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Digital transformation of maritime logistics: Exploring trends in the liner shipping segment

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ABSTRACT

Rapidly evolving needs of shippers, rising competition, advancement in digital technologies and a quest to increase cost and operational efficiencies are all driving the digital transformation of maritime logistics. However, in contrast to other industries such as media, telecom, banking, retail and even other traffic modes, the often family-controlled and network-centric liner shipping industry has historically been conservative in adopting innovations; hence, it is still far behind in embracing digitalization. Based on semi-structured interviews with senior executives of liner shipping companies, this study explores the current digital maturity levels, the opportunities provided by digitalization and the underlying challenges that hinder its implementation in the liner shipping segment within the larger maritime logistics industry and identifies the essential leading strategies of digitalization in this segment. The digital maturity categories applied to liner shipping provide an opportunity for practitioners in this industry to evaluate their business functions' digital maturity levels. Furthermore, based on interview data, digital transformation for the maritime logistics industry is defined, as well as 9 major barriers and 19 different pathways to digital transformation are identified. Understanding the key challenges and success factors in the industry is a key to approaching digitalization problems and developing a healthy digital transformation process.

1. Introduction

The digital revolution over recent decades – also known as the "digital age" – has fundamentally transformed the competitive dynamics of various industries including logistics (Hofmann and Osterwalder, 2017). The maritime logistics industry plays a pivotal role in global and regional trade but can hardly be characterized as a forerunner in digitalization. The industry faces a number of challenges such as high fragmentation, low transparency and visibility, costly manual processes, in many instances outdated customer interfaces, volatile fuel prices, demand uncertainties, environmental regulations and stringent competition within the industry and from rival freight transport modes (Raza et al., 2020; Rodrigue et al., 2017), with the net result being poor predictability. Furthermore, the industry is network-centric with several, in some cases up to 40, independent actors engaged in a port-to-port or door-to-door voyage. Manual processes and a lack of seamless coordination among these maritime logistics actors (Panayides and Song, 2013) lead to longer transit times, delays, poor reliability and the increased cost of maritime logistics services (Jensen et al., 2018). To this end, a study carried out by Maersk shows that in some specific markets, half of transport costs are associated with management and order documents, arising mostly from data processing and customs requirements (Cariou, 2018).

Digital transformation (DT), which refers to the required transformations driving digitalization within and between organizations based on a digital strategy (Heilig et al., 2017), presents major opportunities to improve the environmental and economic performance of stakeholders involved in maritime logistics (Kache and Seuring, 2017; Lind et al., 2018). Recently, the role of digitalization for maritime logistics operations has emerged as the applied discourse of maritime informatics (Lind et al., 2021b). Although the maritime logistics industry is composed of multiple actors, such as shipping companies, rail operators, road hauliers, seaports and inland terminal operators and freight forwarders, the DT of different segments within maritime logistics require separate attention. Considering that the demand from these networks is triggered by the demand for shipping services, the

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digitalization of the shipping industry deserves a focused analysis. Despite the benefits promised by DT, the shipping industry is reluctant to adopt new digital technologies and increase innovation (Sanchez-Gonzalez et al., 2019), when compared with the media, telecommunication, banking or retail industries. Lack of a DT strategy, insufficient technical knowledge and skills, high cost, lack of standardization and interoperability (Pagano et al., 2022), and cyber security are considered to be amongst the key factors that impede the adoption of digital technologies in shipping and logistics (Egloff et al., 2018; Gunasekaran et al., 2017; Mathauer and Hofmann, 2019; Tijan et al., 2021).

DT has garnered interest and efforts from the maritime logistics industry practitioners and policymakers, however, academic research on this topic is still at an early stage. In a recent review, Tijan et al. (2021) emphasise the need for more empirical research to gain deeper insights regarding digital awareness in the shipping industry. Similarly, recent literature reviews by Munim et al. (2020) and Parola et al. (2020) have, in particular, emphasized the need for more research to investigate barriers to DT in maritime logistics. Focusing a lens on liner shipping leads to the development of a deeper understanding of DT in this segment, which is closely connected to the larger maritime logistics industry via door-to-door movements of transport units such as containers and semitrailers.

A better empirical understanding of drivers and challenges regarding DT could enhance the diffusion of digital technologies in shipping and, consequently, improve performance not only from a cost perspective but also from an environmental perspective. As elaborated within the discipline of maritime informatics, the need exists to balance the capital productivity of the single organization with energy efficiency requiring the participation and collaboration among several and, many times, competing actors.

Therefore, the objective of this paper is to explore the benefits of DT together with the underlying factors that hinder its implementation while identifying the essential organizational elements and leading strategies that shape DT success in the maritime logistics industry with a particular focus on the liner shipping segment.

