

World Maritime University

The Maritime Commons: Digital Repository of the World Maritime University

World Maritime University Dissertations

Dissertations

10-31-2021

A review of digital maturity models for shipping companies

Stephen Kgadi Rakoma

Follow this and additional works at: https://commons.wmu.se/all_dissertations



Part of the [Technology and Innovation Commons](#)

Recommended Citation

Rakoma, Stephen Kgadi, "A review of digital maturity models for shipping companies" (2021). *World Maritime University Dissertations*. 1734.

https://commons.wmu.se/all_dissertations/1734

This Dissertation is brought to you courtesy of Maritime Commons. Open Access items may be downloaded for non-commercial, fair use academic purposes. No items may be hosted on another server or web site without express written permission from the World Maritime University. For more information, please contact library@wmu.se.

WORLD MARITIME UNIVERSITY
Malmö, Sweden

THE TITLE OF THE DISSERTATION

**A Review of Digital Maturity Models for Shipping
Companies**

By

STEPHEN KGADI RAKOMA
South Africa

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

MASTER OF SCIENCE
in
MARITIME AFFAIRS

(SHIPPING MANAGEMENT AND LOGISTICS)

2021

Declaration

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

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

(Signature):  (Stephen Kgadi Rakoma)

(Date):.....20/09/2021.....

Supervised by: Associate Professor Gang Chen



Acknowledgements

All thanks to the all mighty God of Mount Zion. This could not have been possible without your will. I dedicate this degree to my wife Ashley Thuli Rakoma my kids for the immense support they have provided. Thanks to my parents and Siblings for the motivation throughout my academic journey here at World Maritime University. My Uncle Kgatsiki Madiga, thank you much for believing in me and always encouraging during this prestigious journey. To Mr Walid Timimi (FICS), It could not have been this fruitful if it was not for our unity and support of one another. I thank you.

I want to appreciate the opportunity and exposure that the WMU have afforded me, the support from the staff, Professors and the network that I have built during my stay in Sweden. To my employer, the South African Maritime Safety Authority, particularly Mr Ian Calvert and the COO, Sobantu Tilayi, thank you for affording me the opportunity to study abroad. I grew as a person and professionally and I appreciate the continuous support from you.

To my supervisor, Professor Gang Chen; Thank you for your guidance throughout my dissertation. It would not have been possible without your patience and support. I really appreciate. Many thanks to the TETA of South Africa for granting me a scholarship to pursue this degree, earn experience, network and knowledge. My family away from home: Dumisa January, Zimasa Macingwane and Ayanda Sikobi, thank you very much for making our stay here homely.

“GOD BLESS YOU ALL”

Stephen Rakoma

Abstract

Title of Dissertation: **A Review of Digital Maturity Models for Shipping Companies**

Degree: **Master of Science (MSc)**

Digital Maturity portrays the readiness and capacity of the organization to change and apply the patterns to stay market competitive. Shipping industry is by nature highly specialized and characterized as a Complex System (Vial, 2019). Shipping companies need to know their digital maturity status through models to gain competitive advantages from the capabilities of digital transformation. It is important to establish the digital maturity model suitable for the maritime transport industry. The objective of this study is to investigate the digital maturity model that will appropriately measure digital maturity of shipping companies. In order to identify the key aspects of this study, we have adopted the CIMO (Context, Intervention, Mechanism and Outcome) model. To conduct this research, we have deployed a 'systematic literature review'. Initial total of 2115 search results was identified using combination of keywords from three data bases (Google Scholar, Science Direct & Scopus). A total number of articles reviewed were 34, 14 of which were searched following citation of the identified articles. The findings of the study show that there is lack of digital maturity research in shipping and the absence of research necessitated a proposed digital maturity model with 8 dimensions and 5 levels of maturity.

KEYWORDS: Digital Maturity, Digital Maturity Model, Measurement, Shipping

Table of Contents

Declaration	i
Acknowledgements	ii
Abstract	iii
List of Tables	vi
List of Figures	vii
List of Abbreviations	viii
1. CHAPTER ONE: INTRODUCTION.....	9
1.1. BACKGROUND.....	9
1.2. PROBLEM DESCRIPTION	11
<i>1.2.1. Awareness of Digital Transformation in Shipping</i>	<i>11</i>
<i>1.2.2. Drawbacks about digital revolution of Shipping</i>	<i>11</i>
<i>1.2.3. Issues on the degree of digital transformation maturity in Shipping</i>	<i>11</i>
<i>1.2.4. Gaps on the application of digital maturity models</i>	<i>12</i>
1.3. OBJECTIVE AND RESEARCH QUESTIONS.....	13
2. CHAPTER TWO	14
2.1. LITERATURE REVIEW.....	14
<i>2.1.1. Shipping Transport.....</i>	<i>14</i>
<i>2.1.2. Digitalization</i>	<i>15</i>
<i>2.1.3. Digitalization and Shipping Transport</i>	<i>17</i>
<i>2.1.4. Digital Transformation</i>	<i>20</i>
<i>2.1.5. Digital Maturity</i>	<i>21</i>
<i>2.1.6. Digital Maturity Models</i>	<i>22</i>
3. CHAPTER THREE	24
3.1. METHODOLOGY.....	24
<i>3.1.1. Formulation of Research Questions</i>	<i>25</i>
<i>3.1.2. Protocol Development</i>	<i>26</i>
<i>3.1.3. Study Searching and Selection.</i>	<i>26</i>
<i>3.1.4. Selection and evaluation</i>	<i>30</i>
<i>3.1.5. Quality Assessment</i>	<i>31</i>
<i>3.1.6. Data Analysis</i>	<i>31</i>
<i>3.1.7. Limitations</i>	<i>32</i>
4. CHAPTER FOUR.....	33
4.1. DATA ANALYSIS AND FINDINGS.....	33
4.2. DISCUSSIONS	41
<i>4.2.1. Context</i>	<i>42</i>
<i>4.2.2. Intervention</i>	<i>45</i>
<i>4.2.3. Mechanism.....</i>	<i>46</i>
<i>4.2.4. Outcome</i>	<i>51</i>
5. CHAPTER FIVE	53

5.1. RECOMMENDATION AND CONCLUSIONS	53
REFERENCE	55

List of Tables

Table 1: Search Keywords and Search Strings. Source by author.....	28
Table 2: Inclusion and exclusion criteria Source, developed by the author	29
Table 3: Literature base and Search Results	35
Table 4: Stages of maturity in research	44
Table 5: Maturity Models & dimensions	48

List of Figures

Figure 1: Supply chain ecosystem of the maritime transport	15
Figure 2: Trending digital technologies, source (Safety4Sea, 2021).....	19
Figure 3: Process of conducting systematic review adopted from	25
Figure 4: Protocol structure	26
Figure 5: Articles searched and filtered. Source, developed by author	30
Figure 6: Published articles in years	36
Figure 7: Articles by country	36
Figure 8: Percentage of Articles by Continent.....	37
Figure 9: Article demographics by sector	38
Figure 10: Databases for article search.....	38
Figure 11: Popularly Used Maturity Models	39
Figure 12: Frequently Used Dimensions	40
Figure 13: Research Method in articles in quantity	40
Figure 14: The CIMO Model.....	41
Figure 15: Stages of UX Maturity of research source	45
Figure 16: Digital Maturity Model for Shipping Companies	49

List of Abbreviations

UNCTAD	United Nations Conference on Trade and Development
DT	Digital Transformation
IoT	Internet of Things
AI	Artificial Intelligence
WHO	World Health Organization
WTO	World Trade Organization
UK DoT	United Kindom Department of Transport
IMO	International Maritime Organization
UN	United Nations
CIMO	Context, Intervention, Mechanism and Outcome
RQ	Research Questions
IT	Information Technology
MASS	Marine Autonomous Surface Ships
BIMCO	Baltic and International Maritime Council
ICHCA	International Cargo Handling Coordination Association
IMPA	International Maritime Pilots' Association
ISSA	International Ship Suppliers Association
IHMA	International Harbour Masters' Association
FONASBA	Federation of National Associations of Ship Brokers & Agents
IPCS	Interpenetrating Phase Composites

1. CHAPTER ONE: INTRODUCTION

1.1. BACKGROUND

During this age of advanced technologies, one cannot engage on improvement of ‘business in context’ without mentioning digitalization, digital transformation, digital technologies automation etc. It has become common in the maritime industry to integrate these modern technological jargons in different platforms of engagements. Digitalization and development of new digital technologies have increasingly become a subject of discussions and research in the maritime industry with different industry experts, scholars, researchers and leading international maritime entities exploring how existing processes can be optimized through digitalization while enabling new business opportunities, trade facilitation and transforming supply chains (UNCTAD, 2019). Eremina et al., (2019) emphasises that in the modern economy, companies should apply innovative solutions through advanced digital technologies to survive. Digitalization depicts the robust change from traditional processes that are symbolized by analogue technologies to an era characterised by digital technologies and automated business processes (Bloomberg, 2018). Adoption of digital technologies, which are developed to drive 4th industrial revolution, well describe digitalization Sanchez-Gonzalez et al. (2019). Maritime sector is another sector that is considered to be behind with digitalization as compared to other sectors such as Aviation, Mining and Manufacturing. Although industries like Sea Ports, Logistics, Shipbuilding are accelerating digitalization and automation, shipping management is considered as a late comer. (Fruth & Teuteberg, 2017).

It is unarguable that maritime transport has been the key driver of international trade for many centuries. Current reports indicates that maritime transport is responsible for moving a proximity of over 80% of trade volume in goods and services globally (UNCTAD, 2018). Recently, UNCTAD, (2021) provided Q1 2021 update regarding the value of global trade volume, showing 4 per cent increase, following Q2 2020 decelerated world trade volume of goods and services which fell to just below negative 15% and 20% respectively resulting from the impact of COVID-19 pandemic that

erupted in the last quarter of 2019. When the World Health Organization (WHO) declared COVID-19 as a global pandemic in the first Quarter of 2020, measures put in place by different countries and business entities suppressed demand, subsequently affecting production levels. This disrupted supply chains, causing reduction in production, destructed supply chains and creating gridlock in supplies Lionetto et al. (2020). However, the resilience of global economy in Q1 2021, which was indicated by the positive trends and further 3 per cent increase compared to same quarter in 2019 (WTO, 2021) reaffirmed the significance of shipping industry to the world's economy and its anticipated existence in the foreseeable future (Christiansen et al., 2007), (UK DoT, 2019).

It was during this time of COVID-19 spread that all the problematic processes in the global economies were exposed, triggering growing awareness and realization of the digitalization prospects. Different sectors in the transport industry faced challenges and pressures to change their business operations. They became aware that traditional business models and methods are becoming more and more ineffective and unproductive (Medyakova et al., 2020). The IMO, the UN, UNCTAD, WTO, and many other entities in the industry have recently been promoting advancement of digitalization and automation for safety, efficiency, sustainability, and transparency in the maritime industry (Süleyman İrtem et al., 2015) , (Jahn & Bussow, 2013). Drawing from the words of Susan Graseck, (2008):, ” *Explore the Past to Understand the Present and Shape the Future*”, this dissertation will explore digitalization in shipping companies and identify suitable digital maturity model to measure digital maturity of their digital transformation.

1.2. PROBLEM DESCRIPTION

1.2.1. Awareness of Digital Transformation in Shipping

Despite Shipping industry being a global backbone of the world's economy (Sanchez-Gonzalez et al., 2019), it still remains behind all the major industries in adopting new technological approaches as in the global economic context (González-Cancelas et al., 2020). Latifov, (2019), acknowledged the effort of the industry to digitalize and automate processes however, he further pointed out the 'infancy stage' at which the industry is at. Lack of stakeholder cooperation and awareness about the potential that digitalization has to the maritime industry, absence of digital abilities and qualified workforce are some of the barriers highlighted by some researchers (Tijan & Jovi, 2021). This could arguably be as a result of the scarcity of digital transformation research in the shipping industry (Sanchez-Gonzalez et al., 2019).

1.2.2. Drawbacks about digital revolution of Shipping

At the moment, shipping industry is experiencing significant change to gain prospects of digital transformation for cargo handling optimization, and the entire operational process (Babica et al., 2020). It is significant for leaders to have readiness overview of their organizations for the era of digital transformation driven by the "industrial revolution 4.0" phenomenon in order to enable appropriate decision making and improve companies' competitive edge (Rajnai & Kocsis, 2018). In another research on digitalization of seaport, it was found that, as the transport and volume of cargo increases, data exchange among stakeholders rises in speed and volume. There already exist stakeholder communication systems like 'electronic exchange systems', e-Commerce and web portals for shipping. Therefore, as slow as the industry is in terms of adoption of advanced technologies, digitalization is a work in progress and the existing systems are enabling digital transformation - hence they can visibly be differentiated by their efficiency.

1.2.3. Issues on the degree of digital transformation maturity in Shipping

When adopted technologies are inefficient, they incapacitate optimization of business processes. (Jović et al., 2020). Shipping companies need to know where they are in

terms of their digital transformation (digital Maturity) and they need to be able to measure their digitalization status because when businesses adopt disruptive technologies earlier than their rivals, they gain high degree of competitive edge (Yang, 2019). The term digital maturity describes the readiness and capacity of the organization to transform and adopt technological innovations contingent upon the trends to stay competitive. Literature shows that most of the researches conducted on the subject of digital transformation or digitalization digital maturity also appear to be studied (Eremina & Natalja. Bistrova, 2019). Also, other researchers provided the evidence that digitally matured companies outperform their rivals from different dimensions of financial performance (Teichert, 2019). As Susan Graseck, (2008), said in one of her articles: ” *Explore the Past to Understand the Present and Shape the Future*”, many researchers commonly agree that the maritime transport’s lack of sufficient research on digitalization causing difficulties in understanding the present and shaping the future of the industry. As part of the purpose of this study, we purport to understand the general status of research status on digital maturity models to the extend at which shipping industry is studied.

1.2.4. Gaps on the application of digital maturity models

Literature indicate that businesses are advancing the adoption of digital transformation technologies. This is reflected through scholarly searches of the key words ”digitalization and ”digital transformation” show thousands of results from different areas (Eremina & Natalja. Bistrova, 2019); (Sanchez-Gonzalez et al., 2019) (Thordsen et al., 2020). This is an indication that researchers continue to explore studies about the concepts: *digitalization* and *digital transformation*. We also note the frequent use of ’digital maturity’ concept from literature when the latter concepts are being studies. As relevant as the digital maturity is in recent times, validation and suitability of the models of digital maturity is still limited (Williams & Lang, 2019). Literature shows that many digital maturity measuring approaches or models, are mostly generalized. Meanwhile, Remane et al. (2017) criticised the existing literature on digital maturity citing the view that business environments are different and do not need to embark on the same path as suggested by many digital maturity models developed so far.

Shipping industry is by nature highly specialized and characterized by Complex System (Vial, 2019). It is important to establish digital maturity model that will be appropriate for the shipping companies. Therefore, in this study we will investigate how the existing digital maturity models are applied; digital maturity model that will be appropriate to measure digital transformation of shipping companies and identify the gaps and challenges of evaluating digital maturity of the ocean shipping sector.

1.3. OBJECTIVE AND RESEARCH QUESTIONS

The objectives section of this research outline the aim intended to be achieved by this study. Study objectives and research questions are well aligned and these seeks to investigate the digital maturity model(s) that will be appropriate to measure digitalization level in Shipping companies.

Before starting the review of literature, relevant research questions need to be identified, as the eligibility criteria and search strategy embedded in research questions (Lim et al., 2019). For us to be able to identify key aspects of this study, we have adopted the CIMO (Context, Intervention, Mechanism and Outcome) approach (Pilbeam et al., 2019).

CIMO Approach:

- C – Status of research on digital maturity
- I – Application of existing digital maturity models by ocean shipping sector
- M – Models of digital maturity appropriate for the ocean shipping sector
- O – Gaps and challenges outcomes of implementation of digital maturity models.

Our research questions are follows:

- RQ1: What is the status of digital Maturity research in shipping?
- RQ2: How are shipping companies applying existing digital maturity models?
- RQ3: Which digital maturity model will be the appropriate for shipping?
- RQ4: What are the gaps and challenges of implementing digital Maturity?

