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Høgskulen
på Vestlandet

# MASTER'S THESIS

*Realizing Digital Transformation in Vessel Management*

**By**

**Michelle Loeffler**

Master Thesis submitted to the Western University of Norway in partial fulfillment of the requirements for the degree of

**Master of Maritime Operations**

Supervisors: Dr. Margareta Holtensdotter Lützhöft,

Dr. Joel Scanlan

**Western Norway University**

Bergen, 17th June 2022

**I confirm that the work is self-prepared and that references/source references to all sources used in the work are provided, cf. Regulation relating to academic studies and examinations at the Western Norway University of Applied Sciences (HVL), § 12-1.**

# Article I  Abstract

Digital Transformation is a phenomenon being witnessed across all industries. The disruption caused by the adoption of digital technologies is having wide ranging impact on organizational structures and work cultures. It lures with benefits such as increased efficiency, business transparency, cost-savings providing a competitive edge when successfully implemented.

Ship Managers, Operators and Owners have been following this digital journey, however cross-sector studies have shown that the likelihood of success in digital transformation projects in achieving the initial goals lies around 30%.

Vessels consist of several highly complex systems that enable their operation and management including the interaction between department within the shipping company and third party service providers. Seagoing vessels are exposed to limited internet access which further complicates the use of online applications and systems.

Therefore, the imperative question is: how can digital transformation be realized for Ship Owners, Managers and Operators?

To address this question this research has undertaken a case study of three organizations in different stages of digital maturity and explored their recent experience in introducing digital projects from perspectives of managers ashore and end-users at sea.

The findings present determinant factors for successful implementation of digital transformation projects provides practical guidance towards the cultural readiness, and improvement processes for the implementation of integrated systems.

The encountered obstacles, and critical considerations are discussed in the context of  recent literature and comparing it to the actual experience of the case organizations. The outcome is a key contribution in the form of strategic guidance for successfully utilizing the potential in their digital transformation journey.

# Article II  Acknowledgements

First and foremost, I want to thank my research supervisors Margareta Lützhöft and Joel Scanlan, for their invaluable advice, dedication and tireless assistance to transform me to become an academic researcher, and always showing the kindest support, as well as sharing their vast experience and knowledge with me.

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I would like to thank all participants, ashore and on board, who I for confidentiality reasons cannot name here, but I want to express my sincerest  gratitude, and thank you for sharing your experience, time, and knowledge with me.

Last but not least I want to thank Ai Leng, Lisa, Charly, Vince and Arne for providing the mental support and making me laugh in stressful times and Roar, for dedicating so much of his nights towards improving this thesis with his proof reading.

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| | |
|---|---|
| AR | Augmented reality |
| CBT | Computer based Training |
| DT | Digital Transformation |
| EAM | Enterprise Asset Management Systems |
| GHG | Refers to IMOs Greenhouse Gas Emissions Strategy |
| IMO | International Maritime Organization |
| IoS | Internet od Ships |
| IoT | Internet of Things |
| PMS | Planned Maintenance System |
| QHSE | Quality Health Safety Environment Compliance and Management |
| SaaS | Software as a Service |
| VR | Virtual Reality |
| VRS | Vessel Reporting System- here referring to a cloud-based report containing consumption data for performance monitoring and Environmental reporting |

# 1 Introduction

The employment of digital technologies has seen a rise in all sectors and industries in the recent years (Matt et al.,2015) disrupting business processes and organizational structures and strategies to utilize the key benefits. This fundamental change and adaptation of organizations to a rapidly changing environment is described as Digital Transformation. It is also commonly referred to as the 4th Industrial Revolution.

Fueled by the COVID-19 pandemic and its implications, digitalization has enabled further acceleration in the Maritime sector. The shipping market is highly volatile in supply and demand and dependent on various other factors such as bunker and steel prices this can constrain organization's ability to be agility and flexibility in adapting to change. The implementation of digital tools for improving decision support and shipping optimization constitute the legacy of contemporary shipping digitalization (Lambrou et al., 2019). The subsequent rise in bandwidth on board the vessels can be seen by Inmarsat's own data showing that data consumption per vessel nearly tripled between January 2020 and March 2021, (*A Changed World*, n.d.) illustrating the rapid pace of transforming the vessels to connected assets.

Integrating and exploiting new digital technologies is one of the biggest challenges that companies currently face (Hess as cited by (Tijan et al., 2021)). The failure rate according to 2020 study by the Boston Consulting Group, published by Forbes, has found that 70% of digital transformation project fall short of their goals- even when leadership is assigned. This claim is supported by Jonathan, (2020) stating that the majority of digitalization initiatives fail to produce the anticipated results.

While being a traditionally conservative sector, the industry's posture changed, adapting to the pandemic- induced new "normal", having created a demand for agility and adaptability which are key values for survival in "Digital Darwinism" (Kreutzer & Land, 2014) and value creation. The World Economic Forum estimate 70% of new value creation in the economy over the next decade in digitally enabled platforms (*Why Digitalization Is Our Best Shot at Saving the Planet*, n.d.).

Key processes, such as cargo planning, purchasing, crewing, vessel performance and monitoring have been transformed with the use of digital applications, however, research of different sectors has shown that high risks of technology implementation failure persist (Furjan et al., 2020).

This thesis is exploring Ship and Operational Managers adoption to the changing digital landscape, the use of digital solutions, the impact of its implementation and success factors and barriers in realizing the benefits of digital transformation.

It aims to fill the gap in the research in the maritime sector, providing a short overview of technologies, potential and marketed applications within the sector, and the application, implementation and value created.

These digital solutions are further explored in their application within the maritime industry, and their company specific application and adjustment, as well as their implementation and use on board. The use of digital systems and digitization is intertwined with the use of Industry 4.0 applications, using the data collected in these systems, e.g., to apply analytics such as predictive maintenance, which represents an innovative digital solution which is based on the previous planned maintenance system

This research is presenting an exploratory case study pf three shipping organizations, namely an integrated Shipping company, a ship owning and commercially operating company and a pure Ship Management Company. These organizations represent different architecture, sizes, and resources, as well as different digital maturity.

With each organization in-depth interviews were carried out with top Managers, as well as one on-line questionnaire for on-board users, to provide experience accounts of the implementation and effect of recent system introductions from opposite perspectives.

This exploratory research is defining core determinants  for successful DT providing empirical evidence of the example organizations.

## 1.1 Structure of the Thesis

The Thesis is structured as per the below table

*Table 1 Thesis content Overview*

| Chapter | Title | Content |
|---|---|---|
| **1** | Introduction | Presentation of the research, summarizing background motivation |
| **2** | Background | Provides an overview of literature concerning Digital Transformation, its origin in the 4$^{th}$ industrial revolution, as well as its core technologies and their application in the Shipping sector |
| **3** | Methodology | Presents the case study structure and its participants, as well as the research procedure and the analytical framework and coding |
| **4** | Results | The findings of the Interviews are presented and categorized in Internal Collaboration Systems. The questionnaire results are conferred |
| **5** | Discussion | This section compares literature findings to the findings of the study, and debate Organizational, Technical and Environmental considerations. It further presents its context in DT. Further the method and its limitations are elaborated. |
| **6** | Conclusion and Recommendations | Summarizes the research and key findings, as well as future research possibilities |

# 2 Background

This Literature review will build the foundation of this research to understand the Digital Transformation, its background as well as the technologies used within. It will explore the drivers, barriers and success factors to digital transformation in other sectors, aiming to establish what is transferable to the maritime sector. Further digitalization trends in Shipping are explored and other impacting factors, such as the impeding environmental regulations.

## 2.1 Overview

The background has been structured covering the following topics as per table below.

*Table 2 Background content overview*

| Sub-chapter | Details |
|---|---|
| **Digital Transformation and Industry 4.0** | Definition and explanation of of DT and Industry 4.0 with background |
| **DT in Maritime** | The role of DT in maritime and current trends and environmental compliance, as well as research collaborations and opportunities |
| **Success Factors in DT** | Literature review of barriers, drivers and success factors in corresponding research |
| **Disruptive Digital Technologies** | Short summary of the following technologies: IoT, Cloud Computing , Big Data, AR &VR, Blockchain, Interorganizational and external collaboration systems |
| **Case Studies in DT** | Review of similar literature |
| **Research Gap** | Definition of the research gap and research question |

## 2.2 Digital Transformation & Industry 4.0

Digital Transformation has been a reoccurring buzzword across industries in the recent years describing it as “a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies” (Furjan et al., 2020).

Even though it is often associated with disruptive technologies the term “transformation” expresses a fundamental change within (Teichert, 2019), triggered by external and environmental and technological change. This adaptation to the change experienced is initiated using digital technologies and transforms the Organization in its structure, bringing new business models and business and operating models into service (Gökalp & Martinez, n.d.), which can result in enclosing new market opportunities and directions deviating from the original trade of the company.

While Industry 4.0 is centered around the technological advancement and specific digital technologies, Digital Transformation is the  a process that focuses, along with the technology, on the pre-requisite/enabling environment (Gökalp & Martinez, n.d.).

The term Industry 4.0 stands for the fourth industrial revolution which is defined as a new level of organization and control over the entire value chain of the life cycle (Vaidya et al., 2018) with the focus on technologies as Internet of Things, Smart and Cloud based solutions, Big Data, AI and machine learning, and depending on the literature further technologies like 3D printing, virtual and augmented reality etc.

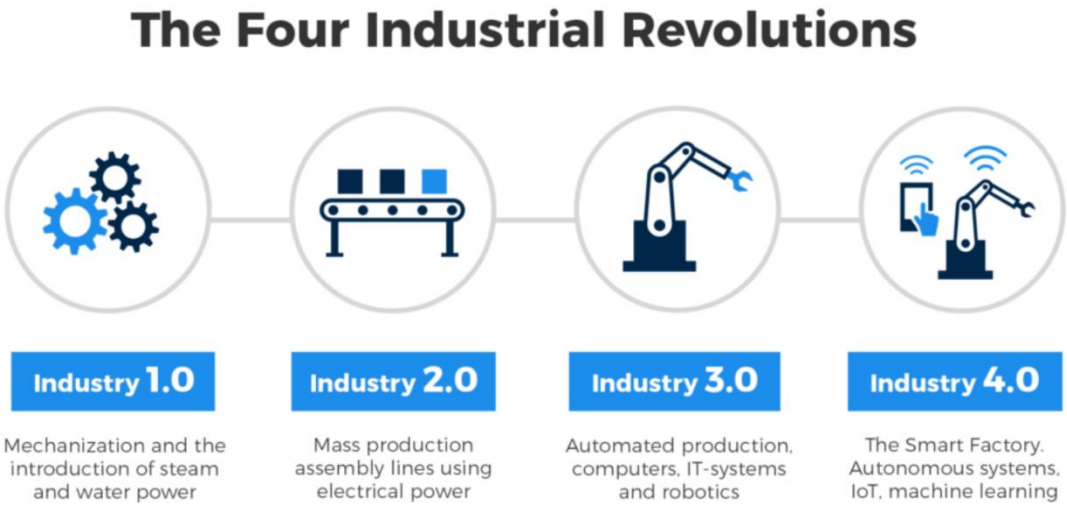



*Figure 1 The four industrial revolutions source: (“Short History of Manufacturing,” 2021)*

The term DX, which is observed as a disruptive technological achievement bringing new business and operating models into the service sector (Gökalp & Martinez, n.d.), thereby converting traditional businesses into corporations able to cope and thrive in conditions of crisis and change, which requires high sustainability, digitalization, resilience and agility (Miceli et al., 2021) and creates strategically resilient businesses.

As in previous industrial revolutions, adaptation to the technologic advance will create benefits with the use of emerging technology and adjust to clients as customer behavior and expectations are changing (Tijan et al., 2021), an example being cargo emissions tracking.

One-fifth of the emission cuts required by 2050 could be delivered by digital technology, according to the world economic forum (*Why Digitalization Is Our Best Shot at Saving the Planet*, n.d.), which further increases the urgency of digital adoption and transformation, due to the enormous cost savings with reduction of consumption and impeding regulatory compliance.

Digital transformation describes the process of an (incremental) change and is described by Berhais and Back (2016) as "the ongoing process to a significantly changing digital landscape in order to meet the digital expectations of customers, employees and partners. This process of adoption has to be actively designed, initiated and executed (Teichert, 2019).

Disruptive technologies are newly emerging technologies with the potential to disrupt businesses and change organizations. A common example from daily life being Netflix as a disruptive innovation replacing major players like blockbuster, due to their online streaming services, or Airbnb, as an online lodging platform, connecting travelers to private lodging possibilities instead of hotels.

However, with new emerging technologies, Gartner has made a graphical representation, the "Hype Cycle" to visualize the development from initial concept to widespread adaption.

An initial innovation Trigger leads to the conceptualization of the technology, which is presented to the market and media, and promoted, leading to widespread hype. This is represented by the steep rise of the graph. Often there is no actual functional technology available at this point.

In the second phase the peak of inflated expectation is reached, as reports of implementations, and realistic experience about failures and successes of this technology are reported.

The expectations rapidly fall towards a trough of disillusionment after the expectations have not been fulfilled. This point is critical, as faults, flaws, bugs etc. might lead to the technology to be abandoned at this point.

If the technology is further developing and adopted, its realistic value is starting to let expectations rise again steadily, as the technology improves and  is adopted within more users. The plateau of productivity represents the wide adoption of the technology, with realistic expectations and good understanding.

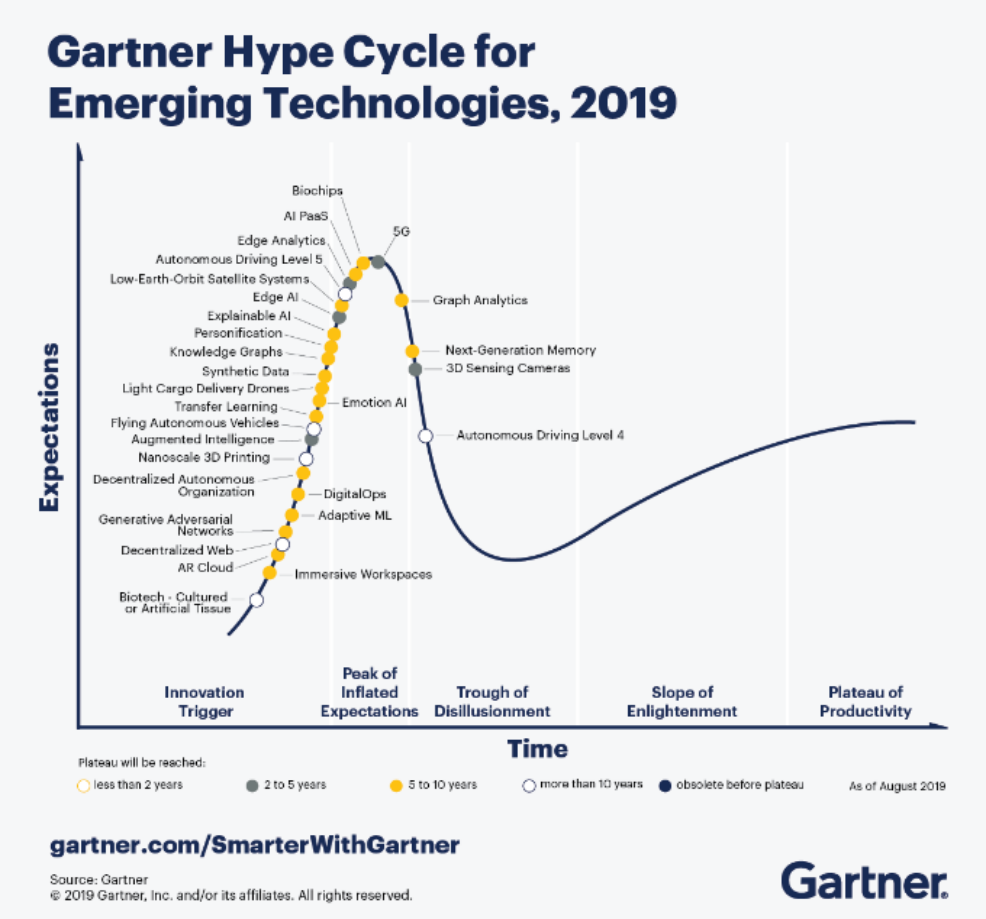



*Figure 2 Gartner's Hype Cycle of emerging technologies 2019*

## 2.3 Digital Transformation in the Maritime Industry

The maritime transport industry is responsible for around 90% of world trade. Vessels are considered as high value assets of which the operational costs are highly volatile, and dependent on market, bunker prices, port congestions, and other factors e.g., like unprecedented COVID-19 related disruption in supply-chain. UNAD's Maritime Transport report 2021 reports the acceleration of technologies such as advanced analytics, on-board sensors, communication technology, port-call optimization, blockchain, big data and autonomous ships and vehicles use to reduce physical contact. This acceleration is expected to continue towards smart, resilient and sustainable maritime operations (LOGISTICS, 2022).

Figure 3 is an excerpt of deployed and tested digital technologies according to Inmarsat's 2020 study. Fleet and vessel performance is the majority of applications deployed, which is confirmed by the SET Maritime toolkit, a software evaluation toolkit is comparing a total of 550 software vendors as the market in digital products for the maritime sector has exploded in the recent years. (*GO for SET Maritime Toolkit to Tackle Shipping's Software Selection Challenge*, n.d.).

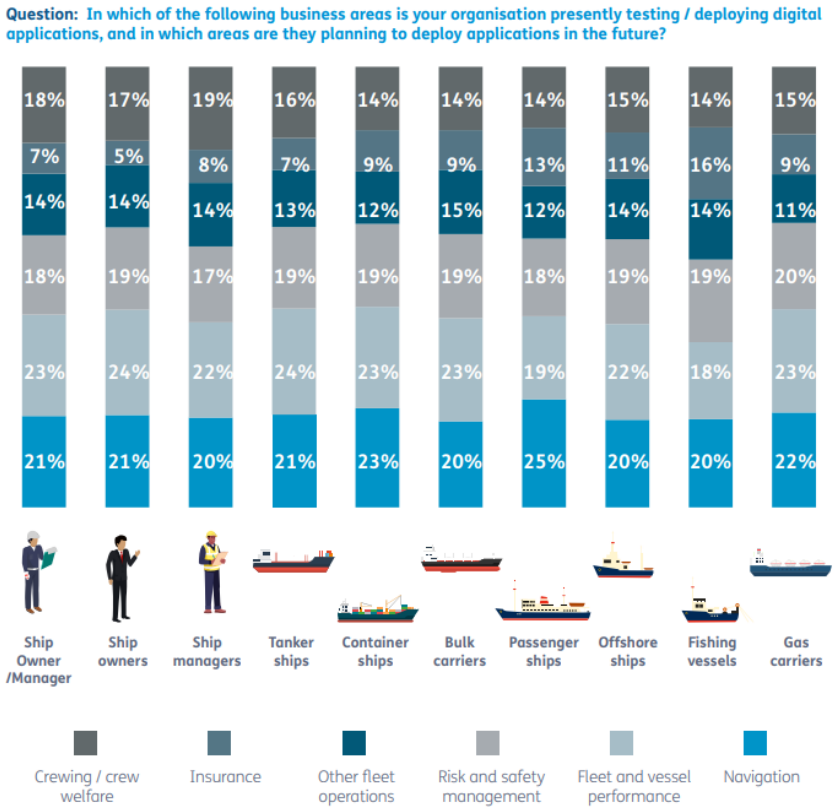



*Figure 3 Digital Applications deployed/tested, by area source: Inmarsat-Digitalization Uncovered*

Many initiatives within the maritime are concentrating on digitization, thereby converting the analog information into bits. An example is the digital logbook, or use of tablets which can increase efficiency, and reduce error rate. Digitization does not change the overall business strategy, whereas digitalization has a holistic dimension (…), based on three mutually interconnected and occurring elements together: computerization, informatization and networking (WSB University in Poznań, Institute of Finance and Accounting & Caputa, 2017).