Consequently, the following four research questions are investigated in this paper:

RQ1: What does digital transformation mean to a liner shipping company?
RQ2: What is the digital maturity status of the liner shipping industry?
RQ3: What are the main drivers and challenges of digital transformation in the liner shipping industry?
RQ4: What are the liner shipping industry's key strategies for embracing digital transformation?

These research questions are empirically addressed following a qualitative research design based on semi-structured interviews with senior executives from liner shipping companies. The findings are analysed both with reference to liner shipping but also in relation to the larger maritime logistics industry. The article is structured as follows. A literature review that clarifies the frame of reference is presented in Section 2. Section 3 describes the methodology, while Section 4 presents the results. Section 5 discusses the results and concludes with some practical and scholarly implications.

2. Literature review

Despite rising interest from both academia and industry, digital transformation still needs conceptual clarification, particularly due to its frequent synonymous use with similar terminology. Often, the terms *digitization*, *digitalization* and *digital transformation* are used in a mixed or even interchangeable fashion. While *digitization* is defined as creating a digital representation of physical objects or attributes (Gong and Ribiere, 2021), *digitalization* refers to the use of digital technologies and digitalized data to alter sociotechnical structures (Osmundsen et al., 2018). Thus, digitalization presumes digitization as it goes beyond a mere technical process of encoding analogue information into a digital format and it aims to increase efficiency and productivity of the existing processes by reducing costs and increasing profits (Tilson et al., 2010).

DT, on the other hand, is defined as a strategy or a broader process of transforming an organization or a network of organizations on different levels such as strategy, governance, leadership, culture, people and technology. It is, in the view of Osmundsen et al. (2018), driven by, built on, or enabled by digital technology. It must be stressed that DT is not about a single technology, but rather it implies major organizational changes based on "combinations of information, computing, communication, and connectivity technologies" (Bharadwaj et al., 2013), p. 471) or it is "a fusion of advanced technologies" that are integrating physical and digital systems (Cichosz et al., 2020), p. 211). Importantly, not all technologies within DT have to be digital, even technologies or machines that themselves are not digital (e.g. delivery vans, forklift trucks and conveyers) can become an element of DT (Mathauer and Hofmann, 2019) when equipped with new technology components so that they, for example, can be tracked with regard to their location and speed. Goran et al. (2017) argue that DT extends beyond a technological shift and that it requires not just technology but also the alignment of strategy and other factors, such as people, culture, mindset, talent development and leadership.

2.1. Purpose and drivers of digital transformation

The fundamental objective of DT is adding value to an organization. Value includes, but is not limited to, operational efficiencies, improved customer experiences, improved business models, development of new products and services, strategic differentiation, competitive advantage, improved stakeholder relationships and cost savings (Kossowski et al., 2020). According to Haffke et al. (2016), competitors' demonstration of advanced digital technologies, new industry and non-industry entrants with disruptive digital business models, regulatory pressure and technological advancements are considered to be the triggers which motivate companies to engage in DT projects. Recent studies by Kuo et al. (2022), Sullivan et al. (2020) and Tijan et al. (2021) similarly indicate that the key drivers of DT in maritime logistics are changing customer requirements and expectations, cost reduction, digital shifts in customer industries (e.g. manufacturing), legislation and changes in the competitive landscape.

2.2. Digital maturity

Cichosz et al. (2020) suggest that DT is a continuous evolutionary process which varies across implementing organizations and relies on their digital maturity. Digital maturity is defined as "the degree to which organizations have adapted themselves to a digital business environment" (Kane et al., 2018, p. 6). Westerman et al. (2014) and Kane et al. (2017) found that greater digital maturity leads to enhanced corporate performance. This is also verified by Kuo et al. (2022) who have found that well-established DT leads to various benefits for the shipping industry actors such as enhanced efficiency, improved customer satisfaction and better environmental performance.

Westerman et al. (2014) further describe that digital maturity is a combination of two separate but related dimensions. The first is digital intensity, which is related to digital capabilities and investment in technology-enabled initiatives to change how a company operates, its customer engagements, internal operations, and even business models. The second dimension is transformation management intensity which consists of the vision, governance and leadership capabilities necessary to drive DT in the organization.