2. CHAPTER TWO

2.1. LITERATURE REVIEW

2.1.1. *Shipping Transport*

At the centre of world trade operations is shipping companies (Muhammad et al., 2018). Efficiency in the maritime transport ecosystem is, therefore, of paramount importance to the global economy (Lind et al., 2018). With globalization in the world economy at the moment, maritime transport must be efficient, safe, reliable to maintain economic growth levels (Sanchez-Gonzalez et al., 2019). Shipping companies are the backbone of industrial supply chain and they play a major role in facilitating trade globally (Grzelakowski, 2019); (L. Li et al., 2021). Generally, maritime transport industry is highly volatile and market competitive. Fuel price fluctuation and inconsistent freight rates characterizes the landscape at which the industry is operating. Majority of shipping companies are under tremendous pressure to recuse costs and maximize their profit margins. They have to do so with consideration of flexibility and resilience required by the competition in the market (Feibert et al., 2018). Supply Chains and costs of transportation have been optimized driven through efficiencies brought by digitalization (IMO, 2020). There are currently eight applicable digital sphere: “*autonomous vehicles and robotics; AI; BD; virtual reality, augmented and mixed reality; IoT; the cloud and edge computing; digital security; 3D printing and additive engineering*” (Tijan et al., 2021). Digitalization integrate processes and companies with integrated supply chain capabilities had realized improvements in their business performance (Nwankpa & Datta, 2017). According to Feibert et al, (2018), the maritime Transport industry is network-centric and need to collaborate with the entire supply chain ecosystem through digitalization.

Figure 1 below shows supply chain ecosystem of the maritime transport. There are many other key players in this value chain and traditionally they operate in a centralized fashion. Paperwork involved duplicates the processes there by hampering efficiency in time and cost.

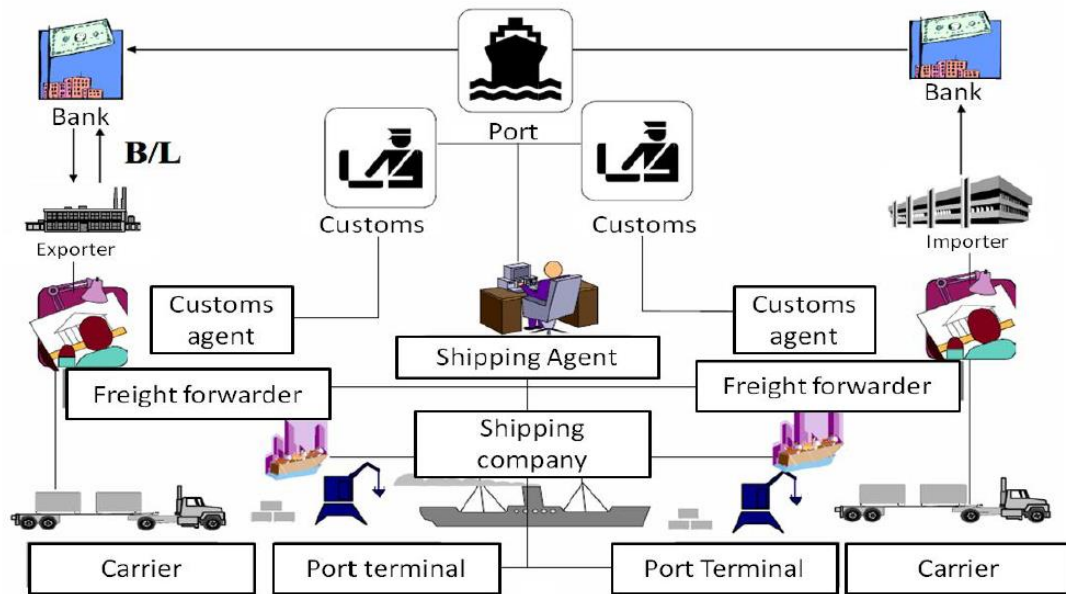


Figure 1: Supply chain ecosystem of the maritime transport

By collaborating with the role players through shared data, enabled by digital technologies, shipping companies can be even more efficient thus increasing their profit margins (Feibert et al., 2018); (UNCTAD, 2019). Shipping business is international in nature and thus not geographically restricted with regards to their resources or sales of their services and therefore there is high competition between each shipping companies and other companies participating within the same freight market and operating ships with common features or characteristics. Although the shipping companies operates in the digital age where management tasks are less complex, there are still limitation to these companies and management. Shipping companies exploit their competitive advantage through operating-cost reduction or value-increase delivered to customers (N, Nikitakos; I, 2001).

2.1.2. Digitalization

Digitalization is generally defined and described in different ways. According to Tijan et al. (2021), Digitalization primarily focuses around the automation of business processes, automation of operations and data processing. Gartner Inc. defines

digitalization as “the use of digital technologies to change a business model and provide new revenue and value-producing opportunities; it is the process of moving to a digital business”. According to Brennen & Kreiss, (2016) digitalization is the way many domains of social life are restructured around digital communication and media infrastructures and defined it as the utilization of computer and technologies. While the term digitalization continue to gain momentum and popularity across different industries, there is still confusion on the use of the terms ‘digitization’, ‘digitalization’ and ‘digital transformation’ (Legner et al., 2017). These terms are often used interchangeably in a broader range of literature. Bloomberg, (2018) refers to digitization as the process of changing information from analogue to digital form. For example, when physical documents are scanned and stored into a computer, the information contained in that document is digitised. Bloomberg, (2018) went further to distinguish digitization and digitalization as a transformation of information and processes respectively. This view is the same as that expressed by Gartner IT glossary. An example of digitalization as a transformation of business processes using digital technologies is the use of Internet of Things (IoT) and sensors in terminals and port gates systems whereby vehicles and container numbers are captured without necessarily having any person recording data manually. Instead, data is transmitted by sensors through IoT capabilities into the cloud environment where such data will be analysed and translate to information accessible and updated across the network of users. One practitioner in an article on digitalization of human resource management described digitalization as a disruptive change that requires the organization to adapt whether they like it or not (Bengtsson, 2017).

In distinguishing digitization, digitalization and digital transformation Jason Bloomberg, *a leading IT industry analyst, Forbes contributor*, refer to digital transformation as a customer-driven strategic business transformation where enterprises deal with overall transformation of the business. Unlike digitization and digitalization - digital transformation does not involve technological change but rather organizational change (Bloomberg, 2018). On the other hand, Parviainen et al., (2017) refers to digital transformation as changes associated with the utilization of digital

technologies in organizations or their operations. Vial, (2019) refers to it as a process that triggers reactions prompting necessary strategies to keep up with developments, changes and in managing barriers. Although other researchers are able to distinguish the three terms and criticize that users who use the terms interchangeably are making mistake, Mikael Lind et al., (2021), argue that using the terms interchangeably or differentiating them does not matter, but rather what matters most is the use of advanced information technology and connectivity of network by businesses in order to transform processes, create sustainable world and increase efficiency. On the basis of the views and definitions given above, '*transformation of processes using digital technologies*' is a common phrase in defining digitalization. For the purpose of this study, Gartner Inc.'s definition of digitalization will be considered.

2.1.3. Digitalization and Shipping Transport

Currently nobody can argue that maritime transport sector gives significant attention to digitalization. (Ryan et al., 2020). Digitalization and development of new digital technologies have increasingly become a subject of discussions and research in the maritime industry with different industry experts, scholars, researchers and leading international maritime businesses exploring how existing processes can be optimized through digitalization while enabling new business opportunities, trade facilitation and transforming supply chains (UNCTAD, 2019). This statement does not take away the reality of the infancy stages of the industry regarding its status on digital transformation. Different sectors of the industry like Sea Ports, Logistics, Shipbuilding etc., are also accelerating digitalization even though they are still considered to be behind in comparison with other industries like Aviation, Mining and Manufacturing (Fruth & Teuteberg, 2017).

'Autonomous ships' is another phenomenon which for the past decade roams the ground of the maritime industry (S. Li & Fung, 2019). These are described by Rolls-Royce, (2016) as highly automated or remotely controlled ships and they are expected to enhance the security and maritime transport efficiency while creating attraction of seafaring career. Whenever the concept of digitalization in shipping arises, Maritime Autonomous Surface Ships (MASS) also emerge. These two concepts (digitalization

& Autonomous ships) that are now big in the maritime industry, furthermore, among others, the latest technologies such as, IoT, Digital Twin, Blockchain, Data Analytics, Data Visualization, Big Data, AI and Mobile Technologies are commonly used to improve safety and efficiency of ships and environment (Bloomberg, 2018). Digital technologies enable autonomous ships to self-monitor, transmit data, transform it into information and make decisions and consequently work a piece of or all of locally available errands related with ship operations (Rolls-Royce, 2016). Wariishi, (2019) in *Mitsui & Co. Global Strategic Studies Institute Monthly Report*, also emphasized that the development of autonomous ships is accelerating due to advancement of digitalization in the maritime industry. Moreover, he emphasizes that as competitive as the industry is, MASS will further expand competition among businesses from different sector of the industry. Although there are many opportunities that come with advanced digital technologies in the maritime industry, UNCTAD, (2019) brought to light the potential dangers and expenses for maritime players in developing countries. This article also stresses the necessity to create balanced playing field.

2.1.3.1. Stages of digitalization in maritime transport

According to UNCTAD policy brief no 75, June 2019, there are three (3) stages of digitalization in maritime transport (UNCTAD, 2019). Below we describe these stages and their effects in shipping environment.

i. Optimization of digital technology in shipping

The adoption of digital technologies such as *digital technologies like IoT, Blockchain, analytics, data visualization, big data, artificial intelligence and mobile technologies*, have major benefits in that they have the ability to enhance efficiency and effective security of data. Furthermore, they assist with the improvement of internal controls and cost reduction. Consequently, the cost intensity, resistance to change and problems of interoperability prevent the shipping industry from adopting these digital technologies. As the global supply chain ecosystem become more integrated through digitalization, it is important that shipping come to speed with the adoption of digital

technologies. (Feibert et al., 2018) Figure 2 shows the seven trending digital technologies.

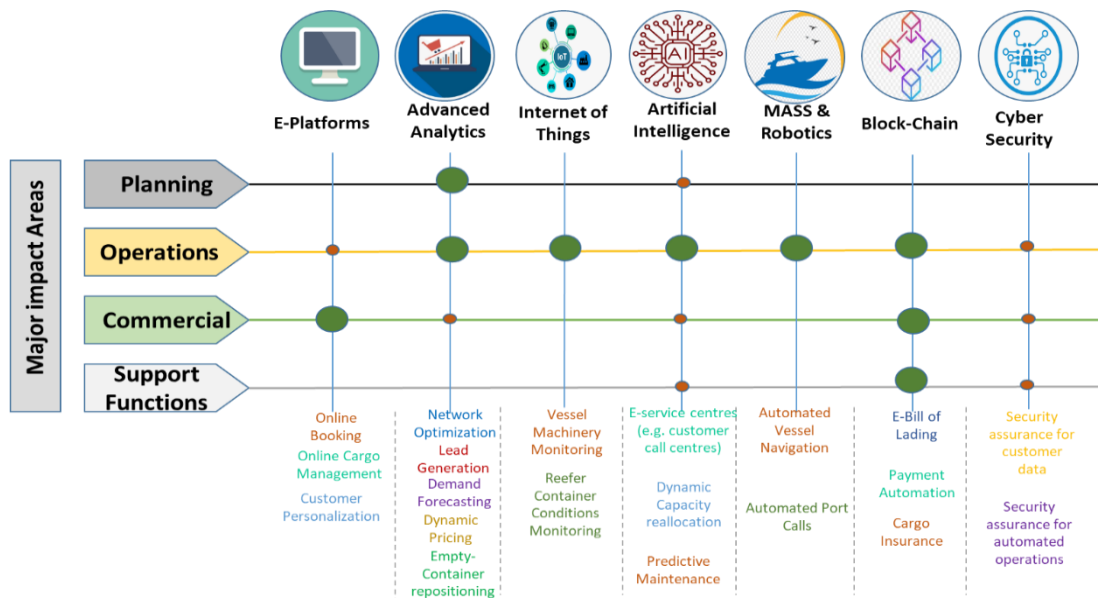


Figure 2: Trending digital technologies, source (Safety4Sea, 2021)

Safety4Sea, (2021), have identified the trend of digital technologies adopted in the maritime sector. The participation of the industry in the advancement of processes is seen to be exploited to take advantage of the competitive edge that result from the adoption of such digital technologies.

ii. Extension

Digitalization enables creation of new business opportunities. In earlier discussion, digitalization was declared as an enhancer of efficiency, safety, compliance, and sustainability and the new digital technologies like big data in the maritime industry demand intense investment thus creating other business segments and new companies venture into data visualization, maritime informatics, smart systems etc. All these means opportunities for new businesses (UNCTAD, 2019). For example, block chain is used in bunkering and cargo tracking. These are opportunities that did not exist prior to the emergence of the new digital transformation (Fruth & Teuteberg, 2017). The recent times of COVID -19 have seen many industries accelerating digitalization

worldwide. In the maritime industry, International Maritime Organization and other organizations like BIMCO, ICHCA, IMPA, ISSA, IHMA, FONASBA and IPCS alluded embarked on a campaign to encourage intergovernmental collaboration in order to fast track digitalization as a response to COVID -19 in the maritime transport sector (IMO, 2020). Because of the absence research papers on DT in the area of shipping, we have additionally reviewed the papers that studied DT in general and DT of the overall transport sector (Tijan et al., 2021).

iii. Transformation

Dalaklis, (2017) describes Transformation change as a redefinition of the organisational processes, structure, change of vision and mission while on the other hand, adaption of evolution refer to the change in the way things are done. Supply Chains and costs of transportation have been optimized, driven through efficiencies brought by digitalization. This will become the global economic factor which will determine the global trade and drive global economic growth. Not only Ports and business in shipping will be transformed by digitalization, the era of digitalization will probably change global trade, as relative benefits of countries will shift positively. Where technology advances, labour costs reduce, and these will no longer be as relevant as in the past but rather efficiency of trade and innovation will become more significant (IMO, 2020).

2.1.4. Digital Transformation

Digital transformation (DT) is an infant shift in technology which is more strategy-oriented and centered around customers. It is a process of transforming organization's infrastructure and processes by deploying advanced digital technologies (Pihir et al., 2018). According to Schallmo et al. (2017), 'digital transformation' does not have a definition that is commonly accepted. Shuo Ma. (2020) describes the emergence of digital transformation as the largest revolution in the history of maritime and like any other revolution, major changes are expected to completely change the whole industry from its historical image. As some researchers allude to the notion that maritime industry is found to be slow and/or even resistant to adoption of new technologies (Inkinen et al., 2019), the evolution of technology bring with it, efficiency and

digitalization is changing the future of maritime transport and how business is conducted forth (Ma, 2020). Matt et al. (2015), describe transformation in a context of organizations as an impactful '*fundamental change*' strategy and structure. Digital Transformation is fundamental but not exclusive to further develop existing in business structures, yet additionally to keep them from becoming outdated (Nerima & Ralyté, 2021). Previous studies show that digital transformation is anything but a one-time measure, it is an all-encompassing methodology of moving business entities towards execution of new strategies for raising hierarchical exhibitions by boosting the authoritative capacities and intensity, making new business models (Pihir et al., 2018). Furthermore, Digital Transformation addresses the essential change of all parts of the business, making another environmental system where innovation makes and conveys value to the partners, empowering entities to adjust to the more rapidly changing conditions (Varriale et al., 2019). According to Salviotti et al. (2019), to guarantee fruitful reception and use of digital technologies, there is a need for entities to foster digital abilities and change their cultures to deal with the digital transformation measurers effectively. Also, the advancement of a particular arrangement of digital capacities prompts elevated degree of digital maturity.