With the volatility and dependency on bunker prices, insurance and other OPEX costs have seen 2020 the fastest pace in over a decade (*Initial IMO GHG Strategy*, n.d.) a rapid increase of operating costs of ( *Hellenic Shipping News Worldwide*, n.d.) due to rising bunker prices, competitive port bookings, and rising OPEX, making control of KPIs critical. Data quality, validity and transparency of processes build the foundation for the analytical evaluation, and applications and invaluable decision support information.

The information Systems community has recognized Maritime Informatics at Americas Information Systems and European information Systems Conference, and although rising academic research activity, is still at an early stage (Agrifoglio et al., 2017). The focus on Ship and Operational Management and its process of integrating DT is under-documented, research works are found within logistics, supply chains and port efficiency.

As the vessels are continuing to get more connected, and operations depend on functional IT in all aspects of operations, from navigation to machinery control systems the aspect of cyber security is highlighted here. This important aspect is further starting to get integrated into the Maritime's regulatory context(Kechagias et al., 2022). By transferring core business to connected systems and increasing the dependency towards these, the vulnerability to Cyber-threats has increased. This is documented in Allianz reports on Shipping Review 2020, which reports that since Corona the maritime sector faced an increase of 400% in attempted cyber-attacks.(Kechagias et al., 2022).

### 2.3.1 Environmental Compliance

Another influencing factor is the IMO's adoption of the GHG emission strategy 2018, making measures to reduce emissions mandatory with the target to reduce CO2 emissions with 40% by 2030 and 70% by 2050 compared to 2008. The measures how to achieve the targets are described in an approved Energy Efficiency Management Plan (SEEMP). The progressively reduced emissions are set by tonnage and ships type and regulate new builds as well as existing vessels) and are described by the Energy Efficiency Design Index (EEDI) for new vessels and Energy Efficiency Existing Ship Index (EEXI). Short term measures such as speed reduction are part of the SEEMP referring to speed optimization, however belong to the short-term measures (*Initial IMO GHG Strategy*, n.d.).

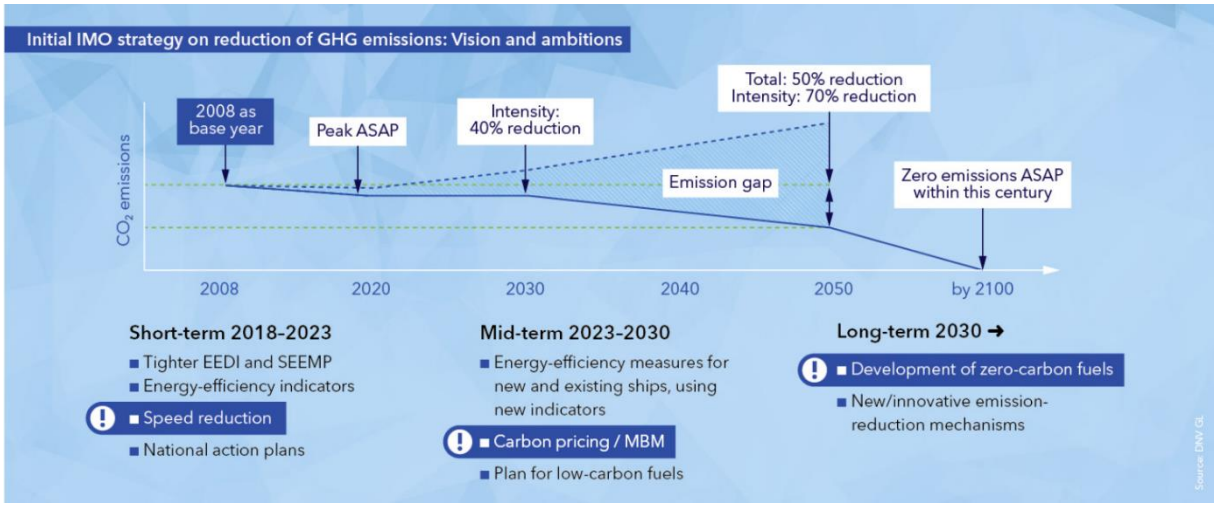



*Figure 4 IMO's GHG strategy on reduction of GHG emissions (source: DNV)*

From 2023 the Carbon Intensity Indicator (CII) will be introduced, measuring the ship efficiency per cargo-carrying capacity and nautical mile. Ratings from A to E are assigned, indicating major superior, minor superior, moderate, minor inferior, or inferior performance levels. D or E-rated ships have to submit a corrective action plan to show how C rating or above are aimed to be achieved (*Initial IMO GHG Strategy*, n.d.).

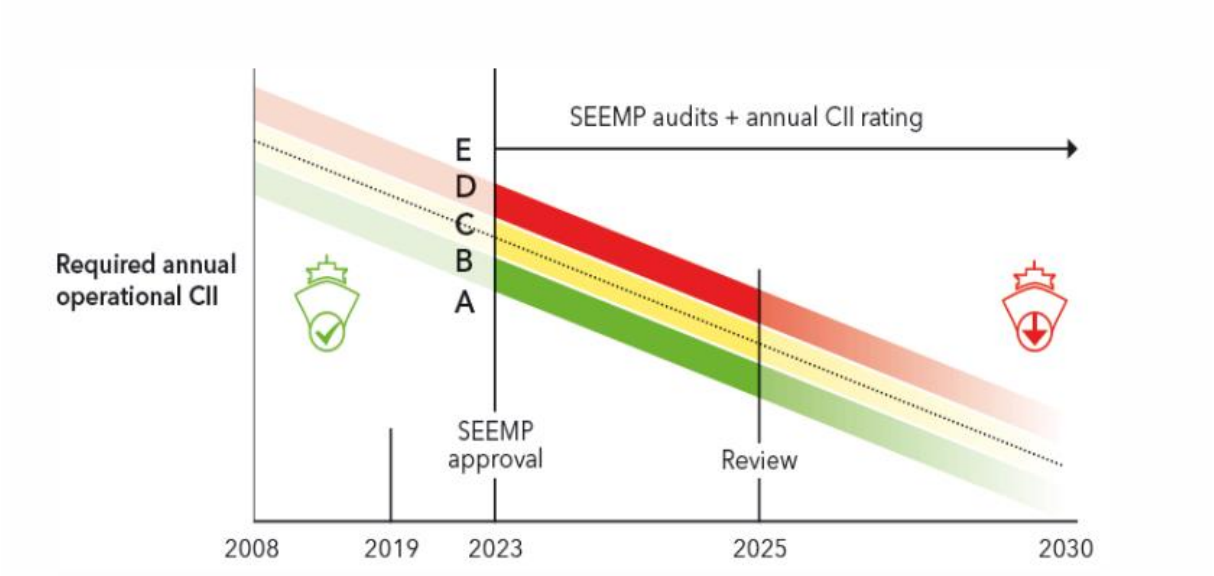



*Figure 5 CII ratings and continuous improvement (source: DNV)*

The CII therefore determines the annual reduction factor, to ensure the continuous improvement of the ships operational carbon intensity within a specific level(*Initial IMO GHG Strategy*, n.d.).

These changes in the regulatory landscape of maritime operations are enforcing sustainability measures to reduce emission and future compliance and have created a collective awareness and requirement of sustainable innovations. These are targeting a combination of the following:

- Speed reduction
- Optimization of operations and logistics
- Implementation of energy efficiency technologies
- Use of alternative fuels (*Initial IMO GHG Strategy*, n.d.)

Digitalization is crucial in order to reduce the environmental impact and ensure sustainable operations according to IMO's short and long term goals ("The Digital Revolution in the Maritime Industry," n.d.). The engagement and use of digital solutions is confirmed by Inmarsat's study in 2020 shipping carried out by Informa Engage, with 368 participants around the sector (*Research Program - Digitalization Uncovered*, n.d.). It shows utilization of a wide range of features for successful fleet and performance management in maritime. It reports that the primary drivers for digitalization are cost reduction and operational efficiency (71%) followed by regulatory compliance (60%). The immediacy of impeding change is confirmed as 83% of the participants are planning to deploy fleet and vessel performance solutions targeting fuel optimization within 24 months.

Examples of the initiatives are Jotun's Hull Performance Solutions, using big data and a fouling risk algorithm to make the vessels fouling control more efficient and predictable, to reduce the vessels water-drag.

A further influencing factor in reaching sustainability, as well as connectivity and DT is the World fleet age, which shows an aging world fleet of which 40% is over 25 years old (Equasis, Ricardo, 2020)

This implies that the systems and original equipment and layout might not be compatible with certain modern solutions. Examples of that are available data tags and sources which as seen on the example of Organization A's vessels have more than doubled within the last decades.

**Table 3 - Total number of ships, by age and size**

| Ship age category | Small[1] | | Medium[2] | | Large[3] | | Very Large[4] | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0-4 years old | 4,072 | 6.9% | 4,476 | 9.5% | 1,976 | 15.5% | 1,483 | 21.9% | 12,007 | 9.6% |
| 5-14 years old | 13,029 | 22.2% | 16,099 | 34.2% | 7,037 | 55.3% | 3,743 | 55.2% | 39,908 | 31.9% |
| 15-24 years old | 9,723 | 16.6% | 8,697 | 18.5% | 3,137 | 24.7% | 1,381 | 20.4% | 22,938 | 18.3% |
| +25 years old | 31,822 | 54.3% | 17,860 | 37.9% | 564 | 4.4% | 172 | 2.5% | 50,418 | 40.2% |
| **Total** | **58,646** | **100%** | **47,132** | **100%** | **12,714** | **100%** | **6,779** | **100%** | **125,271** | **100%** |

**Source:** Equasis [1] GT<500 - [2] 500≤GT<25.000 - [3] 25.000≤GT<60.000 - [4] GT≥60.000

*Figure 6 world fleet age-overview Source equasis*

### 2.3.2 Research Collaborations.

Regional and global collaborations between shipping companies allow exchange of experience and research. An example for the area Bergen, Norway is SINTEF's ongoing research about Smart Maritime focusing on improving energy efficiency and reduction of emissions in the maritime sector (*Smart Maritime*, n.d.) and Maritime Bergen, representing regional maritime businesses in politics and providing a platform for its members. A current initiative of Maritime Bergen focuses on a digitalized maritime industry providing workshops and cross-company data sharing.

These collaborations are local examples of research, projects, and exchanges, which enable smaller companies with limited IT and research capabilities to benefit of the shared knowledge and expertise of research institutions and industry partners.

## 2.4 Success factors for Digital Transformation

The aim of all organization employing DT, is the successful realization of the project, therefore, meeting the initially set aims. However, measurement of success of aims achieved is difficult to quantify. Several researchers (Lambrou et al., 2019), (Tijan et al., 2021), have approached this challenge by analyzing drivers, barriers and success factors resulting in an overarching framework of determinant factors (practices) (Lambrou et al., 2019).

Drivers for DT, which are perceived or expected business advantages resulting from embedded digital technology in shipping operations, smart shipping systems or new business models (Lambrou et al., 2019).

An excerpt of drivers are as follows:

- Improved efficiency and productivity
- Access to new markets
- Optimized supply chain
- Organizational agility(Jonathan, 2020)
- Need for compliance (Furjan et al., 2020),
- Increase profit, cost reduction (Corejova et al., 2016)
- Customer focus and expectations (Lambrou et al., 2019)

Competetive edge(Gökalp & Martinez, n.d.)

- Sustainability (Florek-Paszkowska et al., 2021)
- Radical innovation (Lambrou et al., 2019)
- Energy consumption and environmental compliance Nambisan as cited by (Lambrou et al., 2019)
- Streamlining operations
- New and emerging technologies
- Processing large amounts of data (Tijan et al., 2021)

**Table 2** Drivers of Shipping Digitalization vis-à-vis Digital Transformation Rational

| Digitalization Drivers | Digital Transformation Logic |
|---|---|
| Process improvements | Smart shipping systems automate via self-management properties the planning, and actual operation of technical, commercial and support functions of shipping. Main perceived advantages are further improvement related with safety, and shippers and business partners' process synchronization. Respective digital solutions are: condition-based ship systems monitoring, self-adjustment of ship operations and real time cargo monitoring.<br>Autonomous ship technologies and functions, such as autonomous navigation, collision avoidance and berthing functions will further improve safety and business performance. Complex or risk entailing activities can be performed by autonomous vessels and automated ports infrastructures. |
| Cost Efficiency | Digitalization improves cost–efficiency in terms of a number of digital solutions: more accurate energy (fuel) consumption monitoring, emissions monitoring, crew cost optimization, digital twin platforms for integrated ship design and operation, predictive maintenance and safer ship operations with various levels of autonomy, also cargo monitoring. |
| Customer and Business Partners Expectations | The traceability of freight throughout the shipping and maritime transport process, aligned with the whole supply chain and production processes is essential for the quality levels demanded by end customers. Shipping business is gradually aligning with this business model enabled by digitalization. |
| Data Monetization Models | New business models arise form datafication. Based on historical, real time, big and small data sets and advances in database, cloud and visualization technology but foremost computational techniques, maritime organizations may develop data platforms and data analytics based services and solutions to satisfy old and new strategic objectives and business models. |
| Radical Innovations | (i) Autonomous ships and (ii) blockchains are two radical innovations for the shipping industry. New knowledge, new market structures but also new sources of value are designed, tested and appropriated by competent actors. Incumbent, leading companies are involved in "edge exploration" in both these radical innovation fronts to secure an early mover position and control/ leverage related markets. |
| Market pressure | Competitors already use digital shipping technologies. It is imperative to secure a competitive advantage with digital technology and not lag behind the market standards. |
| Innovation Push | Innovative digital shipping systems create a dominant technology push force, and market competition, both enabling digital transformation. Shipping companies and maritime organizations recursively determine the particular models and practices to generate value. |
| Institutions | Industry associations, regulatory and standards organizations and related industry institutions play a role in setting norms, business and technical standards of digitalization, acting as exogenous factors. |

*Figure 7 excerpt of Lambrous summary of driving Factors of DT*

An excerpt of barriers of success in DT of companies and realization of DT projects are:

- High implementation costs (Tijan et al., 2021)
- Projects not managed and scaled with standardized systematic approach
- Competency barrier
- Capital
- Drive for continuation and development (WSB University in Poznań, Institute of Finance and Accounting & Caputa, 2017)
- Business culture
- Digital Leadership
- Company's vision
- Business model and strategies(Florek-Paszkowska et al., 2021)
- Organizational- lack of awareness
- Tech-oriented culture

Success factors are have been defined in the paper "Digital transformation in the maritime sector"(Tijan et al., 2021), which reviewed and categorized success factors, barriers and drivers for DT in the maritime transport sector from a total of 139 sources, creating a . Success factors according to (Tijan et al., 2021) are:

- New business models
- Actively shaping future strategies
- New and dynamic capabilities
- Organizational agility
- Organization a willingness to take risks and make decisions under uncertainty
- Technology acceptance, employee cooperation
- Creation of digital leadership roles
- Communication within the organization
- Cross-functional collaboration, between different functional areas
- Digital security and compliance
- New technologies embedded in aligned business strategies and processes
- Compatibility and integration between platforms
- Development of business process connectivity and standards
- Mutual trust between organization, leadership, members and external
- Understanding stakeholder needs and expectation
- Inter-organizational data and knowledge exchange

## 2.5 Disruptive Digital technologies

Digital transformation is inherently associated with disruptive technologies, as the implementation significantly alters the way consumers, industries or businesses operate (*What Is Disruptive Technology?*, n.d.).

### 2.5.1 Internet of Things (IoT)

IoT technology is based on sensors, actuators and processors embedded in vessels' technical systems, namely engines, communications and data fusion systems, propellers or cargo systems (Levander (2017 as quoted by (Morakanyane et al., 2020.) These technologies are interconnected via embedded software and include processing layers as well as automations, therefore are transformed from conventional to "smart", by sensing, communicating and processing the information received (Aslam et al., 2020). In the shipping section IoTs, are also referred to as Internet-of-Ships (IoS).

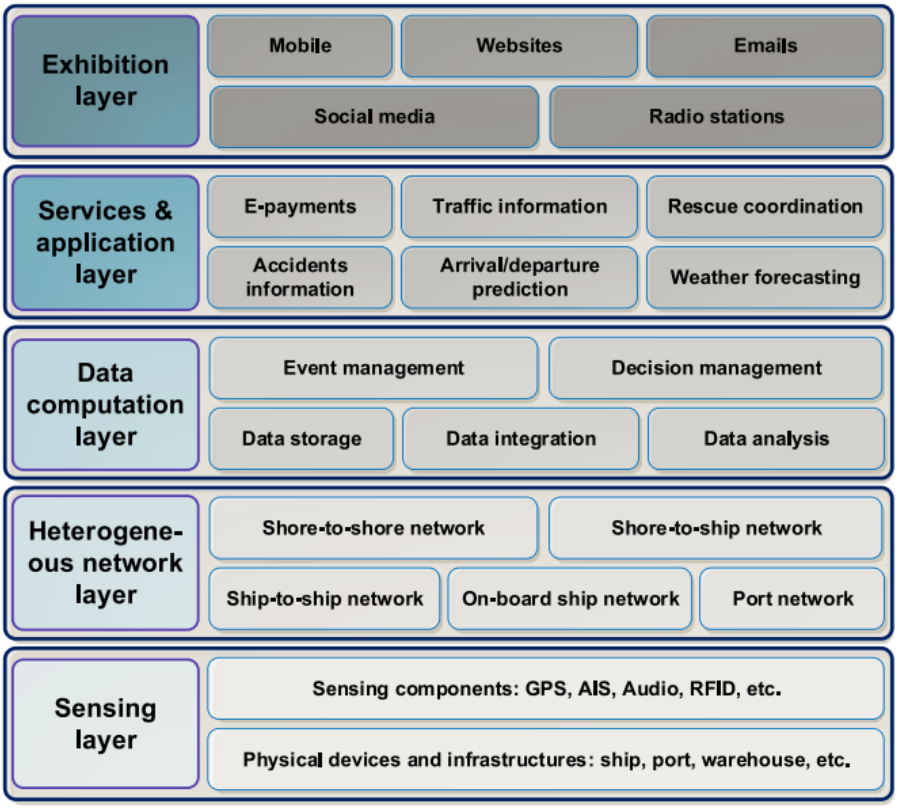



*Figure 8 Overall architecture of IoS source: Aslam et al*

The main strength of the IoT applications is the high impact on several aspects of everyday-life of potential private and business users (Atzori, Iera, and Morabito 2010 as cited by(Agrifoglio et al., 2017)). Similarly, there are several emerging applications of IoS within different aspects of the Maritime Industry building the foundation of semi and fully autonomous ships. Limiting factors of the use of the technology are reliability of connection, as vessels are still subject to loss of connection due to weather, further, the high costs for bandwidth via satellite connection is a further limiting factor.