These two dimensions spell out four different types of digital maturity (Westerman et al., 2014). Firms with weak digital capabilities and

weak transformation management capabilities are digital beginners. In contrast, firms with both strong digital capabilities and strong transformation management capabilities are the digital natives who truly understand how to drive value with DT and achieve competitive advantage by investing in the essential elements of transformation management, which are vision, governance and engagement. The findings of Westerman et al. (2014) indicate that building digital maturity or digital-DNA matters for all industries, as evidenced in their research, so that, on average, digital natives are more profitable than their industry competitors. They generate more revenue through their employees and physical assets, and they create more value and generate higher market valuation ratios. In contrast to conservatives, who focus on control and alignment, digital natives have digital capabilities and have developed a strong transformative vision that motivates employees to make changes happen. Fashionistas, on the other hand, might resemble digital natives, but have not yet managed to integrate digitalization throughout the organization. The typology of DT maturity is viewed in Fig. 1.

For a successful DT, it is important not only to evaluate the current digital maturity level of a firm and to determine strategies to move forward but also to consider challenges that are critical to advance DT initiatives in the firm.

2.3. Digital transformation challenges

For a successful DT and to achieve the positive outcomes, organizations must identify and counteract the impeding barriers that hinder the execution of their transformation (Parola et al., 2020). Table 1 presents various technological, organizational, and operational challenges that confront firms during the DT process.

In his comprehensive literature review, Vial (2019) refers to 35 sources, revealing that one of the most significant barriers to DT is inertia. Inertia is relevant where existing resources and capabilities can act as barriers to disruption highlighting the relevance of path dependence as a constraining force for innovation through digital technologies (Srivastava et al., 2016). In addition, by quoting 40 sources, Vial (2019) further identifies another significant barrier to DT which is the resistance that employees can demonstrate when disruptive technologies are introduced in the organization. To this end, Kane et al., (2018, p. 7) point out "competency traps" with employees who are prisoners of their past successes and may cause resistance, while at the same time organizations may find it difficult to change peoples' mindsets and beliefs as emphasized by Vial (2019). It has been observed that "people are the major hurdle to digital transformation" (Agrawal et al., 2020, p. 299), as there is a lack of a sense of urgency and people lack digital vision. Thus, inertia and resistance are the two biggest challenges that hinder the unfolding of an organization's DT.

In addition to these barriers, the degree of DT introduces new external threats to organizations. Kechagias et al. (2022) and Tijan et al. (2021) reveal that the complexity of ships is constantly increasing, with more software and automation, more internet connectivity, and more interconnection between systems onboard which have made shipping more vulnerable to cyberattacks. The same goes for operations on land where these large liner shipping companies and their interconnected digital systems suffer from cyberattacks frequently which creates further hesitation towards enhanced dependence on digital technologies in the industry.

2.4. Shipping and digital transformation

Presently, the involvement of various autonomous actors in the maritime logistics industry, such as agents, terminal operators, shipping companies, shippers, financial institutions and customs authorities, forms the self-organized maritime practice (Watson et al., 2021) where each actor using different infrastructures and IT systems makes standardized interactions and collaboration among actors difficult (Lind et al., 2018). The success builds upon the actors continually adapting to each other. Nevertheless, this standardization which can be achieved by DT is particularly required in liner shipping segments where shippers are plenty and more conscious about the time-related service-quality attributes, such as reliability, speed, port turnaround time, transit time, convenient scheduling and frequency (Raza et al., 2019). To remain an attractive and contemporary transport option in an increasingly digital economy, the maritime logistics industry has to create a new digital infrastructure based on data sharing among actors, facilitating visibility, predictability and eventually better decision-making for the actors involved (Lind et al., 2020). One of the biggest challenges posed by DT for shipping is a cultural shift where coordination and synchronization needs to move beyond the requirement of being physically present, meaning they will need to move beyond coordination based on physical arrival and the principles of first come, first served (Lind et al., 2021a).

In parallel to this requirement, the ubiquitous presence of the internet and advances in digital technologies and satellite communications have enabled transparency and connectivity in multimodal maritime logistics networks which is a determining success factor for many organizations in manufacturing and service industries (Lind et al., 2020; Seyedghorban et al., 2020). Starting with satellite communications