2.1.5. Digital Maturity

Maturity structures distinguish parts of an effective framework as well as catch the advancement of how digital systems evolve from origination, execution then effect (Khanbhai et al., 2019). It shows the preparedness of an entity or nation to defeat impending changes (Kutnjak et al., 2020a). Digital Maturity portrays the readiness and capacity of the organization to change and apply inventive technologies, contingent upon the patterns, to stay cutthroat on the market (Eremina & Natalja. Bistrova, 2019). Teichert, (2019) described digital maturity as reflection of where the organization is in terms of digital transformation. Moreover, it describes the status of transformation efforts already achieved and its preparedness to further digital innovations. Digital maturity is a relentless, persistent course of change to a fast growing digital environment (Salviotti et al., 2019). Schallmo et al. (2020) found that significant research on digital maturity has been done, zeroing in on advanced abilities in the

digital management and business measures. Digital Maturity is characterized as the level of digitization accomplished by a substance, through the sufficient incorporation of its digitized measures into its construction (Nerima & Ralyté, 2021). Digital Maturity is permitting occasions to calibrate each phase of the conveyance interaction. Its self-measurer includes multi-disciplinary exercises with technology-related components being perhaps the main spaces of interest for organizations alongside the execution of I4.0. There is a continuous contribution by the researchers to broaden the understanding and theory of existing digital technologies (Ryan et al., 2020). According to Salviotti et al. (2019), Digital Maturity alludes to how businesses systematically plan to adjust reliably to continuous digital change. It actually requires carrying out digital innovations by adjusting the business's system, employees, culture, and design to deal with the digital assumptions for clients, representatives, and accomplices. Thusly, digital Maturity is a nonstop and continuous course of transformation to a quickly progressing digital environment. With the point of Digital transformation being to arrive at a palatable level of digital maturity, as per the progressions and difficulties presented by the digitization of the area where the association works, the measurement of digital maturity of an organization is a critical stage in the digitization interaction. The qualities and difficulties of digital transformation are explicit to every area of action and even to each sort of organization. Consequently, every one of them might require a particular digital maturity model (Nerima & Ralyté, 2021). Previous studies demonstrate that the greater part of the current models give a fragmented image of digital maturity, that social credits mirroring culture of technology are not incorporated methodically, and that digital maturity models explicit to certain service areas are obviously under-addressed (Teichert, 2019).

2.1.6. Digital Maturity Models

Digital Maturity Models are apparatuses to characterize the current and expected development arranges nonetheless, they are not prescriptive, as they don't recommend a superior method to arrive at the objective (Menchini et al., 2021). However, Back & Berghaus, (2016); Nerima & Ralyté, (2021) argue that there are two ways in which

maturity models are utilized, descriptive and prescriptive. In their descriptive usefulness, maturity models uncover the measurements which should be planned, while prescriptive usefulness, empower organizations to characterize blueprints or capacities expected to arrive at the ideal phase of development. Furthermore, digital maturity models serve to decide the present status and the level of digital maturity with regards to digital transformation and permit suggestions for future activities emanating from the current maturity level (Schallmo et al., 2020). The utilization of maturity models for illustrating an advancement way has been censured as a distortion of reality frequently missing exact establishment (M. Colli et al., 2018). Maturity model gives some direction in this regard, since it gives an outline of the various regions and guides out regular ways of how organizations approach their change (Back & Berghaus, 2016). Most of existing digital maturity models tends to focus much on manufacturing sector (Teichert, 2019). Maturity model comprises of measurements or dimensions and standards, which depict the spaces of activity, and stages that show the advancement way towards maturity (Back & Berghaus, 2016). By far existing models creates gaps in that they do not give pragmatic firing up strides to help the hierarchical maturity status (MacHado et al., 2020). At time of this thesis, there was no study on digital maturity model for the shipping industry. One article on seaport was identified and clearly indicated that the research excludes all other areas of the maritime ecosystem and only focusing on seaports. This includes the shipping companies with which this study focus on (Philipp, 2020b). Although the subject of digital transformation is highly discussed and studied by researchers and industry experts, there is lack of research on the degree of digitalization or digital maturity. By far we have identified over 25 digital Maturity Models in the literature (Hanif, 2017) (Teichert, 2019); (Gandhi & Sucahyo, 2020).

3. CHAPTER THREE

3.1. METHODOLOGY

In this chapter, we present the research methodology used for this study. We outline research strategy, design and the steps followed.

To conduct this research, we have deployed a ‘systematic literature review’ (SLR) which is also called ‘research synthesis’. The “systematic review,” intends to provide an extensive, impartial combination of numerous relevant completed research studies produced in a single document by researchers, scholars and practitioners (Okoli & Schabram, 2010). While systematic literature review has some significant multiple commonalities with the ‘traditional literature review’, cohering with the overall standard of synopsising information from literature, Systematic Literature review contrasts in that it endeavours to reveal full evidence that is relevant to the question under research. Instead of focusing on conceptual and theoretical research, systematic review focuses on data reporting (Aromataris & Pearson, 2014).

According to (Aromataris & Pearson, 2014), The following features defines systematic review of literature and conduct:

- Objectives and research questions are clearly outlined.
- The protocol section outlines the inclusion and exclusion criteria
- Searching and selecting relevant studies comprehensively from internationally recognised research database

Our Systematic Literature Review methodology will be conducted in three phase: Phase One, Phase Two and Phase Three. Figure 3 shows the process that will be followed in conducting this research.

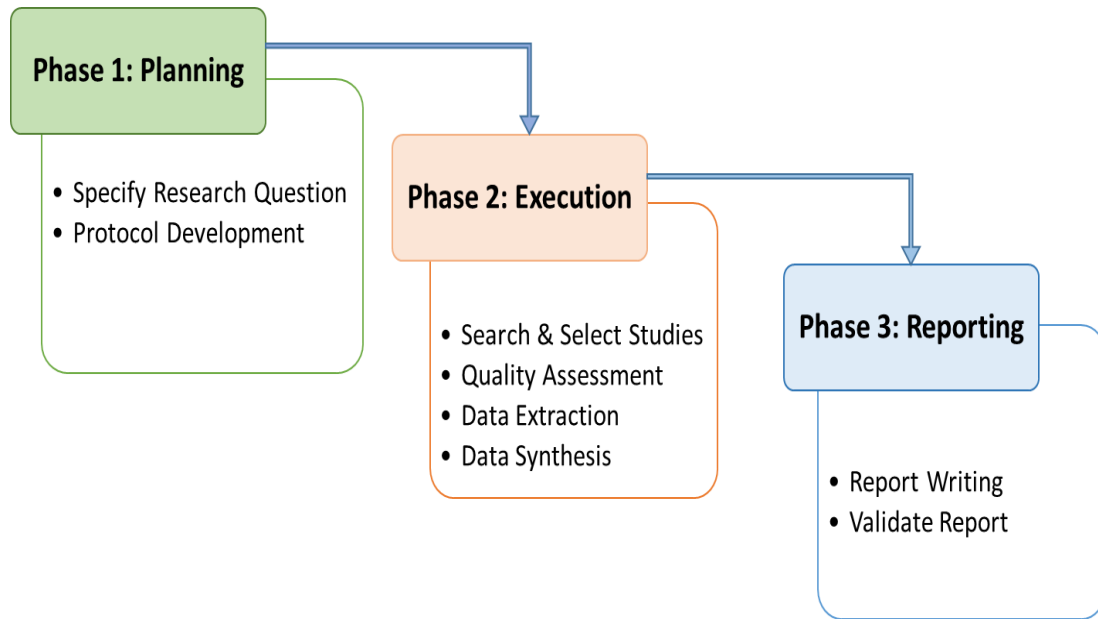


Figure 3: Process of conducting systematic review adopted from Brereton et al., 2007)

3.1.1. Formulation of Research Questions

In order to conduct systematic literature review that is transparent and rigorous, formulation of research questions is extremely important, not only for the discipline within which this research is conducted but across all disciplines. Before starting the review of literature, relevant research questions need to be identified, as the eligibility criteria and search strategy embedded in research questions (Lim et al., 2019). In order to identify the key aspects of this of this study, we have adopted the CIMO (Context, Intervention, Mechanism and Outcome) approach (Pilbeam et al., 2019).

CIMO Approach:

- C – Status of research on digital maturity
- I – Application of existing digital maturity models by ocean shipping sector
- M – Models of digital maturity appropriate for the ocean shipping sector
- O – Positive and negative outcomes of implementation of digital maturity models.

Our research questions are follows:

- RQ1: What is the status of digital Maturity research in shipping?
- RQ2: How are shipping companies applying existing digital maturity models?

- RQ3: Which digital maturity model will be the appropriate for shipping?
- RQ4: What are the benefits and challenges of implementing digital Maturity?

3.1.2. Protocol Development

It is of critical importance that the procedure followed in conducting systematic literature is clearly outlined. This requires a well written nitty gritty protocol report, and preparing for all reviewers to guarantee a consistent process of the review (Okoli & Schabram, 2010). Preferably, the protocol document is created and distributed before the review is started. (Aromataris & Pearson, 2014).

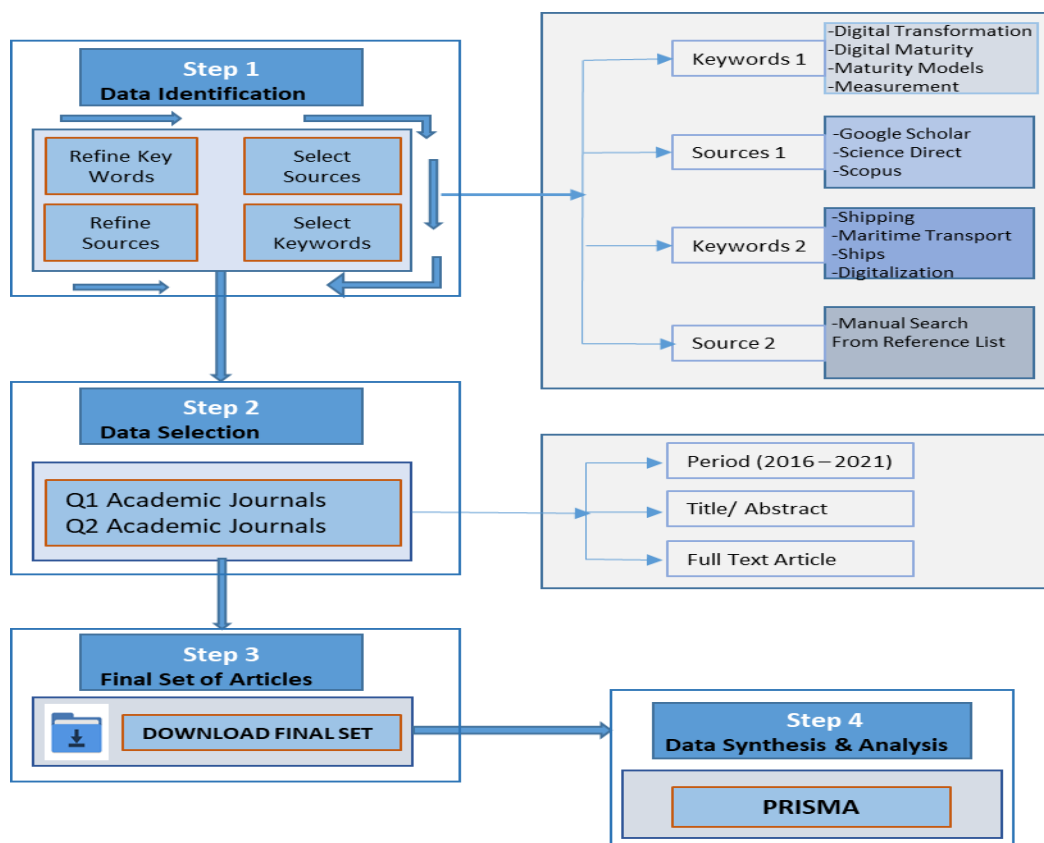


Figure 4: Protocol structure

3.1.3. Study Searching and Selection.

In this section we will identify relevant previous and current studies in order to answer the research questions defined in the latter section. We will identify databases and

search strings that will be used to locate relevant and quality literature. According to Lim et al. (2019), there are three search strategies involved in locating studies. i.e.

- i. *Search Term*
- ii. *Data Collection*
- iii. *Inclusion & Exclusion Criteria*

3.1.3.1. Search Terms

In order to answer the research questions by systematic literature review approach, criteria to select documents for literature was developed. Determining the selection criteria is an important phase of research planning. Our selection criteria were developed in line with the time frame of this dissertation. We are defined the following selection criteria in order to achieve this study. The papers should be focus on three key terms, i.e. “Digital Maturity”, “Digital Maturity Models”, “Measurement”. Further secondary keywords were determined. And will be used to establish search strings: “Shipping” OR “Maritime Transport” OR “Ships” OR “Vessels” OR “Digital maturity Assessment” OR “Digital Maturity Evaluation”. Table 1 below, provide the structure of key words with primary search terms; secondary search terms and search strings used to search for literature to be reviewed.

Search terms and strings used	
Primary Terms	Secondary Terms
Digital Maturity	Shipping
Digital Maturity Model	Maritime Transport
Measurement	Ships
	Vessels
	Digital Transformation
	Digitalization
Search Strings	
"Digital Maturity" AND “Shipping” and (“Maritime Transport” OR “Ships” OR “Vessels” OR “Digital transformation” OR “Digitalization”)	

"Digital Maturity Model" AND "Shipping" and ("Maritime Transport" OR "Ships" OR "Vessels" OR "Digital transformation" OR "Digitalization")
"Measurement" AND "Shipping" and ("Maritime Transport" OR "Ships" OR "Vessels" OR "Digital transformation" OR "Digitalization")

Table 1: Search Keywords and Search Strings. Source by author

We have exhausted all keywords combinations to exploit and explore all possible locations for relevant literature (Okoli & Schabram, 2010).

3.1.3.2. Study Selection

Data was extracted from three databases that are internationally recognised. We used 'Google scholar'; 'Scopus' and 'Science Direct' databases which are popular and frequency used by researchers, practitioners and scholars for research purposes. The basis of our decision to choose these databases was the position or rank in the volume of high quality publications and abstract indexed and the full document access they provide. These databases also hold relevant profile to the domain we have approached. Furthermore, we have searched reference list of reviews so as to that our literature review is comprehensively covered. According to Gebayew, Hardini, Panjaitan, et al. (2018), data can be collected from journals, conference, proceedings, books and thesis, however, in this review we collected relevant articles from journals only. The process of extracting data can be quite challenging (Aromataris & Pearson, 2014), due to the limited time given for this research, we have minimized the number of articles to be synthesised. Information extracted from the systematically selected articles will be used as a primary data for synthesis purposes (Okoli & Schabram, 2010). Table 2 provides data extraction process followed in assessing the relevance of articles in this review.

3.1.3.3. Inclusion and Exclusion Criteria

In this step, we briefly defined the criteria used to include and exclude the articles. According to Okoli & Schabram, (2010), the reviewer must use the key terms to collect a lot of literature review articles that the search criteria. In this study we will only

consider articles that peer-reviewed and published in academic journals. We will exclude all literature that is other than those that are published in academic journals; e.g. conference articles, chapters in the book, abstract, reviews, dissertation and thesis, white paper, ‘grey literature, working papers and government documents. Any less-quality articles will be excluded to avoid the risk of review findings that are bias and contain errors (Aromataris & Pearson, 2014). Since our study focuses of digitalization, we know that technology grow rapidly and advances faster (Hayes & Barnett, 2001), the time period within which searches are done is between 2016 and 2021. Any study prior to 2016 will be excluded from the study. A bunch of unequivocal measures was characterized and applied to guarantee the straightforward choice of the articles. The determination models applied for the incorporation and prohibition of archives are introduced in TABLE 2 below. Furthermore, since the study focuses on digital maturity in shipping, we will include articles that cover only the digital maturity models or measurement in shipping. Any conceptual and framework approach will be excluded.