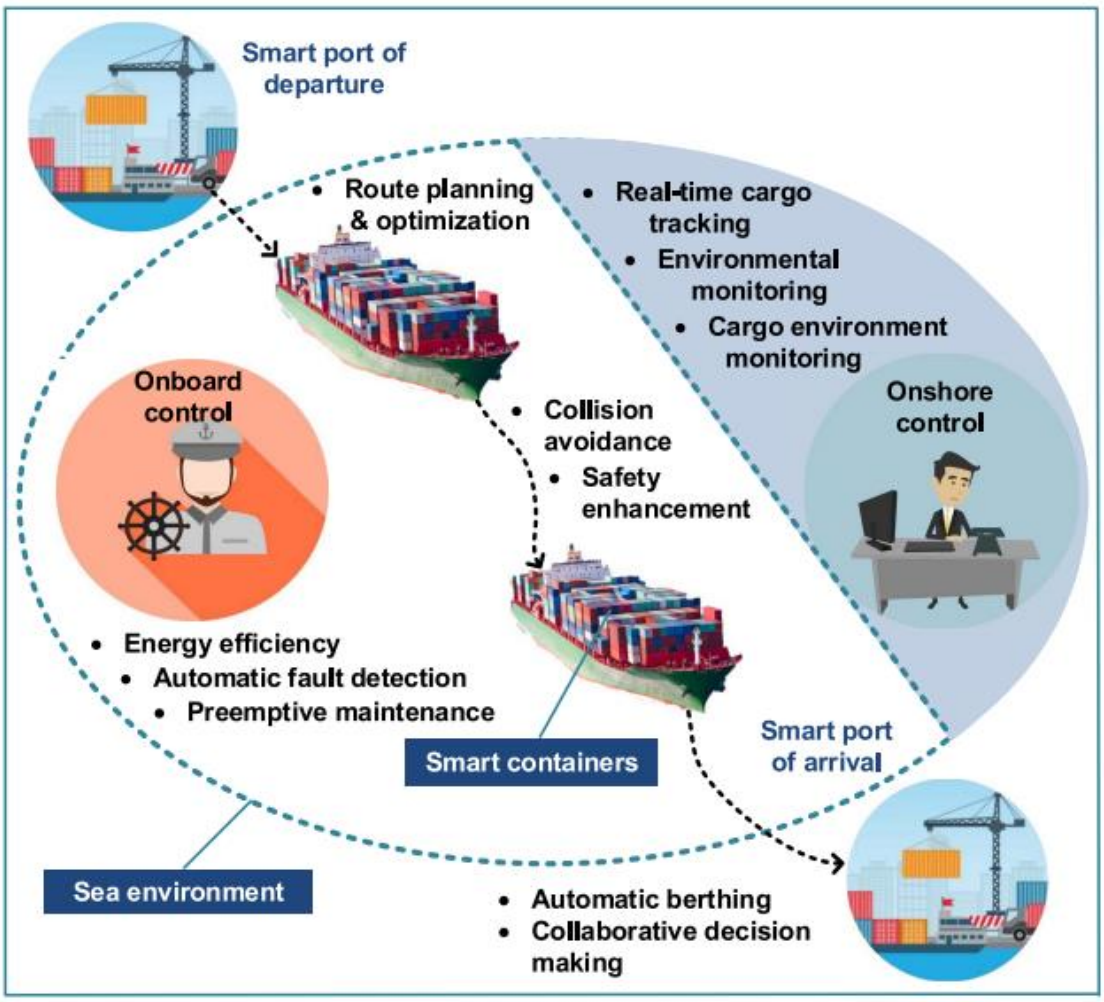



*Figure 9 Key emerging applications of IoS source: Aslam et al.*

### 2.5.2 Cloud Computing

With growing data volumes and the requirement of processing, analysis, and storage of such homogenous volume of data, cloud computing provides a cheap source of the required computing framework (Sen, 2017). It provides on-demand, scalable, device independent, and reliable service, at affordable costs.

### 2.5.3 Big Data

The appearance of the term “Big Data” dates back to the early 2000 due to the explosion in quantity of available and potentially relevant data as a result of the unprecedented advancements in data recording and storage technology, Diebold F as cited in (Favaretto et al., 2020).

These large amounts of data are produced by different sources, examples being manual human input, sensor data and machinery.

On modern vessels most machinery is supplying near continuous data, an example is a new built sophisticated vessel of Organization A with a total of 10.011 sensor tags. However, many of the data streams are confined within their data silos, requiring several interfaces between applications, or a liberation of data within a data lake.

### 2.5.4 Augmented and Virtual Reality

Augmented Reality (AR) is the enhancement of reality with information, which especially in navigation can dramatically increase the bridge team’s situational awareness and closes the gap towards autonomous vessels monitoring. The information can be displayed for example with AR glasses (Laera et al., 2021) or projected.

*Figure 10 Rolls Royce Virtual oX Bridge Concept*

### 2.5.5 Blockchain

IBM defines: "Blockchain is a shared, immutable ledger that facilitates the process of recording transactions and tracking assets in a business network"(*What Is Blockchain Technology?*, n.d.) Shipping involves a complex network of 3rd parties as Port Authorities, customers, charterers etc., accumulating a large amount of documents. Blockchain provides secure data sharing between parties currently used for cargo tracking practices, an example being Maersk using Blockchain technology to track container locations, and conditions via their TradeLense Platform (n.d.).

Further applications are within document management and include a variety of paperwork, such as bills of lading, ,purchase orders, invoices, certificates etc. (Yang, 2019).

### 2.5.6 Interorganizational information Systems (IOS)

The logistical chain in Maritime transport includes several parties requiring intensive coordination. The timely, cost efficient and accurate information flows are of outstanding importance as they can be realized through inter-organizational information systems (IOS).

Interorganizational databases is another IOS possibility as with use of big data from across organizations could provide benefit to several. An example is the proposal of an Energy Efficiency Network, with the scope of sharing information on ship performance to define the impact of specific measures to improve energy efficiency within a network of shipowners (Borg & von Knorring, 2019). Another application

example is Q88, a tanker information management system (SaaS), adopted by 75% of the global maritime industry. It is a centralized data-lake, combining vessel specification, document management and compliance, with an automated questionnaire completion of all major chemical and oil related questionnaires, thereby creating an enormous time saving effect for customer requests. It also contains its own Analytics tools, benchmarking vetting performance.

### 2.5.7 Internal Collaboration Systems

Internal Collaboration Systems enhance the inter-departmental data exchange, as well as improving work processes, by the application of a shared data system. Different layers, or clients, provide the required content to the user. It improves data quality, due to the share data lake.

#### *2.5.7.1 Enterprise Asset Management System*

The Fleet Management System, also referred to as Enterprise Assent Management System, contains core business processes and assets. It is a combination of software, systems and services used to maintain and control operational assets and equipment and is used to optimize the quality and utilization of assets throughout their lifecycle, increase productive uptime and reduce operational costs (*What Is Enterprise Asset Management (EAM)?*, n.d.).

For maritime Managers it is therefore a critical system often incorporating several modules such as safety reporting, purchasing, and planned maintenance (PMS) and document sharing module.

A major consideration for Ship Managers is the product selection and choice. Several large providers specialized within the Maritime sector as for example DNV's offer "off the shelf" solutions as e.g., DNV's Ship manager program consisting of a traditional server based modular solution including Planned Maintenance System (PMS), Procurement, QHSE, crew Management, Hull integrity, dry docking, and analytics. The consideration between investment, development capacities between solutions and flexibility of the programs, define the end product.

Organization A used an Enterprise Asset Management System (EAM) Star IPS, specialized for the shipping sector, which was implemented about 20 years ago, and covered Maintenance and Material Management. It included an incident reporting System, Purchasing System, Maintenance System, as well as document storage. It was server based, relying on the replication of the local database e.g., 2 times a day. The structure was similar to a file system and provided an overview and reports of each vessel. Several modules have been developed and adjusted to the Organizations needs but is based on the original manufacturer's layout. For implementations of adjustments, on board service was required, which for the last adjustment performed took 18 months to complete for the fleet.

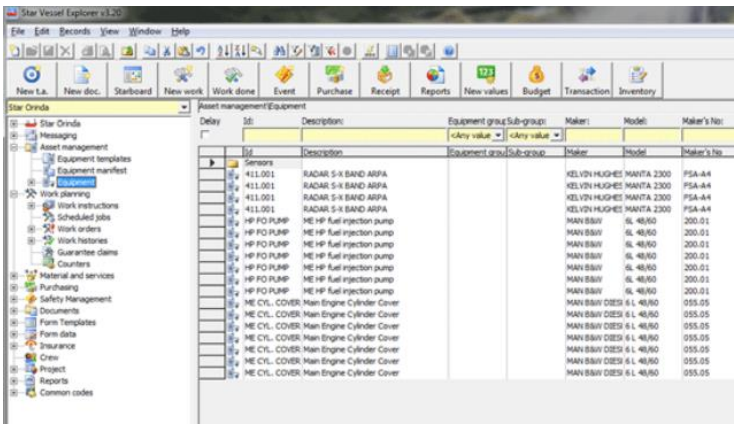
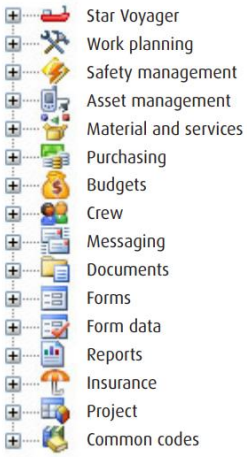


*Figure 11 The old Fleet Management Software Star IPS*




The structure was SFI-based splitting the vessels into main categories with multiple sub-categories. Main users on board such as Master, Chief Engineer, Chief Officer had access levels to add to the SFI structure for stocks control and add maintenance tasks.

Corrective work orders following findings of vetting's or audits were usually initiated by email and inserted locally ono board by the Chief Engineers, resulting in a vessel specific structure, parts, and maintenance descriptions/plans.

The new Fleet Management System (FMS) of Organization A replaced this system with a multi-tenant, cloud-based Enterprise Asset Management Solution (EAM), which tracks assets, maintenance plans and programs, safety management, procurement management, and stock control.

It is integrated with the Crewing Management System, as well as "Ship SERV" within procurement module, an extensive e-trading platform connecting to thousands of verified suppliers of marine assets (*About Us | ShipServ*, n.d.). Further it is interfaced with a Document Management System.

#### 2.5.7.2 Cloud based Cargo System

The cargo stowage system is powered by a data portal, which has been tailored to Organization A's vessels, cargo and equipment. It unifies a stowage tool for port, cargo and sea events. It is further connected to cargo tools and linked to port information. The first launch was in 2013 as a server-based system and web-based launch has been completed in the first quarter 2022. It interfaces with the vessel's stability program and cargo specifications. Users of this system include vessel crew, operators and brokers, internal port-operators, thereby simplifying the data exchange between these parties considerably, while integrated rules alert in case of a breach of vessels regulatory capabilities.

#### 2.5.7.3 Vessel reporting system

This system was developed by Organization B and adopted by Organization C. It includes basic vessel information, such as route, position and logging of port, sea, and cargo events. It is like the "traditional" noon report and includes detailed consumption data of the consumers. It further includes Voyage administration details, such as expenses, income, freights, demurrage etc. and is comparable in its function to Organization A's Cloud based Cargo System. The difference being that the base of the VRS system was the noon report and vessel performance monitoring, while Organization A's system developed from a cargo stowage system.

### 2.5.8 Digital Management and Leadership

The introduction of new Digital Technologies and the transition of towards a digital company requires a cultural change within the Organization, as well as dynamic tools to support themselves in managing the new types of digital innovation processes that emerge (Nylén & Holmström, 2015). Properties of the Systems and their effect business processes; however a four-year MIT study of Gerald Kane reveals companies must focus on talent and business issues-not on technology- to adapt and compete in the digital age. "The most successful digital transformations start with a shift in mindset at the employee, leadership, and organization levels. This shift produces a culture change that allows the company to be more agile, risk tolerant, experimental, and collaborative"(Kane et al., 2019).

"Agility and resilience are among the most important and needed features for future challenges, business continuity and their leaders post-pandemic" Nasser states as quoted by (Florek-Paszkowska et al., 2021). These values and characteristics have gained substantial significance and catalyzed change for the maritime industry in responding to rapid changes such as the Pandemic related limitations enabling remote operation, communication, remote service, and emergency response.

This ability to bounce back or adopt to rapid changes requires an agile structure of the company and enablers like information processing, communication, collaboration and networking(Miceli et al., 2021) to adjust strategies, and develop new options, as well as reconfigure resources.

Strategic embeddedness and digital leadership are determinants of Digitalization (Lambrou et al., 2019), as driving the company's strategy and inspiring a digital mindset within the company, creating lasting change in the company's culture.

This digital leadership of Management is not only to have skills in the Digital Transformation, but also to be capable of leading employees towards it(Furjan et al., 2020). Structurally the organization must be able to give up old hierarchies and develop an organizational structure around self-organizing teams that have autonomy to respond to disruption (Gobble, 2018).

The maritime sector is underrepresented in DT research.  Logistical chains in the maritime sector have been represented in Case studies such as by (Carlan et al., 2018), which conducted a case study of 15 cases in Northwestern Europe studying digital innovations and developments targeted to improve connectivity and performance in maritime supply chains. It focuses on topics, such as traceability, cargo flow, use of blockchain for documentation and innovations for cargo flow.

The Digital Management and IT strategies are element to the progress of the Digital Transformation in the organization. Even though a multitude of research articles, models of DX have been published and enriched the discussion with new angles for value creation and digital value proposition as well as data monetization (Lambrou et al., 2019) A practical example of successful DT is Stena Bulk, which developed a cloud solution, "Orbit" in 2016 in order to reduce the companies dependency on brokers, and liberating data for data collaboration ("Breaking the Silos," 2021)providing operational and commercial data while being integrated in the company's core systems, such as the financial system. It includes Fleet and Performance

Management, emissions calculators and reporting functions, as well as advanced analytic functions

The platform created by Stena, was so successful, that it has been launched as an independent company, Orbit MI, selling their product as a Software-as-a-Service (SaaS) to other organizations. This is a good example of the core of DT, as Stenas progressive contribution, is embracing new digital

technologies and realizing significant change within the company while expanding their business to new areas.

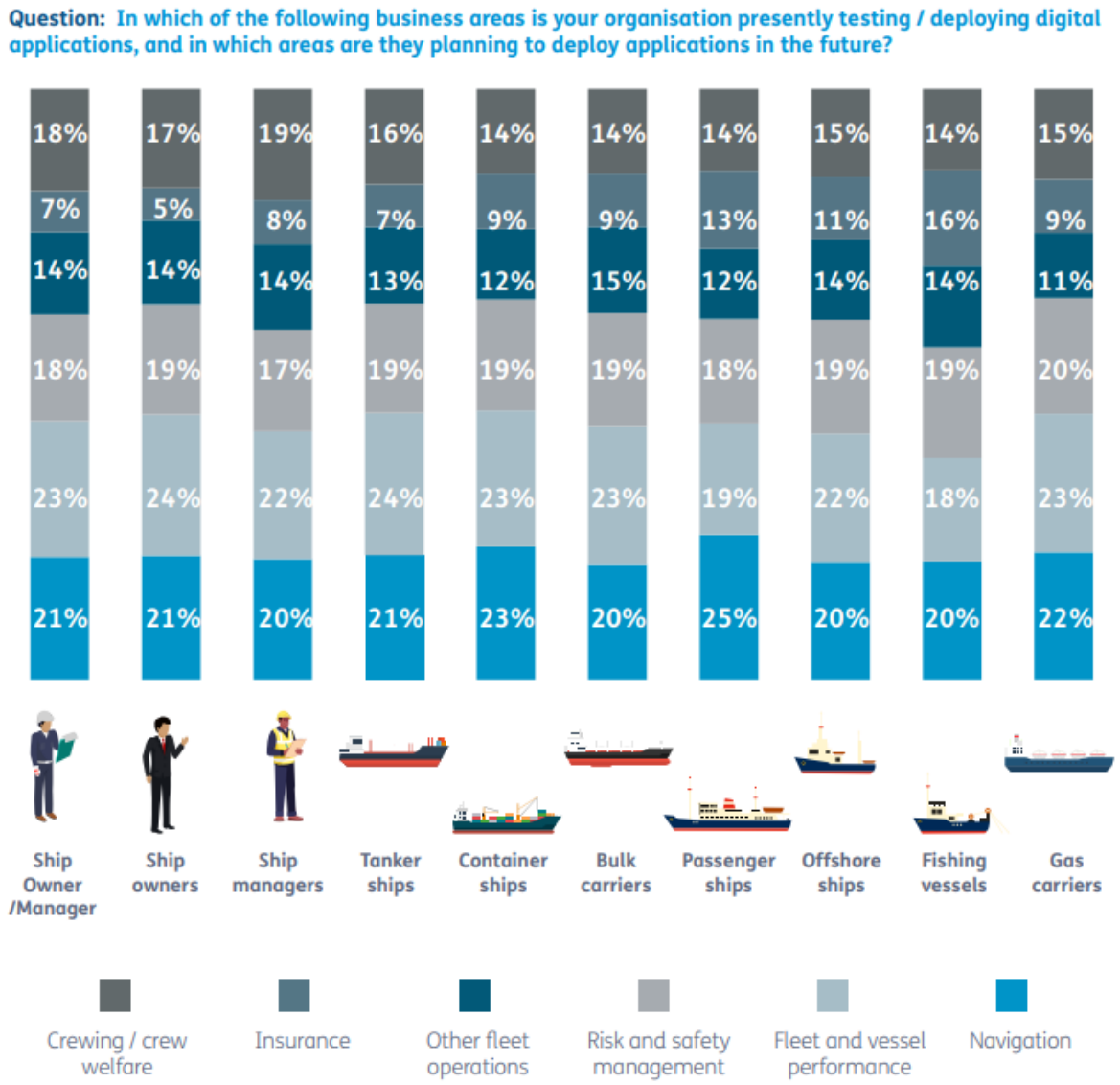



*Figure 12 Digital Applications deployed/tested, by area source: Inmarsat-Digitalization Uncovered*

## 2.6 Case Studies in Digital Transformation

No case studies within the same sector specification, Maritime Ship Management, could be located in this literature review, however (Carlan et al., 2018) is exploring 15 digital innovation cases from Northwest Europe within the Maritime Supply Chain.

