overview of the Respondents

The 43 respondents who participated in the study represented seven (7) categories of the Port community users, namely Port Authorities, Terminal operators, shipping lines, Logistics and Transport companies, Government agencies, ship chandler and importers/exporters. To guide the data analysis and discussion sections, the researcher

re-classified the participants' organizations as either Ports or Port users. The Ports category includes both Ports and Terminal operators (47% of the respondents) while the Port users comprised of the shipping lines, Logistics and Transport companies, government agencies, ship chandler and the importer/exporter categories (53% of the respondents) as highlighted in Table 4 below.

*Table 4: General Overview of the respondents*

| **Classification** | | Port Authorities | | Port Users | | Total | |
|---|---|---|---|---|---|---|---|
| | | No | Percent | No | Percent | No | Percent |
| Number of respondents | | 20 | 47% | 23 | 53% | 43 | 100% |
| Rank | CEO- Director | 4 | 20% | 2 | 9% | 6 | 14% |
| | Manager- Head of Department | 4 | 20% | 12 | 52% | 16 | 37% |
| | Supervisor- Clerk | 6 | 30% | 5 | 22% | 11 | 26% |
| | Others | 6 | 30% | 4 | 17% | 10 | 23% |
| Years of experience in rank | 0-5 | 8 | 40% | 9 | 39% | 17 | 39% |
| | 6-10. | 4 | 20% | 8 | 35% | 12 | 28% |
| | Over 10 Years | 8 | 40% | 6 | 26% | 14 | 33% |
| Level of Awareness of Digital strategy | Yes | 18 | 90% | 18 | 78% | 36 | 84% |
| | No | 0 | 0% | 1 | 4% | 1 | 2% |
| | Not aware | 2 | 10% | 4 | 17% | 6 | 14% |

Secondly, the respondents were from different cadres of their organizations representing 7 countries in Africa. Out of the 43 individuals who participated in the study, 26% were in clerical-supervisory positions, 37% in managerial or head of department positions, 23% in "other" undefined positions while 14% held a CEO/Director title. Further, 39% of the total respondents had been in their current position for up to 5 years, 28% had 6-10 years of experience in their current position while 33% had over 10 years of experience in their current positions.

## 4.3 Brief Profile of the interviewees and their organizations

As indicated in the Table 4 above, 57% of the interviewees were from Port organizations while the other 43% were from the Port user categories. Out of the 7 individuals who participated in the interviews, three (3) were directors with over 10 years of experience in the industry, one (1) was a senior manager with over 20 years of experience, two (2) were senior managers with upto10 years of experience while one (1) senior manager had 5 years of experience in their current role.

*Table 5:Profile of the Interviewees, their organizations and Ports*

| Interviewee | Years of experience in position | Nature of Organization | Size of the Organization(Number of employees) | Fully public owned Port | Presence of both government & GTOs | Digital platform in use (TOS, PCS, SWS) | Number of years of using digitalized platforms |
|---|---|---|---|---|---|---|---|
| Respondent 1 | 10+ | Shipping Agent | 140 | No | Yes | PCS | 2 |
| Respondent 2 | 20+ | Shipping Agent | 35 | No | Yes | PCS | 2 |
| Respondent 3 | 5 | Port Authority | 7000 | Yes | No | TOS/ SWS | 20+ (TOS) ; 10+(SWS) |
| Respondent 4 | 10 | Shipping Agent | 90 | Yes | No | TOS/ SWS | 20+ (TOS) ; 10+(SWS) |
| Respondent 5 | 10+ | Port Authority | 400 | No | Yes | PCS | 20+ |
| Respondent 6 | 10+ | Port Authority | 926 (runs multiple(30) Ports) | No | Yes | SWS | 14 |
| Respondent 7 | 10+ | Port Authority | 5000(for 8ports) | Yes | No | IPMS | 8 |

Two of the respondents' Ports had been on digitalized platforms (Port community systems) for approximately two years while the other five (5) respondents' Ports had worked with digitalized platforms for varying periods of time above 8 years. These digitalized platforms were Terminal Operating systems, Integrated Port Management systems, Port Community systems and Single Window systems. In addition, four of the respondents indicated that they had both government-run as well as private terminal operators whereas the other three respondents indicated that their ports were fully public owned.

A key highlight was the number of employees in the fully public owned Ports, which reported approximately 5,000 and 7,000 employees compared to the employees in the two ports that have engaged private terminal operators, which reported approximately 400 and 926 employees respectively. It was further noted that the Port Authorities with 926 and 5,000 employees operated multiple ports within their jurisdiction. The high number of employees in fully owned public ports may be as a result of the political nature of public owned facilities in which the unions resist the push for digitalization.

The researcher was not able to access data on the number of employees under the 4th Port as well as that from the various terminal operators to facilitate further analysis.

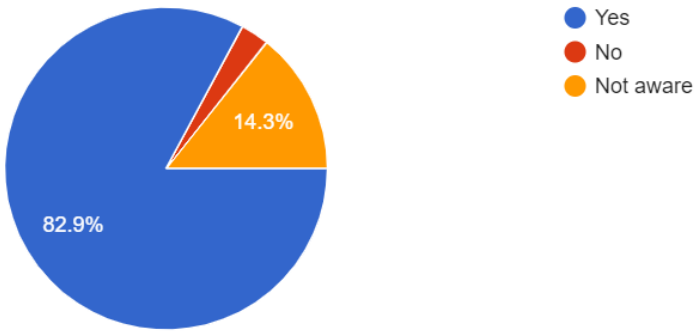
## 4.4 Thematic analysis of the Data

Analysis of the collected data was done as per the five (5) identified themes:

### 4.4.1 Digital Strategy and Awareness

83.3 % of the respondents indicated that their ports had a digital strategy, 13.3% were not aware of the same whereas 4.4% opined that their Ports had none as shown in Figure 2. The researcher further noted that the 5 out of the 6 respondents who were not aware of the Port's digitalization strategy had been in their current position ('others' category) for up to 5 years while one respondent had 6-10 years in their position.

*Figure 3: Presence of Digital strategy in Port*




A similar trend of lack of awareness was observed in the Port community organizations as well. The response to Question 19 in relation to communication of the digital strategy had an average score of 3.57 out of 5 and was one of the poorly rated questions by the respondents. This is an indicator that the Digital strategy is not accessible to or shared with all the stakeholders in organizations.

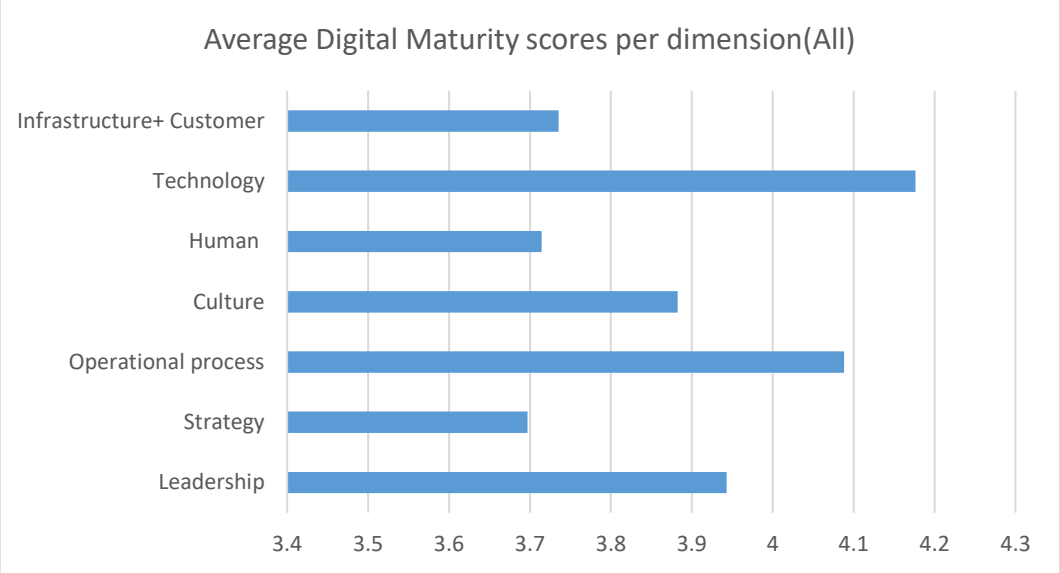
Two of the interview respondents from Ports indicated that their Ports reviewed their digital strategies annually. They further stated that stakeholders were engaged and consulted whenever their Ports were crafting their strategy, and the same was eventually shared with all stakeholders. This finding was corroborated by two

interview respondents from the Port user category who confirmed that the Ports consulted with them as stakeholders when crafting their digital strategies and before rolling out any digitalization platforms and new systems. This engagement and collaboration in their opinion, raised the level of acceptance of the systems among the Port users.

### 4.4.2 Digital Maturity levels of the stakeholders

The researcher attempted to measure the digital maturity of the participant's organizations in general as well as under the categories of Ports or Port users.

*Figure 4: Average Digital maturity scores per dimension for all respondents*




The respondents had been asked to indicate their level of agreement with statements which had been linked to the various digital maturity dimensions. Their responses were coded on a scale of 1-5 to represent the different levels of digital maturity namely: - Limited (1), Emergence (2), Structured (3), Integrated (4) and User driven (5). Using descriptive statistics across all the dimensions, the researcher established that the organizations surveyed had on average, scores of 3.69 and 4.17 across the various dimensions of digital maturity as shown in Figure 3 above. The interpretation of the scores is that on average, the dimensions of the organizations surveyed are between structured and integrated levels of digital maturity across all their dimensions. This

indicates that the organizations surveyed have clear and systematic digitalization methods and probably have many of their key processes and systems digitalized.

To establish the differences in individual maturity level of ports and port users surveyed, the average scores across each of the dimensions of the digital maturity model under the two categories of Ports and Port users were split and have been presented in Table 6 below.

*Table 6:Digital Maturity scores of Ports and Port Users*

| DIGITAL MATURITY DIMENSION | Mean | Standard | Variance | Mean (Port) | Mean (Port users) | Difference in mean |
|---|---|---|---|---|---|---|
| | | | | | | |
| Leadership | 3.94 | 1.06 | 1.11 | 3.82 | 4.06 | -6% |
| Strategy | 3.70 | 1.10 | 1.22 | 3.65 | 3.75 | -3% |
| Operational process | 4.09 | 0.93 | 0.87 | 3.76 | 4.41 | -17% |
| Culture | 3.88 | 1.09 | 1.20 | 3.76 | 4.00 | -6% |
| Human | 3.71 | 0.93 | 0.86 | 3.53 | 3.89 | -10% |
| Technology | 4.18 | 0.80 | 0.63 | 4.06 | 4.29 | -6% |
| Infrastructure+ Customer | 3.74 | 1.08 | 1.17 | 3.65 | 3.82 | -5% |
| | | | | | | |
| | | | | | | |
| **Overall Digital Maturity level** | **3.89** | | | **3.75** | **4.03** | **8%** |

From Table 6 above, whereas the overall average digital maturity score of Ports is established to be 3.75 (structured stage), the human resource dimension maturity level is at a lower score of 3.53. The technology and leadership dimensions had the highest maturity levels with an average score of 4.06 and 3.82 respectively.

On the other hand, despite the average digital maturity score for Port users being higher than that of Ports (4.03) and in the integrated stage, the human resource and infrastructure dimensions have a lower score of 3.89 and 3.82 respectively, placing them within the structured stage. Their Operational, Technology and Leadership dimensions had higher maturity levels of 4.41, 4.29 and 4.06 respectively, placing them firmly in the Integrated stage as compared to Ports whose average scores on the same dimensions were 3.76, 4.06 & 3.82 respectively.

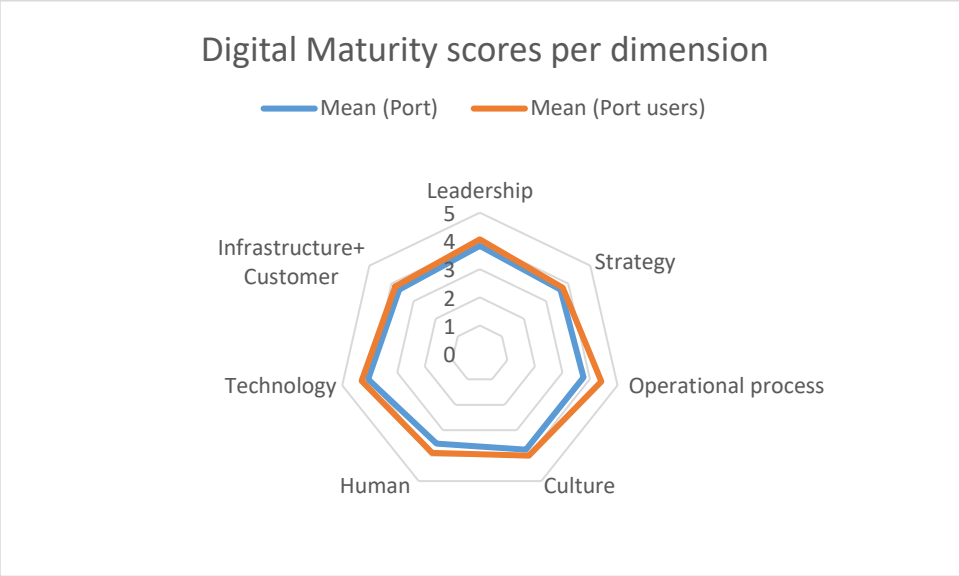
Another key observation made was the level of awareness of the organization's digital strategy which had an average score of 3.75, a score that was generally quite low

compared to the other responses received. This may be a reflection of the digital strategy not being shared across the entire organization.