Criterion	Reason for Criterion use	Inclusion	Exclusion
Document Type	To focus on research articles type of documents published in Journals	Articles published in academic journals	All articles other than those published in academic journals. i.e. review articles, books, abstracts, conference paper , white paper, etc.
Period	The rate at which technology is advancing is very fast. There are many changes, latest research with contributor value to this research.	2016 - 2021	Period before 2016
Document Format	To analyse and synthesis the information presented in the document appropriately.	Full text document	Only Abstract
Document Language	Most published documents are presented in English.	English	Any Language Other than English
Relevant to Digital maturity, models and measurements in Shipping	To focus on the Maturity of Digitalization in shipping	Digital maturity published documents	Published documents on digitalization without digital maturity

Table 2: Inclusion and exclusion criteria Source, developed by the author

3.1.4. Selection and evaluation

This section outlines the study selection process and evaluation. Initial total of 2115 search results was identified using combination of keywords given in Table 1 above. The search results from electronic databases are illustrated in Figure 5. The criteria for inclusion and exclusion in this study were considered in order to achieve increased article reliability, a ‘three-way’ processes of filtering were developed. Papers were refined based on:

1. Context of the abstract and keywords
2. Exclusion of papers on the basis of ‘*inclusion & exclusion criteria*’
3. Manual search from reference list

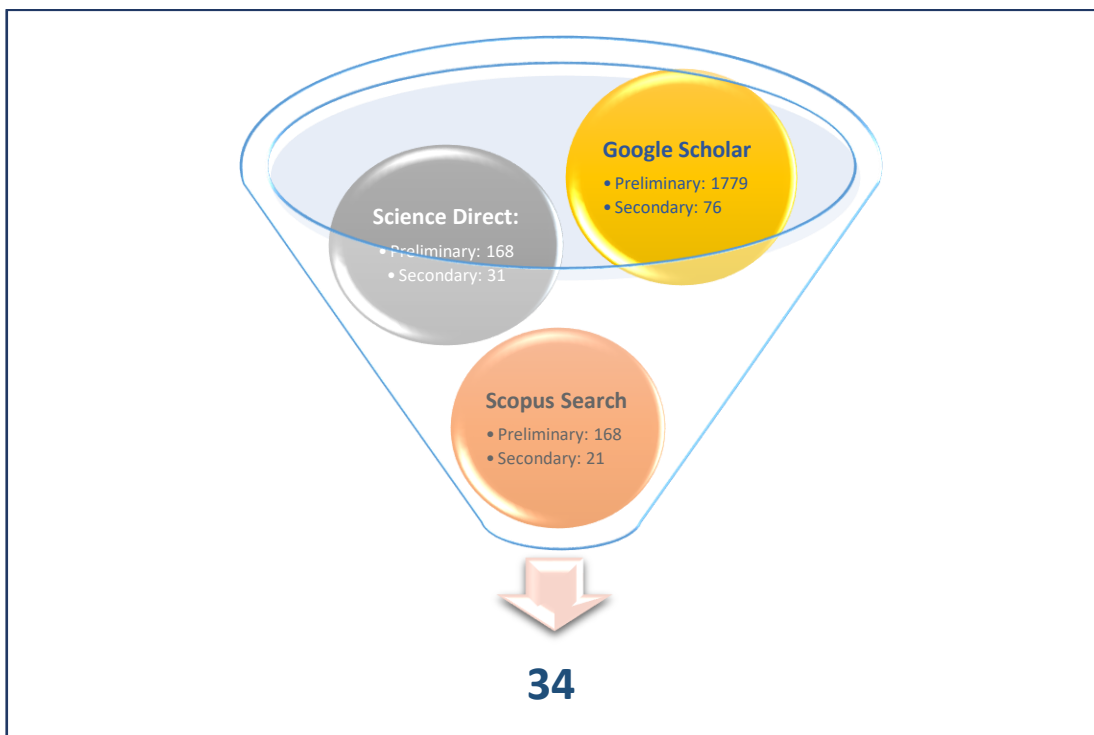


Figure 5: Articles searched and filtered. Source, developed by author

From this process, the total of 20 articles were identified and a further 14 articles were randomly searched through google search and citation of some of the initial 20 articles.

Preliminary search used broad search terms, followed by search strings, including as many keywords as possible to get as close to the research scope as possible. Through this process we excluded more papers, remaining with manageable number that can be scrutinized individually.

3.1.5. *Quality Assessment*

Quality assessment section of this study assist in checking and evaluating the accuracy and reliability of the selected articles. Taking on the quality evaluation from Gebayew et al. (2018). In the process of ensuring that there is reduced level of possible biasness, the review applied the method that can be replicated. The process of searching the required data ensured transparency and science. The reviewer made use of three databases that are recognised internationally to comprehensively search articles that are relevant. We used ‘google scholar’; ‘Scopus’ and ‘Science direct’. These databases have high volume of publications and abstract index. The criteria used is explicit and can be reproduced. To further assure the reliability of the process outlined above the reviewer provide audit trail of the process steps followed in making the selection of the article used in this review. Over and above all, the review did not search articles from specific journals but took note of the quartile index of journals with which the articles identified were selected for inclusion. We particularly considered the *Indexation, Quartile, FI, Publisher, Paper Quality and Editorial team quality journals* in selecting the articles. The exclusion criteria were on the basis of content and quality as well as the methodological quality score. The quality of primary studies is not equal and therefore scoring studies in accordance with the quality of various standards is of paramount importance (Okoli & Schabram, 2010).

3.1.6. *Data Analysis*

In order to provide comprehensive overview of the articles reviewed, descriptive analysis was applied. We further determine the direction that the research will partake for the future. We have partitioned this section in to ‘number of articles, scope of location (geographical), dimensions of digital maturity, research methods and techniques of data analysis.

3.1.7. *Limitations*

Lack of sufficient and relevant data was a major challenge for the reviewer. Having obtained only one article relevant to the industry and this study, we could not deeply obtain better understanding of the applicability of digital maturity model in shipping. Time allocated for this research study was not sufficient enough to allow the development and test the appropriateness of the model and as such leaving only a room to identify the relevant dimensions and recommend further development of model through future studies. The unwillingness of the shipping companies to participate is another limitation in that where methods like case studies, and interviews can be used to yield better reliable results, this is blocked by the rejection to invitation, thus resorting to desk research approach.

4. CHAPTER FOUR

4.1. DATA ANALYSIS AND FINDINGS

The articles systematically selected were 20 in number. Only articles between 2016 and 2021 were selected. These articles relate to digitalization and digital maturity. There were very few articles that relate directly to shipping. We are aware that technology is changing and advancing rigidly, we believed that recent data will be more relevant and useful in answering our research questions adequately and reliably. The structure of our research questions guided the decision to select a time frame of six years as it requires to identify models that will adequately measure digital maturity for shipping companies in to the future. Any data older than six years may be irrelevant and misleading thereby misguiding the objectives of this research. Table 3 below shows the 20 articles that were found to be relevant to this study. The table is arranged by: Author and article publication year; Article Name; Journal and Key words. From the table, it is clear that shipping and maritime as a whole lack research in the area of digital maturity. There is a lot of research conducted on digital transformation in maritime industry, however the digital transformation measurement in terms of the position and degree of digital maturity lack behind. Out of the 20 eligible articles, only one article was maritime related. Given the time frame of six years considered in the literature of digital maturity, only one article is a clear demonstration that as big at Maritime is, research in digital maturity area is encouraged.

Author	Article Title	Journal	Keywords
Schallmo et al. (2020)	An Approach for a Digital Maturity Model for SMEs based on Their Requirements	The ISPIM Innovation Conference – Innovating Our Common Future	digital maturity models; maturity models; stakeholder requirements; requirements for SMEs; digital transformation tools; SME; SLR; deductive method
Kutnjak et al. (2020b)	Assessing Digital Transformation Readiness Using Digital Maturity Indices	Central European Conference on Information and Intelligent Systems	Digital transformation, digital maturity, digital maturity index, agriculture
Eremina & Natalja. Bistrova. (2019)	Digital Maturity and Corporate Performance: The Case of the Baltic States	Journal of Open Innovation: Technology, Market, and Complexity	Digitalization; digital maturity; Baltic equity; corporate performance; total return
Minonne et al. (2018)	Digital maturity variables and their impact on the enterprise architecture layers	Problems and Perspectives in Management	digitalization, maturity models, enterprise architecture, digital management

Philipp. (2020a)	Digital readiness index assessment towards smart port development	Sustainability Management Forum	Digitalisation · Smart Port · Port Performance Measurement · Port Performance Indicators · Digital Readiness Index · Maturity Model
Pihir et al. (2018)	Digital Transformation Insights and Trends	Proceedings of the central European Conference on Information and Intelligence Systems	digital transformation, literature insights, key determinants, digital maturity, future trends.
Khanbhai et al. (2019)	Evaluating Digital Maturity And Patient Acceptability Of Real-Time Patient Experience Feedback Systems: Systematic Review	Journal Of Medical Internet Research	digital maturity; digital technology; feedback; patient experience; real time
Michele Colli et al., (2019)	A maturity assessment approach for conceiving context-specific roadmaps in the Industry 4.0 era	Annual review in control	Digital transformation Industry 4.0 Maturity model Maturity assessment Problem based learning
MacHado et al. (2020)	Maturity Framework Enabling Organizational Digital Readiness	IOS Press	Organizational readiness, digital transformation, maturity, digitalization, Industry 4.0.
Lam & Law. (2019)	Readiness of upscale and luxury-branded hotels for digital transformation	International Journal of Hospitality Management	Digital transformation; Innovation adoption; Customer-centrism; Data-culture; Agility; Technology
Machado et al. (2021)	Digital organisational readiness: experiences from manufacturing companies	Journal of Manufacturing Technology Management	Manufacturing industry, Organisational change, Industry 4.0
Ryan et al. (2020)	Recognizing Events 4.0: The Digital Maturity Of Events	International Journal of Event and Festival Management	Event management, Industry 4.0, Digital technology, Social Network Analysis, Event management education, Digital Maturity
Berghaus, Sabine; Back. (2020)	Stages In Digital Business Transformation: Results Of An Empirical Maturity Study	Tenth Mediterranean Conference on Information Systems	Digital transformation, maturity model, digital strategy, organizational change, transformation
Menchini et al. (2021)	Strategic Capabilities For Business Model Digitalization	Creative Commons Attribution	Maturity in digital business models, Enterprise architecture, Socio-materiality
Salviotti et al. (2019)	Strategic Factors Enabling Digital Maturity: An Extended Survey	Association for Information Systems	Digital Maturity, Digital Transformation, Strategic Factors
Nerima & Ralyté. (2021)	Towards A Digital Maturity Balance Model For Public Organizations	Research Challenges in Information Science	Digital Transformation, Digital Maturity Model, Public Organization
Teichert. (2019)	Digital Transformation Maturity: A Systematic Review Of Literature	Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis	systematic literature review, digital transformation, digital maturity, digital maturity models, digital transformation maturity, digital culture
Ramantoko et al. (2018)	Measuring Digital Capability Maturity: Case of Small-Medium Kampong-Digital Companies in Bandung	Pertanika Journal of Social Sciences and Humanities	Digital capability, kampong digital, maturity, Small Medium Enterprise (SME), virtual value chain
Thordsen et al. (2020)	How to Measure Digitalization? A Critical Evaluation of Digital Maturity Models	ESCP Business School	Digital maturity models; Measurement; Research agenda
Flott et al. (2016)	A Patient-Centred Framework for Evaluating Digital Maturity of Health Services: A Systematic Review	Journal of Medical Internet Research	digital maturity; evaluation; health information exchange; patient-centred care

M. Colli et al. (2019)	A maturity assessment approach for conceiving context-specific roadmaps in the Industry 4.0 era	Annual Reviews in Control	Digital transformation; Industry 4.0; Maturity model ;Maturity assessment ;Problem based learning
Nygaard et al. (2020)	A self-assessment framework for supporting continuous improvement through IoT integration	Procedia Manufacturing	Digital transformation; Industry 4.0 (I4.0); Self-assessment; Continuous improvement; Internet of things; Maturity assessment; Value stream mapping; Model development
Lang. (2021)	A systems theory-based conceptual framework for holistic digital transformation	Event Proceedings	systems theory, conceptual framework, digital roadmap, digitalization digital transformation,
Rafael et al. (2020)	An Industry 4.0 maturity model for machine tool companies	Technological Forecasting & Social Change	Industry 4.0; Digitalization; Maturity model; Implementation process ;Technological providers
Bumann & Peter. (2019)	Action Fields of Digital Transformation - A Review and comparative Analysis of Digital Transformation maturity Models and Frameworks	Innovation und Unternehmertum	Digital Transformation, Frameworks, Strategy, Digital Maturity Models, Organization, Corporate Culture, Technology, Customers, Employers
Sadiq et al. (2021)	Artificial intelligence maturity model: a systematic literature review	PeerJ Comput. Science	Artificial Intelligence, Maturity model, Systematic literature review, Organization
Dikhanbayeva et al. (2020)	Assessment of Industry 4.0 Maturity Models by Design Principles	Sustainability	Industry 4.0; design principles; sustainability; maturity models
Michele Colli et al. (2018)	Contextualizing the outcome of a maturity assessment for industry	International Federation of Automatic Control	Digital transformation, Maturity assessment, Problem Based Learning, Industry 4.0, Smart manufacturing
Halpern et al. (2021)	Ready for digital transformation? The effect of organisational readiness, innovation, airport size and ownership on digital change at airports	Journal of Air Transport Management	innovation Organisational readiness Technology Digital transformation Airports
Okfalisa et al. (2021)	Measuring the effects of different factors influencing on the readiness of SMEs towards digitalization: A multiple perspectives design of decision support system	Decision Science Letters	Small-Medium Enterprise; Performance measurement; Decision Support System; Digitalization Readiness; Fuzzy Analytical Hierarchy; Process
Kupriyanova et al. (2020)	Methods of developing digital maturity models for manufacturing companies	E3S Web of Conferences 224	Hierarchy; maturity Models, digitalization, measurements
Đurek. (2019)	Methodology for Developing Digital Maturity Model of Higher Education Institutions	Journal for Computers	Digital maturity, digital maturity model, maturity framework, maturity instrument.
Bertolini et al. (2019)	Maturity Models in Industrial Internet	Procedia Manufacturing	Industry 4.0; Industrial Internet; Maturity Model; Literature Review
Schallmo & Williams. (2021)	Integrated Approach for digital maturity: Levels, Procedure, and In-depth Analysis	The ISPIM Innovation Conference	Digital maturity; digital strategy; digital transformation; digital implementation; procedure; in-depth analysis.

Table 3: Literature base and Search Results

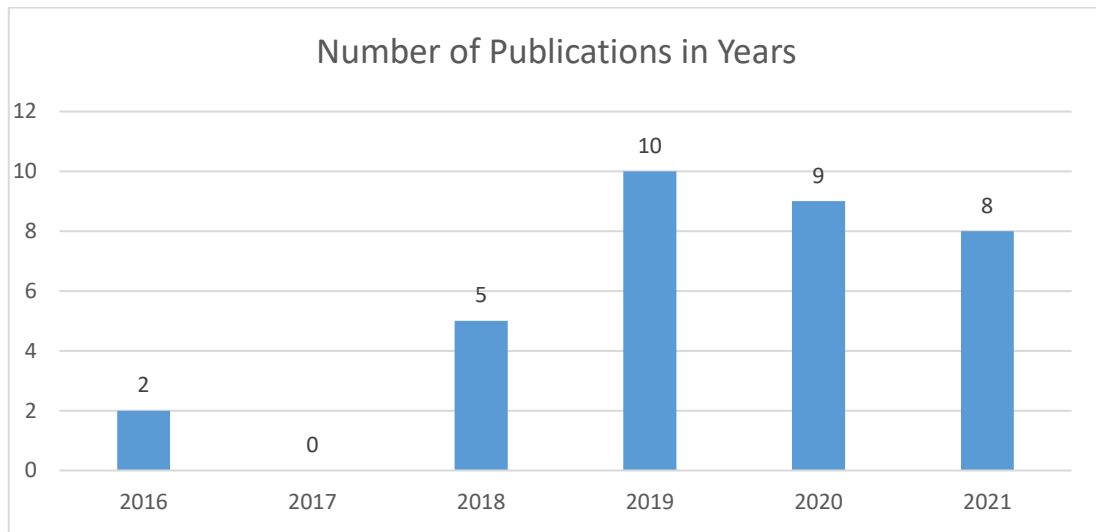


Figure 6: Published articles in years

Between 2016 and 2021, the articles published in relation to the digital maturity models, in particular with regard to the application and development of the models were 34. There is only one article relating to maritime port and none on shipping. Most of these researches were conducted and published in Europe.