Further research focusing on the Digital Transformation process and strategy, as of (Acciaro & Sys, 2020) have used index-based approach using data collected for 59 innovation cases to capture the degree of alignment between innovation strategy and outcomes, with the finding that "little is known of the processes and mechanisms that make innovation successful, with the result that initiatives are often uncoordinated, unfocused, poorly managed, and do not deliver the expected results."

This result is well represented in the literature review of 139 sources performed by (Tijan et al., 2021), who is reviewing of drivers, success factors and barriers to the DT in the maritime sector.

## 2.7 Research Gap

Shipping carries a conservative connotation, as a traditional business, and behind on the digital developments compared to other industries. A large research gap compared to other sectors is found concerning papers on topics connected to Digital Transformation and its technologies "A paradox related to maritime is the lack of digitalization in today's digital age compared to other spheres of human lives and business activities" (Kapidani et al., 2020).

The integration of new digital system and technologies and the consequent Digital Transformation has been subject of several researchers.

Several Case Studies with this topics((e.g. Eremina et al., 2019),(Urbinati et al., 2020)) have been reviewed, however no research was found focusing specifically on Shipping companies and their Digital transformation cases. While several research projects include logistical chains, and port operation, the Shipmanagement/operation presents a research gap, which is aimed to be reduced by this work. The scope is defined as an exploratory multiple case study due to the various technologies used in three organizations. It allows the researcher to investigate the digital maturity, technologies used, their implementation and created value.

## 2.8 Research Question

Based on the identified research gap the main research question is focusing on the Digital Transformation of the Organizations, triggered by the introduction of digital systems.

“How is Digital Transformation successfully realized in Ship and Operational Management?”

### 2.8.1 Sub Questions

What impact did the introduction of recent technologies have on the organization?

How can the introduced technologies deliver the value and benefits imagined?

What considerations must be taken to achieve maximum utilization of the systems?

# 3 Methodology

## 3.1 Introduction

This research is a qualitative exploratory case-study, which allows an in-depth explanation of the social behavior (Zainal, 2007), exploring the digital journey of the organizations and their technologies from planning to implementation and effect on the organization in its digital transformation.

The qualitative method is chosen to understand several layers of the organization, from strategic and technical considerations, organizational structure to the human element and the cultural approach towards the technologies from various perspectives.

Due to the complex, multi-perspective topic of Digital Transformation covering a multitude of technologies the case study has been chosen to provide in depth views, and perceptions of the interviewees, intending to understand the organizations digital maturity, as well as process and value, barriers and drivers of the digital technologies introduced. The case study method provides a holistic multi-perspective in depth understanding to the perception and use of these technologies within the organizations from the viewpoint of the interviewees.

The format followed for this research categorizes according to Yin(1984) as cited by (Zainal, 2007),as an exploratory case study exploring the phenomenon of Digital transformation in in three Organizations operating, managing and owning vessels. It uses general, semi-structured questions in the interview questionnaire to capture answers in the interviewees own words to provide rich and varied data.

The qualitative exploratory case study allows the exploration of the challenges in realizing digital transformation in the organizations. Several surveys report that company culture is considered as the number one hurdle to digital transformation(Teichert, 2019), therefore, in depth interviews with several persons are the main research tool exploring their experience, opinions and expertise of their field. to explore the barriers, and opportunities during implementation of a new digital systems.

As the digital transformation is an ongoing process of adoption to a significantly changing landscape, which requires active input (Berghaus & Back, 2016) the method chosen allows a closer look towards the digital adoption of the cases in the study, focusing on the perspective of top Management, as well as a counter perspective, provided by the end and main users on board.

While the interviews with Managers, were carried out in personal face to face interviews, end users on board of Organization A, were participating via an online questionnaire consisting of mainly open-ended questions, to represent both perspectives in this study.

## 3.2 The organizations

The selection of participating companies was limited to three cases, due to the limited time frame of the study.

To provide different perspectives the three cases chosen to represent a fully integrated company, ship owner and commercial operator and a pure ship management company. Fleet sizes vary from around 15 to around 80 vessels. A further large contrast is found in their digital maturity, IT and innovation capacities, connected to size and available investment.

The main focus of the case study was on Organization A, as the researcher had access to several departments, managers, as well as the fleet and vessel crew itself. The organization itself was chosen, due to its large size and its reputation for technological excellence, organizational agility, as well as its focus on sustainability. It is a fully integrated ship owning, operating and management company, which has in-house technical, commercial Management and crewing, as well as hosting a technology department and IT department with development capabilities.

| ***Organization*** | **Fleet** | **Scope** |
|---|---|---|
| *Organization A* | A total of 80+ owned and pooled, chartered and leased vessels | Integrated Ship and Operational Management |
| *Organization B* | 15+ vessels | Ship Owner, Commercial Manager |
| *Organization C* | 15- vessels managed locally. 700+ total | Ship Manager for Organization B in local office, which is part of a larger cooperation managing several hundreds of vessels |

Organization B is a ship-owner which commercially operates 16 vessels, with partly outsourced IT department and limited in-house research capacity, due to the size of the company. Due to strategic reduction of fleet size in the recent years Ship Management has been outsourced. Organization B has been a chosen as a commercial manager, thereby leaving the focus of Organization B on the operational and commercial considerations, with a high importance of communication between external technical Managers.

Organization C is a leading provider of technical and digital asset management in the offshore and maritime industry and is employed in the technical and marine Management of the vessels of Organization B.

This presents a cross selection of different organizational and managerial structures, from all integrated to the outsourced solution of a small ship owning company. It provides crewing, marine and technical Management for over 700 vessels with various locations world-wide. For interviewees, the persons and Managers in responsible for Organization B's vessels were interviewed.

## 3.3 Procedure

The data collection consisting of interviews and the on-board questionnaire was anticipated by contacting employees in higher management for permission to conduct the study. The research proposal and information letter were shared and the time frame of 1,5 months was set to conduct the interviews with the support of the Managers.

### 3.3.1 The Interviews

The onshore personnel interviewed were holding managerial or departmental leading positions, as they were presupposed to be familiar with the organizational strategies and digital policies and development.

Several department leaders are included in the interviewee list, to reflect the culture within the organization and the experience and expectations towards new technologies and their implementation process, as well as to have an insight towards their digital leadership.

All interviews were carried out in person at the interviewee's office, in the natural work setting of the participants. The target time frame of 45minutes was extended in most interviews to a maximum of 1,5h.

| ***Title*** | **Organization** | **Responsibility** |
|---|---|---|
| *Marine Manager* | A | Head of Marine Management, Marine Superintendents, vetting, regulatory compliance, incident investigation of 37 owned vessels |
| *Fleet Manager* | A | Head of fleet management, technical & marine management, QHSSE, KPI monitoring, project leader of Fleet Management Software/EAM implementation |
| *VP Technology* | A | Head of technology, project management, over 94 operated vessels |
| *Manager Digital Products* | A | Head of IT development and operations |
| *Global Head Ship Management* | A | Head of Ship Management, QHSSE performance, crewing, Emergency Response |

| | | |
|---|---|---|
| *Manager Digital Applications* | A | Head of IT Applications management/development over Fleet and Office |
| *Manager Asset Maintenance Group* | A | Head of Asset Maintenance, and relating EAM Systems maintenance and development |
| *VP Technology and Projects* | B | Connecting Owner and Manager, OPEX monitoring, project Management, newbuilds |
| *VP Operations* | B | Head of Commercial Management of fleet |
| *Fleet Performance Manager* | C | Responsible for efficiency in operations and environmental compliance |
| *Fleet Director* | C | Head of fleet management, technical, crewing |

*Table 3 Interviewee Overview (note, sequence does not follow interview numbers due to confidentiality of the participants)*

For each person an in-depth in-person interview was scheduled, with the persons as listed above, to allow for the researcher to pick up on non-verbal cues and attitudes, which can be followed up in the conversation.

This conversational Interview style is chosen, as several studies have shown that conversational interviewing reduces response bias for complex survey questions(West et al., 2018). Compared to Standardized interviewing, the interview was semi-structured to allow the interviewer to clarify survey concepts(Conrad & Schober, 1999) and ensuring the questions were understood, as intended. Further it allowed the researcher to ask for further elaboration on certain topics mentioned.

The questionnaire was divided into two parts, namely the background questions, inquiring about the department responsibilities, strength and fleet size, as well as the organizational structure of integrating the innovation process, and the second part focusing on the experience of the integration and implementation of DX and in the organization.

All interviews were performed in person and started off with a brief introduction to the study, continuing with the background questions to provide a context of the interviewee in the organization.

The second part continued with the inquiry of recent digital technologies implemented in the organization, and the future or potential technologies. It was followed by questions about the implementation process and the effect of the work process and personnel.

Lastly the questionnaire asked about the current and expected value generated by the implementation and challenges expected in the DT for the organization and the maritime sector. A summary of questionnaire topics is found below.

*Table 4 Overview of On-board Questionnaire topics*

| ***Question*** | **Topic** | **Subtopics** |
|---|---|---|
| *1* | Inventory of Digital Technologies | a. Currently/recently introduced<br>b. Potentially/in the near future |
| *2* | Expectations of technology | implementation |
| *3* | Impact of technology | personnel<br>operation<br>process |
| *5* | Lessons learned | n/a |
| *6* | Value generated | currently<br>expected |
| *7* | Digital transformation | opportunities<br>barriers<br>success factors |

### 3.3.2 Vessel Questionnaire

The vessel crew represented a large group of end users of the digital systems introduced. To include these end users on board and sample the experience and perceptions towards the introduced technologies an online questionnaire was created.

It was sent out to Organization A's Vessels Captains with the request to forward it to the Shipboard Management team consisting of Captain, Chief Engineer, 2nd Engineer, Chief Officers and other main users of the systems. It has been anonymized in order to keep identities confidential.

The Questionnaire is structured in two parts. It starts by covering background information about the user, such as age group, and generable comfort in using digital technologies in form of multiple-choice questions. The second part is formed by open ended questions, to allow the users to define their experience and opinions in their own words.

Implementation of new digital technologies is the main topic and is introduced by an opening question of "in your opinion, what is required for the successful implementation and use of digital solutions on board. Please elaborate".

This general question opens for the further inquiry to the recent (2 years) introductions of "impactful" systems, to allow the user to name and define the systems perceived as impactful.

It was followed by questions inquiring about the user's expectation, implementation and effect of the named systems.

The questionnaire is completed by a multiple-choice question to what degree the expectations were fulfilled, giving a categories choice of 5 levels from no expectations were fulfilled to all were fulfilled.

Open questions were dominant in the questionnaire, for respondents to tap into their own choice of words to describe the answers, and to provide richer less biased data

The on-board questionnaire has been included in the research, to allow feedback from the end users of the systems in Organization A's fleet. They form the main users in numbers of the systems and are subjected to different working conditions on board and different IT capabilities as for example connection coverage and broadband width.

Google forms was chosen as the transporting website providing simple, add free forms and the possibility to include a dynamic layout. This was required, as the number of systems named by the users, dictated the further questionnaire. This structure was chosen to be able to match the answers per digital system named.

### 3.3.3 Case Study Boundaries

The research is defined by boundaries, specifically by the defined time frame and accessibility to participants. In this study, all interviews of one organization are conducted in a short period of time of 1-2 weeks for one organization, to perceive the various perspectives in the same period of implementation and to keep within the time frame of the research.

Further multiple sources of information such as reports, interviews, and public documents of the organizations are reviewed, which will improve the credibility, validity, and reliability of the findings. Thereby improving the findings and the conclusion, by bringing several aspects, such as personal and professional opinions and experience.

## 3.4 Analytical Framework

To interpret outcomes, interpretive and theoretical frameworks are used. The collected information and data are used within the framework to identify main topics and validate findings.

The samples and data used describes different organizations of different size, as well as different stages of digital maturity, therefore the framework needs to be flexible to capture the dynamic data collected.

In framework building the focus was on categorizing data to further analyze the main topics and compare manageable amounts of data with each other to extract and highlight barriers and success factors in creating value of the recently introduced Systems.

The data collection is performed via collecting background information, interviews, and questionnaires. The selection of interviewees ranged from higher Management positions, and IT perspective, as well as with Managers directly in daily contact with the vessels, as well as the vessel crew to be able to represent a variety of perspectives.

To provide structure and an unbiased measuring instance and to increase validity of the research.

**What**: The first level of the framework is representing the category of the technology introduced, based on the applicable technologies defined. This separation is inserted, as the implementation and application area of the technologies vary vastly.

**When**: The second segregation is the time frame, defining the time frame from planning, implementation and established and mature.

**How**: 3rd is the overall expectation and effect pre and post implementation. It investigates the personal experience of the interviewees in how this technology was experienced.

The final stage is using several layers of Axial Coding to separate the thematic items, which build the foundation for the conclusion of the research.

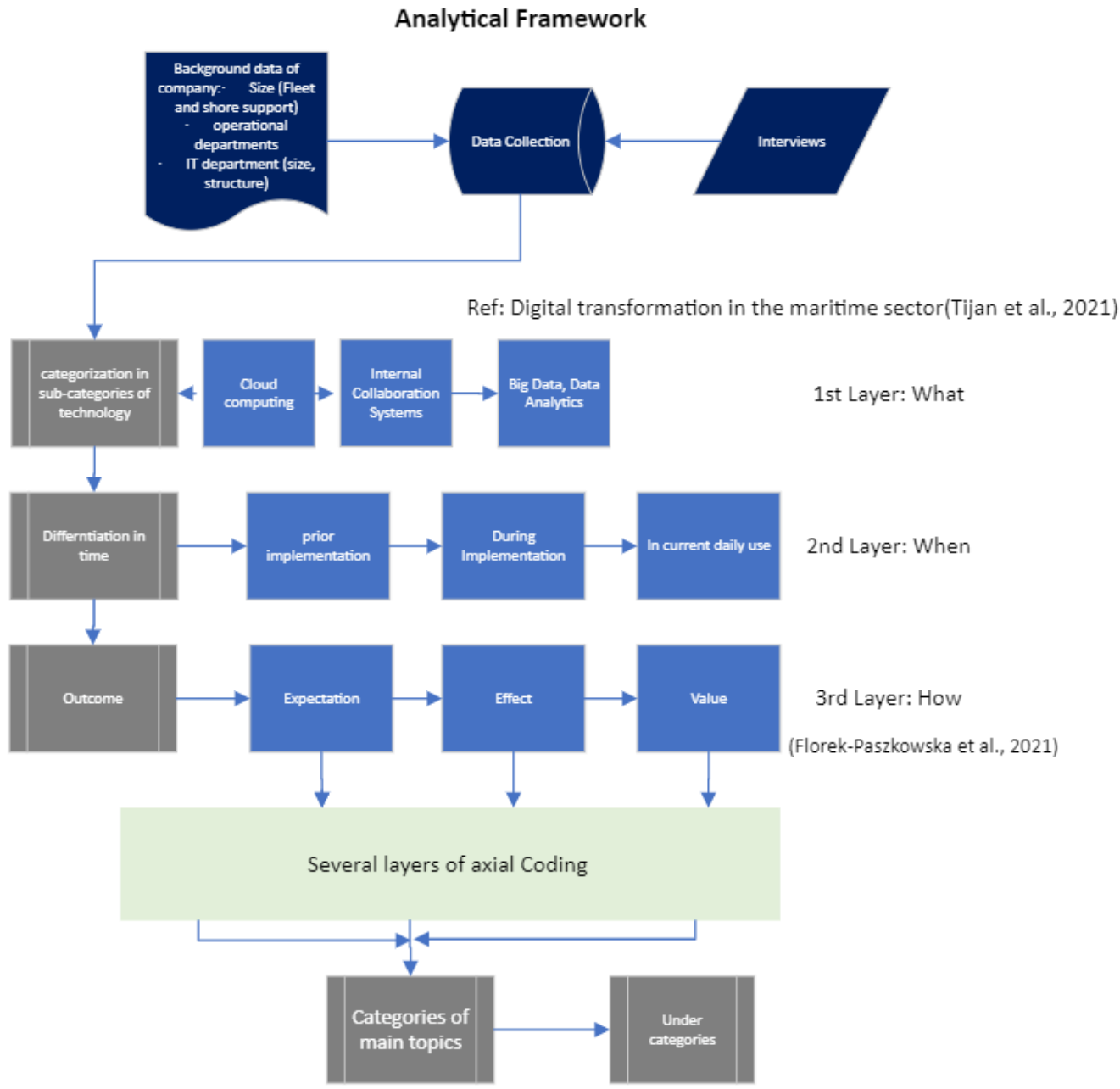



*Figure 13 Analytical Framework*

## 3.5 Data Analysis Interviews

A total of 11 interviews resulted in 9,7h of data, with an average of 53min per interview. These recordings were transcribed using an online speech-to-text program using automated algorithms. Sound quality, accents, pronunciation, and shipping/tech specific vocabulary led to transcription mistakes, which were corrected in a first transcription review by the researcher.

To make this qualitative data quantifiable, a reduction and extraction of the main topics and themes was performed using coding.

Each transcription was separated in "statements" of a main topic, this could be a sentence or a paragraph capturing the essence of the phrase.

By converting these "statements" into excel, a table was created to separate these and apply the first In-Vivo Coding, which uses the Interviewees words, to highlight the subject. The next layer of Coding was Constructed Code which summarized the topic as described by the researcher.

The statements were also assigned to the technology/system the interviewee referred to in the

| Transcription | Question | In Vivo Coding | Constructed Code | System |
|---|---|---|---|---|
| And, and we require very high data quality. And we need the data as short to the origin time of the data till we can process it, that time has to be as close to real time as possible. Yeah. So, I think tho those were main driving factors for, for doing this. | 2 | driving factors… very high data quality…. Close to real time | live high-quality data | EAM, Crewing system |

*Figure 14 Excerpt of the data analysis worksheet*

conversation as per analytical framework, as in above example both Enterprise Asset Management and Crewing System were discussed, which both are Inter-organizational Collaboration and Management Systems.