#### 4.4.2.1 Differences in perceptions between Port and Port users

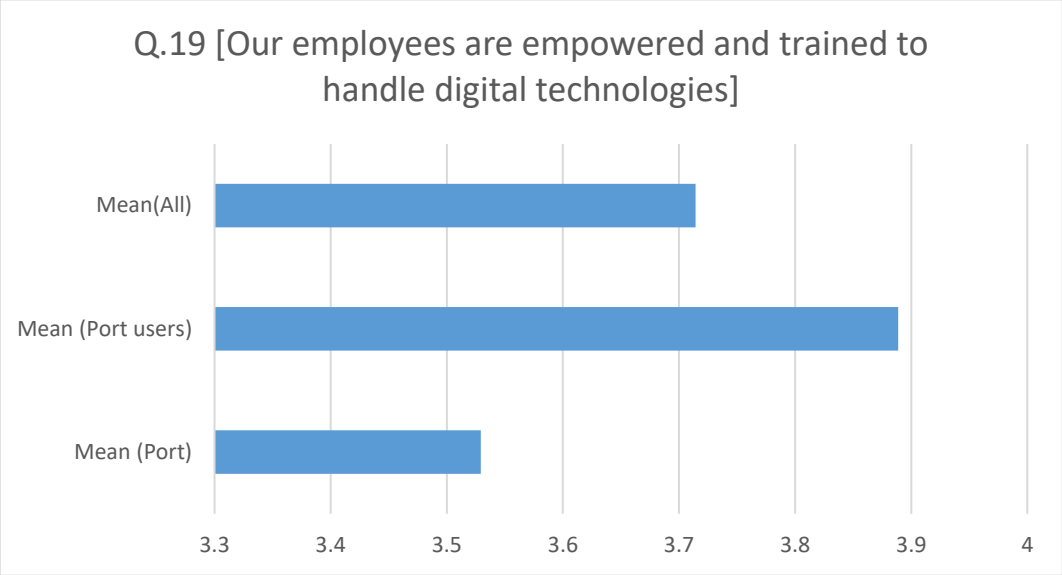
Further, when the scores are broken down to the stakeholder level of Ports and Port users, the emerging pattern indicates that they perceive their levels of digital maturity differently, with some areas seemingly more mature than others. Figure 5 below compares their digital maturity scores per dimension.

*Figure 5: Comparison of digital maturity scores per category of respondents*




The researcher used descriptive statistics across all the dimensions after categorizing the respondents as either Ports or Port Users. The mean distribution of the various dimensions that were measured indicated major gaps between the perceptions of the respondents from the Ports as compared with those of the Port users on their levels of digital maturity (Table 6). For instance, there was a 10% difference in their perception of the Human resource dimension marked *"Our employees are empowered and trained to handle digital technologies"*

*Figure 6: Comparison of the Human resource dimension per category*




In addition, there seems to be a disconnect between the average score for technology dimension under both Ports and Port users which has been rated at 4.06 and 4.29 respectively against the Human resource dimension of empowering and training of employees to use these technologies whose scores are 3.53 and 3.89 and respectively (Table 6). Such mismatches highlight the severity of the challenge of the human dimension in digitalization and are likely to contribute to under-utilization of technologies, high levels of resistance, unnecessary continued use of manual or paper transactions and lengthy processes which demotivate the employees and lead to high levels of customer dissatisfaction. This finding is corroborated by what were highlighted as the main challenges facing the organizations regarding digitalization, as captured in Question 15. 80.6% of the respondents indicated that they lacked proper training in new systems whereas 67.7% opined that the organization's systems were under-utilised. Further, 71% indicated resistance from users was yet another key challenge, and which may be contributing factor to under-utilization of technology and systems.

This further corroborates an issue highlighted by one interviewee from one public owned port who stated that training remains a challenge at their Port because of the bureaucratic way of handling training, where the budget and decision to train is

controlled by the Human resource department and not the user departments. As a result, most of the staff rarely undergo continuous training thus contributing to the under-utilization of the system. However, another interviewee from yet another publicly owned Port stated that their success over the years stems from their culture of embracing new ideas and change and ensuring that they have invested in fully training their staff in the upcoming technologies. One interviewee from the Port user category indicated that their organization, which is privately owned, has an elaborate training schedule, particularly when they were changing systems. In addition, they had prioritized one-on-one training sessions with all employees to sensitize them on how to safely navigate the systems to reduce cyber-security threats. There is clearly a need for better sensitization, stakeholder management, training and change management across the board.

In addition, a difference in perceptions of 6% was noted under the Cultural dimension under "*Our organization encourages experimentation and adoption of new processes, strategies and technologies".* The average score by Ports was 3.76 against a score from Port users of 4. However, there was a 17% difference in the average score between them under the Operational processes dimension marked *"openness to change and continually improve their models"*, where the average score of the Ports was 3.76 against a score of 4.41 by Port users as seen in Figures 6 &7 below. This finding is aligned to the nature of the Port organizations surveyed, which are mainly publicly owned as compared to the Port user organizations that are private entities and would be more aggressive in pursuing profits.

*Figure 7: Comparison of the Operational processes dimension per category*

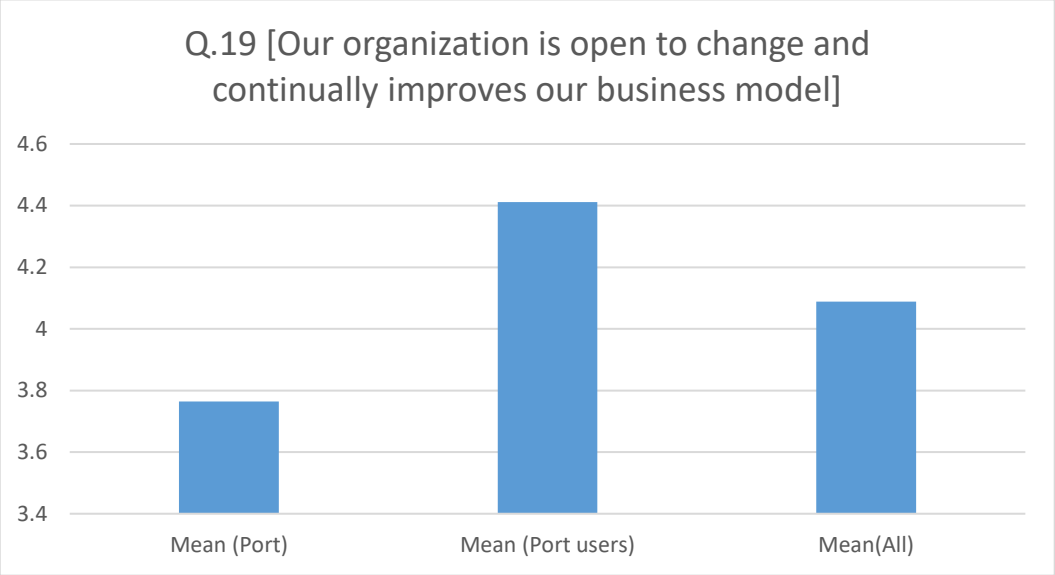
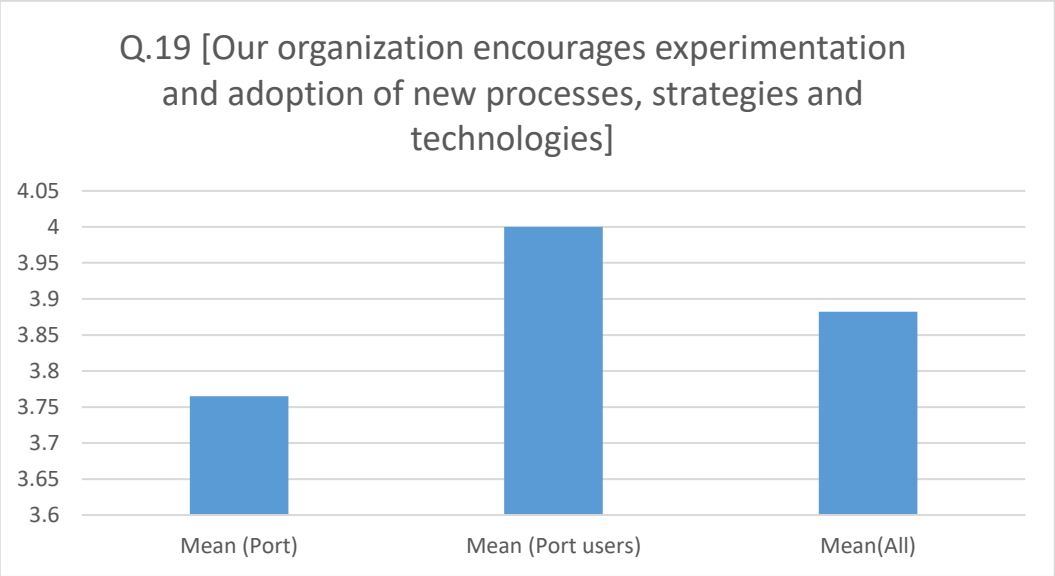
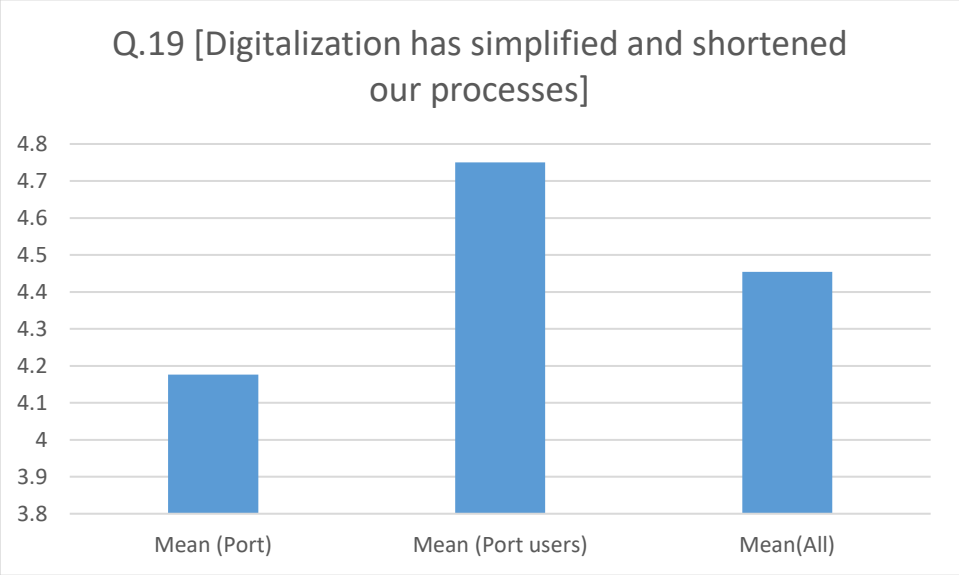



*Figure 8: Comparison of the Organizational culture dimension per category*




However, it emerged that regardless of their individual organizations' digital maturity level, the respondents indicated that digitalization had simplified and shortened their processes to a very large extent. Port users rated the impact at 4.75 while Ports rated the impact at 4.18 out of 5.

*Figure 9:Impact of digitalization on processes*



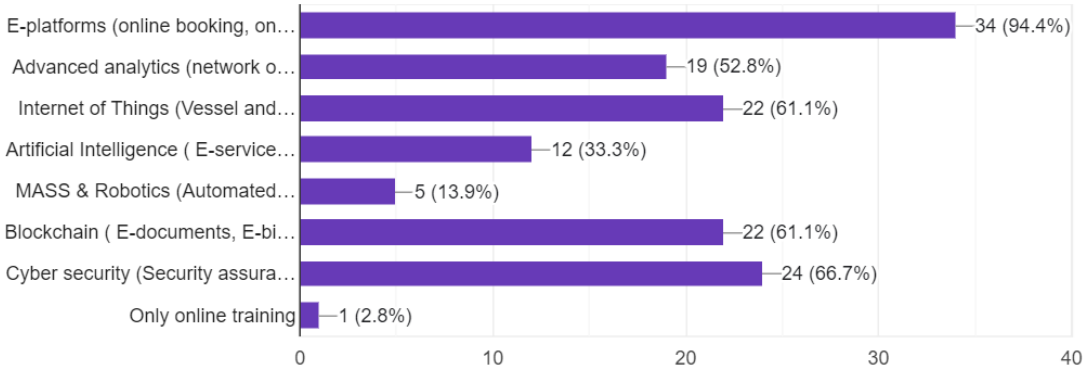

Although an attempt has been made to establish the digital maturity level of the organizations involved, the researcher appreciates that the level of bias of the responses does have an impact on the overall score.