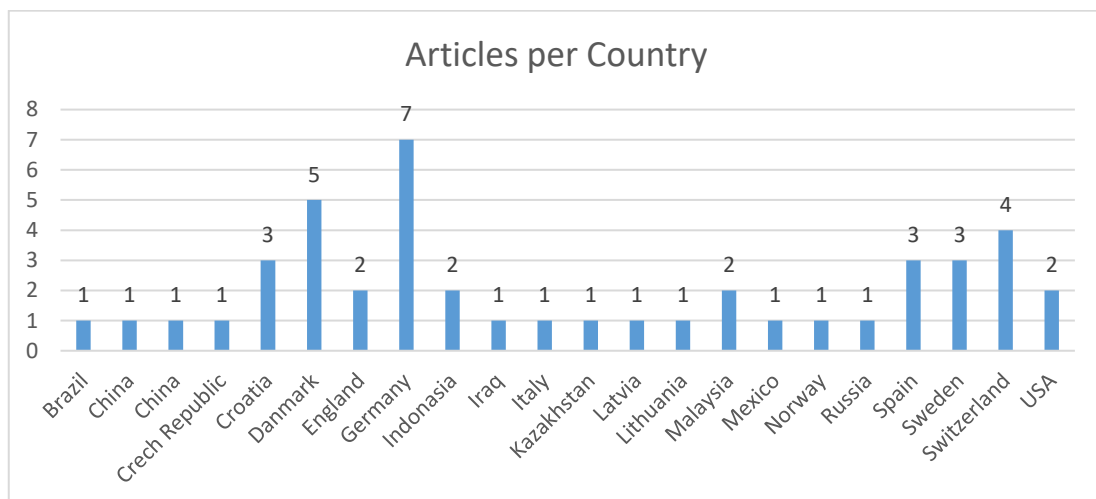


Figure 7: Articles by country

There is an indication that European countries are exploring their digitalization degree of maturity more than other continents, particularly in Manufacturing sector. Switzerland leading with 3 article over 20, still reflect low interest of research in the area of our study. Figure 8 Shows that 83% of the articles eligible to study the digital maturity model that will be appropriate for shipping companies are studied in Europe, followed by Asia then South America.

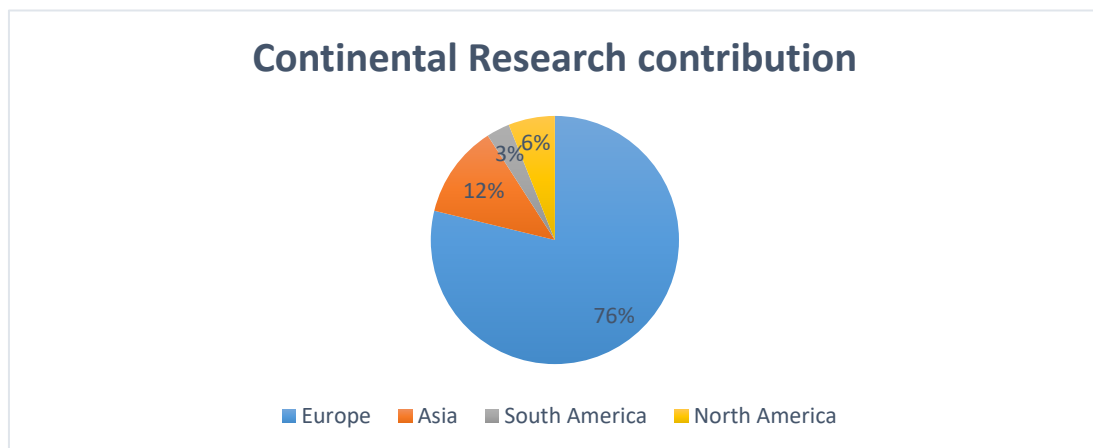


Figure 8: Percentage of Articles by Continent

There is a huge interest in the manufacturing sector to develop maturity models, to adopt maturity models that are already in use. There were many articles, although excluded due to the exclusion criteria, that were of digital maturity in nature from manufacturing sector. 8 articles were generalized research with no focus on a particular industry or sector. Figure 9 provides the demographics by sector in number of articles.

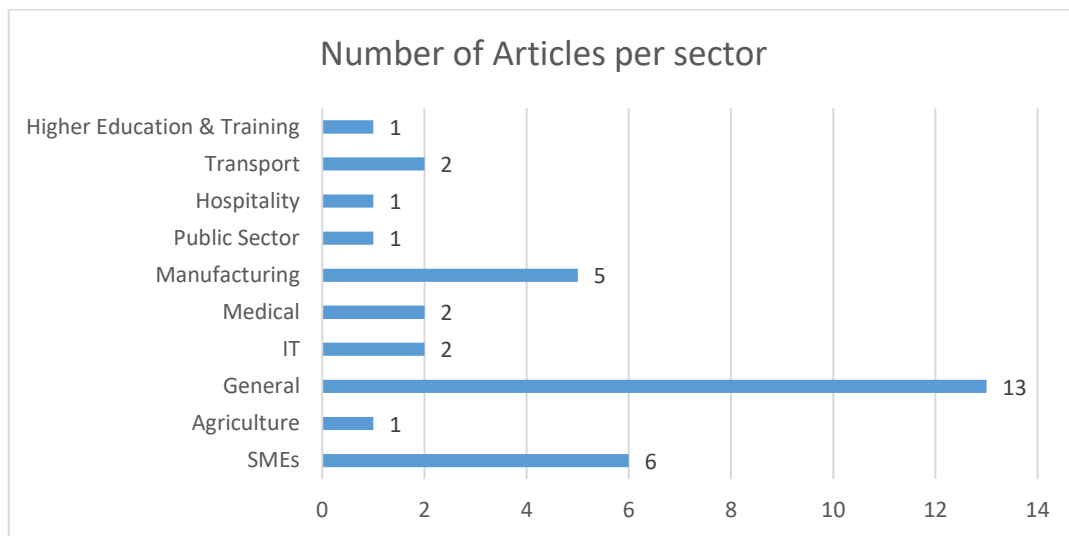


Figure 9: Article demographics by sector

The articles reviewed were mostly containing digital maturity model that are generic in nature and not developed for a specific sector. 13 articles reviewed were general followed by SMEs, and Manufacturing. Manufacturing in particular is the area that seems to attract researchers on the concept of digital maturity. Some of the articles under SMEs contain case studies of manufacturing or production firms.

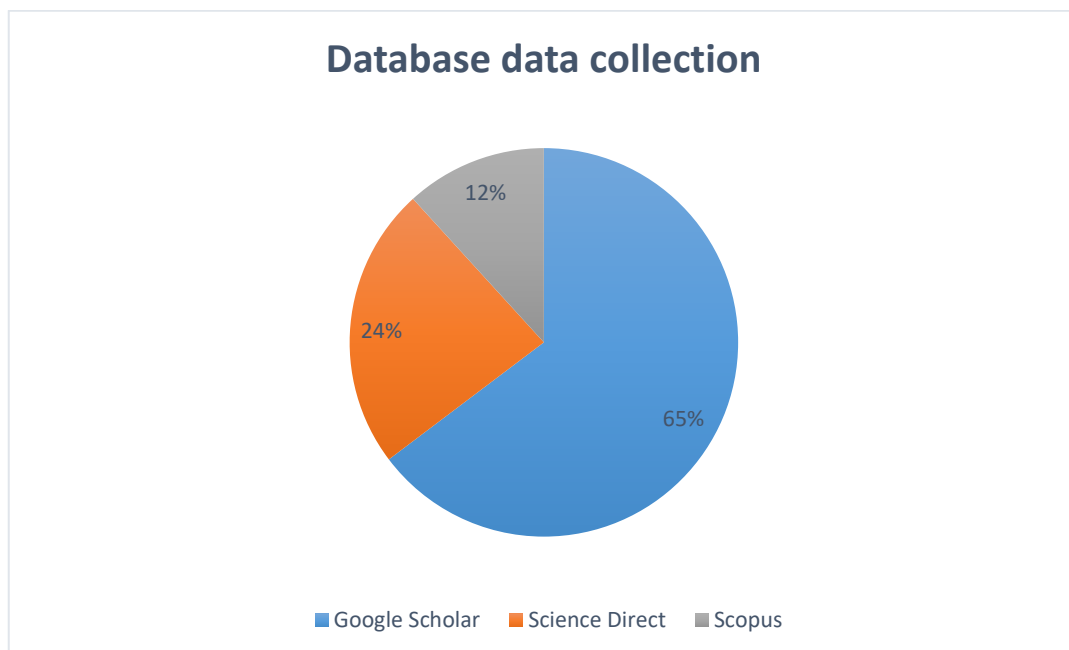


Figure 10: Databases for article search

The majority of the relevant articles in this study were collected through Google Scholar. More than 60% were collected but excluded due to duplication from other data bases.

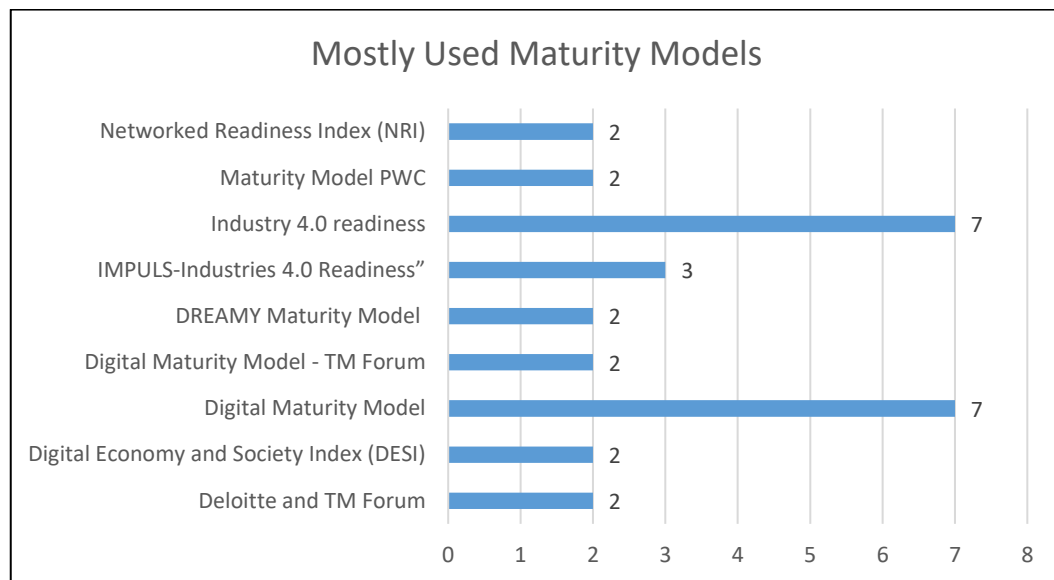


Figure 11: Popularly Used Maturity Models

Out all the articles, there were 51 maturity models mentioned, used, developed or adopted. We found 9 out of 51 to be popularly models from different articles. Industry 4.0 readiness & Digital Maturity Model appeared 7 times each from the 20 articles reviewed. Further to our analysis, we evaluated the dimensions that are used frequently in the models. There is not standard terminology of dimensions. Synonyms or extended terms are used by different researchers for dimensions. There were over different terms referring to one thing, for example, Human Capital, the term human resource, labour force, labour market; employees etc. are used to address the human capital factor or dimension. We have grouped such terms to identify the dimensions that are frequently used in maturity modelling. We found 12 dimensions to have been used in many articles to measure the degree of digital maturity or in development of digital maturity models for different industries. Figure 13 shows all the 12 dimensions that were identified as being used frequently and number of times they were used in different maturity models within the reviewed articles.

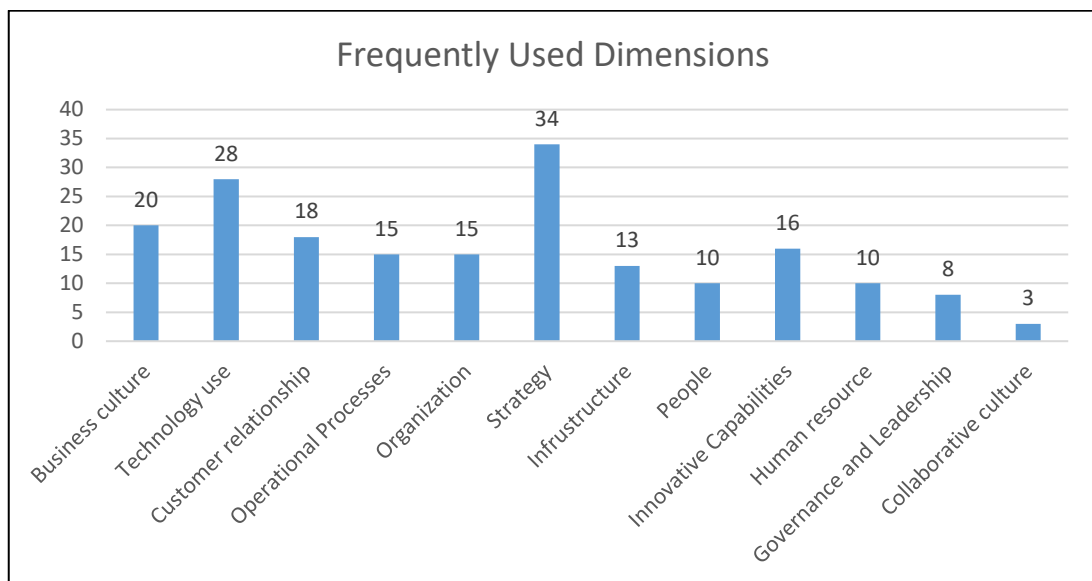


Figure 12: Frequently Used Dimensions

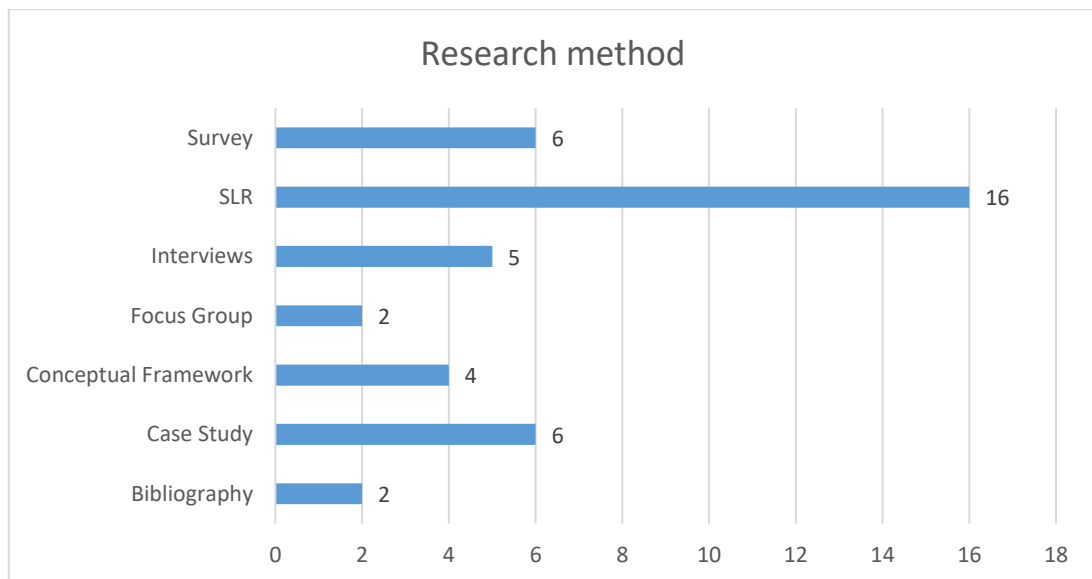


Figure 13: Research Method in articles in quantity

The finding indicate that digital maturity research attract desk researchers or systematic review researchers. 16/34 articles reviewed adopted the SLR approach. It is not clear what attract this approach over other methods of research.

In review of articles, Systematic Literature review, case study and surveys are the most methods used to collect data to study the digital maturity, either for development, adoption or exploratory studies.