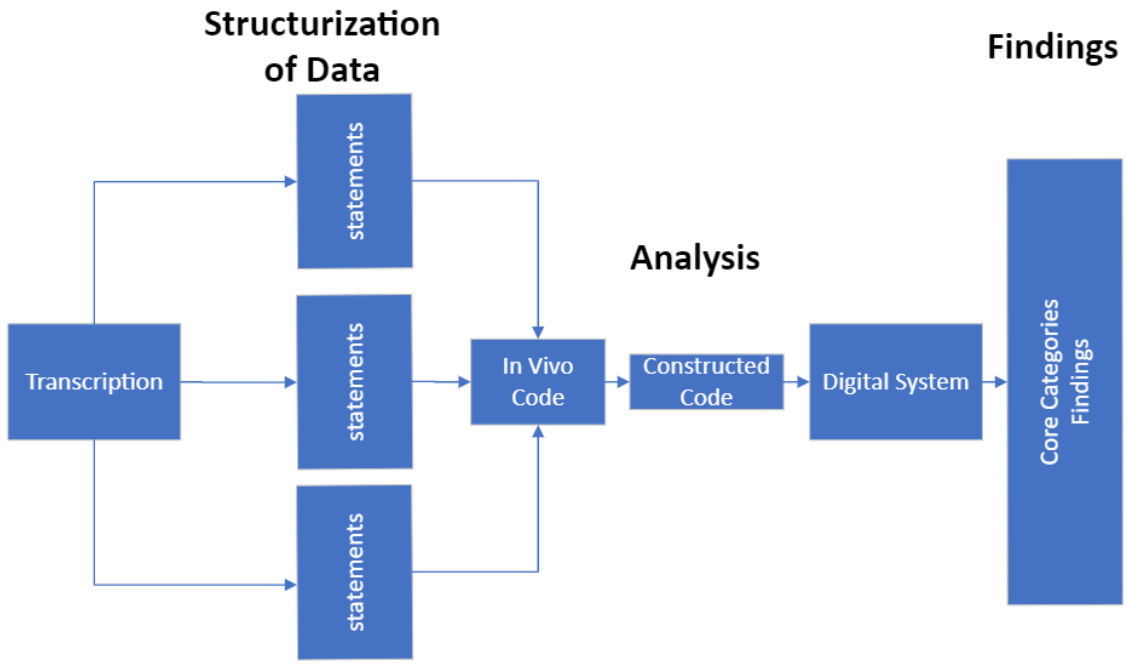



*Figure 15 Structurizing and Coding of Data*

Further the questions were added, as they anticipate answers in the category of the question.

This Coding was developed during the initial data review and led via inductive analysis to the Core Categories of each System discussed. By using Excel filtering tools, each column can be examined comparatively to different Systems as well, as questions, to analyze, and follow up possible relations between systems and topics. In this research the data was mainly regarded by system groups as per analytical framework layer one. Further axial coding was from the data as per 3rd Layer describing the outcomes, which is discussed in Chapter 4.

### 3.5.1 Data Analysis Questionnaire

The questionnaire, executed as an online questionnaire, provided a mixture of quantitative and qualitative data. It was structured in a general background part and main section about a recent digital system implemented.

The areas discussed by the participants can be categorized as:

- **Expectations:** towards the system, planning and setup
- **Experience:** with implementation, training
- **Effect:** impact on efficiency, workflow, mindset

### 3.5.2 Expectation

Expectations were encouraged to be formulated and were first separated according to the ratings from low to high. To provide a generic overview of the expectations the responses were categorized in high, neutral, low and other, by key word identifications, in the data, as per below table.

***Expectations***

| *Category* | High | Neutral | Low | Other |
|---|---|---|---|---|
| *Key words* | Better<br>More efficient<br>User friendly<br>Faster<br>Improving workload | Expected transition<br>From difficult to managed | Previous poor experience - anticipating similar | Describe experience not expectations |

The answers of the participants ranged from one-word answers to full paragraphs containing several sentences. To attain higher data quality, the main key words were extracted and grouped.

### 3.5.3 Experience of the roll-out

The responses were categorized in to good-neutral and bad, according to the below

***Implementation***

| *Category* | Good | Neutral | Bad | Other |
|---|---|---|---|---|
| *Key words* | Benefit<br>Ok<br>works | Functionality of system<br>Includes connectivity issue | Difficulties<br>Negative impact<br>Challenges<br>workability | Description of process |

### 3.5.4 Effect of the System

The described effect the implemented system had was described by the participants and categorized as per below. Here further keyword search was performed to highlight the shared topics.

***Effect***

| *Category* | Positive | Neutral | Negative | Other |
|---|---|---|---|---|
| *Key words* | Ok<br>Worth it<br>Convenient<br>Works<br>Easy<br>Instant live data<br>good | Managed to use it<br>Changed<br>same | Not efficient and time consuming | description |

## 3.6 Ethical considerations

Certain ethical considerations are anticipated in the research, as several companies are considered in the case studies. Therefore, ethical issues are evaluated, and institutional permission is applied for, and received-, prior starting the qualitative study.

An integral part are the interviews with several personnel in leadership positions within the corporations.

The aim is to keep the integrity of the interviewees prior, during and after publishing. Often this is achieved by anonymizing the interviewees. In this research the researcher is personally connected to the companies, therefore there is a possibility of identification via the described job titles.

Protecting by anonymity the researcher is using quotes referring to “Interviewee *number”, however the numbers are not defined as titles or with any identifiers to protect participants in the survey.

The interviewees will be introduced to the research and the proposal and its aim. Further consent must be given prior the interview shall start, without pressuring any individual to be part of the research. All participants have freely given informed consent

All notes, or voice recordings pose a possible ethical threat and will be deleted after completion of this thesis.

The questionnaires have been completely anonymized, to protect the on-board employees. On the questionnaire, the participants are informed that phrases can be used for publishing.

# 4 Results

This chapter presents the findings in the form of core categories which were produced by the inductive method used in the data analysis. The main topics were selected for further analysis, chosen by the actual impact of the business processes and on the users and high level of representation within the dataset. These focused on the Internal Collaboration systems such as the Enterprise Asset Management (EAM) and the Vessel reporting System (VRS). An excerpt of systems used, is found in the below table.

Further findings from the on-board Questionnaire are presented as retracted after analysis and categorization according to Framework, Coding and inductive categorization.

| ***Organization*** | **Vessel operation** | **Performance** | **Collaboration** |
|---|---|---|---|
| *A* | Weather routing<br><br>Voyage Administration (Position, crew, vaccination status, cargo) | Analytical visualization tool (Power BIB)<br><br>Learning tool | EAM<br><br>Voyage Admin<br><br>Remote service<br><br>Stowage and Cargo Collaboration |
| *B* | Weather routing<br><br>Voyage administration<br><br>Accounting Systems | Analytical visualization tool (Power BI) | Port Information and Collaboration system (Agent and disbursement handling) |
| *C* | Weather routing<br><br>Vessel reporting system<br><br>E-budget<br><br>E-crew Management<br><br>Class systems<br><br>Accounting Systems | Analytical visualization tool (Power BI)<br><br>Learning tool (cloud) | |

## 4.1 Internal Collaboration Systems

The data analysis revealed that the highest quantity of data is referring to the EAM from Organization A, due to its recent implementation and the large impact to the organization. The second largest data set refers to the VRS system of Organization C. Both Systems are Internal Collaboration Systems creating an

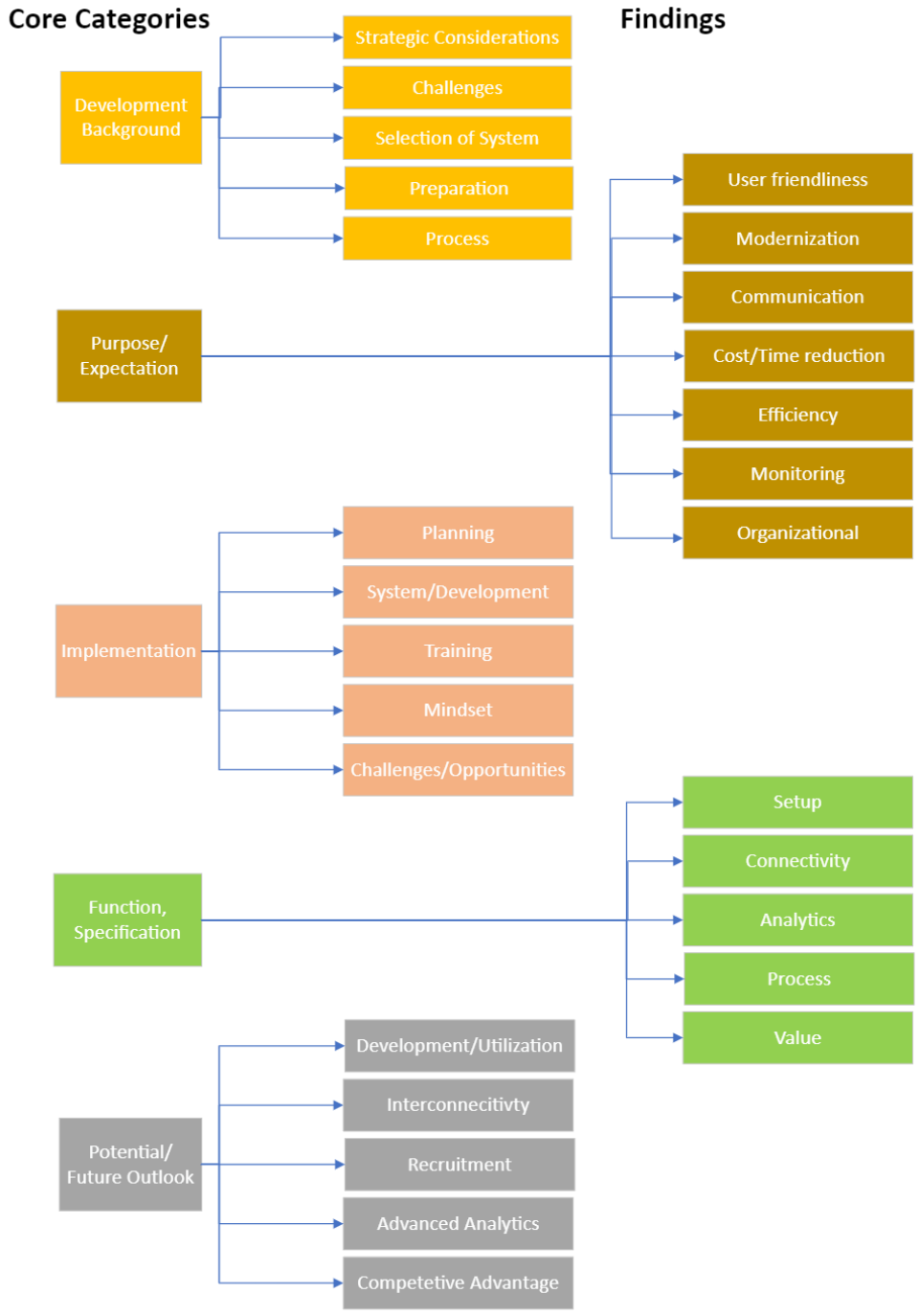



*Figure 16 Internal Systems Core Categories and Findings*

organizational data lake with several layers and clients to reduce the administrational workload and improve data quality for all departments.

Internal Systems like the EAM of Organization A, which was purchased as base software, and highly adjusted and developed for the company's business needs, and the Vessel Reporting System of Organization B & C, which was developed in house, both serve the company in its strategy to digitalize, increase efficiency, transparency, and costs.

The data of these systems was categorized in five main Categories derived by inductive analysis from the dataset (shown in Table 3):

- Development and Background –planning, preparation, and selection of the system
- Purpose and Expectations –the various expectations and motivations
- Implementation – process and observations during implementation
- Function, Specification – setup and technical details and capability of the systems
- Potential, Outlook – long term outlook for the company/industry in DT

The high-level categories, and their relevant findings, will be described in the following section.

### 4.1.1 Development and Background

Development and Background summarizes the observations of the participants regarding strategic considerations required in the planning and preparation phase to achieve the highest value and utilization possible of the purchased or developed system. An integral strategic consideration is thereby a thorough problem definition and prioritization, as Interviewee 6, Organization A describes, "*very often start with the systems and then you, and wrong from the beginning. So, with the project we started with, what do we need, what are we going to do? What do we want the system to do for us?*".

To bridge the gap between Ship Management and data scientists and software developers, the use of expert consultation to evaluate the selection, and possibilities of current systems, as well as defining the transfer process and structure increased the outcome. As Interviewee 10 Organization A stated, *"we only saw the true value of Star IPS after we got consultants in, that was going to change it out for us".*

A major part of this value was the cleanup project of historic data and the process definitions for the new system so "*by introducing this technology, which is (…) a process driven system, will of course bring*

*to the surface and challenge our procedures. Cause when we are actually doing programming of our procedures into the work process, we see there are bottlenecks, there are some challenges there*" and "*this process mapping has really made us aware of what hell are we doing and who is doing what, who is responsible for what*" (Interviewee 11, Organization A).

An overview of the Findings and details are summarized in the table below

*Table 6 Findings overview: Development and Background*

| Core Category | Findings | Details |
|---|---|---|
| **Development & Background** | Strategic Considerations | Problem definition and expectation<br>Investment and value of return<br>Expert Consultation |
| | Challenges | cleaning of historic data, transfer potential/costs vs data quality<br>regulatory, GDPR and officials' acceptance |
| | Selection of System | system flexibility and utilization potential<br>cloud vs conventional<br>off the shelf inhouse developed system<br>competitive advantage<br>maritime vs mainstream supplier<br>analytic capabilities<br>resources |
| | Preparations | historic data value and utilization<br>centralization and data quality control |
| | Process | redefinition of business processes |

### 4.1.2 Purpose and Expectations

This category is covering the drivers and expectations of the interviewees of the systems. The motivation is in all of this research's studied Organization an increase in efficiency, by reduction of administrational and double reporting of crew on board, as well as centralizing control by creating a common data lake with several client interfaces, thereby improving accessibility as well as data quality.

All cases are further using data visualization and analytics tools (Microsoft Power BI) for monitoring purposes, as well as 3rd party software integration to extract e.g., environmental reporting items. Therefore, reliable high data quality is crucial to provide accurate monitoring and outlier tracing for Management.

In anticipation of a successful implementation the alignment of expectation would result in the same vision, however, as Interviewee 9 states "*expectations are growing in different directions for what people think this is going to be. That was difficult."* He further explained "*managing expectations, I think was probably what we, I, I won't say that we failed on it, but (…) you cannot explain it better than the person sitting in front of you perceptive because you are not a specialist*". This challenge was intensified, due to the systems properties being highly developed and adjusted by the company itself,.

This is in stark contrast to Organization C as the performance Manager describes "*what I was expecting is what I saw. So, it was not the mismatch in between expectations and reality*", His expertise in VRS systems and previous work experience with various VRS systems covering similar scopes, as well as his background, with implementing similar systems on a regular basis may contribute to this statement.

*Table 7 Findings Overview: Purpose and Expectations*

| Purpose and Expectations | Category | Determinants |
|---|---|---|
| | Modernization | replacement of systems, capabilities and utilization |
| | | use of new technology |
| | Communication | alignment of expectations |
| | Cost/Time reduction | purchase module |
| | | unplanned activities control |
| | | time reduction, tablet use |
| | | budget control |
| | | spare part control |
| | Efficiency | reduction of double reporting |
| | | reduction of workload |
| | Monitoring | tools for overview |
| | | improved data |
| | | outlier identification |
| | | transparency |
| | Organizational | resources |
| | | IT competency |

### 4.1.3 Implementation

In this section the actual roll-out and implementation experience was discussed with the interviewees covering the encountered challenges introducing the systems to the fleet. The data of the cases is here not comparable between the cases as Organization B &C implemented a smaller Vessel reporting system, mainly focusing on energy efficiency and environmental reporting several years ago, while organization A implemented a large EAM covering several departments such as QHSSE, purchasing, technical and marine management.

Training, Mindset and Challenges are overlapping, as the mindset and motivation dictates the competency outcome of the training, which presents a large challenge, "to get the good, good training or good session you have to involve yourself" (Marine Manager Organization A). During the implementation of Organization A, the implementation plan contained training sessions, vessel open hours, guides etc. All training was due to the COVID travel restrictions converted to remote sessions, a deviation with the planned on-boarding in person "*we were thinking we need to be on, more a week, at least per ship with crew training and transferring the, the local stores and adjusting the local accounts and all these things*" (Interviewee 10, Organization A). This was the catalyst for the accelerated roll out and training which was completed without IT or company personal boarding the vessels, due to the extraordinary situation.

The implementation success precedes the success of the system integration, however the implementation was from various Managers described as "*painfu*l", "*uncomfortable*" costing "*blood sweat and tears*", as personnel was encountering several challenges such as slow speed of internet, system bugs, missing functions, and modules etc. it was described as "*costly and non-comfortable. But again, when you are able to chew yourself through that, you come out at a much better place*" (Interviewee 9, Organization A).

The cost of implementation, often underestimated is a further consideration "*our golden thumb rule, if, if you invest $1 million in software, you should also invest 3 million in implementation costs, doing data, cleaning, process, mapping, all the stuff you need to do.*"(Interviewee 11)

*Table 8 Findings Overview: Implementation*

| Implementation | Category | |
|---|---|---|
| | System/ Development | Initial roll out, outstanding development items and initial bugs<br>Resources available/dedicated<br>Continuous development of system<br>Implementation costs |
| | Training | Training Plan<br>Feedback sessions<br>Continuous development – continuous training |
| | Mindset | Negative feedback anticipated<br>Frustration encountered<br>Communication<br>Human element- Management |
| | Challenges/ Opportunities | COVID restrictions, remote implementation |

### 4.1.4 Function & Specification

This category describes the technical setup, and functionalities of the system, as well as the system designs, such as process driven, closed loop and centralized (EAM). Further it covers the issue of Connectivity of the cloud-based systems, which was connected to the implementation challenge, and frustration of the end users, due to long loading time, as interviewee 10 states “We still have some challenges with bandwidth and speed and everything, but it it's a system for the future. So, we just have to be patient and solve issue by issue”

*Table 9 Findings Overview: Function, Specification*

| Function, Specification | Category | Determinants |
|---|---|---|
| | Setup | system setup<br>Functionalities<br>Integration capabilities |
| | Connectivity | Bandwidth and speed challenges<br>Increased costs<br>Offline capability |
| | Analytics | Power BI integration<br>Internal analytics within system for users |
| | Process | Process design of the system<br>Authority definition |
| | Value | • Remote maintenance, update<br>• Traceability<br>• Real time |

### 4.1.5 Potential & Future Outlook

Lastly the participants discussed the outlooks and their expectations of future systems and developments in their companies and sector. Here the interviewees focus on the recently introduced systems and their capabilities, as Interviewee 11 of Organization A states "*I expect that external requirements to shipping that will change more and more rapidly, especially now with the digitalization all over and really, really focus on the environment*". In this section the data quality, as foundation of further development of machine learning and predictive functions, simulations are main topics.