In addition, the researcher was able to establish the types of digital technologies employed in port, the level of use of both manual digitalized equipment and the digital platforms used as well as their perceived impact on various functions operations. These have been enumerated below: -

*i) Digital technologies employed in Ports*

There are various digital technologies employed by Ports today as shown in Figure 10 below.

*Figure 10:Digital technologies employed in Ports*




94 % of the respondents indicated that their Ports are currently using e-platforms (i.e. online bookings) while 66% of the respondents confirmed that their Ports had cyber-security technologies in place. The low level of response on use of cyber-security technologies is against 47% of the respondents indicating that they had experienced cyber-threats in the recent past. Since the risk of cyber-security attacks has increased four-fold since 2020, then the maritime players need to invest more in this area.

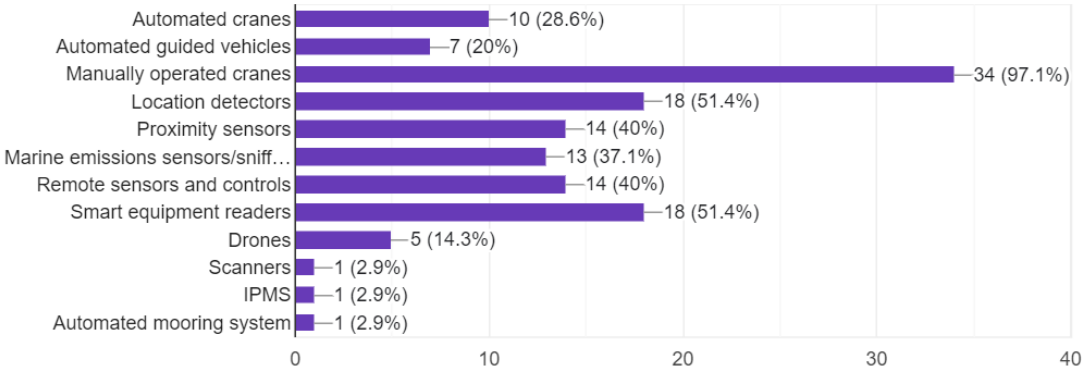
Further, 61% of the respondents indicated that their Ports were using IOT for vessel and reefer monitoring while another 61% and 52% indicated their Ports were using various Blockchain and Advanced analytics respectively. Higher level technologies such as Artificial intelligence and MASS & Robotics seemed to have the least application in Ports with only 33% and 13% of the respondents confirming their respective use (Figure 10).

Three interviewees pointed out that the industry has been lagging behind and most of the technologies that had been in use for years in other industries were only either adopted or fully embraced at the onset of Covid-19. Two of the interviewees who both indicated that they had a background in ICT highlighted the need and benefit for the industry players to embrace Block-chain technologies fully just like most of the service industries have done. They indicated that there was still a lot of room for improvement, particularly in the adoption and use of advanced analytics and Internet of things.

*ii) Port equipment*

The researcher established that some ports are using digital port equipment, but on a lower scale while other Ports are not employing any digital equipment at all.

*Figure 11:Various port equipment present in Ports*




As indicated in the Figure 11 above, 97.1% of the respondents indicated that their Ports were using manually operated cranes whereas only 28.6% acknowledged use of automated cranes in their Ports. Smart equipment readers and location detectors were highest rated digitalized equipment that were in use at the ports with a 51.4% and 51.4% of the respondents respectively acknowledging their use. 40% of the respondents indicated that their ports were using proximity sensors, marine emission sniffers and remote sensors. Use of automated guided vehicles and drones featured in only 20% of the respondent's ports. Under the category marked "others" respondents included the use of scanners.

It is clear from the above statistics, that most of the Ports have a long way to go in terms of embracing automated or digitalized equipment. This may lead to challenges in achieving their goal of environmental sustainability as monitoring and reduction of GHG emissions is hampered. Further, one of the interviewees pointed out that the Ports may have budgetary allocation challenges or are not sufficiently convinced that investing in automated or digitalized Port equipment makes for a good business case, given the high capital costs required to procure this equipment. Another interviewee

indicated that this "gap" can be remedied through public-private partnerships as well as opening up their Ports to global terminal operators. In addition, one of the interviewees from the Ports that had opened up to global terminal operators indicated that they had a higher incidence of use of automated port equipment at their terminals. He further indicated that opening up to partnerships with global terminal operators has improved their productivity and efficiency levels, lowered their costs and made their exports more competitive in the global market. However, they did not share actual KPI scores or statistics with the researcher to validate this.

*iii) Digital platforms*

On matters of digital platforms, 47% of the respondents confirmed using a Single Window system while 37% confirmed using a Port Community system (PCS) to exchange information amongst the various stakeholders in the maritime sector. 16% of the respondents were not aware of the digital platform in use. The use of digital platforms is consistent with the perspective of the respondents who indicated one of the impact of digitalization was that *it had simplified and shortened their processes,* with a very high average score of 4.45 (Table 4).

All the interviewees also re-iterated that their integrated systems, be they Single Window systems or integrated Port community systems had simplified the processes undertaken by the Port and Port users since all users had a single point of contact. These platforms had brought thousands of users together, enhanced information exchange through EDI files, reduced paperwork and bureaucracy, improved the relationships between the parties and significantly facilitated trade.

*Table 7: Integrated systems used in Ports*

| **Classification** | | Port Authorities | | Port Users | | Total | |
|---|---|---|---|---|---|---|---|
| | | No | Percent | No | Percent | No | Percent |
| System in Use in Port | Port Community System | 6 | 30% | 10 | 43% | 16 | 37% |
| | Single Window System | 11 | 55% | 9 | 39% | 20 | 47% |
| | Not aware | 3 | 15% | 4 | 17% | 7 | 16% |

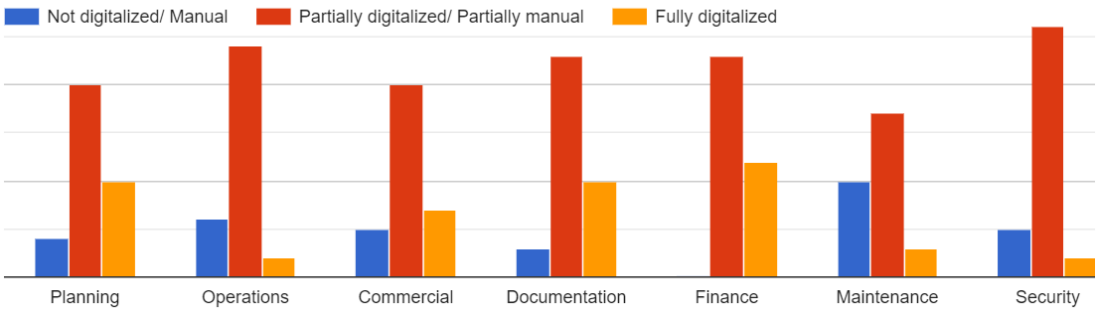
The researcher noted that some of the Single Window Systems (SWS) in use were seemingly more mature than others. These had been improved over time and were very

comprehensive incorporating up to 20,000 corporate users. Three interview respondents pointed out that although Customs were part of the SWS, they still maintained their separate systems. Two of the interviewed respondents were using Port Community systems, which brought together all parties to the cargo. The Customs Authority in one of these Ports was using a separate system while the other was part of the PCS.

The researcher noted one interviewee's response on the security of their Single Window system, which he mentioned was backed up by their country's Ministry of Defence. In addition, the key factors enabling successful implementation of PCS and SWS as established from the interviewee's responses were political goodwill, continuous stakeholder engagement and a good change management strategy.

### 4.4.3 Digitalization of processes and operations within Port and its perceived benefits

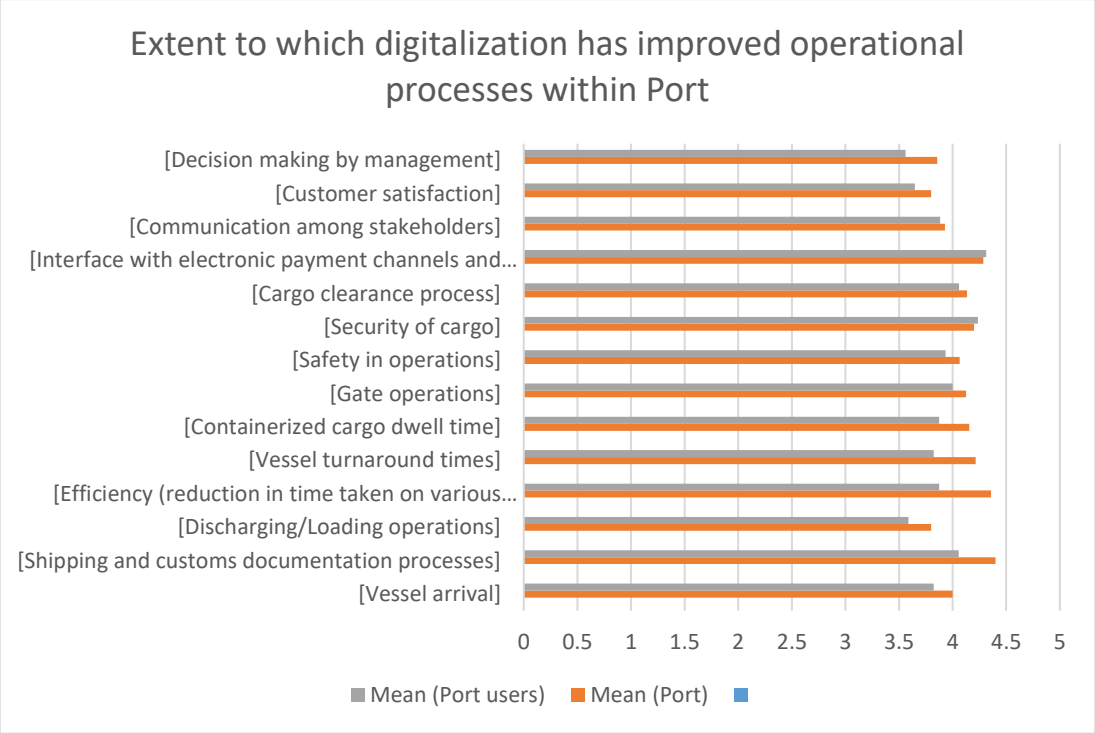
*Figure 12: Digitalization levels of processes at the Port*




The responses as captured in Figure 12 indicated that various functions or sections have differing levels of digitalization. The Finance functions were rated as the most highly digitalized by all respondents with apparently very little to no manual intervention (Question.8), which ties in with the high rating of payment interface with banks which had an average score of 4.3 (Question.11). The Maintenance, Operations, Security and Commercial functions were rated as the least digitalized with a high level of manual operations and partially digitalized operations.

The researcher observed that the Port Authority staff rated the levels of port operation process improvement in most categories higher than their customers, the Port users.

*Figure 13: Port and Port users perceptions on the impact of digitalization on operational processes within Port*



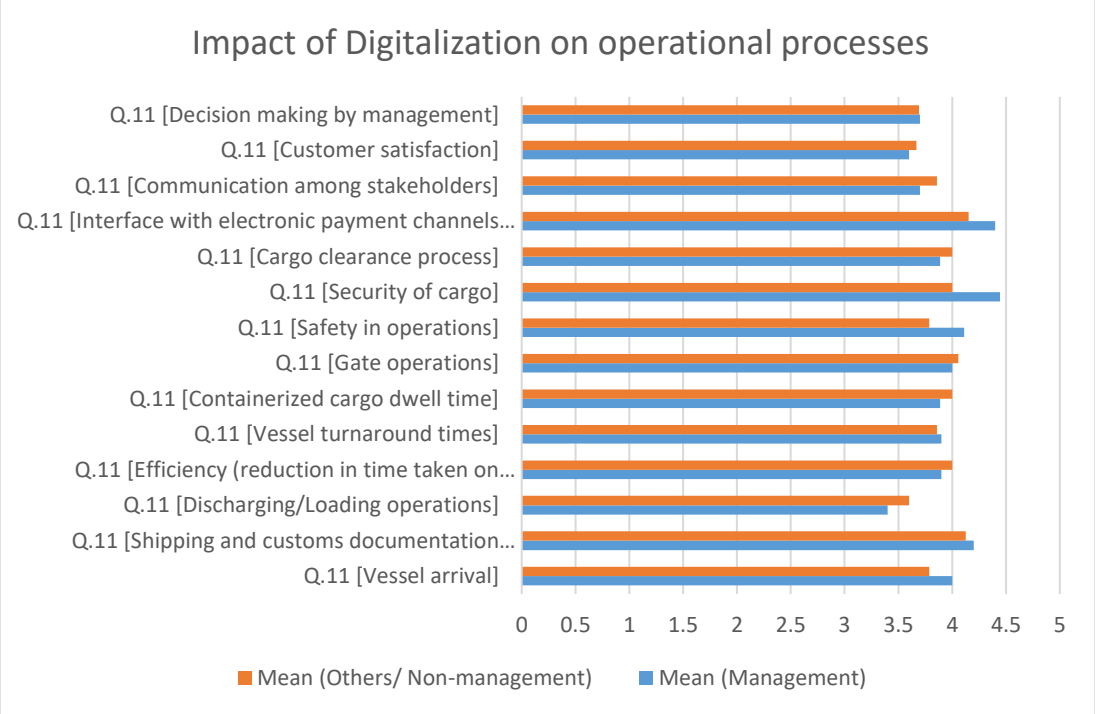

However, there were two categories where the average rating of improvement as perceived by the Port users was higher than that of respondents from Ports. These were *the interface with electronic payment channels* and *security of cargo*. This is a clear indicator that the cargo owners have seen a positive and significant impact in these two areas.