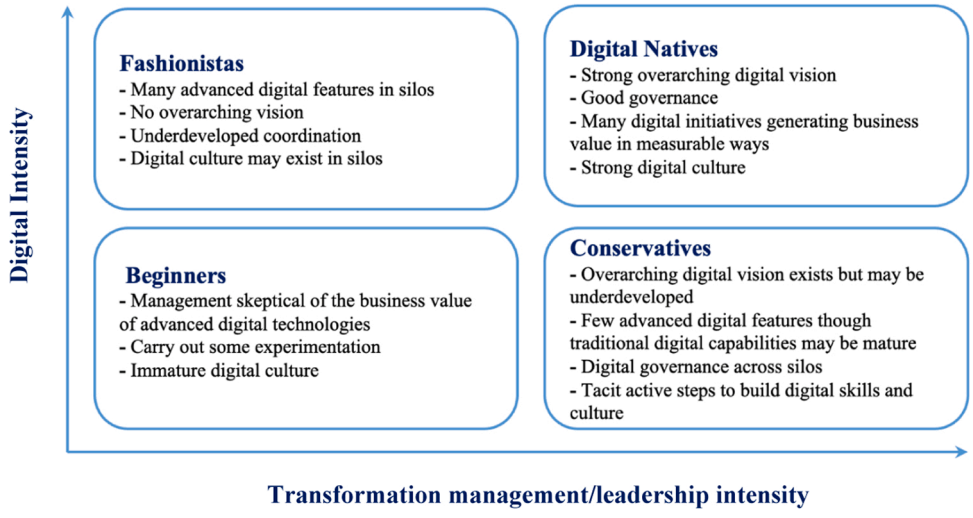

Fig. 1. The digital maturity matrix.
Adapted from Westerman et al. (2014).

Table 1
Challenges to digital transformation.

Challenge type	Challenge	Description	Source
Technological	Data security	Highly interconnected systems as part of DT may pose data security risks and provide more exposure for cyberattacks.	Fruth and Teuteberg (2017),Kechagias et al. (2022)
	Lack of standardization	The incompatibility and/or lack of interoperability between different IT systems used by actors involved in a freight ecosystem can restrict the use of digital technologies.	Gong and Ribiere (2021)
	Type of technology	Determining the right type of digital technologies and how to implement them to support the overall digital strategy of a business remains the main challenge.	Agrawal et al. (2020)
Governance and organizational	Being likely to experiment and iterate	Getting people to take risks, experiment, iterate and work in a more agile way is a key challenge.	Kane et al. (2017)
	Organizational culture	The structural components of the organization, both tangible (e.g., means of production) and intangible (e.g., organizational culture), are so embedded within everyday practices that they stifle the innovative and disruptive power of digital technologies.	Heilig et al. (2017),Tijan et al. (2021)
	Inertia and resistance	Firms performing operations in conventional ways for years have a natural tendency to resist changes. Firms find it difficult to change employees' mindsets and beliefs.	Vial (2019)
	Lack of digital vision	There is a lack of a sense of urgency and a digital vision in firms.	Agrawal et al. (2020)
	Trust and corporate secrets	Due to the fear of falling behind or being exploited by competing organizations, firms are unwilling to share information with partners involved in an ecosystem. Developing interorganizational trust is thus a major challenge.	Vial (2019)
Operational	Resource scarcity	High investment is required to ensure the availability of new digital technologies and resources.	Agrawal et al. (2020),Tijan et al. (2021)
	Missing skills and talent	There is a significant deficit of digital talent. Employees need training and development to upgrade their IT skills and process knowledge.	Raj et al. (2020),Tijan et al. (2021)
	Lack of clarity regarding the economic benefit	Productivity gains and economic benefits of technological implementation are unclear due to fragmented implementation across the value chain.	Heilig et al. (2017)

connecting vessels with shore centres in the 1980 s (Hoffman, 1980; Volta and Soncin, 1980), digital technologies have developed into IT delivery models (e.g. cloud/edge computing), pervasive computing (e.g. internet of things (IoT), cyber-physical systems, mobile computing, blockchain, virtual augmented and mixed reality, digital twins, robotics, autonomous vessels and vehicles in ports, real-time data and related tools (e.g. big data, artificial intelligence [AI], machine learning [ML]) (Jović et al., 2022a). Merchant ships have been equipped with sensors (automatic identification system) for the last 20 years providing continuous updates on position, speed and direction. This provides an enormously valuable source for predictive analytics relying on big data foundations and consequently providing intelligence on the supply chain progress. The technologies address various needs of different segments of the maritime logistics industry. For example, IoT allows for monitoring every cargo handling and operation within logistics centres aiming at taking prompt action to solve accidents or bottlenecks (Parola et al., 2020).

Fundamental to any digitalization initiative in transport and logistics is the need to have appropriate information and communication infrastructure for data capturing, storage, processing and sharing to build robust digital connectivity within and between organizations. Woxenius et al. (2013) emphasize using and communicating data for increasing load-capacity utilization in intermodal rail transport and suggest the use of multiagent-based simulations. Cloud computing – initially known as utility computing or on-demand computing – has become mainstream after more than a decade's development (Wang and Sarkis, 2021). Cloud computing enables authorized users to simultaneously access online platforms from different devices and enjoy real-time services, such as networks, servers, storage and applications. It is, however, just as important for managing organizational foundations, willingness and incentives for sharing data across the network of involved organizations.