*Table 10 Findings Overview: Potential, Future Outlook*

| **Potential, Future Outlook** | **Category** | **Determinants** |
|---|---|---|
| | Setup | Capabilities of the system<br>Increased transparency through all levels |
| | Interconnectivity | System integration<br>3rd party inter-face |
| | Recruitment | Adjustment of recruiting policy |
| | Advanced Analytics | Data Quality |
| | Competitive Advantage | Capitalization on DT strategy |

## 4.2 Questionnaire results

A total of 64 responses were registered in the online on-board questionnaire sent out to a total of 37 vessels of Organization A targeting the Senior Management team consisting of Captain, Chief Officer, Chief Engineer, and Second Engineer. Out of the responses 43 discussed the EAM introduction, 27 respondents discussed the cloud-based loading and cargo system, developed in-house, and 17 participants discussed the cloud-based crewing system. Seven respondents elaborated on Microsoft Teams, while the remaining elaborated on navigational publications, digital chart Management system and others. The participants had the choice to write about one or up to three digital systems implemented within the last two years.

Below the results are presented according to system

in the three stages described by the participants: Expectations- prior implementation, Implementation-rollout and training experience and lastly Effect on the participants working with the new system.

### 4.2.1 EAM Expectations

The data analysis of the expectations in the new EAM, revealed that 81% of the participants had high expectations that the introduction would result in a positive effect for the users, such as “real time system”, which is “simplifying work” and assists in “accomplishing activities faster”, while being “easy to learn”, “user friendly” and an improvement to the previous system, resulting in an overall improvement of efficiency

*Table 11 Questionnaire findings: Expectations*

***Expectations***

| *Category* | High | Neutral | Low | Other |
|---|---|---|---|---|
| *%* | 81% | 5% | 2% | 12% |
| *Key Words* | Better<br>More efficient<br>User friendly<br>Faster<br>Improving workload | Expected transition<br>From difficult to managed | Previous poor experience - anticipating similar | Describe experience not expectations |

### 4.2.2 EAM Introduction

The introduction of the system was described by many participants with major positive and negative effects, therefore several responses were marked both, as positive and negative. The neutral answers describe the system itself as satisfactory but describes the dependency on internet speed as a problem to the utilization: “There are instances where work was halted or times that you cannot hardly work at all. Blind spots on Marlink system, weather conditions, satellite down time are just an example of challenges using this system”

*Table 12 Questionnaire findings: Implementation*

***Implementation***

| *Category* | Positive | Neutral | Negative | Other |
|---|---|---|---|---|
| *%* | 23% | 21% | 53% | 7% |
| *Details* | Benefit<br>Ok<br>works | Functionality of system<br>Includes connectivity issue | Difficulties<br>Negative impact<br>Challenges<br>workability | Description of process |

The category “negative” achieved 53% or participants response, describing the roll out with the majority of the following problems: “not efficient and time-consuming working with this system”. However, several respondents (23%) also see value in the change implemented “if you are familiar then it will make some tasks easy, as long as we have good internet”, further improvements described are traceability of goods, work planning monitoring and live up to date data.

### 4.2.3 Effect of EAM

This category describes the impact on the on-board users, included the description of the effects of the introduction of the system. To provide more detailed information the categorization has been expanded and categorized according to the data, based on the categories of the interviews previously:

- User Experience- effect on the human experience, feelings -split in positive and negative
- Efficiency- effect on the processes and performance
- Connectivity- connectivity of systems, internet

*Table 13 Questionnaire findings:Effect*

| ***Effect*** | **User Experience** | | **Efficiency** | **Connectivity** |
|---|---|---|---|---|
| *%* | 21% | 40% | 53% | 44% |
| *Details* | Frustration, not easy, stress, slow familiarization, many problems, nuisance | Ok, good, managed, works well | Delays, waiting, double workload, time consuming | longer time, buffering, slow/bad/ lost/poor connection, unstable/internet speed, time consuming, requires faster internet, insufficient bandwidth |

As shown in the table, more than half of all participants named a reduction of efficiency in their response “There are some improvements, but in my current evaluation, the system has some inherent redundancy in data inputs which actually adds more time to complete a task.”

40% of the participants receive the system is positive with naming the system itself is “sufficient” or “beneficial” and seeing value created in areas like monitoring and information sharing.

A total of 21% had a dominating negative experience in the category, relating to frustration and stress: “It almost doubles up the workload and not healthy to use.  It's stressful to use.” Most of these responses describe the frustration with the systems dependency of a good internet connection, initial bugs and user friendliness, leading to waiting times delaying the actual completion of work

One participant summarizes it “Created a lot of frustration and extra work in trying to get a grip of how the system worked. When we need to have several guides for how to perform various tasks, said system is not self-explanatory. That the system in online based, and no available "off- line" use, made the start poor. Many times, the communication was lost, and simple task could not be completed and therefore all work on the pms had to be put on hold, and resumed when connection was re-established”.

### 4.2.4 Cloud-based Cargo system

25 respondents of the on-line questionnaire discussed the cloud-based cargo stowage system as discussed in Chapter 2 Background. This system was first introduced in 2013 as a local server program. The re-launch was a cloud-based system with additional features completed beginning of this year.

*Table 14 Questionnaire findings Cloud systems overview*

| | **Expectation** | **Implementation** | | **Effect** | | |
|---|---|---|---|---|---|---|
| *Category* | Expectation High | Implementation Negative | Implementation Positive | Easier | Delays | Faster time saving |
| *%* | 92% | 28% | 52% | 24% | 32% | 20% |
| *Details* | Better, helping, easier, improve, simplify, good, higher performance | Bugs, time consuming, errors | Well tested, information supplied, simple layout, ok, simplification | User friendliness reduced workload | Slower due to buffering | |

# 5 Discussion

## 5.1 Introduction

This chapter explores findings of this work and considering the meaning of the results and its alignment to the literature outlined in the background chapter. This is done to gain insight into the Digital Transformation observed in the three case study organizations.

The Literature Review discussion section compares the literature from the background chapter to the findings of this research, of this work defining commonalities and differences.

The Result discussion further elaborates on several findings, in order to provide context and comparable data towards the success factors and barriers of the cases in realizing their digital potential in the systems implemented.

In further providing the reader with a critical view to the used method and procedure, a method discussion highlights possible biases for full transparency.

## 5.2 Literature Review Discussion

The results of the case studies confirmed several points of previous studies. The thorough literature review of Tijan et al. (2021) and Morakanyane (2020) defined several of the barriers, drivers, and success factors which were also identified in Organizations A, B and C.

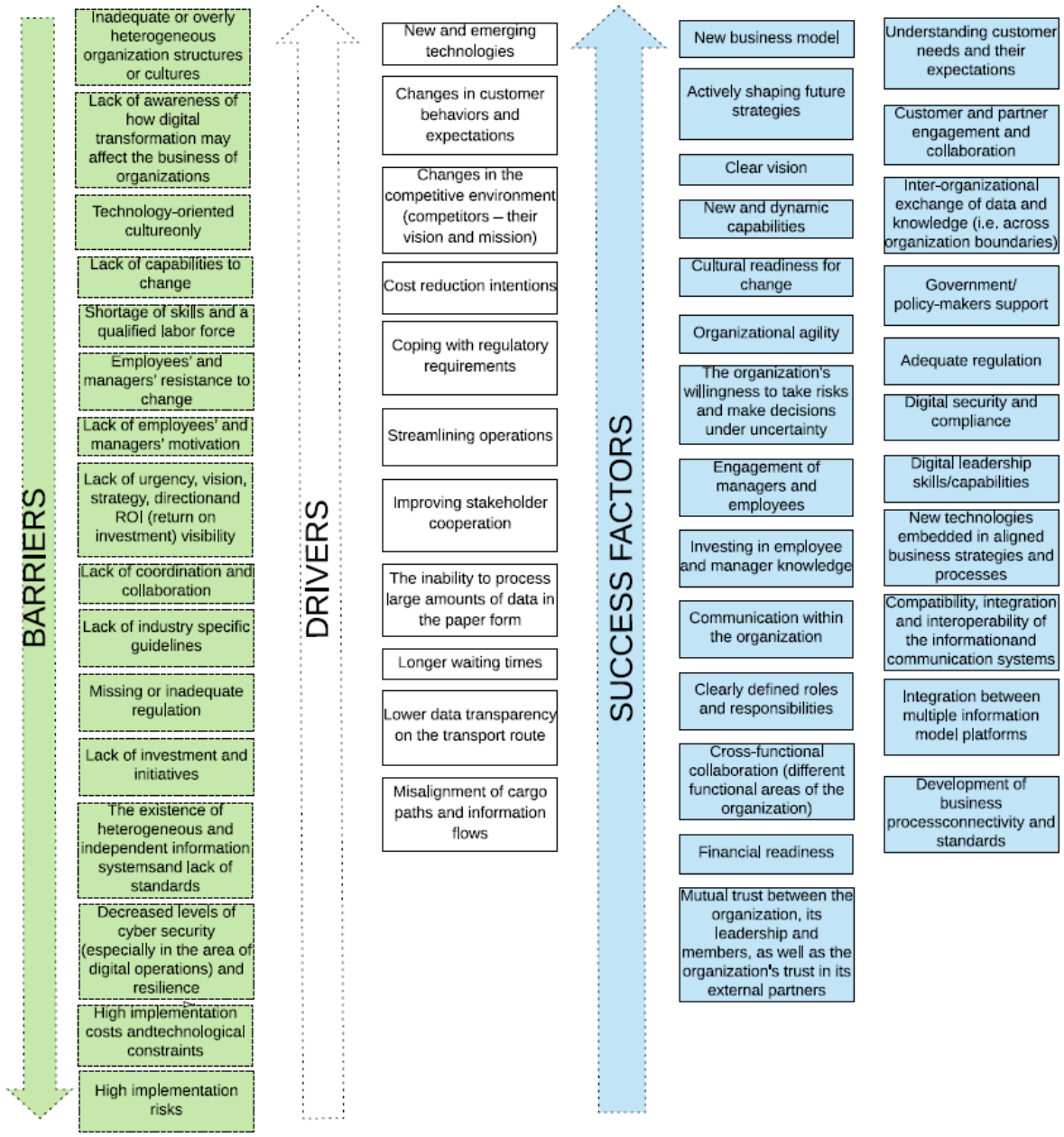



*Figure 17 Identified Drivers, Barriers and Success Factors of Literature Review by Tijan et. Al.*

Morakanyane et al. in their work, present a case study of five shipping related companies digitalization activities. This research is resulting in an overarching theoretical model systematizing the technological components (technology typology), the prevailing management rationale (strategic drivers) and determinant factors (practices) of successful shipping digitalization (Morakanyane et al., 2020). The paper identifies 7 success factors and 23 subthemes, as per below.

The approach of Morakanyane (2020) shows a more strategic focus, as a framework represents a

| Success Factor (7) | Sub-factors (23) |
|---|---|
| Determine Digital Trigger (16) | Know the type of trigger (2)<br>Know the type of inducer (14) |
| Cultivate Digital Culture (28) | Ensure a shared conceptualization of DX (7)<br>Exhibit strong organizational leadership traits (10)<br>Adopt good governance practices (11) |
| Develop Digital Vision (16) | Carry out a digital present assessment (3)<br>Formulate a digital future (5)<br>Develop a digital strategy (2)<br>Establish a communications strategy (6) |
| Determine Digital Drivers (50) | Determine digital technologies to leverage (12)<br>Determine skills & capabilities required (5)<br>Determine other resources required (3)<br>Exhibit strong digital leadership traits (30) |
| Establish Digital Organization (15) | Establish a digital innovation functional structure (12)<br>Create a digital innovation implementation structure (3) |
| Determine Transformed Areas (11) | Determine transformation opportunities (4)<br>Identify target transforming areas (4)<br>Building the DX initiatives (3) |
| Determine Impacts (38) | Define the expected customer facing impacts (4)<br>Determine the realized customer facing impacts (9)<br>Define the expected organization facing impacts (4)<br>Determine the realized organization facing impacts (17)<br>Determine measures of impacts (4) |

*Figure 18 Morakayanes DT success factors and attributes*

theoretical model, while Tijan et al. represents a categorization of all findings of recent DT maritime literature. In the table below a comparison of determinant factors, (or success factors) is made between the three papers. It is split between three main topics: Organizational, Technical and Environmental.

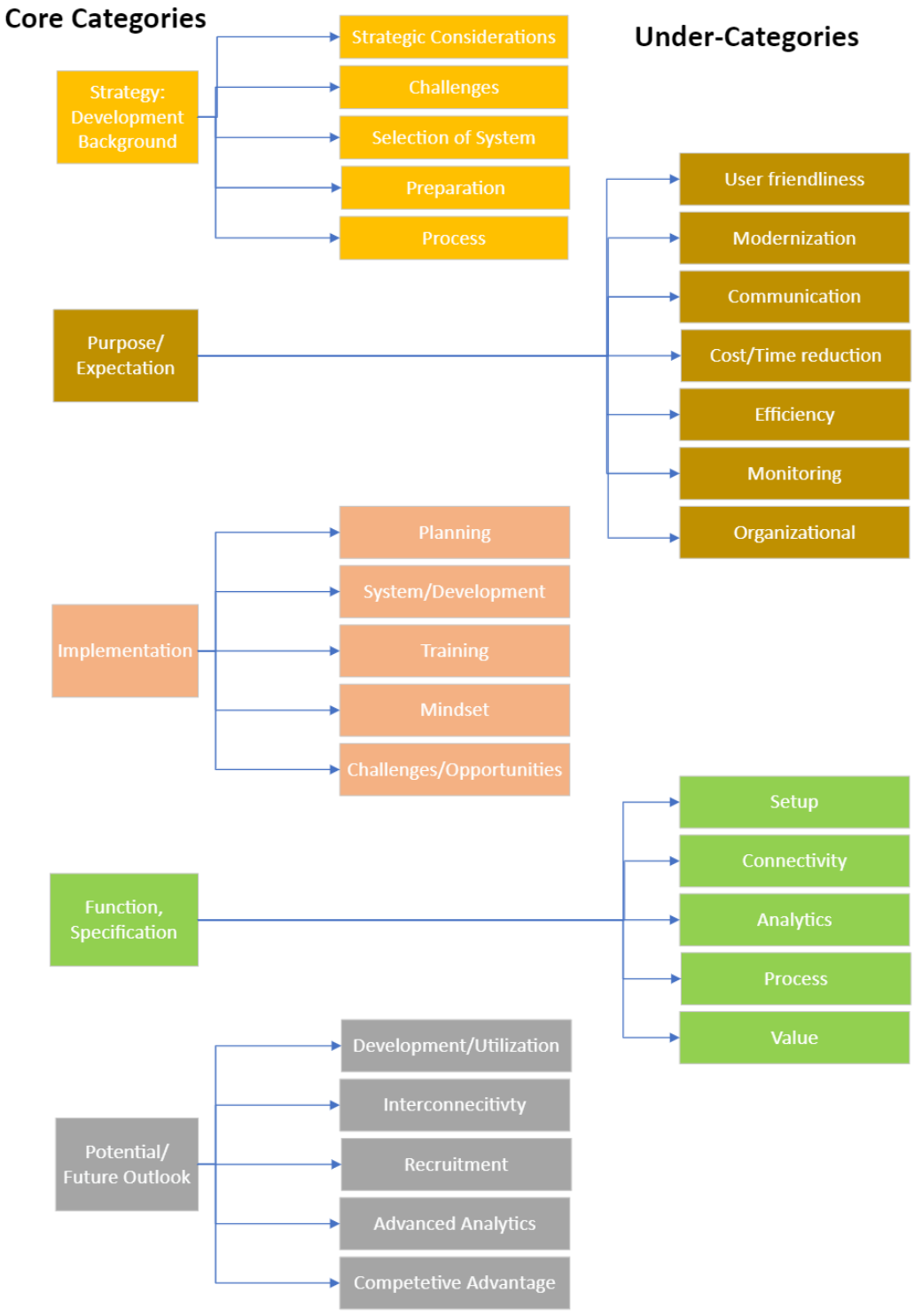



*Figure 20 Determinant factors of this research*

***Common Success factors***

| | Tijan et al | This case study | Morakanyane et al |
|---|---|---|---|
| *Organizational* | Strategy<br>Vision<br>Company culture<br>Communication | Strategic considerations<br>Vision/Philosophy<br>Mindset<br>Communication<br>Training | Establish Digital Organization<br>Develop Digital Vision<br>Establish Communication Strategy |
| *Technical* | Security<br>Compatibility<br>Process<br>Connectivity | Security reference<br>Integration capability<br>Process- redefinition<br>Connectivity<br>System selection<br>User-centered design | -<br>-<br>-<br>-<br>Process improvement |
| *Environment* | Government/policy makers<br>Customer and partner collaboration | Regulatory<br>Interconnectivity 3rd party | -<br>Customer impacts |

*Table 15 Comparison of Tijan et. Al, Morakanyane et al. and this research of core determinant factors*

From the comparison common findings are derived and found in accordance with Tijan et al. and Morakanyane et al..Morakanyane is focusing on the strategy and culture in its determinant factors, which is confirmed by the findings of this research. However, technical aspects like security, integration, system specifications and user-centered design are listed by the author as further critical aspect, as this significantly impacts the end user's experience, work process and perception of the system.

It can be concluded that the major focus on strategy, vision, and company culture as well as communication is integral to the success of DT and determines the employee's reception, involvement, and utilization of the implementation.

The architecture, setup, and specification, as well as selection and development capabilities, must create a functional system. Interviewee 2 elaborates that the performance monitoring based on the VRS data provided as a Ship Management service is not integrated with other forms. Owners deciding to keep their company related reporting forms, and adopting the service of Organization C, are creating doubling of administrational workload for the crew. Therefore, interconnectivity between systems is essential, if data silos are used, to avoid creating inefficiencies.

In the below chapter the identified main findings and determinant factors are discussed and underlined with the findings from the case study. They are structured in organizational, technical, and environmental aspect.

## 5.3 Results discussion

### 5.3.1 Organizational

*(a) Strategy*

The works findings presented the category: Development and Background, which is describing the philosophy of approach (problem-based vs technology-based), planning, initial approach, expected initial investment vs return, competitive advantage, and capabilities amongst others. It describes the systematic considerations, innovations and vision as well as considerations in choice of technology, and impact inter-organizational and commercially. Therefore, it can be described as strategy.