4.2. DISCUSSIONS

This section discusses the findings in line with the reviewed articles and answer the research questions on the bases of such reviewed articles. The digitalization research area in shipping as a whole is ongoing and as broad as it is, there is a huge gap of research about the maturity of digital maturity of shipping companies. At the time of this study, empirical data collection about the status of digital maturity research in shipping, the application of existing generic or specific maturity models, choice of models that shipping companies are currently using or can use, was difficult to obtain. This is amongst the challenges faced by many other researchers. The CIMO model is therefore appropriate to discuss the findings of our study. Figure 15 illustrate the CIMO model as an approach to answering the research questions of this study.

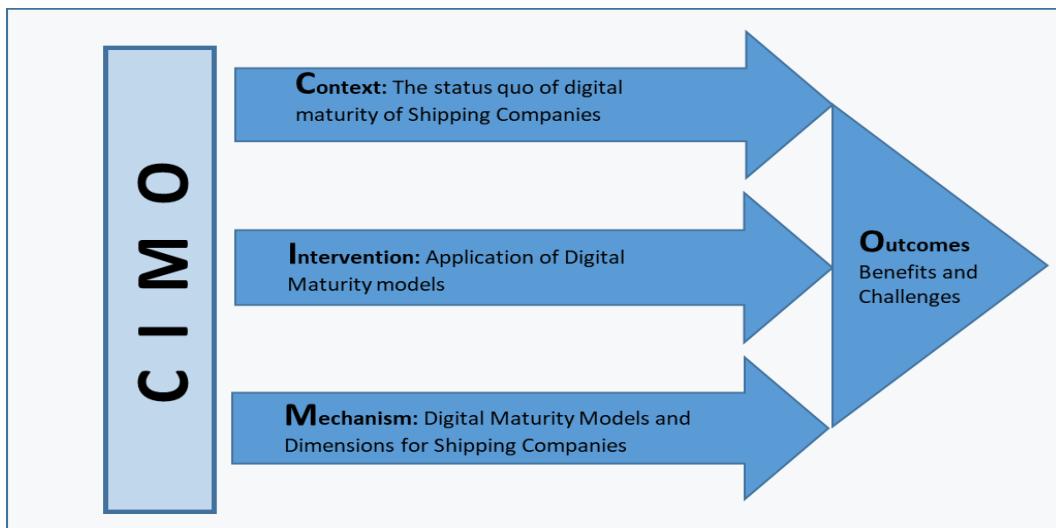


Figure 14: The CIMO Model

We summarize our findings through the CIMO-model in order to answer the research questions. According to this point of view, the review evinces that the Mechanism (M) identified with Digital Maturity Models (created models appropriate to Shipping

Companies) may deliver various Outcomes (O), in light of various Intervention (I), contingent upon the particular research in Shipping Context (C).

4.2.1. Context

The context here is the digital maturity research from the perspective of shipping companies. The research gap identified in the literature review (chapter 2) illuminates that there is interest of research in digitalization, digital transformation and adoption of digital technologies within the shipping industry. What is not clear is the digital maturity research area hence *RQ1*:

“What is the status of digital Maturity research in shipping?”

Research of Digital Maturity in a broader context (all industries) is explored by many researchers and practitioners. There is a lot of literature on the subject, be it searched research topic, key word or part of the body of knowledge. Although Shipping is a global industry and visible in all the global continents, the results of our research demonstrates that academic research on digital maturity in shipping is low. Between the years 2016 and 2021, there was only one article that was relevant to the concept of digital Maturity. Very few continents are interested in studying the digital maturity of shipping companies. This study has identified only four out of seven continents that have conducted scholarly research on digital Maturity, majority of which are produces in Europe at 76%, Asia at 12%, North America 6% and South America at 3% which only 1/34 articles. The difficulty in obtaining articles relevant to this study was the first indication of the status of the digital maturity research in the shipping industry. The search was extended beyond the systematised process thereby searching further through citations and random google search and there were no results relevant to the topic. Having identified one article relevant to this study, since 2016, it is clear that there is still a lot of research that need to be conducted to enable reasonable reflection of the status of digital maturity in shipping. We take note that more research in shipping is focused on the adoption of digital technologies than the degree of digitalization or the level of digitalization. As indicated earlier that Digital Maturity portrays the readiness and capacity of the organization to change and apply inventive

technologies, contingent upon the patterns, to stay cutthroat on the market (Eremina & Natalja. Bistrova, 2019)., knowledge of the status of digitalization or digital maturity is of paramount importance for the shipping companies and as a result, shipping companies, researchers and the industry experts need to advance research in this field, develop more digital maturity models to exploit the benefits that emanate from the knowledge of their digitalization position. The results shown in figure 8 indicates how insufficient research is at the global level. Having 1/7 of the global continents dominating in the digital transformation maturity levels for a world's international trade back bone simply call for attention of the entire industry and researchers to encourage interest in this area of research. To conclude the response to the RQ1, we measure the status of digital maturity research by adopting the UX maturity stages. UX Maturity stages consist of SIX stages: Absence (S0); Limited (S1); Emergent (S2); Structured (S3); Integrated (S4) & User- driven (S5). The stages are explained in the context of this research. Table 3 provides the stages of maturity.

Stage	Context
Absence	<ul style="list-style-type: none"> • There is not research in the field. • Research area is ignored • The area is uncovered or no awareness
Limited	<ul style="list-style-type: none"> • There is less studies conducted • Less or insufficient relevant studies on the research area • There is low level of interest
Emergent	<ul style="list-style-type: none"> • The existence of studies is visible and interest increase • There are inconsistencies on the understanding of the research area among researchers • Inefficiencies
Structured	<ul style="list-style-type: none"> • Partially systematic and different views and approaches the he study

Integrated	<ul style="list-style-type: none"> • Comprehensive, pervasive and universal research of the topic
User- Driven	<ul style="list-style-type: none"> • Body of Knowledge is embraced and adopted • Acknowledged approaches and reproducible scientific or systematic mechanisms of research. • Frequent or regular research

Table 4: Stages of maturity in research

Based on the discussion above, the status of digital maturity research in the context of shipping is at S1 of the UX maturity as shown in figure 16. This conclusion is justified by the findings of only one article indirectly related to shipping (Philipp, 2020b). To the best of our knowledge, at the time of this research, there was no academic research relating to the digital maturity of shipping companies or digital maturity models thereof. These finding are on the basis of open access articles. It could be that there are research articles relevant to the topic with restricted access. As a result, the limited research studies indicates that digital maturity research in shipping is still at its infancy

stages. Further studies need to be conducted to lay a foundation for exploration of the digital maturity and development of models for shipping companies.

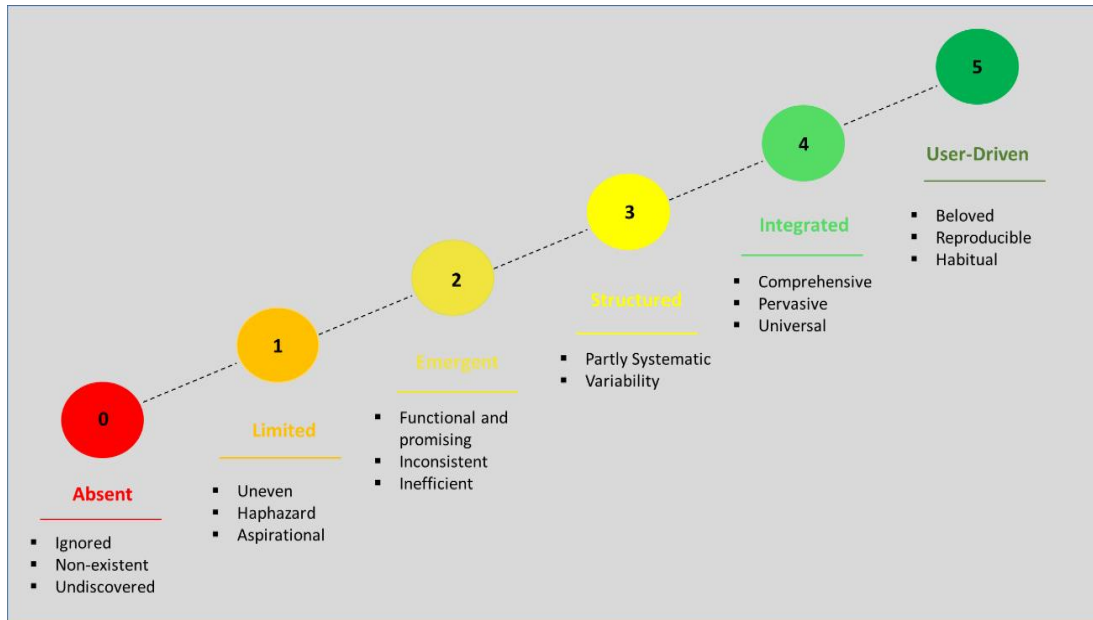


Figure 15: Stages of UX Maturity of research source

4.2.2. Intervention

The intervention refers to the action taken in the past to improve the processes. This subsection intends to explain the application of digital maturity models, either specially developed and generic-model adopted by shipping companies to measure the degree of their digital transformation.

RQ2: How are shipping companies applying existing digital maturity models?

Our findings in relation to RQ2, concludes that at the time of this research, there were not digital maturity models identified. The digital maturity models from the 34 reviewed articles did not cover the shipping sector, neither specifically not generically. Some researchers indicated that there is no one model that could be considered to be generic and application across different sectors. (Schallmo et al., 2020) indicates that there is no digital maturity model that meet measurement requirements. As complex as Shipping is industry specific digital maturity models need to be developed in order to measure the level of digital transformation reliably. At the current moment, there is

no certainty if models that were tested in larger companies can be effectively applicable in SMEs (M. Colli et al., 2019). With most shipping companies falling within the SME category of business, the findings of our study shows that only 18% of the reviewed articles were SME related or focused. Most of which adopt generic maturity models. Therefore, most of the existing models are generic and cannot be assumed to be applicable to shipping companies. At the time of this study, there is no academic literature that suggest the application of existing digital maturity models for Shipping companies. The qualities and difficulties of digital transformation are explicit to every area of action and even to each sort of organization. Consequently, every one of them might require a particular digital maturity model (Nerima & Ralyté, 2021). It is clear that at the moment the application of all the existing digital maturity models is not practical for shipping. This observation was based on the data and resources available at our disposal at the time of his research. We have however identified the 8 dimensions that are frequently used to develop digital maturity model. These dimensions can be used for further research in developing digital maturity model that can be used by shipping companies to measure the degree of their digital maturity. The 8 dimensions are: Business culture; Technology use; Customer relationship; Operational Processes; Strategy; Infrastructure; Human resource; Governance and Leadership. Based on these findings we propose a model that can be used as the base or contribution to the foundation of further research through other research approaches such as case studies to test the applicability of the proposed digital maturity model for shipping companies.

4.2.3. Mechanism

Firstly, Digital maturity model is considered a mechanism that enable businesses and managers to measure their degree of digital transformation. The finding of our review reveals that the mechanism component of the CIMO model in the context of this research is short of sufficient data to enable the reviewers to scientifically or otherwise verify of confirm the appropriateness of any existing digital maturity model for

shipping companies. Through a development of a digital maturity model, enabled by the intervention (I) discussed earlier, we answer RQ3.

RQ3: Which digital maturity model will be the appropriate for shipping?

Based on the reviewed papers, there was no one model that could convincingly be considered generic or specific and thus appropriate for adoption by shipping companies. The reviewed articles revealed over 71 Maturity models and 165 dimensions. Among the identified maturity models and dimensions, there were some of the most popularly adopted or frequently mentioned as provided in Table 5.

Model	No of Articles appearance	Reference	Dimensions
Deloitte and TM Forum	2	Anderson & Ellerby. (2018)	5 Dimensions: Customers; Strategies; Technologies; Operations; Organizations; and Culture.
Digital Economy and Society Index (DESI)	2	European Comission, (2019)	5 Dimensions: Connectivity; Human Capital; Use of internet; Integration of digital technology; Digital Public Services
Digital Maturity Model	7	Kutnjak et al. (2020b)	4 Dimensions: Culture; Organization; Technology; Insights
Digital maturity Model - TM Forum	2	Deloitte, (2018)	4 Dimensions: Customer Centricity; Organization & Culture; IT and Software
DREAMY Maturity Model	2	Felch et al. (2019)	4 Dimensions: process; monitoring and controlling; technology; organization
IMPULS-Industries 4.0 Readiness”	3	(Wang et al., 2010)	6 Dimensions: strategy and organization, smart factory, smart operations, smart products, data-driven services, and employees.

Industry 4.0 readiness	7	Agca et al. (2017)	6 Dimensions: Products and services; Manufacturing and operations; Strategy and organisation; Supply chain; Business model; Legal considerations
Maturity Model PWC	2	Mohamed, (2019)	3 Dimensions: Organization & Governance; Processes & Toolkits; Systems & Data
Networked Readiness Index (NRI)	2	Portulans Institute, (2019)	5 Dimensions: Management; Human Capital; Functionality (IT); Technology; Information

Table 5: Maturity Models & dimensions

Our analysis indicated that there are common dimensions among the different models, some used individually; while others are applied in combination with others. There is no common terminology for the individual dimensions, synonymous words are used to term dimensions which creates confusion to dimensions that refer to the same meaning and purpose. We have therefore separated combined dimensions, identify those that refer to one meaning (e.g. “human capital, human resources, people”, or “Management and Leadership”). Based on the later, we can consider ‘appropriate model’ for shipping as one that incorporate the 8 dimensions (Business culture; Technology use; Customer relationship; Operational Processes; Strategy; Infrastructure; Human resource; Governance and Leadership), reason being that shipping industry is part of the supply chain ecosystem where digital integration defines the organizations that will remain in the market competition. The 8 dimensions accommodate all the role players in the ecosystem. Figure 17 illuminates the proposed digital Maturity model for Shipping companies. This model is not an ultimate model but one that seeks further review and tests the credibility, reliability and accurateness of the model through future research.

Digital Maturity Model for Shipping						
Dimensions	Digital Maturity Stages and Levels					
	5 User-Driven	4 Integrated	3 Structured	2 Emergence	1 Limited	0 Absence
Business culture						
Technology use						
Customer relationship						
Strategy						
Human resource						
Governance & Leadership						
Operational Processes						
Infrastructure						

Figure 16: Digital Maturity Model for Shipping Companies

The model developed in figure 17, is further elaborated in tabular form to guide the users or potential users on the key indicators to observe under each dimension

The Model

The model proposed consist of eight dimensions and five levels. The foundation of a set of qualities that digital-driven shipping companies are relied upon to show at characterized level of maturity for every one of the dimensions that include the model.

Dimensions

The dimensions of the proposed model for the shipping companies are described below:

1. *Business culture*: alludes to the believes and practices that decide on the interaction between the entity's management; its employees and other stakeholders and support the process along the proposed digital maturity mechanism.
2. *Technology use*: Addressing the abilities that empower viable innovation planning, implementation and coalescing to support the companies.

3. *Customer relationship*: Focusing on digital integration of customer interface and coalescing through products & services of the company.
4. *Operational Processes*: Involves the process of identifying, examining and ameliorating processes that exists within the business for performance enhancement with the objective of meeting the high level of standard of practice and/ or improving the quality and the customer and end-user experience.
5. *Strategy*: Represent the direction a company will take to establish new competitive edge through digital means, and the strategies it will adopt to accomplish these progressions
6. *Infrastructure*: Focuses of advanced technologies in systems (deployed digital technologies) that allow interoperability and sharing of data to improve customer experience.
7. *Human Capital*: Involves the process where technologies such as *mobile, analytics and cloud* are exploited to make human capitalization effective, inclusive and efficient.
8. *Governance and Leadership*: Focuses on stablishing accountability and authoritative decision making of the presence of digital transformation and adoption of advanced digital technologies. It involves the decisions about security, privacy, data credibility and integrating digital transformation capabilities the company and stakeholders.

Maturity Levels & stages

Table 3 entail the maturity levels and stages used to measure the degree of maturity against the dimensions of the above.