As highlighted in Figure 13 above, all respondents indicated that the interface with electronic payment channels, security of cargo, processing of shipping and customs documentation and gate operations have greatly improved since these processes were digitalized, as evidenced by the high scores of between 4 and 4.33. Similarly, there has been an improvement in containerized cargo dwell time, vessel turnaround times and cargo clearance, whose scores were between 4.09 and 4.21. The lowest ranked process was that of the discharging and loading operations which had an average rating of 3.80

while customer satisfaction, decision making and communication with stakeholders scored between 3.70 and 3.90. In addition, the average rating of the level of improvement of efficiency levels was at 4.10 Some respondents indicated that digitalization has reduced loopholes for fraud and corrupt practices. All these indicate the respondent's positive perception of the value added by digitalization.

One interviewee from the Port user category said that digitalization had shortened many processes. Container dwell times, vessel turnaround times had reduced significantly thereby reducing port storage costs attributable to previously lengthy processes. The respondent further indicated since the adoption of the Port community system about two years ago, the average container dwell time had moved from 10days to 5 days. Although digitalization was one of the factors that played a role in the overall improvement, he indicated that other factors such as the ongoing Port expansion which had eased the level of congestion also contributed to the reduced dwell time and turn-around times.

*Figure 14:Management Vs Non-management views on impact of digitalization of processes*



The researcher further established that management level staff rated digitalization's impact on security, safety and vessel arrivals more highly while non-managers rated discharge/load operations, communication and cargo clearance more highly (Figure 14).

In conclusion, the researcher established a high correlation between the level of digital maturity and its impact on simplifying and shortening the processes (0.66), turnaround time (0.59) and security of cargo (0.58) although the correlation with overall efficiency of processes was lower (0.39).

*Table 8: Correlation results*

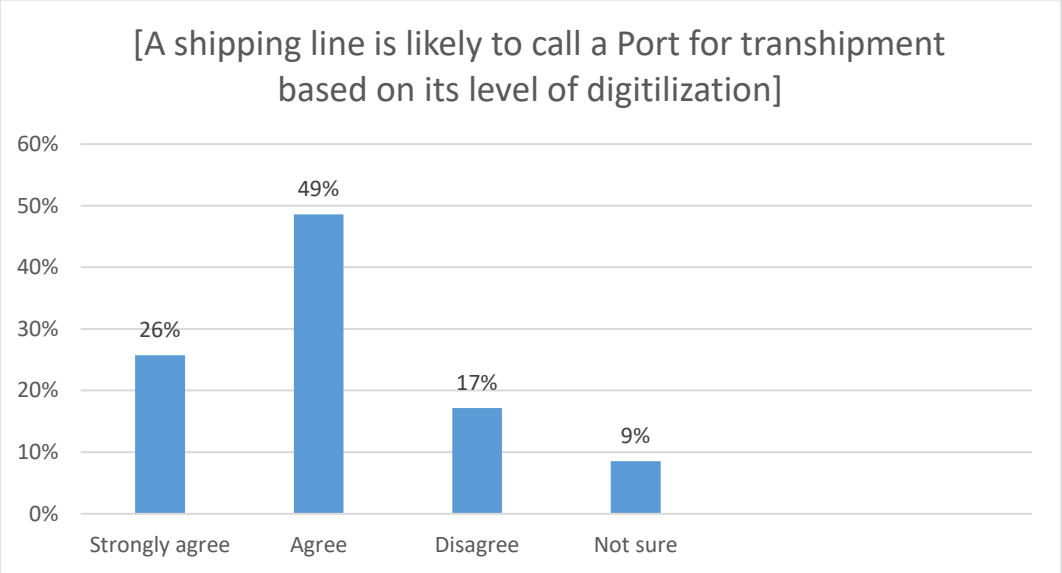
| Correlation with Digital Maturity | Port | Port Users | All | R2 | pvalue | Interpretation |
|---|---|---|---|---|---|---|
| Simplifying and shortening Processes | 0.69 | 0.36 | 0.66 | 0.4 | 3.454E-05 | Significant |
| Transhipment decision | 0.07 | 0.28 | 0.17 | 0.02 | 0.4000772 | Not significant |
| Turnaround time | 0.82 | 0.46 | 0.59 | 0.36 | 0.0001656 | Significant |
| [Efficiency (reduction in time taken on various processes)] | 0.86 | 0.18 | 0.39 | 0.26 | 0.0015482 | Significant |
| [Security of cargo] | 0.77 | 0.26 | 0.58 | 0.28 | 0.0008724 | Significant |
| [Interface with electronic payment channels | 0.48 | 0.18 | 0.31 | 0.22 | 0.0041518 | Significant |
| [Shipping and customs documentation proc | 0.72 | 0.23 | 0.38 | 0.25 | 0.0020605 | Significant |
| [Gate operations] | 0.58 | 0.23 | 0.41 | 0.21 | 0.0057095 | Significant |
| [Containerized cargo dwell time] | 0.48 | 0.41 | 0.43 | 0.24 | 0.0028707 | Significant |
| [Vessel arrival] | 0.65 | 0.52 | 0.56 | 0.32 | 0.0003665 | Significant |
| [Cargo clearance process] | 0.83 | 0.28 | 0.55 | 0.35 | 0.0001651 | Significant |
| [Discharging/Loading operations] | 0.62 | 0.49 | 0.50 | 0.299 | 0.0006664 | Significant |
| [Safety in operations] | 0.69 | 0.36 | 0.56 | 0.24 | 0.0029495 | Significant |
| [Communication among stakeholders] | 0.57 | 0.42 | 0.48 | 0.27 | 0.0013826 | Significant |
| [Customer satisfaction] | 0.76 | 0.18 | 0.45 | 0.24 | 0.002683 | Significant |
| [Decision making by management] | 0.51 | 0.64 | 0.57 | 0.29 | 0.0007903 | Significant |

A regression analysis was performed to understand the impact of digital maturity on all the operational processes. The result was a p value of below 0.05 for all operational processes and r-squared values between 0.21 & 0.40 (Table 8), indicating that the impact of digital maturity on these processes was significant. According to the perceptions of the respondents, organizations with advanced digital maturity levels are likely to experience benefits in these particular operational processes.

### 4.4.4 Transhipment port choice and level of port digitalization

Whereas the majority (75%) of the respondents from the questionnaires indicated that a shipping line is likely to call a Port for transhipment based on its level of digitalization, 80% of the interviewed respondents disagreed with this statement. They opined that transhipment decisions are mainly based cost and efficiency and would not necessarily be influenced by the digital maturity level of a Port. However, they pointed out that digitalization does have a positive impact on the two key factors of cost and efficiency. Although the researcher requested for empirical data during the interviews to validate the respondent's claims, none was provided.

*Figure 15:Respondents views on transhipment port choice*

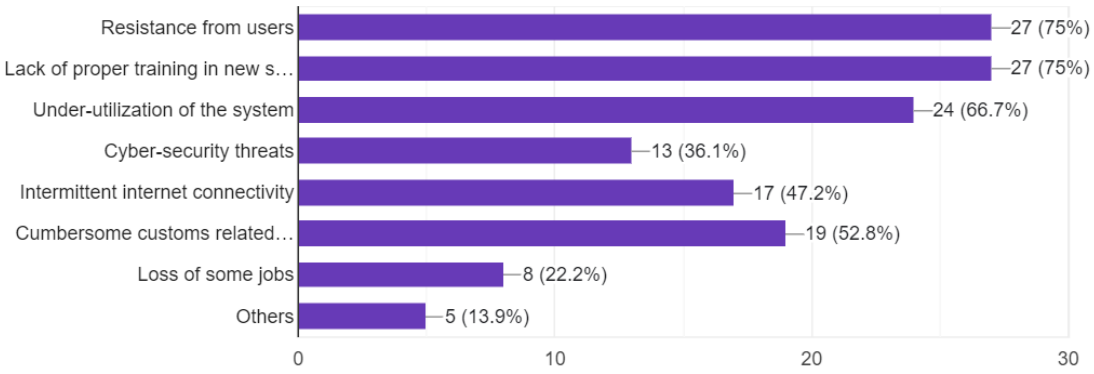



Lastly, it was established that there is no statistically significant relationship between the level of digital maturity of a Port and transhipment port choice made by shipping lines (Table 8) as the p-value was above 0.05. This result means that the level of digital maturity has no direct impact on port choice decisions.

### 4.4.5 Challenges associated with Digitalization

The study noted that human-related challenges in digitalization had a higher rating than the information technology (IT) related ones.

*Figure 16:Major challenges facing digitalization*




For instance, port employees indicated that they generally felt ill-equipped to handle emerging technologies or digital equipment in use. This may be as a result of proper training in new systems which is another challenge that was highlighted by 75% of all the respondents.

In addition, 75% of the respondents indicated that their organizations faced resistance from users in their digitalization journeys whereas 66% opined that the organization's systems were under-utilised. The lack of sufficient training as well as the different digital maturity levels or 'digital gap' may be a contributing factor to under-utilization of technology and systems, and possibly resistance. Two interviewees from the Port pointed out that although their internal users have accepted the digital technologies and platforms, some of their external key stakeholders prefer to either handle their transactions manually or are at a lower level of digital maturity. As a result, they maintain a hybrid system in some functions within Finance, particularly for supplier payments. In addition, they are working on an incentive system that will encourage more of the cargo truck drivers to come on-board the digitalized processes. One other interviewee from Port indicated that their challenge on under-utilization of systems was as a result of a high staff turnover and loss of key personnel who opted for early retirement packages. This brings to focus the roles of the Human resources function in motivating and retaining key talent as well as in succession planning when managing

change. 52% of the respondents pointed out that cumbersome customs processes outside the system were a key challenge to digitalization. One interviewee from the Port reiterated that customs systems downtime as well as their manual procedures had a significant impact on their key KPIs such as truck turnaround time and contributed to congestion in Port.

Meanwhile 47 % and 36% of the respondents indicated experiencing the challenges of intermittent internet connectivity as well as cyber-security threats respectively. On the issue of cyber-security threats, one interviewee disclosed a cyber-attack in 2021 had a huge negative impact on their operations and finances and consequently affected all their stakeholders. Considering the inter-connectivity of international trade, Ports and Port users must ensure that their systems are cyber-secure to reduce their exposure.
Lastly, two of the interviewees from Port indicated that financial constraints and budgetary allocation are a key challenge especially for publicly owned ports when procuring digital platforms, systems and equipment. The huge costs as well as lengthy and bureaucratic processes results in delayed adoption of the latest technology. This also highlights the differences in the decision-making processes as well as how investments in infrastructure are prioritised by Ports that are publicly owned compared to those with private terminal operators.

### 4.4.6 Overcoming challenges associated with Digitalization

The respondents had several suggestions in relation to overcoming the key challenges. These included having in place a coordinated change management process when rolling out digital solutions and engaging users from the onset of digitalization programs to ease their fears. In addition, cultivating better stakeholder collaboration to raise awareness of the benefits of digitalization as well as engaging in continuous user training were identified as keys to reducing the level of resistance from users. Training would also enhance system utilization as well as raise the level of awareness of cybersecurity matters by users in order to reduce exposure. Lastly, engaging reliable internet service providers and high investment in cyber-security as well as regular

vulnerability assessments would help ease the problem of intermittent internet connectivity and deal with cyber threats respectively.

### 4.4.7 Digital gap and Opportunities brought by digitalization

Most of the digital and high-tech port equipment are designed to improve efficiency, safety and security of cargo as well as minimize the incidents of accidents in port. The researcher noted a low response rate pertaining the use of digital equipment at the Port such as automated cranes, AGVs, sniffers and sensors. This means that these Ports still have a long way to go in matters of efficiency, safety, security as well as environmental sustainability. Digitalization has been used to enhance Ports efforts towards environmental sustainability by proactively and effectively monitoring and reducing the levels of emissions within Ports in many developed countries. There exists a gap for the Ports in Africa to achieve IMO's decarbonisation agenda if they cannot effectively monitor and reduce emissions. There is therefore a need for these Ports to consider investing in digital infrastructure and equipment.