The lack of coordination and broken links within maritime logistics networks caused by the involvement of different actors, time zones and the global nature of operations can be resolved by using location detection and tracking technologies (RFID and GPS) (Parola et al., 2020). Improving tracking capability is a quick win as it can substantially enhance container shipping companies' performance by increasing visibility and reducing transaction costs as asserted by (Sanchez-Gonzalez et al., 2022).

As a result, enhanced connectivity and visibility bring several advantages including situational awareness for all the actors which is essential for improved and accelerated decision-making at sea, at port and in the hinterland, seamless track and trace of goods, better inventory control, better demand forecasting, shorter order fulfilment lead times, improved logistics flexibility and asset performance (Aamnes, 2017; Becha et al., 2020; Parola et al., 2020). Furthermore, these advantages can lead to energy efficiency, reduced operating costs, better customer satisfaction and reduced emissions through, for instance, slow steaming for just-in-time arrivals, optimized port call operations and enhanced coordination among maritime logistics actors (Sanchez-Gonzalez et al., 2019).

Despite these potential benefits of DT, only a few leading shipping companies have been investing significantly in digital technologies for enhancing their commercial and operational activities. For instance, Maersk Line uses IoT sensor data from its 600 vessels for fuel economy enhancement, voyage optimization, reefer container monitoring and empty container optimization (Teradata, 2018). Another initiative was introduced by Hapag-Lloyd when it started to equip its container fleet with IoT devices for real-time tracking (Bruno, 2022). However, research shows that digitalization in the shipping leg of maritime logistics is primarily related to ship safety or navigation technology and not to commercial transactions or operational improvements (Feibert et al., 2017). The industry continues to depend on manual documentation and operations while maintaining their reluctant position regarding DT (Sanchez-Gonzalez et al., 2019), but it is currently changing quickly as the need for digital support for commercial operations has become very clear during the pandemic.

3. Methods

Based on the recent calls for more empirical research on DT in the maritime logistics industry and guided by the frame of reference that focuses on its scope, challenges and the benefits for organizations in general and the shipping industry in particular, an exploratory, qualitative research design (Flynn et al., 1990) has been adopted to study the topic in depth. A qualitative research design addresses research questions where the aim is to understand the meaning of the studied concept for study participants that represent a certain context as well as their perspectives in relation to the event or situation that is under focus (Maxwell, 2009). A qualitative research design fits well with the emerging nature of the concept in the studied context of maritime logistics in general and liner shipping in particular (Munim et al., 2020;

Parola et al., 2020; Tijan et al., 2021).

When selecting the respondents, we focused on the liner shipping segment considering the higher value of cargo handled, sensitivity of the customers to service improvements and performance and the complexity of the transport networks (Raza et al., 2019). Liner shipping also manages multiple customer interfaces, in contrast to tramp shipping where there may be one or a few customers for each departure. Furthermore, liner shipping is very closely connected to the larger maritime logistics industry to provide door-to-door logistics services. A majority of the actors in the liner shipping segment are also active in inland transport and logistics operations. Thus, studying this segment enabled us to transfer the findings to the larger context of maritime logistics.

Table 2 provides information about the selected respondents and the activities of the organizations they represent. A purposeful sampling strategy (Coyne, 1997; Flick, 2014) was followed which is in line with qualitative research design as the sample demonstrates both homogeneity and heterogeneity characteristics (Robinson, 2014). Homogeneity is driven by the main service the sample firms provide, liner shipping service. On the other hand, heterogeneity is achieved with respect to the subsegments that they operate within and the extended logistics services they provide.

Based on a comprehensive literature review, an interview protocol was prepared. To maximize the interaction with the interviewees and capture phenomena we had not foreseen, semi-structured interviews were conducted. In total, seven interviews on Zoom or in person were conducted in December 2021 and January 2022. On average, each interview lasted 60 min. All interviews were recorded and later transcribed. An interview guide (Appendix A) was sent to interviewees beforehand, and the interviewees were assured about the anonymity of their respective companies and their individual responses. Significant amounts of data obtained through in-depth interviews with highly experienced executives with several years of experience and representing multiple liner shipping segments of different sizes provided a reasonable base for reaching some general conclusions. Sample selection approach, development of an interview guide based on the frame of reference that explained the concept to be studied, and the comparison of the findings with related literature assured research quality, particularly with reference to transferability of the findings to other settings (Halldórsson and Aastrup, 2003). Within the scope of this study, the findings are transferable to the larger maritime logistics setting and allow the understanding of DT for this larger industry that has rather vague boundaries with liner shipping due to very frequent interaction and overlaps.

Table 2
Summary of respondent companies.