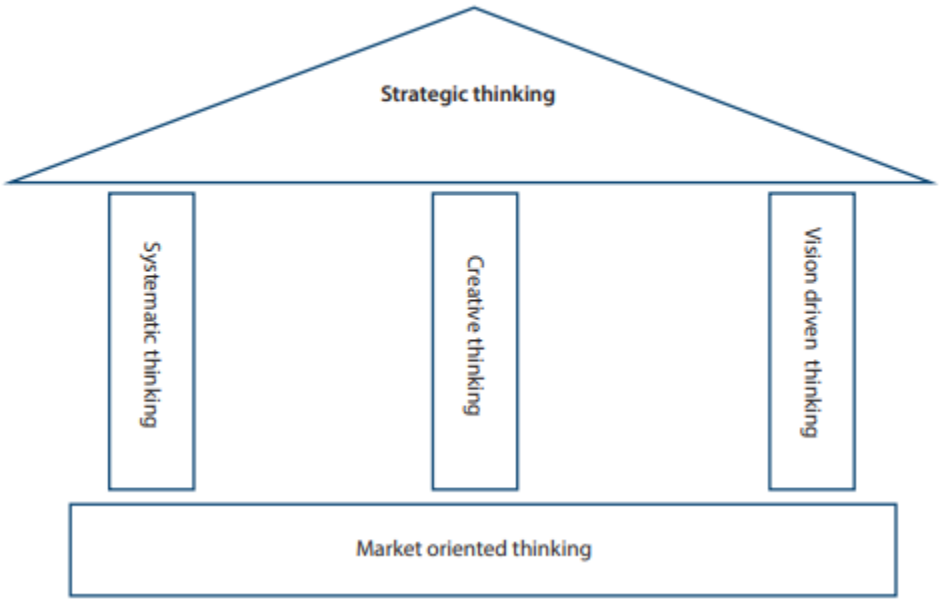



*Figure 21 Elements of strategic thinking Jelassi et al, as adopted from Moon(2013)*

The company's strategy is the foundation of success in Digital Transformation as strategic embeddedness and digital leadership are the determinants of digitalization (Lambrou, et al 2019). This statement is found in all DT literature reviewed by this author, with the core message that "Strategy, not Technology Drives Digital Transformation"(Kane et al., 2015). The systematic thinking is considering the Organization holistically, evaluating competitive potentials, integration with existing measures and align with individual processes and network (Tijan et al., 2021) or as Interviewee 6 states "*very often start*

*with the systems and then you, and wrong from the beginning. So, with the project we started with, what do we need, what are we going to do? What do we want the system to do for us?*".

To answer this, an assessment of the current digital status of the organization, (Morakanyane et al., 2020.) is required, as well as the equipment and capabilities. Organization A and B have performed this assessment on the vessel equipment and data tags have been inventorized of machinery and components. Further, example logs are being extracted from test vessels, and archived, in anticipation of future opportunities and application of this historic data. An application example Organization B is engaged in with collaboration with SINTEF is the simulation of eco fitting of vessels, eg. With Flettner rotors, to anticipate the potential emission reduction.

The assessment, however, must further include the digital competency of employees and Management, as the decisions on technology providing solutions, as well as realistic understanding of their capability, resources required, and development potential will affect the quality of decision on the technology selected. As demonstrated Organization A has bridged this, by using expert consultants, for extended planning, decision, development, and implementation. However, in digital leadership the message and expectations of new systems must be realistically and transparently communicated to all users, to avoid the over-hyping of expectations.

The third part of "*what do we need*" is as Morakanyane describes the identification of the trigger and the inducer. As an analysis of the problem itself will reveal the inherent potential. Interviewee 7 describes an example of boiler consumption, which was reduced from 3 t/day to 0.8t/day, by identifying the trigger and inducer of the high consumption number and acting accordingly. However, going from 0.8y/day to 0.7t/day would require more data, maybe IoT integration would result in a further 0.1t/day reduction, however, would result in much higher costs. This is a practical example of value creation versus initiating costs.

The overarching strategy of the company is imperative as foundation for the digital vision, leadership, training, and company culture. Figure 17 presents the architecture of digital portfolios, interconnection and breaking of data silos towards a centrally managed system, requires business adjustments, reinvention and remodeling to achieve maximum utilization.

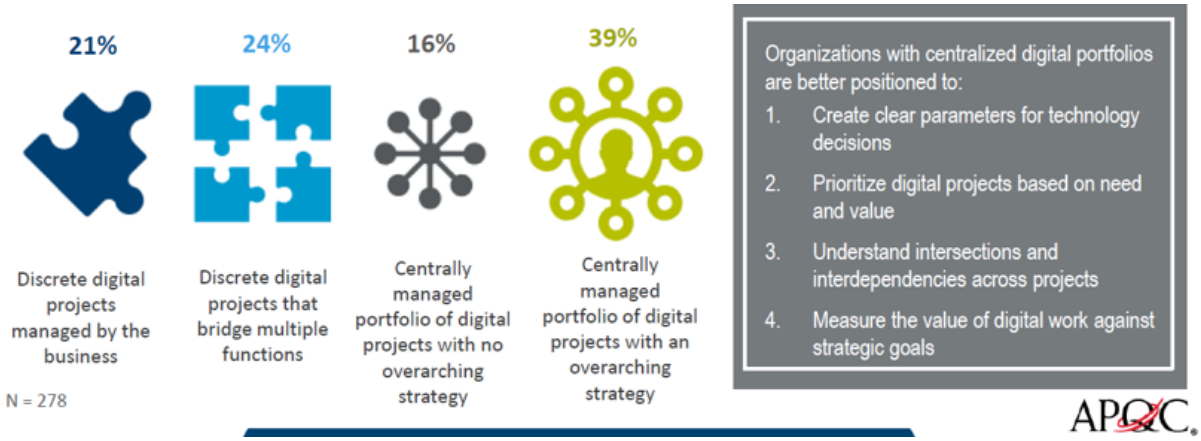



*Figure 22 APOC*

Organization A has integrated the digital movement within their strategy and in their organization, part of it is in form of a Digital Innovation Group, to facilitate digital innovation projects. Also, Organization B is engaged within several research and collaboration projects, due to the limited size of fleet and IT resources. In all implementation the integration with other systems is a minimum pre-requisite with the aim towards an overarching strategy centrally managed portfolio.

### *(b) Company Culture*

In Stoianova et al.'s, 2020 research based on surveys, 93% of Managers see the cause of failure of DT in company culture(Stoianova et al., 2020). The basis of driving change is people; therefore, the term "cultural readiness" has been introduced to describe the ability to overcome the shortcomings which are to be expected with the introduction of a new digital technology.

Many of the participants of this research, give account of the difficulties and struggle of creating and receiving change within the company "the difficult part for human beings is the mindset to change. And despite that you want to change, and you want to drive change, it is not comfortable" (Interviewee 9), for the EAM implementation of Organization A 21% expressed it created frustration "Makes most tasks to be done a hassle and uninspiring" (Online questionnaire participant). However, the responses of the questionnaire also state the origin of frustration, as extended buffering times, system bugs and usability.

To improve the implementation and utilization and efficiency of introduced systems, employee engagement and ownership of the system is critical, as well as education, training and transparency of plans, communication, and active engagement in the effort to improve the system.

Interviewee 6 describes a scenario receiving a long email of the vessel of complaints about the newly introduced system, the action of a Technical Superintendent (TSI) was a 5min phone call, and of all the issues only half a page remained. In this account active engagement of the TSI resulted in immediate reduction of frustration, creating an open communication environment, and transferring knowledge to the vessel users.

Organizational culture is seen as the number one hurdle to digital transformation (Buvat et al., 2017)(Teichert, 2019). Overcoming this hurdle requires active input of the organization. Stoianova et al., 2020 in their research are defining actions of organizations to actively increase their cultural readiness and improve their corporate culture, with measurable metrics to evaluate the readiness assessment. Andriole (2020) confirms that leadership, corporate culture, discontentment, incentives, and punishment determines the success or failure in digital projects.

Examples of this input are:

- continuous employee development: competency - ensuring minimum percentage of people receiving training per department
- building employees engagement: encouraging employees initiatives - monitoring number of innovation proposals and, support program for young professionals and older professionals
- Talent attraction: Collaboration with universities, scholarships- events and programs of the organization
- Knowledge-Management System: Shared platform is actively used-average information added, number of clicks used. Active Mentoring system
- Motivation and support for transformation: professional development change of work functions- inter organizational change of job functions, support for professional development- external courses
- Cross-functional collaboration – projects of cross functional teams

The above list provides a guideline for measurable activity to improve the cultural readiness, as the DT is realized by committed employees, not by the installation of new technologies.

### *(c) Communication & Alignment of Expectations*

The contrast of some of Organization A's Managers description of the implementation success of their EAM, and the results of the on-board questionnaire where half of the participants are pertaining to a reduction of efficiency is evidence to the difference of perspective, use and priorities given in the design phase of the software.

The roll out and feedback from the participants of this research showed the main factor of frustration and delays accountable to broadband connection on board. While a backup solution was present, it did not solve the long buffering times. Since implementation the Organization has taken action to reduce this effect, by increasing bandwidth, installing 4G antennas and is developing a mobile application with offline capabilities. However, the initial difficulties encountered created a negative impact. This example demonstrates is not chosen to point out shortcomings, but to demonstrate the importance of creating awareness and understanding within new systems and technologies. An on-board user describes it as follows: "*As I observed, I find it quite necessary for different individuals onboard to possess a certain degree of knowledge and competency when it comes to information technology or as mentioned, Digital Transformation in general, especially for old timers who are not familiar with this kind of systems. Not does it only helps make our jobs easier and more systematic, it also helps safety and security for/from cyber attacks".*

The cultural change, shared vision & strategy and digital leadership are core aspects to successfully realize the DT potential within the Organization. Communication and organizational interaction is the vehicle to achieve a cultural shift.

It can be stated that the initial strategy must include the shift of perspective towards a "digital mindset", using digital tools as solutions when reviewing actual business problems. This requires Leaders and Managers, as well as employees to have competencies within digital developments.

Henriette et al. (2016) argue that digital transformation begins with the adaptation of existing systems, and over time, evolves into a holistic transformation across an organization, describing it as a stepwise improvement.

In planning and budgeting of a DT project, several sources confirm the findings of this work: the tendency to overfund in hard/software and the neglection of soft variables (Andriole, 2020).

Company B&C have shown with their focus on user-friendliness and intuitive layout, as well as a prolonged overlap period, that the adoption of the Vessel Reporting System (VRS) as a smaller module proved technically very easy.

"*The only problem is the psychological part*" (Interviewee 2, Organization B), as the shared vision of integrating a tool for decision making must be accepted and understood as a value both on board and ashore. As Interviewee 2 explained, the installation of sensors can have a negative effect on the crew and shared his experience with a chief engineer, who is using his fingers on the engine to measure vibrations, and with years of experience thereby "reading the engine" but perceiving additional sensors and data sharing and external monitoring as a threat to his competency and authority.

This concept of data accumulation and sharing is not novel to the maritime industry has been applied to several areas of life. An example is the automobile industry several specifically Tesla, which is while protecting private information of the driver and owner, is generating shared data to "fulfill products and services" and "improve and enhance products and services", as well as processing and monetizing the owned data(*Privacy Notice*, n.d.)

Organization A has invested in implementation and communication, fully aware of the necessity of the end user adoption of the system, to achieve the data quality required for further use, however despite the anticipation of the system, the actual experience was described as frustrating.

From the on-board questionnaires the discrepancy between high expectations described by 81% of the participants towards the degree of fulfillment of the expectation which averaged of 3 out of 5, or 60% shows a misalignment between the end users' expectation and reality of the implemented system.

"The expectation was high. However, when rolled out, many of us got very disappointed." This quote of an on-board user highlights the mismatch between expectations and system which was provided. How to align expectations, is a challenge which was shared by some Management personnel, as the system was not completed and presentable, but developed prior roll out to the fleet. This created an uncertainty of expectations towards the end product. Communication and transparency of the process and the expected challenges, as for example bugs, updates, connectivity issues and backup solutions could have been shared at an early stage of implementation, as well as the concept of an agile iterative approach.

The Parento principle states that 80% of consequences come from 20% of the causes (*Pareto Principle Definition*, n.d.). This model is used in software development where 80% of the value is developed in 20% of the time, or specifically a working prototype can be built in 20% of the time, demonstrating 80% of the products value (Bullock, 2021). Knowledge of this principle creates understanding and improves the alignment of expectations, as the roll-out of a developed software cannot be expected to be bug free, but that the development efforts will be ongoing and are dependent on users input to achieve its true value.

Familiarity with the hype cycle of Gartner can further increase the understanding and mitigation of the negative impacts. As in Figure 18, the trigger leads to development of a system, the examples being the EAM of Organization A, aiming to replace an outdated system and the VRS of Organization B&C, aiming to analyze vessels performance data, for monitoring and reporting purposes.

In phase one, the active measure of the Organization implementing a digital technology, should aim to inform and increase knowledge about the system, its opportunities, value, as well as difficulties which will accompany the roll-out. These targets inflated expectations towards a realistic expectation.

Phase two marks the implementation and active use of the system, followed by a rapid decline of expectations when reaching the trough of disillusionment.

In this phase active development work on the system, and training, and communication is required to create the understanding and realistic value and capabilities until entering the plateau.

Organization A's introduction of the EAM system was a large shift from several systems to one integrated system in a cloud architecture. It can be presented by curve b) as the deviation from expectations to the experience after rollout was significant.

Organizations B&C's VRS system, represented a minor change for the vessels, as the format was derived from the common noon report, therefore familiar for the end users. The major barrier of this implementation was "soft" work, to reduce the perception of "monitoring" and remotely demanding control of operations on board, towards seeing the value of improved analytics and trends and using the information of outliers to take early action. Its implementation could be represented by curve a, while its current status is established and commonly used, located in phase five, the plateau.

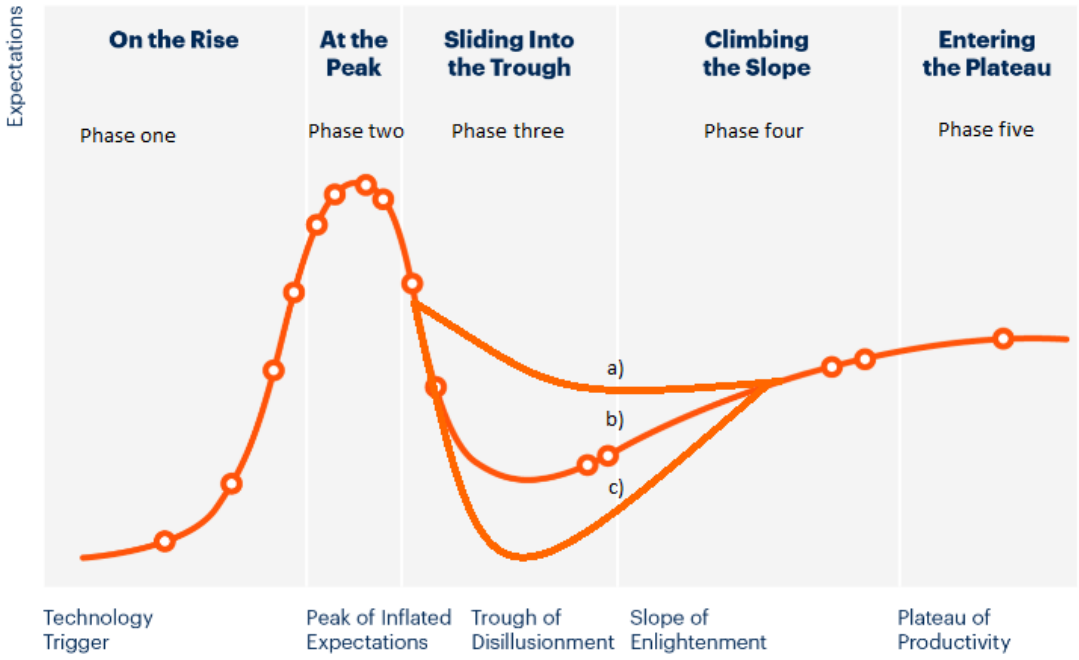



*Figure 23 Hype cycle based on Gartner n.d.*

Of company A's on-board Management team's half have stated a loss of efficiency during the implementation of the EAM system on board. While this reflects only an excerpt of 64 participants of a total pool of over 1000 seafarers s a thought experiment shows that the implementation of a system on 40 vessels resulting in 15min additional time usage results in a total of 4800minutes, or 80h which would account to 10 working days (à 8h) of time lost every single day.

A comparable situation is found with company C, who as pure Ship Managers offer Vessel Performance Monitoring, requiring the vessel to complete the cloud based VRS report.

*Table 16 Efficiency loss projected to Fleet-Global context*

| | Vessels | Main users of Company Systems per vessel | Total users | 15min delay/day |
|---|---|---|---|---|
| *Company A* | 40 | 8 | 320 | 4800min<br>80hours<br>10 days (8h working days)<br>3,3 (24h days) |
| *Vessels Global* | 50.000 | 770.000 officers | 770.000 | 11.550.000 min<br>192.500 hours<br>24.062 (8h working days)<br>8.020 (24h days) |

### 5.3.2 Technical

#### 2.5.8.1.1 User centered design

It has been established that cultural change is one of the core success factors for DT, however in the on-board study the reception of the recent technologies is varied depending on the systems, setup, functions, training and implementation Software produced without due attention to its users' needs is doomed to fail(Scanlan et al., 2022).

In the on-board questionnaire, more than one third of the participants named user friendliness in their initial expectations e.g. "a more user defined system easy to use".

The selection and setup of the system is integral to its success, as it must provide a richer user experience (Nylén & Holmström, 2015). "*We felt it was kind of not user of friendly. It was too many clicks to come to the, to the goals*".(Interviewee 5)

Off-the-shelf products have the advantage of being tested and proven by previous customers, therefore the end product is more defined with less risk.

However, these systems have an inherent rigidity, which could be outperformed, by a highly developed system, adjusted to the actual business processes, providing an agility in volatile environment.

An example of Organization A, was the in-house collaboration system containing a Position list, of the vessels, as well as the possibility to further drill down towards cargo details , port rotations, agent etc.

Due to the COVID situation a high importance was giving to knowing the vaccination status of the crew. The in-house development team developed an add on within several days, which was implemented after testing and debugging a short time after, providing an overview to the shared data, of the status of vaccination on board.

The agility and opportunity in these tailored solutions can provide the competitive edge, however, are higher in initial investment, continuous development and implementation.

Hapag-Lloyd is following similar steps, as it announced in march 21, that they will roll out an IOT ready maritime fleet management system replacing several of the shipping company's existing fleet management systems. (*Hapag-Lloyd Selects SERTICA Fleet Management System for 70 plus Vessels*, n.d.)

The architecture of the systems and active management of products is required to gain the maximum utilization of the product, as Interview 8 from Organization A states:

"*for product portfolio management is basically the central management process to collectively analyze and manage projects and sequence their execution. And then this is all about matching those initiative to appropriate organizations, goals, basic goals yeah, I mean basically want to improve the business outcome*".

In the maritime surrounding the limited connectivity as discussed in 5.3.2 c) must be taken into account in providing the user experience. A system architecture for on-board applications must be optimized in the number of clicks for the user, as well as interface and search function and categorization, to avoid longer loading times and fast processing "*Sometimes it takes more time completing the report than doing the job itself*" (On-board Questionnaire response)

The trend is the move towards cloud computing. Lloyds Registers (LR) followed suit with its Cloud Fleet Manager EAM SaaS system. In their product portfolio LR quotes "56% of executives agree that cloud migration has become an absolute necessity".