## 4.5 Summary

In summary, the findings indicated that: -

a) The overall digital maturity of the various respondent organizations is between 3 and 4(structured and integrated stage), with Ports having an average lower digital maturity score of 3.75 while Port users score is 4.03. Whereas both categories had their weakest dimension being Human resources where the average score was 3.53 and 3.89 for Ports and Port users respectively, there is a lot of room for improvement across all the other dimensions.
b) The use of digital equipment and advanced technologies within Africa is quite low as the response rates on the individual technologies employed were between 12% and 53%. Collaboration with other ports in Africa should be pursued to learn from best practice as well as to reduce the perceived "digital" gap and to facilitate seamless international trade.

c) Digitalization has had a positive impact and improved many of the processes within Port and within the individual Port user organizations. The introduction, use and continuous enhancement of the Port community and Single window systems has been highlighted as a turning point by most of the interviewed respondents. Further, the results of the statistical analysis indicated that the impact of digital maturity level on port operations was significant, albeit with a low coefficient. The analysis also indicated no significant relationship between digital maturity level and transhipment port choice.

d) The challenges associated with digitalization are more human-related than IT related. There is therefore need for better stakeholder collaboration as well as continuous training in order to maximise system utilization levels as well as reduce level of resistance. A good change management process can assist organizations overcome these challenges.

e) Having a digital strategy in place is not enough. It should be reviewed regularly with as well as shared with the stakeholders.

f) Cyber-security awareness and preparedness is one area that all maritime players must prioritise given the international nature of trade, their "connectedness" and the high costs of cyber-attacks.

g) For ports and organizations in Africa to progress, they must be more open to ideas and take on risks. In addition, they need to contextualize the ideas and technologies adopted as every Port has its unique challenges.

h) In conclusion, political goodwill plays a key role in digitalization of processes that facilitate trade both locally and internationally.

The discussion of the findings is done in chapter 5.

# Chapter 5 Discussions

This section provides an overview of the findings and discusses the links between these findings and the previous research as highlighted by the articles captured in the literature review section. The extent to which the findings are aligned or contrast previous research will be discussed in order to answer the following research questions:

RQ1: How do the Port Authorities and Port users perceive the impact of digitalization on port operations in the Africa region?

RQ2: What is the level of digital maturity of the Port Authorities and Port users in their perspective?

RQ3: What are the major challenges encountered and opportunities identified by the stakeholders at the different stages of digital maturity*?*

## *5.1 Perceived digital maturity levels of the Port Authorities and Port users in Africa*

The researcher was able to establish the perceived level of digital maturity of both the Port Authorities and Port users. By applying the digital maturity model adopted in this study, we established that the average digital maturity level of the Port Authorities was 3.75, which was lower than that of the Port Users which was 4.03. These scores place both the Ports under the "structured" category, which means that most of their key processes and systems are digitalized whereas some are not. The Port user category is in the "Integrated" category in which *digitalization permeates throughout the entire organization and is more comprehensive.* These average digital maturity scores are based on the respondent's opinions and are likely to be highly biased. Another key observation was that regardless of the level of digital maturity, most of the respondents rated the impact of digitalization on their processes and operations highly and positively. In addition, one of the main differences was that most of the Port user organizations included in the survey were privately owned compared to the Ports, which were mainly publicly owned. The higher level of digital maturity of Port users

as compared to that of Ports is not surprising because most of the Port users are private owned companies facing stiff competition for the same shippers in the market. Their organizations are therefore quicker in adopting the latest digital technologies in their strategies and processes so as to give them a competitive edge and secure their customers, who are more often also tech savvy. This may not be the case for Ports, particularly the publicly owned ones, who tend to be "laggards" or followers as opposed to leaders in matters of digitalization. Further, private owned organizations are profit focussed and will therefore adopt strategies that ensure they attract and maintain customers in a highly competitive environment. This may be one of the reasons why most of their digital maturity dimensions, particularly those of Leadership and governance, Operational processes and Technology have very high scores.

Despite the Ports and Port users attaining relatively high digital maturity ratings, some of the Ports have limited awareness of Industry 4.0 and generally lag behind in terms of investing and adopting latest digital technologies. There is a lot of room for improvement and more benefits through adoption and use of advanced analytics, IoT and Blockchain technologies. However, the higher level of digital maturity of Port users, who include leading global transport companies, is consistent with literature which acknowledges that Ports are normally followers (Philipp, 2018).

### *5.2 Impact of Digital Maturity on Port Operations in Africa*

The researcher was able to establish that although the Port Authorities and Port Users in Africa have varied perceptions of digitalization and its impact, majority of the respondents stated that the impact on their operational processes had been largely positive. For instance, the introduction and use of the Port community and Single window systems that integrated multiple users on one platform has simplified cargo processes and was highlighted as a turning point by most of the respondents. In addition, digitalization has improved many of the processes within Port and within the individual Port user organizations. The average rating on the extent that '*digitalization*

*has simplified and shortened our processes'* by the Port users was 4.75 while that of Ports was 4.17. Further the average rating by Ports and Port users on *"our organization uses online and e-platforms such as e-bills of lading, e-manifests, e-booking, e-cargo tracking, e-payment"* was 4.17 and 4.29 respectively.

The regression analysis results further indicated a statistically significant relationship between the level of digital maturity and the various operational processes. The impact on shortening of processes, improved efficiency and turnaround times and security of cargo as perceived by the respondents are in line with existing literature which highlights these as some of the benefits of using digitalized systems and platforms. Further, the benefits of short processes and shorter vessel and cargo turnaround times are lower operational costs for the Port users.

### *5.3 Impact of Digital Maturity on Transhipment Port choice in Africa*

With regard to transhipment decisions made by the shipping lines, the interviewed respondents disagreed with the majority opinion of the questionnaire respondents that digitalization of a Port played a major part in these decisions. They opined that cost, efficiency and location were the key factors shipping lines considered when choosing transhipment ports, which is aligned to literature reviewed in this study. The choices made by shipping lines and the alliances formed between them influence the port hierarchy and the utilization of transhipment hubs, and these decisions are informed by tactical, financial, and operational factors (Notteboom et al., 2017). Port attractiveness is influenced by a variety of factors, with cost and time being the two most leading attributes. However, port users, primarily shipping lines, do not always base their choices solely on cost. Other perceptive elements, such as the knowledge that is readily available from diverse sources such as a port's reputation, experience and port marketing, may be equally important (Adolf Ng, 2006).

According to Chen et al., 2017, shipper and freight forwarders have differing preferences when selecting transhipment hubs. However, they identify eight factors that are considered highly important by all the stakeholders. These are location, cost

of route, customs regulations and government policies, port service, facility, cargo information, connectivity, and legal and financial service. Out of these, the most significantly important factors that affected stakeholders' choice of transhipment hub as per the survey were cost of route, customs regulations and government policies, and connectivity; with most decisions being cost-driven. Further, the stakeholders reiterated that governments ought to establish one-stop hub services to improve and simplify the regulatory processes.

Lastly, even though no statistical significance between the digital maturity level and transhipment decisions exists, we established that digitalization improves the efficiency levels and shortens the operations processes hence an indirect relationship between digital maturity level and port choice exists. A major limitation of the study was that it covered 7 ports in Africa therefore the respondents' views from the represented ports with regard to transhipment may vary widely. It is important to note that increasing the sample size may yield different results.

### *5.4 Human resource related challenges*

The major challenges identified by the stakeholders were either human related or IT related. The human related challenges were rated much higher than the IT-related ones. For instance, the human resource dimension rating by the Ports was at 3.53 while that of Port users was at 3.88, which indicated the gap in empowering and training employees to handle digital technologies. The challenge of proper training in new systems was highlighted by 80.6% of the respondents whereas 71% of the respondents indicated that their organizations faced resistance from users in their digitalization journey. One of the human related challenges of resistance to change was attributed to the strength of unions in Ports. Whereas this study did not specifically address unions, the problem with unions has plagued Ports worldwide and some ports have been able to handle them better than others. For instance, the Port of Singapore adopted a remuneration system that rewards productivity and high performance thus avoiding confrontation from workers. The government, management and the port workers'

union also worked on a harmonious relationship that enhanced communication between them, warding off any labour strikes since the mid 1980's (Cullinane & Dong, 2007).

Some of the ways of overcoming the human related challenges include regular engagement and collaboration with all stakeholders and including them in the digitalization roadmap for a seamless and efficient way of working. The importance of good change management processes, continuous training and proper succession planning in digitalization cannot be over-emphasized. It serves to motivate and retain employees as well as reduce the level of resistance by users whenever new systems are rolled out (Mullins, 2016).

Majority of the Ports covered by the study were public owned, with one of them having approximately 7,000 employees. As has been highlighted in literature, fully public owned ports are characterized by inefficiencies of dockers, often reflected in the top-heavy administrations, over-manned and undertalented personnel who are equally resistant to change (Alderton, 2008). Some of the respondents recommended that full or partial privatization through collaboration with private terminal operators would serve to embrace digital technologies more, reduce bureaucracy, improve efficiency and productivity. It would also reduce the size of port labour much to the chagrin of the unions as well as allow for economies to raise funds for other public activities (ICS, 2013).

### *5.5 IT related challenges*

The major IT related challenges were intermittent internet connectivity as well as cybersecurity threats. The challenge of internet connectivity can be resolved by governments investing and improving high-speed internet infrastructure such as fibre optic cables as well as the Ports and Port users engaging reliable service providers. The low level of response on use of cyber-security technologies against a background

of increasing cyber-threats in the maritime space is very surprising. Despite having zero attacks, cyber-security needs to urgently be prioritized and regular vulnerability assessments carried out by organizations as any breach has a huge negative effects on the global supply chain. Training all users on awareness of cyber risks and how to navigate the digital space safely to minimize their exposure is key.

### *5.6 Digitalization gap*

Although most of the respondents' Ports are utilizing digital and electronic platforms and systems in most of their processes to a large extent, a huge gap was noted in the level of use of digitalized and automated Port equipment. A low level of investment in digitalized equipment may be attributed to lack of awareness of their benefits or financial constraints given the associated costs of investment. The Associated British Ports annual review 2022 report on embracing innovation and sustainability indicates investments in electric and hybrid equipment and wind turbines costs over £60 million while investments in digitalisation and sustainability measures in Wales cost them approximately £50 million since 2019 (ABP, 2022).

Ports in Africa can overcome these challenges through regular engagement and collaboration with ports that have already embraced digital technologies to establish their real benefits (UNCTAD,2021a). Partnerships with Private terminal operators has also been documented as a way Ports have been able to improve their productivity and efficiency. In addition, governments need to prioritize and incentivize investments in high internet speed infrastructure. Investment in the digitalized port equipment and digital solutions will also assist Ports in Africa reap benefits such as improved productivity and efficiency levels, enhanced safety and security of cargo, reduced costs as well as enhanced environmental sustainability. By proactively monitoring and constantly working towards reducing the levels of emissions, Ports in Africa can also achieve the Net zero carbon emissions by 2050.

# Chapter 6: Conclusions and Recommendations

## 6.1 Conclusion

At the beginning of this study, the researcher set out to assess the impact of digital maturity levels on port operations in Africa. The study achieved all the stated objectives as will be demonstrated below.

The researcher applied a novel digital maturity model establish the level of digital maturity of the Port Authorities and Port users. It was established that Ports in Africa have embraced digitalization to a certain extent as all the respondent Ports indicated that they were using integrated digitalized systems such as PCS, SWS and Integrated Port management systems, with some of these systems having been used for over 20 years.

In addition, Port user organizations were at a higher digital maturity level compared to the Port Authorities. Whereas the Port users were in the Integrated stage, the Port Authorities were at the structured stage. However, it should be noted that the average rating was based on the respondent's subjective perceptions, which may be biased.

Further, the researcher established that both Port Authorities and Port users had a positive perception on the impact of digitalization on port operations. In their opinion, most of the operational processes had improved to a great extent; the level of efficiency and the vessel turnaround times had reduced thereby reducing the overall operational costs.

The findings of this study corroborate what various authors have reiterated regarding the challenges associated with digitalization being more human-related than IT related. Nevertheless, considering the recent increased incidences of cyber-attacks in the maritime sector, the various stakeholders indicated that they adequately prepared and had cyber risk mitigation strategies in place.

Lastly, with regard to the digital gaps noted in Ports, regular collaboration with stakeholders and other leading ports would assist Ports in Africa make informed decisions on digitalization investments.