Company ID	Business areas	Turnover 2021 and service region	Interviewees' role	Interviewees' experience
C1	RoRo, RoPax, multimodal, logistics	2–5B € Europe	VP Technology and Innovation	20 years
C2	RoPax	< 500 M € Europe	Chief Digital Officer	20 years
C3	RoRo, logistics	2–5B € Global	Chief Digital Officer	27 years
C4	Container, multimodal, logistics	500 M-1B € Global	Chief Information Officer	28 years
C5	Container	500 M-1B € Europe	Chief Information Officer	10 years
C6	Container, multimodal, logistics	> 20B € Global	Senior Manager Operations	27 years
C7	Container, multimodal, logistics solutions	> 20B € Global	Head of Customer Experience	17 years

RoRo=Roll-on-Roll-off; RoPax=Roll-on-Roll-off Passenger (ferry).

Handling qualitative data is not usually a step-by-step linear process where we first import, then code, then interpret and then write up the recorded interview. Instead, it tends to be an iterative process where we explore, code, reflect, and code again (Miles et al., 2020). The coding process in qualitative inquiry is informed by research scope and research questions. The coding approach can be done in a top-down, bottom-up or an iterative manner which involves both.

In this study, the recorded interviews were firstly transcribed by an external party and the transcripts were carefully examined by the researchers. Then, the research questions acted as the a priori codes (Miles et al., 2020) for the iterative coding process. The interview data was coded into themes and concepts such as definition of DT, drivers, challenges, opportunities, key digital technologies, and DT strategies. These initial codes were adjusted and enriched with emerging new codes and subcodes from the dataset when unexpected and relevant information was found. NVivo software (QSR International) was used to categorize the data into codes and subcodes. The coding process was combined with frequency analysis for selected thematic categories to demonstrate the emphasis put on certain codes in the dataset.

4. Results and analysis

The findings based on analysis of the interview data are presented in this section. Shipping industry from this point on, refers to the liner shipping segment from where we collected our data.

4.1. An anatomy of the digital transformation in shipping

The results suggest that respondents from the shipping lines equally view the notion of DT as a means to transform the current business processes and operations using digital technologies and keeping the customer at the centre of this transformation process. According to C1:

> *DT is a combination of three main aspects. The first is redefining the customer relationships and ways of doing business with customers and this is where most companies start. The second is redesigning and automating processes where most of the value lies and where most of the firms fail. The third is redesigning business models, because once a firm starts dealing with the first two aspects of DT, it can quickly realize that its current business model does not necessarily make sense.* (C1)

A substantial focus on customer centricity and collaborating with the stakeholders have emerged as key components of DT in our findings. Majority of the respondents define DT from the customer's perspective and start their DT journey with customer demands or customer service. They extend this journey to other maritime logistics actors such as suppliers, service providers and even competitors.

Bearing in mind the complex and network-centric nature of the maritime logistics industry, and by carefully examining the views of all the interview participants regarding their perception of DT, we define the notion of DT for the maritime logistics industry as follows:

> *Digital transformation in maritime logistics is a process of strategic change across the different business units and operations of shipping organizations, or a network of organizations in an ecosystem of shipping. This ecosystem is defined as the maritime logistics industry, and this process of digital transformation is supported or enabled by digitization and digital technologies as well as organizational capabilities in change-management, collaboration, and agile ways of working with the objective to enhance the customer experience, increase operational and cost efficiency and create new business models.*

4.2. Drivers of digital transformation in shipping

Creating value for the organization and its stakeholders is found to be

a key goal of DT as indicated by our interviewees. As shown in Fig. 2, our findings demonstrate that there are a number of internal and external factors which have pushed shipping companies to embrace DT.

Our findings indicate that customer requirements regarding visibility, lower prices and lower carbon footprint of their freight transport as well as increasing operational and cost efficiency are the chief drivers of DT in shipping, as C4 explains:

> *Over the last 2–3 years we have seen a strong push from our customers who want to have more visibility and large shippers are signing up for logistics platforms which offer full end-to-end visibility across their entire supply chain, and as a carrier we simply must comply and implement digital technologies to meet our customers' requirements.* (C4)

In addition, DT paves the way for new business opportunities, such as data provision, new service offers, alternative business models and value channels. Hence, DT is viewed as an alternative income source on top of liner shipping firms' traditional services.