#### 2.5.8.1.2 Connectivity & Interconnectivity (3rd Party)

Of the on-board respondents of the questionnaire, over half stated that efficiency is reduced following the implementation of the EAM system "There is a big impact if the internet is not stable. It creates overdue jobs since we can't access due to unstable internet connection". This issue has been evaluated prior to implementation, blind spot areas have been identified, and the data speed has been tracked. The actual behavior of the system on board was tested, in a trial run, therefore the connectivity issue has been not expected by the users on board. As the system is novel within the shipping sector, a large roll out to a large fleet has not been performed. There are backup procedures in place, and further introduction of an offline system is anticipated within this year.

#### 2.5.8.1.3 Environment

With the regulatory environment changing rapidly towards sustainability, the pressure compliance is high, which is represented by the large investments seen towards vessel performance monitoring. The regulatory framework is created by the IMO, however certain regions like US and EU and other regulatory bodies are further creating tightening requirements.

Another impact these regulatory bodies inherit, are the regulatory framework, allowing for the application of emerging technologies, as e.g., the importance of a physical paper trail in form of log looks, places a complication on the owners journey to digitalization.

3rd Parties and External suppliers and customers are also influencing the progress of the Organizations, as for many initiatives interconnection between systems is required e.g., to allow for automations (auto-reporting, auto-purchasing of critical items, etc.) while keeping data secure.

### 5.3.4 Is this digital transformation?

The introduction of Company A's EAM and Company B & Cs introduction of the VRS represents initiatives of the Cases to digitalize their organizations.

As digital transformation often refers to the use of "disruptive" technology in reference with the 4th industrial revolution (Andriole, 2020; Teichert, 2019)the cases of this research could be regarded not as part of the Digital Transformation, as Interviewee 10, Organization A, describes "it's not a digital transformation(…) I don't think it has changed us in, in how we are as a company, but it has changed, made more, maybe a bit more effective". In contrast the implementation had a large effect on the crew on board reporting a 51% reduction of efficiency, due to connectivity problems and system layout, while Management has described the implementation as "paradigm shift" in using data supported decisions and increased organizational transparency.

This gap of perspective of DT is due to the wide understanding, varied definition, and the description of a "disruptive" impact. DT can follow different incremental development stages with the aim of a continuous, perpetuals state of innovation supported by a digitalized corporate culture, as for example described by the model in the figure below, or leapfrog between different stages of digital maturity.

Contrary to publication and sales advertisement for digital products, the biggest challenge as confirmed in this thesis is the ownership of the system by personnel of the organization and the understanding an adoption of the corporate digital vision

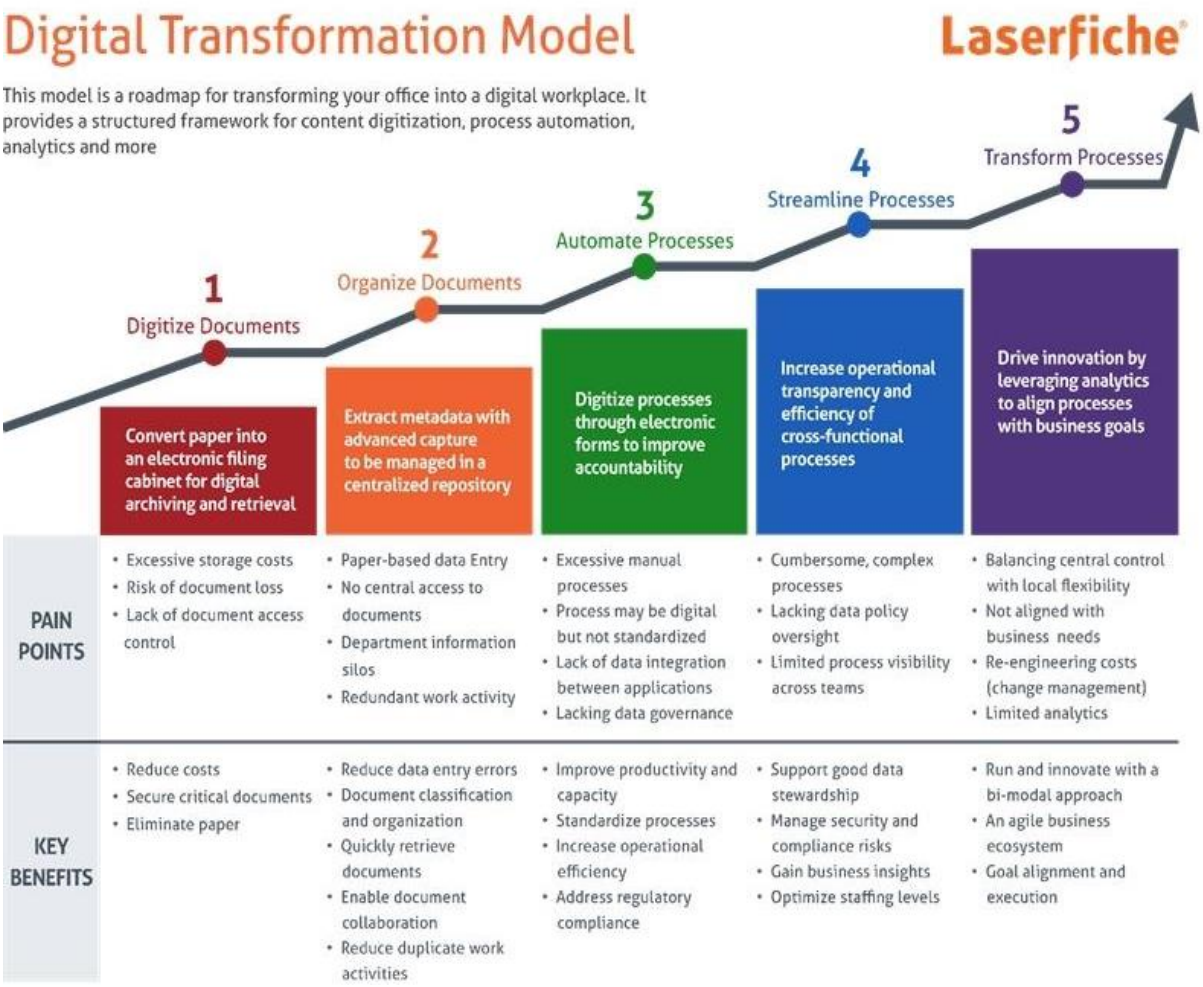



*Figure 24 Digital Transformation model source:Laserfiche*

## 5.4 Method discussion

In this section the research method and its potential weaknesses are discussed to address the validity and value of the research outcomes to the reader.

Primarily the reduction of validity in case studies could be caused by the biased view and input from the researcher, steering the conversation and therefore data in a certain direction. BY the identification of this risk, open ended questions, and review of the interviews conducted, this risk is mitigated.

Further, this in-depth research is limited, due to the small sample researched, therefore making it difficult to draw parallels and generalize conclusions.

Another risk in this case study lies in reduced validity, due to the boundary conditions. The limited time frame of the research and interviews conducted, limits the number of cross cases included in the study, and the depth  Resource limitations, in time to perform several in depth case studies, selection of cases and resources define the depth within the given time frame of the research

Sociotechnical method in regarding the example of fleet management software, to explore the DT on a specific example which is the introduction of a cloud-based Fleet Management Software (FMS). This software can have various reaches, but usually includes the Planned Maintenance System (PMS), for reoccurring maintenance work on board and on-board systems, purchasing and stock control. Often the Incident and Near Miss reporting, Audits, Document control, Certificates, Crewing, Rest hours can be performed on the FMS. The integration of IoTs and alarms and controls can be due to the cloud-based system be viewed “live”.

The value creation and loss if applicable will be discussed on this system and the focus in the case studies involved.

### 5.4.1 Interview

Conversational interviewing has been criticized to provide the opportunity to be leading by the interviewer(Conrad & Schober, 1999), as by interacting, highlighting, and returning to questions. While it provides a better understanding of the interview questions as intended, the cost of the clarification can result in a streamlined biased result. It was chosen in this research, as the opportunity to reduce misunderstandings and misinterpretations of the interview questions, ultimately leading to more accurate responses of the Interviewees. A key instrument in this research is the researcher collecting background data about the organizations, systems, as well as interviewer of the participants of the case study.

### 5.4.2 The Interview Questionnaire

The Interview Questionnaire is split in three sections.

1) *The Background* questions cover department and fleet size, and responsibility area of the interviewee, as well as the process of innovation within the organization.
2) *DX implementation and strategy* inquiries about the recent implementations of Digital tools and systems, their effect and lessons learned, as well as the expected and generated value of the implementation

The Questionnaire designed in the initial stage of the research, was tested and revised, during the first interviews it was noted that several interviewees, were not part of any implementation of recent digital technologies, rendering the questionnaire not directly applicable to several questions of part 2.

As conversational interviewing style was chosen, it gave the researcher the opportunity to re-route the question to previous experience in different roles and expected process of implementation of possible future technologies introduced. The choice of style allowed to use the questionnaire as a script but depending on the applicability allow flexibility within the conversation.

This also affected the actual reading of the questions, due to several sub questions, such as in question one as per below. In the interview only the first part was read and the timeline as current, recently (which was described by the researches as a timeframe of around 2 years) and future use.

1. *What digital technologies are used in your company?*
    a. *Currently or recently introduced*
    b. *Potentially used in the near future*
    c. *How is the collected data used?*

Here the conversational style allowed for definitions, explanation and a timeframe which was not indicated in the question alone.

Constructing the questionnaire, required the selection of wording and terms used, such as the example above with “digital technologies” may result in ambiguity and different interpretations. Research by Belson and others have demonstrated that ordinary words such as “you”, “children” and “work” are interpreted very differently by different respondents (Martin, 2005).

The first question enquires about “digital technologies” used and create the first possible ambiguity at the beginning of the questionnaire, as what would be considered a digital technology? This ambiguity the researcher was met with during the interviews as well and further explanation was given as digital system with a considerable impact to the company and its processes were meant.

The initial expectation of the researcher to begin of the research was going towards smart systems, industry 4.0, however during the interviews these technologies were mentioned only in conjunction with future possibilities.

### 5.4.3 The on-board Questionnaire

The on-board questionnaire has been included in the research, to allow feedback from the end users of the systems in Organization A's fleet. They form the majority in numbers of the systems and are subjected to different working conditions on board and different IT capabilities as for example connection coverage and broadband width.

Google forms was chosen as the transporting website, after several commercial survey sites were visited, and rejected, due to the amount of advertising subjected to when using the free version. Google forms, provided a simple, add free layout and the possibility to include a dynamic layout. This was required, as the number of systems named by the users, dictated the further questionnaire, progressing through part 2 describing the implementation and user experience of the technology introduced.

In constructing the questionnaire the wording was carefully considered, as research is showing that small changes can substantially affect responses (Martin, 2005). To produce data with high validity and reduced bias the potential effects were required to be considered.

An example in the on-board questionnaire is the question of "how many impactful IT technologies were implemented within the last 2 years?". This question can be regarded as a presupposition, as it presupposes that a technology was implemented within the two-year time frame, and that it has been "impactful". This is an example both of a presupposition and an ambiguity of the interpretation of "impactful".

The design of this question has been purposeful, as it was of interest which technologies would be regarded in their interpretation as impactful, as around 9 introductions of digital systems could be named.

Order and arrangement of questions can further influence the answers of the users, as certain questions trigger feelings and thought processes influencing the subsequent question. For this questionnaire the chronological order was chosen. Naming the impactful technology was the first question of the second part of the questionnaire, followed by the expectation to this system the experience during implementation and the work effect. By finishing with a rating to which degree the expectation was fulfilled, the user had the opportunity to think about the challenges, opportunities and their implementation experience in the previous questions.

The above argumentation describes the reasoning behind the researcher's choice of words and order, but this choice could be challenged, by reducing ambiguous words like "impactful" and some presuppositions the results could be different from the ones achieved, as the words and question composition chosen may influence the target topic.

By choosing open ended questions in most of the questionnaire, the intention of a qualitative data collection was intended, however this gave the opportunity for the respondents to generalize, respond in one-word answers and answer vaguely. It further also increased the workload in coding the open answers and catalogue/analyze the responses.

To initiate the responses from the participants, an email notification was sent out to 39 vessels via the captain's email address, for the voluntary participation in this research. It was aimed towards senior officers on board the vessels. An initial response after the first three days was low with a total of 19 replies. A follow up email, directly to Captains, Chief Officers and Chief Engineers was sent out totaling to 117 crew, of which 64 participated resulting in a 55% participation rate. By addressing the crew via their direct contact emails a possible effect or might be created, due to the researchers affiliation within the organization

## 5.5 Method discussion Summary

The limitation of the study is to be regarded within its exploratory terms only, due to the limited case size of different organization structures, sizes and responsibilities the results are ot transferrable to a larger audience, further research with larger sample size, of companies located worldwide would improve the quality issue of the work.

Cultural aspects have not been covered, but are in shipping present, with various background of seafarers, as well as locations of onshore offices which can be directly related to the organizational culture.

## 5.6 The Researchers perspective

As a trained Nautical Officer with the Background in Offshore renewables, and one year experience in a Ship Management as a Marine Superintendent the perspective the researcher has towards the industry and topic is biased, by experiences in the sector

The industry is antiquated, as shipping is a traditional business, with two case Organizations being family founded business with a traditional background. This perception is due to the organizations interacted with, where the average age of shore personnel, is well above the researchers, but especially seen across the industry. The large amount of email communication for documentation requests in pre-vetting of vessels, or brokering of the vessels, the workflow has not changed in its core, even if using more digital tools. Similarly, the equipment and practices on board most vessels is old, as the world fleet is aging with Therefore, also a different perspective towards technology and background knowledge of machine learning could be influencing the conception and direction of the research.

To clarify this potential disposition, the background of the researcher is shared with the reader to evaluate the possible impact on the results

The direction of the research has an underlying agenda to provide practical information of Measures of Digital Transformation in maturity as well as in the success factors. To provide a perspective of where the company is in its progress of DT and if it is “working” and providing the expected value.

By starting the research off with a Literature Review and comparing similar research projects in different industry sections with an Ontological assumption and the aim to report different perspectives, by using references and quotes of the participants.

# 6 Conclusions & Recommendations

## 6.1 Introduction

The World Economic Forum forecasts 70% of new value creation by 2030 will be on digitally enabled platforms (*Why Digitalization Is Our Best Shot at Saving the Planet*, n.d.). This confirms the immense business opportunity for organizations that lies in the successful application of appropriate technology. This technological revolution surrounds us in applications like, smart phones, smart homes, smart

transport and has also reached the shipping industry creating an urgency of adjustment: “The digital challenge in a nutshell is, that we are in a competitive survival game and technology is involved incredible fast. So doing nothing is really not an option” (Interviewee 8).

Even though, this is an ongoing process, the practical application within shipping organizations has not been extensively studied. This research has identified determinant factors in realizing DT from literature and within the practical experience of three case study organizations.

The contrast of organizations represented shows the different stages of these organizations within their own digital journey, which is related to their businesses as in relation to fleet size, organizational structures, and resource capabilities. From limited capabilities and research activity, as well as outsources IT department (C), to active digital innovation efforts Organization (A), This is reflected in Organization A’s ambitious introduction of a cloud-based Enterprise Asset Management (EAM) software and organization C’s Vessel Reporting System.

## 6.2 Addressing the research Question and Contribution

Digital Transformation as the 4$^{th}$ industrial revolution improved efficiency and productivity, access to new markets, and optimized supply chain (Jonathan, 2020), as well as securing the company’s competitive edge, and ultimately the survival.

While previous literature is defining barriers drivers and success factors, the practical application on shipping organizations presented a research gap.

The core findings are presented as categories of determinant factors. The difference of approach between literature and definitions, which often are focused on the digital systems used, contrasts with the strategic approach represented in this study. Many DT definitions include “the adoption and use of digital technologies”(Henriette et al., 2016 as cited by Tijan et al., 2021). This approach is technology driven, and conflicting with the findings of this research. It has been established, that the overarching strategy must include the critical review of business processes and review of organizational needs, anticipating the introduction of digital technology.

Further, active corporate, cultural change is highlighted, to enable digital leadership, and the digital mindset. This is transforming the organization to a digitally aware business with the competence of

making informed decisions and finding dynamic digital solutions to current business problems, as well as enclose new opportunities within the market.

DT therefore does not start with the adoption a digital technology, but in preparation, by defining core processes and business problems, needs and assessing the current organization, creating a shared vision and digital competence throughout the organization. This change of approach from the technology-driven, towards the process-driven, standardized, and systematic approach provides the outcome leading to increased utilization and ultimately to increase business value and competitiveness.

To realize this vision the cultural change towards a digital, innovative organization is imperative. This requires experts in their field e.g., software developers to be integrated within highly developed system, and training of employees towards digital competence.

Organization A showed at the example of the EAM system implementation, the hype cycle realized, currently in the critical stage of the trough of disillusionment, which is in line with drastic reduction of efficiency reported from on-board users . Active organizational and technical initiatives are required to enter the slope of enlightenment and increase the understanding and correct use of the technology.

The core contributions of this research include the practical account of the case organizations and the highlighted core considerations of:

- Shared Vision – Structured and analytical approach to
- Cultural Readiness - Digital Awareness and Competence, as well as inter-departmental exchange creating an agile workforce
- Technical Capabilities – Setup, Integration abilities, maintenance, and development capabilities

This research is therefore contributing to the understanding of successful realization of DT in shipping organizations by the account of empirical evidence provided by the case Organizations, highlighting determinant factors and providing practical guidance to readers.

## 6.3 Research Limitations

This research is limited to three organizations, with an unbalanced amount of data being represented, due to the different stages and numbers of initiatives ongoing, with Organization A accounting for a larger comparative portion of the data. The time frame has further limited this work, which in practical terms meant more participants could not be included in the study. In addition the limited time also meant that it was not possible to utilizing all data collected, therefore was limited to only highlighting the major determinants.

It has revealed the importance of strategy and corporate culture and added new perspectives and experience accounts to existing research.

## 6.4 Further Work

The findings in direct comparison to recent literature has added an additional dimension, requiring a larger study of more organizations and technologies to confirm these findings and to form generalizations.

This would provide an assessment of the current situation of shipping companies digital transformation.

The data collected for this research has not been exhausted in the representation of findings, and within the scope as the data collected exceeded expectations in variety and number of topics and insights, well worth investigating.

Further topics included:

- application possibilities of IoT,
- data collection, big data processing and use
- cloud computing and current application as well as planned applications
- integration and structural architecture of applications
- Hype vs Value creation – analytic capabilities with current systems and the increase of value by application of emerging technologies

These analyses have not been completed in this research and allow for future research opportunities.

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