## 6.2 Key learnings and Recommendations

- Regular assessment of the digital maturity levels of both Ports and Port users will enable their Port managers and policy makers establish and focus on their areas of weakness and come up with better digitalization strategies enhance efficiency and customer satisfaction levels. Improvements in the levels of digital maturity are associated with benefits such as increased visibility and insight, streamlined and safer operations in port and fuel efficiency, reduced costs as well as enhanced sustainability, among others.
- Policy makers and top management must realise that the human resource dimension is very critical to the successful implementation of digitalization and technological initiatives. Organizations that want to run successful digitalization programs and achieve higher digital maturity levels must ensure that they improve their relationships and collaboration with their key stakeholders; as well ensure their human resource is continuously trained, digitally savvy and effectively managed.
- Although most the respondents faced similar challenges in their digitalization journey, the organizations which embraced a culture of openness and experimentation and were collaborative were able to deal with them better. Creating a culture of openness and collaboration seems to lead to winning strategies.
- Cyber threats usually paralyze operations and cause colossal losses to multiple businesses in the entire supply chain. The top management in maritime sector therefore need to prioritize and invest in cyber security and effective cyber-risk management for seamless functioning of secure the single window systems, port community systems and logistics chain operations. They must also invest in training the employees or system users to understand the importance of cyber

security and remain vigilant even when using new technologies and collaborating with other stakeholders to minimize the organization's exposure.

- Maritime players within the Port community in Africa need to open up to research and share information in order to pinpoint pain areas, learn from best practice and come up with strategies that will improve their performance and attract more customers to their Ports.
- In addition, there is a clear need for governments, Ports and Port users in Africa to increase their investments in digital technologies, high speed internet infrastructure and digital equipment to facilitate trade. Africa has also come of age to embrace and compete in the digital space internationally.
- The researcher gained a lot of insight particularly from the maritime and ICT experts who were interviewed.

## 6.3 Limitations

- The digital maturity model used did not specify any weighting of the dimensions hence the researcher used equal weights in coming up with the average scores. Adjusting the model to work with fewer dimensions and weighting of the dimensions giving more weight to certain key aspects may result to a better measure of digital maturity.
- This study used the perceptions of users to measure the digital maturity levels, which is likely to be biased. Moreover, different persons have different understanding of the subject matter. This high level of subjectivity means that digital maturity rating levels generated for the various organizations may be higher or lower than it would be if more empirical data was used. Data that can be used to complement the assessment of digital maturity in future would include operational and financial performance KPIs.
- In addition, data on port performance in the region covered by the study is not published in the public domain and many respondents were reluctant to share information. The only available public data was not sufficient to fully support

the respondent's opinions yet availability of empirical data would have corroborated the findings making the study more objective.

- Lastly, the unwillingness of potential respondents to participate in the survey, the low response rate (43 respondents from 7ports) is likely to have an impact on the findings. The sample may not be representative of the population in the region the findings may therefore not reflect the real situation.

## 6.4 Implications for future research

The researcher recommends that future research explore measurement of digital maturity levels of Ports using an improved model that is adequately weighted while a bigger sample size and using objective data.

Finally, this study has contributed to literature about digital maturity in the maritime field, and in particular the less studied region of Africa.

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# Appendices

## Appendix 1: Informed consent for the questionnaires and interviews

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: .....

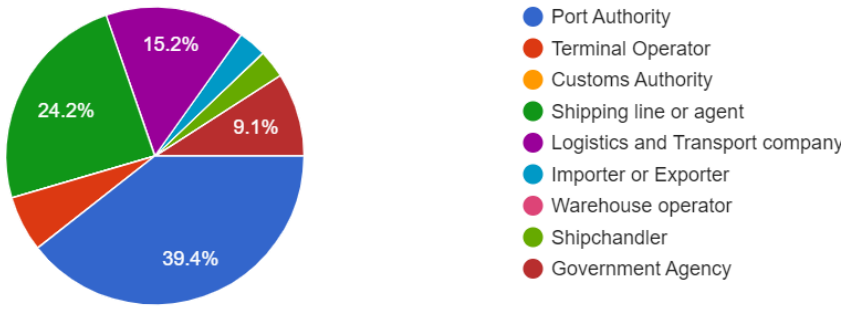
* Required

1. Email *

## Appendix 2: Presentation of data collected through Questionnaires

Q.2 b) Nature of the organization's business

33 responses



Q.3 Your position in the organization

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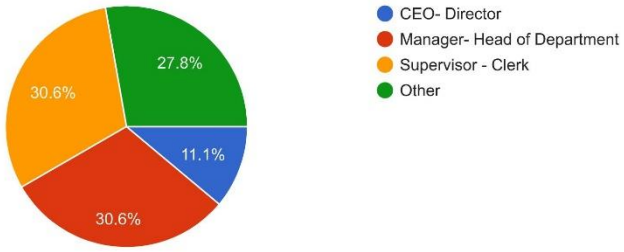
36 responses




Q.4 How long have you been in this position?

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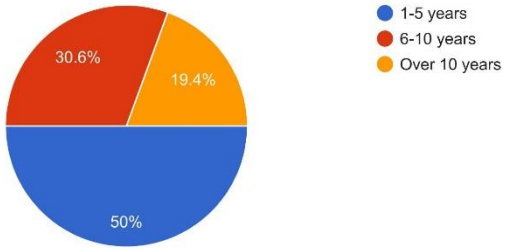
36 responses




Q.5 Is there a digital strategy in place at the Port? (*A digital strategy or digital transformation strategy is a company's overall vision in the context of digitalization, including strategic measures to achieve this. It defines concrete, short and long-term digitalization goals and initiatives in the context of products, services and value creation within the organization)*

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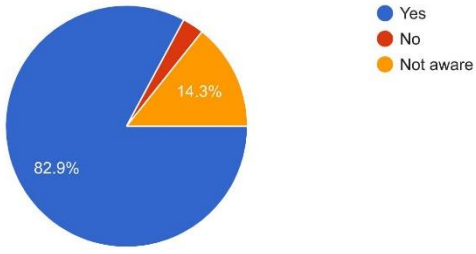
35 responses



Q.6 What are the various digital technologies that are currently in use at the Port?(Tick all appropriate answers)

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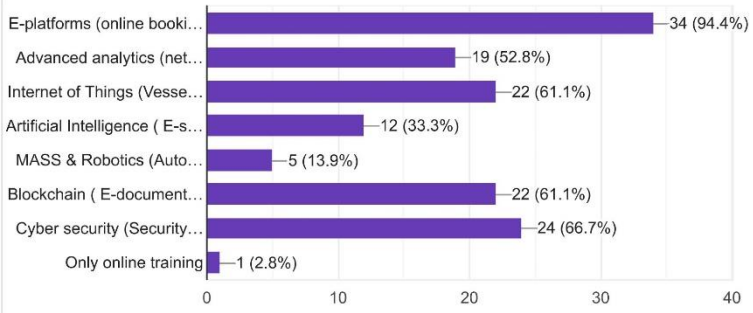
36 responses




Q.7 a) Please tick all appropriate answers. Our port has the following equipment

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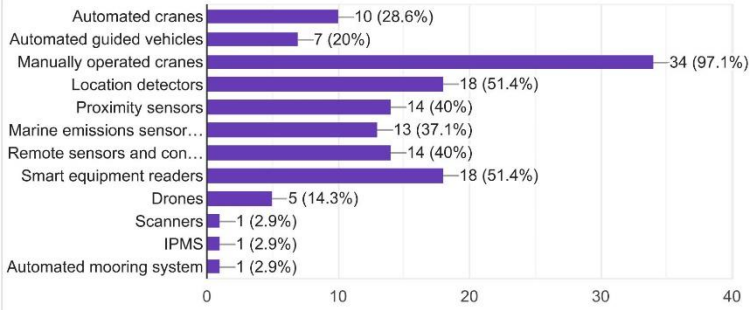
35 responses




Q.7 b) If your answer in the above Question was '"Others"', please elaborate

4 responses

Integrated Port Management System

I may not know all of the automations at the port

N/A

Automated mooring system

Q.8 What is the level of digitalization of the following processes at the Port?

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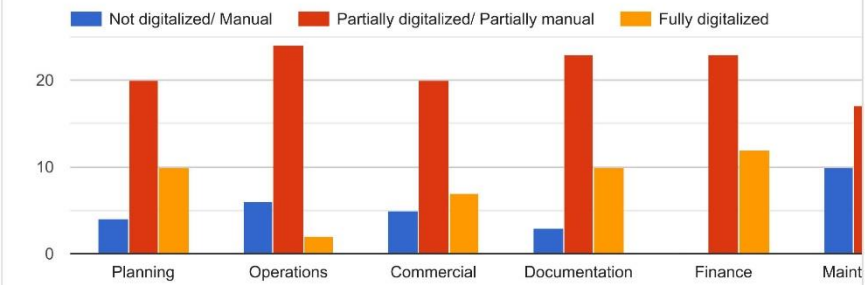


Q.10 Our Port actively uses the following systems(tick all appropriate answers)

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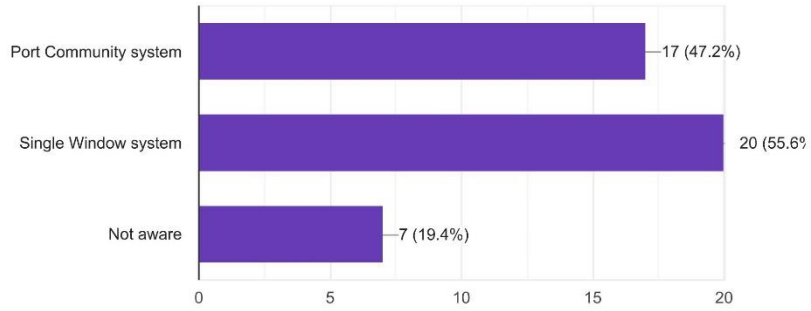
36 responses



Q.11 In your opinion, to what extent has digitalization improved the following aspects at the port?

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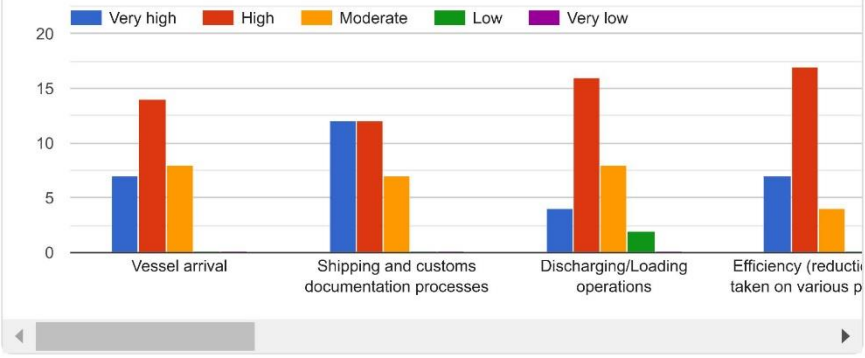


Q.12 Please elaborate your answer to the above question

18 responses

On billing and documentation procedures.

in time documentation and cargo clearance

Whistle the is communication between all stack holders I believe that there are a lot of areas which we can improve

There is still room for improvement including attitude by the Port staff

Digitalization has enhanced process of receiving cargo & clearance hence enabling faster truck and vessel turnaround time. This increases customer satisfaction and helps the port Authority to be more efficient and hence handle more cargo making it competitive and increase profit margins.

Digitalization has enhanced operation time management,security and flow of operation are swift.

Though digitalization has improved many processes, there is still a long way to go as some processes are not yet digitalized while others are partially digitalized. Also management decision making has not fully embraced digitalization in its decision making process.

Digitalization has improved efficiency

I think the level of improvement depends on how many third parties are involved in the particular step. E.g gate saw a big improvement with digitization because they are wholly under the controll of the port authority. However, customs clearance which will involve atleast 7 different parties will take longer to show a significant improvement. Management decision are more complex, digitization plays just a partial role at making them.

Digitalization has improved the efficiency levels of most of the operations at the Port. The customs documentation and finances processes have seen remarkable progress. Customer satisfaction levels have been enhanced but there is still a lot of room for improvement particularly for the load, discharge and quay operations as well as in planning and communication among stakeholders.

Port been digitized has seen improve in overall port productivity

The organization procurement system that the port is using is a total nightmare, as the marine department needs the spares for tugs maintenance but this system takes forever to procure or buy essentials for the department.

Because there is an efficient interaction between the authority and it's customers

Digitization has speeded up cargo movement at port and sealed all loopholes for malpractice by clearing agents,it has simplified operations which initially were paper work.

I have not answered the above question because the terminals were concessioned and are operated independently from the port authority.

Digitization of majority of the port processes has simplified operations at the port

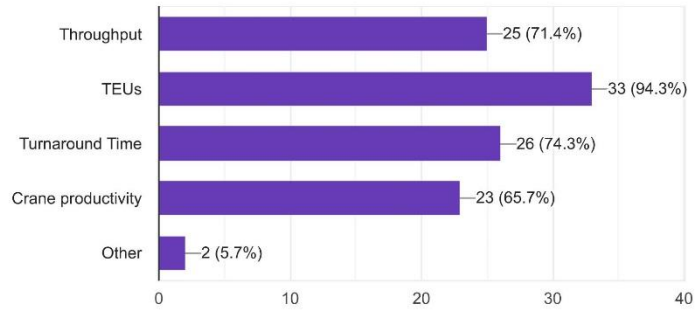
Digitization of various procecesses at the port has greatly improved the overall performance, thus increasing the efficiency of the port.
Due to automation of processes and deployment of artificial intelligence; shippers, shipping agents, cargo forwarders and other port users greatly benefit from the reduced ship and cargo turn around times at the port.
Digitization has also made it possible to adopt a 'Single Window System' and interface with electronic payment systems and banks, strategies that have gone a long way into ensuring reduced documentation, enforcing early adoption of technology among the stakeholders, improving communication amongst the port community and to some extent reducing fraud. These, among other factors, improve the overall performance of the port.