Furthermore, competition from non-industry entrants and fear of missing out (FOMO) have also motivated shipping companies to implement DT. As C1 describes,

> *In logistics there has been a huge growth of start-ups in LogTech attacking many aspects of our value proposition and our operational expertise. It has started to become apparent for our people and business that they are bumping against digital freight forwarders and visibility platforms.* (C1)

The liner shipping segment is already truly complex with many actors, but the existence of these actors depends on knowledge gaps between different parts of the maritime logistics industry. These knowledge gaps produce multiple intermediaries that add inefficient layers to the industry which can be eliminated with effective DT according to the respondents. However, this driver also becomes a barrier for DT in the industry because none of these actors want to give up their privilege, and information sharing across systems becomes impossible.

The results further highlight that Covid-19 proved to be another driver and has increased the pace of DT in shipping. The following excerpt from our interviews shed more light on the impact of Covid-19 on DT as stated by C3:

> *Covid last year forced us to look at how we could use the digital solutions to keep doing our business. We couldn't fly a technician between our processing sites in North America, [so] we brought a technician virtually to a site using augmented reality and remote assist. Covid gave the impetus to all the discussion around the use of digital technologies.* (C3)

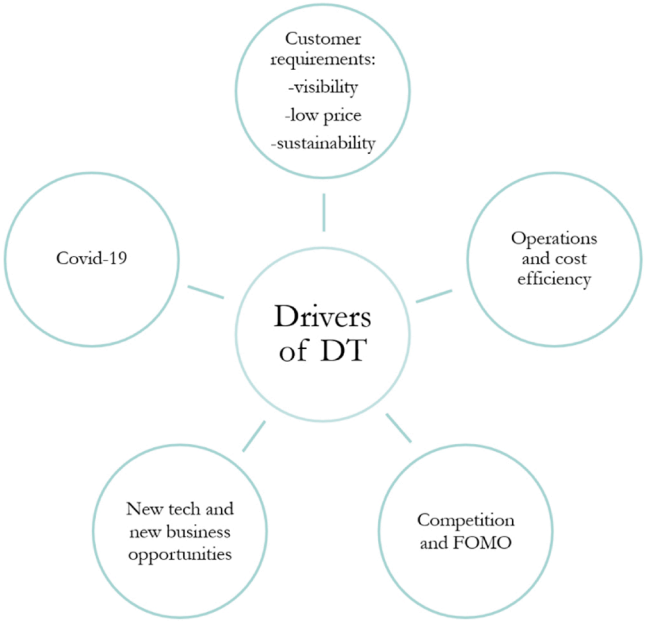

Fig. 2. Drivers of digital transformation in the maritime industry.
Source: Authors, based on expert interviews.

4.3. Key digital trends in shipping

Results demonstrate that as a part of their DT journey, shipping companies have adopted various digital technological solutions each having an impact on different areas of their business. Fig. 3 provides an overview of the key digital trends, related opportunities and the impact on business operations in the shipping industry.

The respondents have shown consensus that data, IoT devices, geolocation technology, AI or ML, and cloud solutions are the most common and promising digital solutions offering several advantages to the shipping industry and stakeholders involved, while APIs, blockchain, automation, robotics, and digital twins will also gain more traction in future.

Reflecting on the importance of **data** for the shipping industry, C4 states:

> *Years ago, we realized that "data" is absolute key to intelligent digital solutions. If you want to become more data driven and build decision support and automated algorithms and so on you need data. We have retrieved data from all our data points, operational systems, and financial systems. We have built data models, forecasting solutions, solutions to support capacity decisions on a technical basis and operational basis which we run on weekly cycles. Our vision is to continue using data and using algorithms in our day-to-day operations and embed them into our different processes. It could be about rerouting containers and monitor incoming containers, optimizing the loading of vessels and trains. Data sharing would be a key tool to increase the capacity utilization of our equipment in the future.* (C4)

In addition, **cloud computing** capabilities and **IoT** solutions play an important role in reshaping the whole industry, as emphasized by our respondents. According to C3:

> *Cloud-based, cloud-first or cloud-native data approaches are the key tools for digitalization. On a typical vessel there are about 6000 data points and leveraging that data we have made a lot of progress in the last 18 months in digitalizing our vessels and vessel operations and the core of this whole digitalization process is the IoT and cloud capability.* (C3)

Our findings further suggest that **AI** or **ML** is increasingly being applied together with IoT and cloud solutions to digitalize the shipping industry. Our respondent companies have applied AI in a range of use cases such as upselling based on buying patterns, handling operations at ports and terminals, predictive maintenance, fuel consumption, capacity forecasts, customer segmentation and prioritization. These uses are extended even to customer service failure and recovery management, as stated by C7:

> *We are using AI tools to read all the emails which helps us to determine customer satisfaction level. A manager can get an instant overview and if a customer is unhappy a manager can follow up the customer and try to support them in every possible way which helps us to retain our customers and increase their satisfaction level.* (C7)