Usage of the Model

The model plans to portray the degree of digital maturity of shipping companies at a given point on schedule. It additionally gives a view of what more digitally matured shipping company resembles. Be that as it may, the model isn't prescriptive with respect to what is the "most ideal way" to climb in the maturity scale. It additionally doesn't propose that level 5 is a prerequisite for all shipping companies. All things

being equal, it is an execution model where the levels are a depiction of the degree of execution.

4.2.4. Outcome

Outcome is the last component of the CIMO model. For the purpose of this discussion will observe the gap and challenges digital Maturity based on the findings of this research.

RQ4: What are the gaps and challenges of digital Maturity for shipping companies?

1. Gaps

Our study indicates that there is low level of digital maturity research interest in the shipping industry. The results show that between 2016 – 2021, not only shipping but Maritime as a whole contributed less than 5 research articles with open access. Relevant to this study we could only identify one article which was studied from a Port perspective. The structure and objective of our study was different from the latter thus resulting in considering a universal approach. By universal approach we mean that instead of reviewing digital maturity in shipping, we reviewed digital maturity, focusing on model development and application in different industries. Manufacturing industry stood out to be the most explored field in terms of research. African countries and the USA are not active in this field of research within the maritime industry. This is an opportunity for researchers from parts of the world that directly or indirectly participate in shipping and Maritime sector to begin the foundation for studying the digital maturity for shipping to advance the digital transformation agenda in the industry. Although digitalization and digital transformation in shipping, maritime and supply chain eco-system is more popular among the practitioners and academic researchers, the industry may struggle to progress in the process of digitalization if they are unaware or uninformed or their status of digital maturity. It is important that the digital strategic position of the management of shipping companies is guided by research conducted academically and tested. There are still inconsistencies in how the dimensions that are used to measure digital maturity are defined and applied. It is through extensive research in that area of research that the consensus about the

application, description, definitions and use of dimensions can be achieved. Further research in this topic should be conducted to close the gap identified in this study.

2. Challenges

Information sharing in shipping as a whole is a problem. One of the challenges that leads to less research in maritime industry particularly in the area of digitalization is the unwillingness of the shipping industry to participate in the research studies. During our study we, intended to conduct this research through a case study approach and interviews, when we invited shipping companies, large, medium and small, at different levels for participation in a study, it was clear that our research will not be a success when we received positive response from only less than 1% of the targeted 105 potential participants from different shipping companies (operations and ship management). Some were either not interested, company policy not allowing to participate in research studies, not available, or some just ignore the invitations. Digital maturity models require pragmatic approach to validate them. Without passing the test of application they remain theoretical and therefore may not serve the intended purpose. Securing case studies with well-established companies to thoroughly conduct research on these subject is close to impossible as these companies fear disclosure of their digital strategies as this may temper with their market competition strategies in that competitors may either counter strategies or identify weaknesses that are supposed to be internal. Transparency in shipping remain a challenge for researchers in that data cannot be obtained with ease. Data platforms for shipping companies is highly restrictive and the information is treated with high level of confidentiality. Given the time allocated for this study, not all options were explored to derive possible desired results.

5. CHAPTER FIVE

5.1. RECOMMENDATION AND CONCLUSIONS

In this research paper we have followed a SLR approach on digital maturity. The objective was to investigate the digital maturity model can appropriately measure digital maturity level in Shipping companies. We developed four research questions by adopting the CIMO (Context, Intervention, Mechanism and Outcome) approach (Pilbeam et al., 2019). RQ1: What is the status of digital Maturity research in shipping? ; RQ2: How are shipping companies applying existing digital maturity models? ; RQ3: Which digital maturity model will be the appropriate for shipping? ; RQ4: What are the gaps and challenges of implementing digital Maturity?

Based on this approach, to answer the questions we have systematically identified and reviewed a total of 34 digital maturity related articles relevant to the study. There is insufficient research on digital maturity models within the maritime industry. the study was therefore conducted from a broader view of digital maturity.

The status of digital maturity in shipping could not be adequately measured, furthermore, the absence of research articles indicates that digital maturity research in shipping is still at it infancy stages. There is no one digital maturity model that meet measurement requirements generically. Organizations develop their own models adopting from the existing models to suit their own strategy, organizational culture and resources. The study further revealed that there is no certainty that models which were tested in larger companies can be effectively applicable in SMEs (M. Colli et al., 2019). The outcome of the findings necessitated the development of digital maturity Model for shipping companies. Given the complexity and uniqueness of shipping industry, the existing models may not be appropriate for the shipping companies to apply in an attempt to evaluate the status of their digital maturity. Instead shipping companies should individually develop their own digital maturity models. The developed model was not tested due to the time frame, however, other researchers and practitioners in the shipping industry may use it as a base for the development of a pragmatic model for their own companies the model comprise of 8 dimensions

(Business culture; Technology use; Customer relationship; Operational Processes; Strategy; Infrastructure; Human resource; Governance and Leadership), and 5 levels of measurements. Shipping transport is part of the supply chain ecosystem where digital integration defines the organizations that will remain in the market competition. The 8 dimensions were identified and adopted based on their applicability to all the role players in the ecosystem. When measuring digital maturity these dimensions will enable reliable reflection of the digital maturity status quo.

This study revealed that one of the challenges that leads to less research in maritime industry particularly in the area of digitalization is the unwillingness to participate in the research studies. Obtaining research information in shipping industry remains a challenge for the researchers. Further to this study, we recommend that future studies should focus on the development of digital maturity model for shipping companies using a case study to test the applicability of the model. This study directly contributes to the existing research in digital maturity models in maritime research field. Researchers and practitioners can use this paper as part of the foundation of digital maturity model of shipping companies for future research. The findings of this research will enable other researchers to focus on the relevant approach in this area of research. It is of significant importance that the researchers attempt to answer the question: “How are shipping companies applying digital maturity model?” By answering this question, the researcher will contribute to the body of knowledge about the digital maturity model application mechanisms that are effective or ineffective for shipping companies, particularly at the current era where the industry is in the process of advancing digitalization.

REFERENCE

- Agca, O., Gibson, J., Godsell, J., Ignatius, J., Wyn Davies, C., & Xu, O. (2017). An Industry 4 Readiness Assessment Tool. *International Institute for Product and Service Innovation*, 1–19.
- Anderson, C., & Ellerby, W. (2018). Digital Maturity Model. *Deloitte, February*, 9–12.
- Aromataris, E., & Pearson, A. (2014). The systematic review: An overview. *American Journal of Nursing*, 114(3), 53–58.
<https://doi.org/10.1097/01.NAJ.0000444496.24228.2c>
- Babica, V., Sceulovs, D., Rustenova, E., & Kolbe, L. (2020). Digitalization in Maritime Industry: Prospects and Pitfalls. In E. Ginters, M. A. Ruiz Estrada, & M. A. Piera Eroles (Eds.), *ICTE in Transportation and Logistics 2019* (pp. 20–27). Springer International Publishing.
- Back, A., & Berghaus, S. (2016). Digital Maturity & Transformation Studie: Über das Digital Maturity Model. *Universität St. Gallen*, 2(November), 1–19.
https://aback.iwi.unisg.ch/fileadmin/projects/aback/web/pdf/digitalmaturitymodel_download_v2.0.pdf
- Bengtsson, C. (2017). Human Resource Management in the Digital Era. *International Conference “Current Economic Trends in Emerging and Developing Countries” (TIMTED-2017)*.
- Berghaus, Sabine; Back, A. (2020). Stages in Digital Business Transformation_ Results of an Empirical Maturity Study. *Journal of Critical Reviews*, 7(19), 738–750. <https://doi.org/10.31838/jcr.07.19.90>
- Bertolini, M., Esposito, G., Neroni, M., & Romagnoli, G. (2019). Maturity models in industrial internet: A review. *Procedia Manufacturing*, 39(2019), 1854–1863.
<https://doi.org/10.1016/j.promfg.2020.01.253>
- Bloomberg, J. (2018). Digitization, Digitalization, And Digital Transformation: Confuse Them At Your Peril. *Forbes*, 1–6.
<https://www.forbes.com/sites/jasonbloomberg/2018/04/29/digitization->

- digitalization-and-digital-transformation-confuse-them-at-your-peril/#78e677fd2f2c
- Brennen, J. S., & Kreiss, D. (2014). *Digitalization*.
<https://doi.org/10.1002/9781118766804.wbiect111>
- Brereton, P., Kitchenham, B. A., Budgen, D., Turner, M., & Khalil, M. (2007). Lessons from applying the systematic literature review process within the software engineering domain. *Journal of Systems and Software*, 80(4), 571–583.
<https://doi.org/10.1016/j.jss.2006.07.009>
- Bumann, J., & Peter, M. (2019). Action fields of digital transformation—a review and comparative analysis of digital transformation maturity models and frameworks. *Digitalisierung Und Andere Innovationsformen Im Management*, 2(November), 13–40.
- Christiansen, M., Fagerholt, K., Nygreen, B., & Ronen, D. (2007). *Maritime Transportation*. 14(06). [https://doi.org/10.1016/S0927-0507\(06\)14004-9](https://doi.org/10.1016/S0927-0507(06)14004-9)
- Christine Legner, Torsten Eymann, Thomas Hess, Christian Matt, Tilo Bohmann, Paul Drews, Alexandra Madche, N. U. & F. A. (2016). *Digitalization opportunity and challenges.pdf*. Springer Fachmedien Wiesbaden GmbH.
<https://doi.org/https://doi.org/10.1002/9781118766804.wbiect111>
- Colli, M., Berger, U., Bockholt, M., Madsen, O., Møller, C., & Wæhrens, B. V. (2019). A maturity assessment approach for conceiving context-specific roadmaps in the Industry 4.0 era. *Annual Reviews in Control*, 48, 165–177.
<https://doi.org/10.1016/j.arcontrol.2019.06.001>
- Colli, M., Madsen, O., Berger, U., Møller, C., Wæhrens, B. V., & Bockholt, M. (2018). Contextualizing the outcome of a maturity assessment for Industry 4.0. *IFAC-PapersOnLine*, 51(11), 1347–1352.
<https://doi.org/10.1016/j.ifacol.2018.08.343>
- Colli, Michele, Berger, U., Bockholt, M., Madsen, O., Møller, C., & Wæhrens, B. V. (2019). A maturity assessment approach for conceiving context-specific roadmaps in the Industry 4.0 era. *Annual Reviews in Control*, 48, 165–177.
- Colli, Michele, Madsen, O., Berger, U., Møller, C., Wæhrens, B. V., & Bockholt, M.

- (2018). Contextualizing the outcome of a maturity assessment for Industry 4.0. *Ifac-Papersonline*, 51(11), 1347–1352.
- Dalaklis, D. (2017). *Safety and Security in Shipping Operations*.
https://doi.org/10.1007/978-3-319-62365-8_9
- Deloitte. (2018). Digital Maturity Model. *Deloitte, February*, 9–12.
<https://www2.deloitte.com/content/dam/Deloitte/global/Documents/Technology-Media-Telecommunications/deloitte-digital-maturity-model.pdf>
- Dikhanbayeva, D., Shaikholla, S., Suleiman, Z., & Turkyilmaz, A. (2020). Assessment of industry 4.0 maturity models by design principles. *Sustainability (Switzerland)*, 12(23), 1–22. <https://doi.org/10.3390/su12239927>
- Đurek, V. (2019). Methodology for Developing Digital Maturity Model of Higher Education Institutions. *Journal of Computers*, 14(4), 247–256.
<https://doi.org/10.17706/jcp.14.4.247-256>
- Eremina, Y., & Natalja. Bistrova, J. L. (2019). Digital Maturity and Corporate Performance : The Case of the Baltic States. *Journal of Open Innovation: Technology, Market, and Complexity*.
- European Comission. (2019). Digital Economy and Society Index - Cybersecurity. *Ec.Europa.Eu*, 1–11. <https://ec.europa.eu/digital-single-market/en/news/digital-economy-and-society-index-2018-report>
- Feibert, D. C., Hansen, M. S., & Jacobsen, P. (2018). An integrated process and digitalization perspective on the shipping supply chain - A literature review. *IEEE International Conference on Industrial Engineering and Engineering Management, 2017-Decem*, 1352–1356.
<https://doi.org/10.1109/IEEM.2017.8290113>
- Felch, V., Asdecker, B., & Sucky, E. (2019). Maturity models in the age of industry 4.0 - Do the available models correspond to the needs of business practice? *Proceedings of the Annual Hawaii International Conference on System Sciences, 2019-Janua*, 5165–5174. <https://doi.org/10.24251/hicss.2019.620>
- Flott, K., Callahan, R., Darzi, A., & Mayer, E. (2016). A patient-Centered framework for fvaluating digital maturity of health services: A systematic review. *Journal*

- of Medical Internet Research*, 18(4). <https://doi.org/10.2196/jmir.5047>
- Fraser, J., & Plewes, S. (2015). Applications of a UX Maturity Model to Influencing HF Best Practices in Technology Centric Companies – Lessons from Edison. *Procedia Manufacturing*, 3(Ahfe), 626–631.
<https://doi.org/10.1016/j.promfg.2015.07.285>
- Fruth, M., & Teuteberg, F. (2017). Digitization in maritime logistics—What is there and what is missing? *Cogent Business and Management*, 4(1), 1–40.
<https://doi.org/10.1080/23311975.2017.1411066>
- Gandhi, A., & Sucahyo, Y. G. (2020). *Towards a Comprehensive Exploration and Mapping of Maturity Models in Digital Business : A Systematic Literature Review*. 40(4), 253–261.
- Gebayew, C., Hardini, I. R., Henry, G., Panjaitan, A., & Kurniawan, N. B. (2018). A Systematic Literature Review on Digital Transformation. *2018 International Conference on Information Technology Systems and Innovation (ICITSI), October*, 260–265. <https://doi.org/10.1109/ICITSI.2018.8695912>
- Gebayew, C., Hardini, I. R., Panjaitan, G. H. A., Kurniawan, N. B., & Suhardi. (2018). A Systematic Literature Review on Digital Transformation. *2018 International Conference on Information Technology Systems and Innovation, ICITSI 2018 - Proceedings, October*, 260–265.
<https://doi.org/10.1109/ICITSI.2018.8695912>
- González-Cancelas, N., Molina Serrano, B., Soler-Flores, F., & Camarero-Orive, A. (2020). Using the SWOT Methodology to Know the Scope of the Digitalization of the Spanish Ports. *Logistics*, 4(3), 20.
<https://doi.org/10.3390/logistics4030020>
- Graseck, S. (2008). *Explore the Past to Understand the Present and Shape the Future*. 72(7), 367–370.
- Grzelakowski, A. S. (2019). Global container shipping market development and its impact on mega logistics system. *TransNav*, 13(3), 529–535.
<https://doi.org/10.12716/1001.13.03.06>
- Halpern, N., Mwesiumo, D., Suau-Sanchez, P., Budd, T., & Bråthen, S. (2021).