There are still other factors that affect port operations.

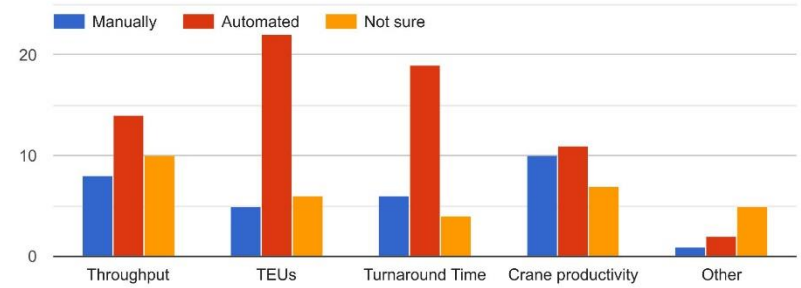
Q.13 Which Key Performance indices (KPIs/metrics) are in place to measure transhipment performance at the Port? (check all that apply)

Copy

35 responses

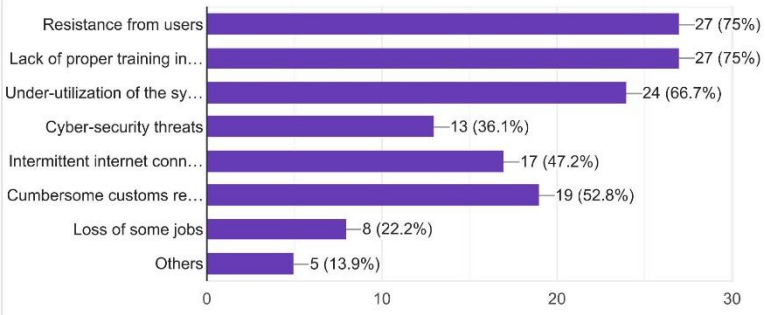


Q.14 Are these KPIs measured manually or is the process automated? Copy




Q.15 What are the major challenges associated with digitalization facing your organization? Copy

36 responses



Q.16 If one of your answers to the Question above was Others, please describe it

8 responses

Many users resist digitalization due to fear that they'll lose their jobs once automation is done hence the need to train staff on emerging and new technology and offer more opportunities to advance their careers within the organization.

For multinationals, the digital strategy is defined at the HQ, so the local office isn't idependent to adpot some digital elements available locally that may be way ahead of the HQs current level of digitization

None

Not all employees are connected to the internet.

Funding

N/A

high costs, reluctance from unions, lack of skilled personnel, high employee turnover after training, voluntary service package caused loss of experienced staff

different levels of digital maturity of suppliers e.g. truck drivers resist digitalization efforts and supplies preferring to use manual invoices; infrastructure challenges of congestion

Q.17 In your opinion, how would you overcome the challenges associated with digitalization?

31 responses

1. Through awareness both port users and staffs
2. Reliable sources of internet services providers.
3. Introduction of remote services

sensitization and collective approach both the management and the system users

We need to engage with team members and have learning tools to assist the other staff.

Sensitization and training for all stakeholders.

Attitude and full training of staff. Curbing of corruption which makes lot fo staff want to use manual interventions.

More engaging and educational stakeholder engagement

Create awareness, training of personnel, updates and upgrades to system, embracing new technologies, enhancing manpower,

Sensitization of the relevant stakeholders on usage of the several available platforms and their merits as opposed to manual processes.

By upskilling my skills and be conversant in the utilization of the systems

Training and Awareness

Through proper and regular trainings,reliable internet connectivity,reliable power sources.

Improving connectivity is a quick win together with proper training and awareness training on benefits of digitalization among users. Customs needs to be brought and board but this is more of a change management issue as it has to do with attitude more than anything else.

The current online booking for trucks is a challenge due to limited slots provided by the port, which becomes a challenge to transporters to gate in containers into the port for exports stack (limited time). The port could resolve this providing more slot availability based on vessel/voyage stacking time.

Proper training of employees and awareness

Government, Private Sector partnerships. Full privatization of ports. Proactive influence from the government through the regulatory arms and legislation

More training and integration of digitalization

Sensitization and Training!

Embracing proper change management methods when changing systems to gain traction as well as engage in continuous training. For the cumbersome customs related processes, there can be more engagement with Customs through the Shipping Agents Association to ensure most processes are captured electronically or digitally. Training and awareness in cyber-security risks as well as investing more in cyber-security as has become a very high risk area.

More training needed ,

Yes

Create more awareness to customers and the employees as to counter the more emerging technologies around the world.

By empowering those in the system to be digital,and sealing all loopholes that would pause a challenge.

Creating awareness about the advantages of digital services and their utility. Train the users.

Change management and negotiation with unions. Secure funding.

Engage more in stakeholder sensitizations, embrace modern technologies

The biggest challenge associated with digitization in my organisation is resistance from users, mainly due to lack of proper training. To overcome this challenge I would suggest that the management adopts a training programme that focuses on training staff at all levels on the use of technology as well as adoption of any new digital systems.

REGULAR TRAINING AND APPLICATIONS

mass training of users, salary adjustments, improve employee satisfaction, change management programmes

stakeholder collaboration communicate with staff to change their mindset on the importance of change

collaboration with stakeholders and good relations with them, have a good change management system, communication with users to show them the importance of digitalization, strong protocols for access to systems and regular vulnerability assessment to proactively deal with threats.

Build trust with partners and define common goals with all partners; More sensitization and engagement with stakeholders; Incentivizing use of digital options to reduce resistance levels (e.g. discounts or offering credit/ refunds); Success of digitalization initiatives depends on developing skills and digital competencies of stakeholders and total government support, Training and having a feedback system; Training via YouTube;

Q.18 Kindly indicate your level of agreement with the following statement:

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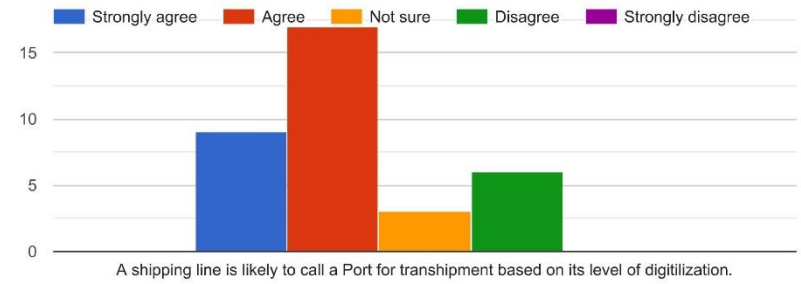


A shipping line is likely to call a Port for transhipment based on its level of digitilization.

Q.19 Kindly indicate your level of agreement with the following statements with regard to your organization

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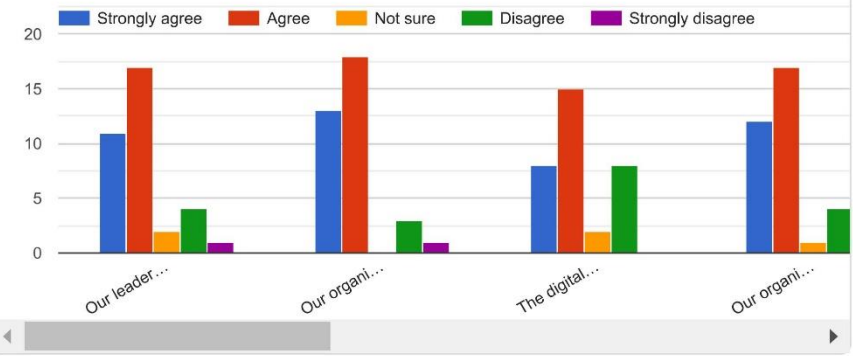

# Appendix 3: Semi-structured Interview questions

**SEMI-STRUCTURED INTERVIEW QUESTIONS**

**TOPIC: The Impact of the Digital Maturity Level on Port Operations in Africa**

1. What is the name of your organization?
2. What is your position in the organization?
3. How long have you been in this position?
4. What is the size of the organization? (Approximate number of employees)
5. a) Is yours a fully public owned port or have you opened to private terminal operators? Elaborate.

   b) How has the port positioned itself as a transhipment hub? What is their competitive edge?

   c) Does digitalization play a role in this?
6. On a scale of 1-5, how would you rate digitalization as a factor that shipping lines consider when making decisions to call a port for transhipment?
7. Is there a digital strategy (digital transformation strategy) in place at the Port?

   *(Definition of digital strategy: A company's overall vision in the context of digitalization, including strategic measures to achieve this. It defines concrete, short and long term digitalization goals and initiatives in the context of products, services and value creation within the organization).*

   If yes, please elaborate? How often is it reviewed? Is it current? Is it built on an ISO standard that harmonizes information flow in the Port community? Are all employees aware of the same? When did the company embark on the digitalization journey? Is there a separate division that is responsible for digitalization? Do you have a team of experts? (e.g. experts in digital platforms and digital security?) Kindly elaborate.
8. Kindly indicate your level of agreement with the following statements about your organization (Options:Strongly agree, Agree, Not sure, Disagree, Strongly disagree)

a) Our leadership fully embraces digitalization and are considered "early adopters"
b) Our organization has a division/department responsible for digitalization
c) The digital strategy is communicated throughout the organization
d) Our organization is open to change and continually improves our business model
e) Our organization encourages experimentation and adoption of new processes, strategies and technologies
f) Our employees are empowered and trained to handle digital technologies
g) Our organizations uses online and e-platforms (e-bills of lading, e-manifests, e-bookings, e-cargo tracking, e-payments)
h) Our organizations uses web-based, mobile apps and automated channels to respond to customer queries
i) Our organization is using manual (paper) transactions to a large extent
j) Digitalization has simplified and shortened our processes
k) Digitalization has improved our decision making (data driven decisions and strategies?)

9. Is your Port using a:
    a) Port Community system? b)Single Window system?
10. When did you implement these systems? Are they safe and secure platforms? Are there data protection & privacy clauses? Cyber-security investment and threats? Is it a major concern for you? How are you handling it? Post -covid developments?
11. In your opinion, what are the key enabling factors for successful implementation of a Port community system or single window system?

    What are the key enabling factors for successful implementation of a single window system? Political will, dedicated team, stakeholder management, change management, budgets?

b) What are the major challenges associated with digitalization at the port? (Options: Resistance from users, lack of proper training in new systems, under-utilization of the system, cyber-security threats, intermittent internet connectivity, Power disruptions, cumbersome customs related procedures outside the system).

c) In your opinion, how have you overcome the challenges mentioned in the above question?

(Do you have a clear business continuity plan/ disaster recovery plan? How often does it roll in? How often do you have frequent downtimes? ) Increased Cybersecurity attacks? Budgets? Adequate Personnel?

12. What are the various digital technologies that are currently in use at the Port? (Options:

a) E-platforms (online booking, online cargo management, online manifests submission, online training)

b) Advanced analytics (network optimization, demand forecasting, empty container repositioning)

c) Internet of Things (Vessel and machinery monitoring, reefer container condition monitoring)

d) Artificial Intelligence (E-service centre, dynamic capacity reallocation, predictive maintenance)

e) MASS & Robotics (Automated Vessel Navigation, Automated port calls)

f) Blockchain (E-documents, E-bills of lading, payment automation, cargo insurance)

g) Cyber security (Security assurance for customer data, security assurance for automated processes)

h) Others (please specify)

13. What other emerging digital technologies are in the pipeline and can be employed?

14. What is the level of digitalization of the following processes at the Port? Planning, Operations, Documentation, Commercial, Finance, Maintenance, Others (Not digitalized/manual; Partially digitalized; Fully digitalized). Also elaborate on Others.
15. Does the Port use any modern or automated equipment? If yes, please list them (Options: Automated cranes, automated guided vehicles, manually operated cranes, location detectors, proximity sensors, marine emissions sensors, remote sensors, smart equipment readers, scanners)
16. In your opinion, to what extent has digitalization improved the following aspects at the port? (Answer options: Very high extent, high, moderate, very low, low extent)

    Vessel arrivals, shipping and customs documentation, Discharge/load operations, efficiency of processes (time taken), Vessel turnaround times, Safety in operations, security of cargo, interface with payment channels and banks, communication among stakeholders, customer satisfaction, decision making by port management.

    d) Please elaborate your answer (What is the impact of digitalization on performance, efficiency, integration, decision making, customer service)

17. Which Key Performance indices (KPIs/metrics) are in place to measure transhipment performance at the Port? (Throughput, TEUs, Turnaround time, Crane productivity, Berth productivity, Container dwell time)

    b) Is performance measurement manual or automated?

18. Please provide data on the Annual

    a) Import, export and transhipment volumes handled by the Port over the last 10 years;

    b) Average productivity per crane and berth over the same period;

    c) Average vessel turnaround times and container dwell time.

19. Your last words…….Lessons learnt.

Appendix 4: Presentation of Interview data

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Theme 1: Digital Strategy and Awareness** | | | | | | | |
| **Digital strategy in place** | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| **Separate division responsible for** | No (IT) | No (IT) | No (IT) | No (IT) | No (IT) | No (IT) | Yes(Special projects) |
| **Theme 2: Digital Maturity of Stakeholders** | | | | | | | |
| **Digital platform in use (TOS, PCS, SWS)** | PCS | PCS | TOS/ SWS | TOS/ SWS | PCS | SWS | IPMS |
| **Number of years of using digitalized platforms** | 2 | 2 | 20+ (TOS) ; 10+(SWS) | 20+ (TOS) ; 10+(SWS) | 20+ | 14 | 8 |
| **Theme 3: Digitalization of Processes and Operations** | | | | | | | |
| **Use of e-platforms (e-bls, e-manifests, e-cargo booking, e-payments)** | Very high | Very high | Very high | Very high | Very high | Very high | Very high |
| **Investment level in cyber-security** | High | High | High | High | Very high | Very high | High |
| **Incidence of cyber-security attack** | No | No | Yes in 2020; Ransomware; Didn't paralyse operations and was averted by the Israeli company | Yes in 2020; Global attempt (Phising) but was promptly handled | Yes (not at Port Authority but at the APM terminal in 2018. Stopped ops for 3 days) | No | July 2021. Paralysed operations for a week/ Fall back plan was manual operations across board. Normalcy returned after a month |
| **Existence of business continuity plans** | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| **Level of manual operations** | Moderate | Moderate | Moderate | Moderate | Very low | Very low | Moderate |
| **Level of use of paper** | Moderate | Moderate | Depends on functions - Finance is low; Operations is still moderate | Functional related/OBLs still in use for cargo release | Very low | Depends on functions e.g. Finance (supplier payments is moderate); | High |
| **Use of manual cranes** | Very high | Very high | Very high | Very high | Very high | Very high | Very high |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Use of automated equipment (cranes,** | Low | Very low | Low | Low | Moderate | Moderate | Moderate |
| **Use of high-tech digital equipment** | No | No | Moderate | Moderate | High | Moderate | Moderate |
| **Other digital technologies in use** | | | | | | | Moormaster and shore-tension technology; |
| **Need for upgrade( looks at maturity of system)** | | | Very high(TOS) | High | Low | Low | High |
| **Continuous upgrade of system** | Yes | Yes | Yes | Yes | Yes(ISO 40001 certified); | Yes, evolved from PCS in one Portin 2012 to SWS (for all Ports) in 2015; Added features to the SWS | Yes |
| **Most Improved aspects** | All operations | | Finance (Simplified billing and payment); Shipping and customs documentation; Security systems; Speeding up some operations(Vessel arrivals and vessel turnaround); Decision | Finance (Simplified billing and payment); Shipping and customs documentation (manifests and EDOs working well for the last 4 years); | All RORO/ Passenger fully | All operations are integrated (incorporated all stakeholders under PCS) | Operations/ Documentation |
| **Least improved aspects** | Finance | | Maintenance & Commercial; Container tracking module not | Quay operations; Planning | Optional services | Managing trucks | HR/ Change management |
| **Theme 4: Port Choice / Transhipment Port decision** | | | | | | | |
| **Positioning of Port (Transhipment)** | | | | As the Port with the second largest capacity along the Indian Ocean. Performing better | High Efficiency, low cost (partly attributable to digitalization) | High Efficiency, low cost (partly attributable to digitalization); Having one platform facilitates trade+ reduces costs of IT cyber-security; Cyber-security handled by an Israeli firm/ backed up by the Ministry of Defence | Higher Ship turnaround(Moormaster and shore-tension technology) & improved efficiency(IPMS for booking services and invoicing, also linked to AIS),vessel tracking; NAVIS for monitoring containers, digitalization of weather forecasts; ), lowered overall cost (partly attributable to |

| Theme 5: Challenges and Opportunities | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Main challenges** | | | Training budget under HR not user departments and training needs not fully met;Paying for system modules that are not being used at all; Budgetary allocation and constraints; Resistance from users and running processes manually whereas the same can be automated; Customs systems downtime impacting on key KPIs such as truck turn around time; Internet connectivity | Partial implementation of the digital strategy and technologies (under-utilization of the TOS); A big digital gap between Port and Users exists and needs to be addressed | Low level of resistance | Different digital maturity levels of stakeholders; Initially customs processes were a bottleneck but not any more- infact they will be fully onboard PCS/ integrated in the next one year; Resistance from truck drivers; Infrastructural challenge of congestion | Unions(40% unemployment rate; Labour intensive)/ Poor change management/ HR challenges (high turnover/ low retention/ lack of skilled personnel)/ Cost of equipment |
| **Overcoming challenges** | | | More sensitization and engagement with all stakeholders, Prioritizing training in budgets and change management with a focus on benefits of digatilization in order to raise user acceptance levels; Engage terminal operators through public-private partnerships to raise efficiency levels in Operations and reduce wastage of resources (equipment and HR) | Investment by Port in more digital infrastructure and e.g. automated cranes; Move more towards completely minimising manual transactions (seek legal solutions to use of OBLs); Engage terminal operators through public-private partnerships to raise efficiency levels in Operations. There is evidence e.g. from the terminals ran by DP world, Bollore and APM Terminals; Training users to fully utilise systems and on cyber-security hygiene issues as the threats especially of Phising are on the rise through one on one sessions as it is a techical subject | Build strong stakeholder relationships - this will help in coming up with better digitalized solutions and reduce resistance; Remain open to ideas, learn from errors; Train continuously | Build trust with partners and define common goals with all partners; More sensitization and engagement with stakeholders; Incentivizing use of digital options to reduce resistance levels (e.g. discounts or offering credit/ refunds); Success of digitalization initiatives depends on developing skills and digital competencies of stakeholders and total | Sensitization/ Mass training/ Motivating employees through better reward systems/ Split personnel into specialists;Simplified procurement system for digitalized equipment; Link early retirement with succession planning |
| **Recommendations** | | | Consistently put more efforts in digitalization of all processes in order to meet/exceed customer expectations/ attract more business to the Port; | Embracing blockchain technology by all stakeholders will move the industry forward | Consistently benchmark with the leading ports but also contextualise while adopting as environments and cultures are peculiar /different; Embracing | Keep innovating/ open mind to try new ideas, try them and contextualise them. Innovation must be part of your DNA; Cooperate with other | Temper the voluntary service package in order to retain key talent/ Proper succession planning |
| **Digital Maturity concerns** | | | Mainly IT related/ depts running with this; Invest in a more robust cyber-security system and train users on potential risks | Mainly IT related/ depts running with this; Covid accelerated adoption of digital processes(finance fully digitalized; Exports only exceptional DG bookings handled manually; Digital score higher | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Advantages of digitalization** | | | | | Improved visibility of cargo (RORO); Eased tracking of cargo after customs declaration; Overall efficiency improved & Lower costs (making it attractive as a transhipment Port as well as making the exports competitive internationally) | Reduces formalities & simplifies procedures;Reduces vessel turnaround time &cargo port stay; Reducing logistics costs by optimally scheduling port calls | Improved visibility and planning; reduces errors & improves safety; simplifies procedures; Improves recording keeping (easily get reports and track and know your costs.....numbers dont lie) ;Reduces vessel turnaround time &cargo port stay; |

Appendix 5: Descriptive & inferential statistics

a) Descriptive statistics – Digital Maturity dimensions

| DIGITAL MATURITY DIMENSION | Mean | Standard I | Variance | Mean (Port) | Mean (Port users) | Difference in mean |
|---|---|---|---|---|---|---|
| | | | | | | |
| Leadership | 3.94 | 1.06 | 1.11 | 3.82 | 4.06 | -6% |
| Strategy | 3.70 | 1.10 | 1.22 | 3.65 | 3.75 | -3% |
| Operational process | 4.09 | 0.93 | 0.87 | 3.76 | 4.41 | -17% |
| Culture | 3.88 | 1.09 | 1.20 | 3.76 | 4.00 | -6% |
| Human | 3.71 | 0.93 | 0.86 | 3.53 | 3.89 | -10% |
| Technology | 4.18 | 0.80 | 0.63 | 4.06 | 4.29 | -6% |
| Infrastructure+ Customer | 3.74 | 1.08 | 1.17 | 3.65 | 3.82 | -5% |
| | | | | | | |
| Division/ Strategy | 4.11 | 0.99 | 0.99 | 4.29 | 3.94 | 8% |
| Impact | 4.45 | 0.71 | 0.51 | 4.18 | 4.75 | -14% |
| | | | | | | |
| **Overall Digital Maturity level** | **3.89** | | | **3.75** | **4.03** | **8%** |

b) Descriptive statistics – Operational Processes

| OPERATIONAL PROCESSES | | Mean | Standard | Variance | Mean (Port) | Mean (Port users) | Difference in mean |
|---|---|---|---|---|---|---|---|
| [Vessel arrival] | | 3.90 | 0.75 | 0.56 | 4.00 | 3.82 | 4% |
| [Shipping and customs documentation processes] | | 4.21 | 0.78 | 0.61 | 4.40 | 4.06 | 8% |
| [Discharging/Loading operations] | | 3.69 | 0.78 | 0.61 | 3.80 | 3.59 | 6% |
| [Efficiency (reduction in time taken on various processes)] | | 4.10 | 0.61 | 0.37 | 4.36 | 3.88 | 11% |
| [Vessel turnaround times] | | 4.00 | 0.73 | 0.53 | 4.21 | 3.82 | 9% |
| [Containerized cargo dwell time] | | 4.00 | 0.60 | 0.36 | 4.15 | 3.88 | 7% |
| [Gate operations] | | 4.06 | 0.61 | 0.37 | 4.13 | 4.00 | 3% |
| [Safety in operations] | | 4.00 | 0.59 | 0.34 | 4.07 | 3.93 | 3% |
| [Security of cargo] | | 4.22 | 0.55 | 0.31 | 4.20 | 4.24 | -1% |
| [Cargo clearance process] | | 4.09 | 0.69 | 0.47 | 4.13 | 4.06 | 2% |
| [Interface with electronic payment channels and banks] | | 4.30 | 0.70 | 0.49 | 4.29 | 4.31 | -1% |
| [Communication among stakeholders] | | 3.90 | 0.79 | 0.62 | 3.93 | 3.88 | 1% |
| [Customer satisfaction] | | 3.72 | 0.89 | 0.79 | 3.80 | 3.65 | 4% |
| [Decision making by management] | | 3.70 | 0.84 | 0.70 | 3.86 | 3.56 | 8% |

Correlation and Regression Analysis

| Correlation with Digital Maturity | Port | Port Users | All | R2 | pvalue | Interpretation |
|---|---|---|---|---|---|---|
| Simplifying and shortening Processes | 0.69 | 0.36 | 0.66 | 0.4 | 3.454E-05 | Significant |
| Transhipment decision | 0.07 | 0.28 | 0.17 | 0.02 | 0.4000772 | Not significant |
| Turnaround time | 0.82 | 0.46 | 0.59 | 0.36 | 0.0001656 | Significant |
| [Efficiency (reduction in time taken on various processes)] | 0.86 | 0.18 | 0.39 | 0.26 | 0.0015482 | Significant |
| [Security of cargo] | 0.77 | 0.26 | 0.58 | 0.28 | 0.0008724 | Significant |
| [Interface with electronic payment channels | 0.48 | 0.18 | 0.31 | 0.22 | 0.0041518 | Significant |
| [Shipping and customs documentation proc | 0.72 | 0.23 | 0.38 | 0.25 | 0.0020605 | Significant |
| [Gate operations] | 0.58 | 0.23 | 0.41 | 0.21 | 0.0057095 | Significant |
| [Containerized cargo dwell time] | 0.48 | 0.41 | 0.43 | 0.24 | 0.0028707 | Significant |
| [Vessel arrival] | 0.65 | 0.52 | 0.56 | 0.32 | 0.0003665 | Significant |
| [Cargo clearance process] | 0.83 | 0.28 | 0.55 | 0.35 | 0.0001651 | Significant |
| [Discharging/Loading operations] | 0.62 | 0.49 | 0.50 | 0.299 | 0.0006664 | Significant |
| [Safety in operations] | 0.69 | 0.36 | 0.56 | 0.24 | 0.0029495 | Significant |
| [Communication among stakeholders] | 0.57 | 0.42 | 0.48 | 0.27 | 0.0013826 | Significant |
| [Customer satisfaction] | 0.76 | 0.18 | 0.45 | 0.24 | 0.002683 | Significant |
| [Decision making by management] | 0.51 | 0.64 | 0.57 | 0.29 | 0.0007903 | Significant |