- Ready for digital transformation? The effect of organisational readiness, innovation, airport size and ownership on digital change at airports. *Journal of Air Transport Management*, 90(October 2020), 101949.
<https://doi.org/10.1016/j.jairtraman.2020.101949>
- Hanif, S. R. (2017). *AN EXPLORATORY STUDY OF DIGITAL TRANSFORMATION MATURITY MODELS*.
- Hayes, B. C., & Barnett, T. P. M. (2001). *System Perturbation : Conflict in the Age of Globalization*.
- IMO. (2020). Coronavirus (COVID-19) – Accelerating digitalization of maritime trade and logistics – A call to action. *Circular Letter No.4204/Add.20 (5 June 2020)*, 44(4204).
- Inkinen, T., Helminen, R., & Saarikoski, J. (2019). Port digitalization with open data: Challenges, opportunities, and integrations. *Journal of Open Innovation: Technology, Market, and Complexity*, 5(2), 1–16.
<https://doi.org/10.3390/joitmc5020030>
- Jahn, C., & Bussow, T. (2013). Best practice ship management. *Germanischer Lloyd SE*.
- Jović, M., Tijan, E., Aksentijević, S., & Sotošek, B. (2020). The role of electronic transportation management systems in seaport digitalization. *32nd Bled EConference Humanizing Technology for a Sustainable Society, BLED 2019 - Conference Proceedings, December*, 1–15. <https://doi.org/10.18690/978-961-286-280-0.1>
- Khanbhai, M., Flott, K., Darzi, A., & Mayer, E. (2019). Evaluating digital maturity and patient acceptability of real-time patient experience feedback systems: Systematic review. *Journal of Medical Internet Research*, 21(1), 1–10.
<https://doi.org/10.2196/jmir.9076>
- Kupriyanova, M. V., Evdokimova, E. N., Solovyova, I. P., & Simikova, I. P. (2020). Methods of developing digital maturity models for manufacturing companies. *E3S Web of Conferences*, 224. <https://doi.org/10.1051/e3sconf/202022402034>
- Kutnjak, A., Pihir, I., & Furjan, M. T. (2020a). Assessing Digital Transformation

- Readiness Using Digital Maturity Indices. *Central European Conference on Information and Intelligent Systems*, 307–314.
- Kutnjak, A., Pihir, I., & Furjan, M. T. (2020b). Assessing Digital Transformation Readiness Using Digital Maturity Indices. *Central European Conference on Information and Intelligent Systems*, 307–314.
- Lam, C., & Law, R. (2019). Readiness of upscale and luxury-branded hotels for digital transformation. *International Journal of Hospitality Management*, 79(April 2018), 60–69. <https://doi.org/10.1016/j.ijhm.2018.12.015>
- Lang, K. (2021). *A systems theory-based conceptual framework for holistic digital transformation* A systems theory-based conceptual framework for holistic digital transformation Daniel Hasler * Tobias Hackl Katharina Ehmig-Klassen. June, 0–24.
- Latifov, K. (2019). *The Maritime Commons : Digital Repository of the World Maritime* A critical evaluation of potential outcomes of using modern artificial intelligence and big data analysis technology in maritime industry A critical evaluation of potential outcomes of using .
- Li, L., Wu, H., Yuan, Y., & Zhou, L. (2021). Industrial Supply Chain Optimization Based on 5G Network and Markov Model. *Microprocessors and Microsystems*, 80(November 2020), 103559. <https://doi.org/10.1016/j.micpro.2020.103559>
- Li, S., & Fung, K. S. (2019). Maritime autonomous surface ships (MASS): implementation and legal issues. *Maritime Business Review*, 4(4), 330–339. <https://doi.org/10.1108/MABR-01-2019-0006>
- Lim, S., Pettit, S., Abouarghoub, W., & Beresford, A. (2019). Port sustainability and performance : A systematic literature review. *Transportation Research Part D*, 72, 47–64. <https://doi.org/10.1016/j.trd.2019.04.009>
- Lind, M., Ward, R., Jensen, H. H., Chua, C. P., Simha, A., Karlsson, J., Göthberg, L., Penttinen, T., & Theodosiou, D. P. (2021). *The Future of Shipping: Collaboration Through Digital Data Sharing*. https://doi.org/10.1007/978-3-030-50892-0_9
- Lind, M., Watson, R. T., Ward, R., Bergmann, M., Bjorn-Andersen, N., Rosemann,

- M., Haraldson, S., & Andersen, T. (2018). Digital Data Sharing: The Ignored Opportunity for Making Global Maritime Transport Chains More Efficient. *Digital Ship*, 9(November 2018), 16.
<https://unctad.org/en/pages/newsdetails.aspx?OriginalVersionID=1850>
- Lionetto, F., Pappadà, S., Buccoliero, G., Maffezzoli, A., Marszałek, Z., Sroka, R., Stencel, M., Buser, Y. M., Grouve, W. J. B., Vrugink, E., Sacchetti, F., Akkerman, R., Rudolf, R., Mitschang, P., Neitzel, M., Xu, X., Ji, H., Qiu, J., Cheng, J., ... Dhondt, M. C. (2020). No 主観的健康感を中心とした在宅高齢者における 健康関連指標に関する共分散構造分析Title. *Composites Part A: Applied Science and Manufacturing*, 68(1), 1–12.
<http://dx.doi.org/10.1016/j.ndteint.2014.07.001><https://doi.org/10.1016/j.ndteint.2017.12.003><http://dx.doi.org/10.1016/j.matdes.2017.02.024>
- Ma, S. (2020). Economics of Maritime Business. In *Economics of Maritime Business*. <https://doi.org/10.4324/9781315658124>
- MacHado, C. G., Almstrom, P., Oberg, A. E., Kurdve, M., & Almashalah, S. Y. (2020). Maturity Framework Enabling Organizational Digital Readiness. *Advances in Transdisciplinary Engineering*, 13, 649–660.
<https://doi.org/10.3233/ATDE200204>
- Machado, C. G., Winroth, M., Almström, P., Ericson Öberg, A., Kurdve, M., & AlMashalah, S. (2021). Digital organisational readiness: experiences from manufacturing companies. *Journal of Manufacturing Technology Management*, 32(9), 167–182. <https://doi.org/10.1108/JMTM-05-2019-0188>
- Matt, C., Hess, T., & Benlian, A. (2015). Digital Transformation Strategies. *Business and Information Systems Engineering*, 57(5), 339–343.
<https://doi.org/10.1007/s12599-015-0401-5>
- Medyakova, E. M., Kislitskaya, N. A., Kudinova, S. G., & Gerba, V. A. (2020). COVID-19 as a trigger for global transport infrastructure digitalization. *IOP Conference Series: Materials Science and Engineering*, 918(1).
<https://doi.org/10.1088/1757-899X/918/1/012227>
- Menchini, F., Russo, P. T., Slavov, T. N. B., & Souza, R. P. (2021). Strategic

- capabilities for business model digitalization. *Revista de Gestão, ahead-of-p*(ahead-of-print). <https://doi.org/10.1108/rege-10-2020-0086>
- Minonne, C., Wyss, R., Schwer, K., Wirz, D., & Hitz, C. (2018). Digital maturity variables and their impact on the enterprise architecture layers. *Problems and Perspectives in Management*, 16(4), 141–154.
[https://doi.org/10.21511/ppm.16\(4\).2018.13](https://doi.org/10.21511/ppm.16(4).2018.13)
- Mohamed. (2019). *PwC Tax Management Maturity Model (T3M); Meeting tomorrow's tax challenges today*.
- Muhammad, B., Kumar, A., Cianca, E., & Lindgren, P. (2018). Improving Port Operations through the Application of Robotics and Automation within the Framework of Shipping 4.0. *2018 21st International Symposium on Wireless Personal Multimedia Communications (WPMC)*, 387–392.
<https://doi.org/10.1109/WPMC.2018.8712998>
- N, Nikitakos; I, T. (2001). Network centric organizations in shipping. *Journal of Management Science and Regional Development*, 3, 183–197.
- Nerima, M., & Ralyté, J. (2021). Towards a Digital Maturity Balance Model for Public Organizations. *Lecture Notes in Business Information Processing*, 415 *LNBIP*(May), 295–310. https://doi.org/10.1007/978-3-030-75018-3_20
- Nwankpa, J. K., & Datta, P. (2017). Balancing exploration and exploitation of IT resources: The influence of Digital Business Intensity on perceived organizational performance. *European Journal of Information Systems*, 26(5), 469–488. <https://doi.org/10.1057/s41303-017-0049-y>
- Nygaard, J., Colli, M., & Wæhrens, B. V. (2020). A self-assessment framework for supporting continuous improvement through IoT integration. *Procedia Manufacturing*, 42(2019), 344–350.
<https://doi.org/10.1016/j.promfg.2020.02.079>
- Okfalisa, Anggraini, W., Nawanir, G., Saktioto, & Wong, K. Y. (2021). Measuring the effects of different factors influencing on the readiness of smes towards digitalization: A multiple perspectives design of decision support system. *Decision Science Letters*, 10(3), 425–442.

- <https://doi.org/10.5267/j.dsl.2021.1.002>
- Okoli, C., & Schabram, K. (2010). *Working Papers on Information Systems A Guide to Conducting a Systematic Literature Review of Information Systems Research*. 10(2010).
- Parviainen, P., Tihinen, M., Kääriäinen, J., & Teppola, S. (2017). SciKA - Association for Promotion and Dissemination of Scientific Knowledge. *International Journal of Information Systems and Project Management*, 5(1), 63–76.
- Philipp, R. (2020a). Digital readiness index assessment towards smart port development. *Sustainability Management Forum / NachhaltigkeitsManagementForum*, 28(1–2), 49–60.
<https://doi.org/10.1007/s00550-020-00501-5>
- Philipp, R. (2020b). Digital readiness index assessment towards smart port development. *Sustainability Management Forum / NachhaltigkeitsManagementForum*, 28, 49–60.
- Pihir, I., Tomićić-Pupek, K., & Furjan, M. T. (2018). Digital Transformation Insights and Trends. *Proceedings of the Central European Conference on Information and Intelligent Systems*, 141–150.
- Pilbeam, C., Denyer, D., Doherty, N., & Davidson, R. (2019). Designing safer working interventions through a literature review using a mechanisms-based approach. *Safety Science*, 120(May), 352–361.
<https://doi.org/10.1016/j.ssci.2019.07.017>
- Portulans Institute. (2019). *Network Readiness Index 2019 Cameroon*.
<https://networkreadinessindex.org/2019/countries/cameroon/>
- Rafael, L. D., Jaione, G. E., Cristina, L., & Ibon, S. L. (2020). An Industry 4.0 maturity model for machine tool companies. *Technological Forecasting and Social Change*, 159(March), 120203.
<https://doi.org/10.1016/j.techfore.2020.120203>
- Rajnai, Z., & Kocsis, I. (2018). Assessing industry 4.0 readiness of enterprises. 2018 *IEEE 16th World Symposium on Applied Machine Intelligence and Informatics*

- (SAMI), 225–230. <https://doi.org/10.1109/SAMI.2018.8324844>
- Ramantoko, G., Fatimah, L. V., Pratiwi, S. C., & Kinasih, K. (2018). Measuring digital capability maturity: Case of small-medium Kampong-digital companies in Bandung. *Pertanika Journal of Social Sciences and Humanities*, 26(T), 215–230.
- Remane, G., & Hanelt, Andre; Kolbe, Lutz M; Wiesboeck, F. (2017). *DIGITAL MATURITY IN TRADITIONAL INDUSTRIES – AN EXPLORATORY DIGITAL MATURITY IN TRADITIONAL INDUSTRIES – AN EXPLORATORY ANALYSIS*. May.
- Rolls-Royce. (2016). Autonomous ships: The next step. *AAWA Position Paper*, Rolls Royce Plc., London, 7. <http://www.rolls-royce.com/~media/Files/R/Rolls-Royce/documents/customers/marine/ship-intel/rr-ship-intel-aawa-8pg.pdf>
- Ryan, W. G., Fenton, A., Ahmed, W., & Scarf, P. (2020). Recognizing events 4.0: the digital maturity of events. *International Journal of Event and Festival Management*, 11(1), 47–68. <https://doi.org/10.1108/IJEFM-12-2019-0060>
- Sadiq, R. B., Safie, N., Abd Rahman, A. H., & Goudarzi, S. (2021). Artificial intelligence maturity model: a systematic literature review. *PeerJ Computer Science*, 7, e661. <https://doi.org/10.7717/peerj-cs.661>
- Salviotti, G., Gaur, A., & Bocconi, U. (2019). Strategic Factors Enabling Digital Maturity: an Extended Survey. *The 13th Mediterranean Conference on Information Systems (MCIS)*, 1–13. <https://aisel.aisnet.org/mcis2019/15>
- Sanchez-Gonzalez, P. L., Díaz-Gutiérrez, D., Leo, T. J., & Núñez-Rivas, L. R. (2019). Toward digitalization of maritime transport? *Sensors (Switzerland)*, 19(4). <https://doi.org/10.3390/s19040926>
- Schallmo, D., Lang, K., Ehmig-Klassen, K., Hasler, D., & Williams, C. A. (2020). An Approach for a Digital Maturity Model for SMEs based on Their Requirements Digital Maturity Models: Towards the transformation of SMEs View project An Approach for a Digital Maturity Model for SMEs based on Their Requirements. *The ISPIM Innovation Conference – Innovating Our Common Future*, June, 0–17.

- <https://www.researchgate.net/publication/342202259>
- Schallmo, D., & Williams, C. A. (2021). *Integrated Approach for Digital Maturity : Levels , Procedure , and In-Depth Analysis. June.*
- Schallmo, D., Williams, C. A., & Boardman, L. (2017). Digital transformation of business models-best practice, enablers, and roadmap. *International Journal of Innovation Management*, 21(8). <https://doi.org/10.1142/S136391961740014X>
- Süleyman İrtem, Ş., Bayar, S., & Alkan, G. (2015). The Implementation of Maritime Labour Convention in the Ship Management: A Case Study on Risk Management On-Board. *International Journal of Operations and Logistics Management*, 4(4).
- Teichert, R. (2019). DIGITAL TRANSFORMATION MATURITY : A SYSTEMATIC REVIEW OF LITERATURE. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, 67(6), 1673–1687.
- Thordsen, T., Murawski, M., & Bick, M. (2020). How to Measure Digitalization? A Critical Evaluation of Digital Maturity Models. In *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics): Vol. 12066 LNCS*. Springer International Publishing. https://doi.org/10.1007/978-3-030-44999-5_30
- Tijan, E., & Jovi, M. (2021). *Technological Forecasting & Social Change Digital transformation in the maritime transport sector. 170.* <https://doi.org/10.1016/j.techfore.2021.120879>
- Tijan, E., Jović, M., Aksentijević, S., & Pucihar, A. (2021). Digital transformation in the maritime transport sector. *Technological Forecasting and Social Change*, 170. <https://doi.org/10.1016/j.techfore.2021.120879>
- UK DoT. (2019). *Maritime 2050 Navigating the future.*
- UNCTAD. (2018). Reveiw of Maritime Transport. In *United Nations Conference on Trade and Development*. https://unctad.org/en/PublicationsLibrary/rmt2018_en.pdf
- UNCTAD. (2019). *Digitalization in Maritime Transport: Ensuring Opportunities for Development*. UNCTAD Policy Brief No. 75 (UNCTAD/PRESS/PB/2019/4).

- UNCTAD. (2021). *Global Trade Update. June*, 1–8.
https://unctad.org/system/files/official-document/ditcmisc2020d2_en.pdf
- Varriale, V., Cammarano, A., Michelino, F., Caputo, M., Jones, M. D., Hutcheson, S., Camba, J. D., Zapata, M. L., Berrah, L., Tabourot, L., Peter, M. K., Kraft, C., Lindeque, J., Williams, C., Schallmo, D., Lang, K., Boardman, L., Colli, M., Berger, U., ... Wickramarachchi, R. (2019). Digital maturity models for small and medium-sized enterprises: a systematic literature review. *Journal of Strategy and Management*, 48(11), 1–15.
- Vial, G. (2019). Understanding digital transformation: A review and a research agenda. *Journal of Strategic Information Systems*, 28(2), 118–144.
<https://doi.org/10.1016/j.jsis.2019.01.003>
- Wang, L., Bai, Y., Lu, Y., & Wang, H. (2010). Nitrogen nutrition diagnosis for corn using different spectral parameters. *Nongye Gongcheng Xuebao/Transactions of the Chinese Society of Agricultural Engineering*, 26(2), 218–223.
<https://doi.org/10.3969/j.issn.1002-6819.2010.02.038>
- Wariishi, K. (2019). Maritime Autonomous Surface Ships : Development Trends and Prospects-How Digitalization Drives Changes in Maritime Industry. *Mitsui & Co. Global Strategic Studies Institute Monthly Report September, September*, 1–8.
- Williams, C., & Lang, K. (2019). Digital Maturity Models for Small and Medium-sized Enterprises : A Systematic Literature Review Daniel Schallmo Luke Boardman. *ISPIM Innovation Conference –*, June, 1–16.
- WTO. (2021). *World Trade Statistical Review*.
- Yang, C. S. (2019). Maritime shipping digitalization: Blockchain-based technology applications, future improvements, and intention to use. *Transportation Research Part E: Logistics and Transportation Review*, 131(July), 108–117.
<https://doi.org/10.1016/j.tre.2019.09.020>