Finally, our respondents have provided mixed views on **blockchain technology**, despite it being widely discussed in the business press and its promised benefits in streamlining the events and increasing end-to-end visibility in supply chains involving shipping. The following excerpts from the interviews (C2, C3 and C5, respectively) reflect some of the challenges related to the application of blockchain in shipping:

> *Blockchain is important of course for the paper trail, to enable collaboration and to support the whole transport ecosystem. I think the industry has so many fundamental operational challenges and therefore I see BC is like icing on a cake and we have not fixed the cake yet.* (C2)

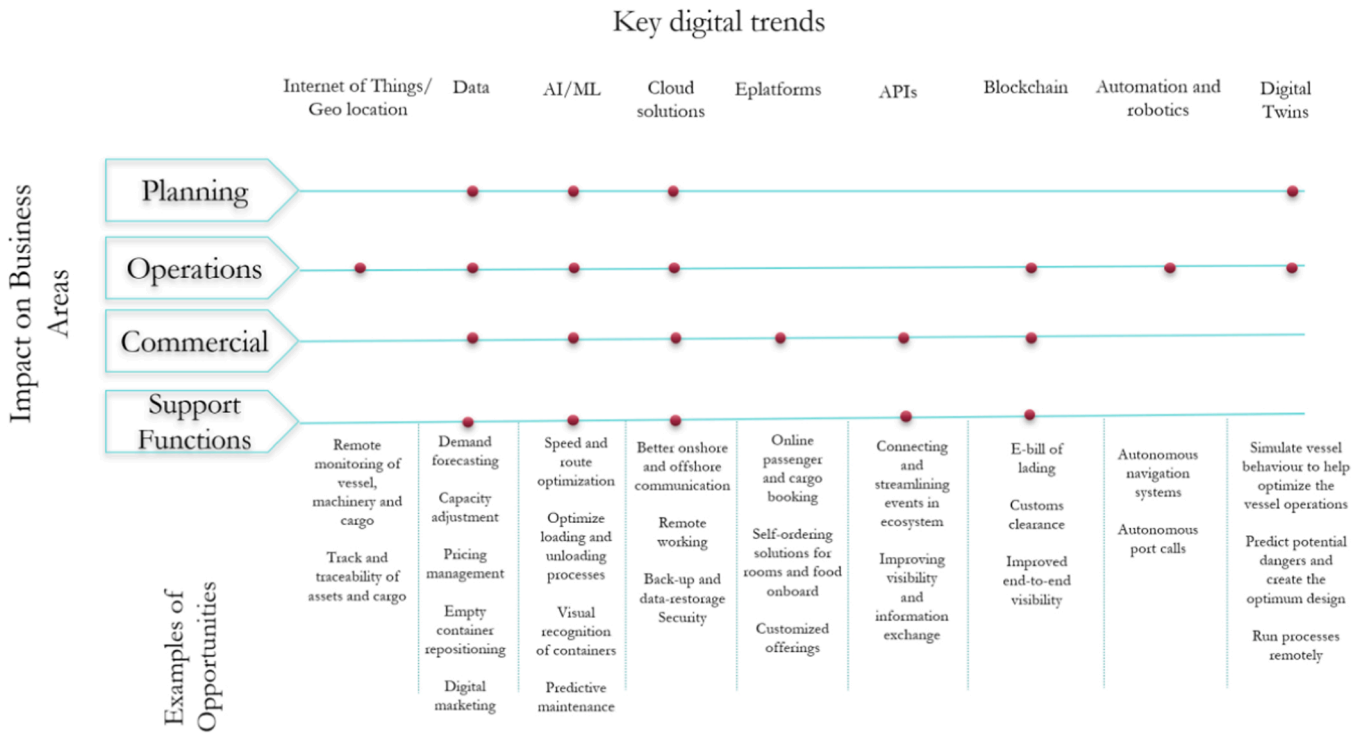

Fig. 3. An overview of key digital trends, their impact and the opportunities provided.
Source: Authors, based on expert interviews.

We will get away from this panacea thinking that certainly blockchain is going to come in and fix everything miraculously, particularly when some blockchain initiatives in shipping initially claimed that we can transform shipping and we are going to own it. There are challenges related to defining port codes and every company is doing its own thing and there is no IATA [International Air Transport Association] in shipping. (C3)

There are many platforms, but there is no one which is the Amazon of the shipping industry where you see a substantial number of customers and volume go through this. (C5)

These findings confirm the reluctance to information sharing and highlights the beliefs of respondents with respect to seamless connectivity across organizations in the shipping industry. Although they are more enthusiastic about the benefits of digital technologies that they can use within the organization – e.g. IoT or cloud computing – and

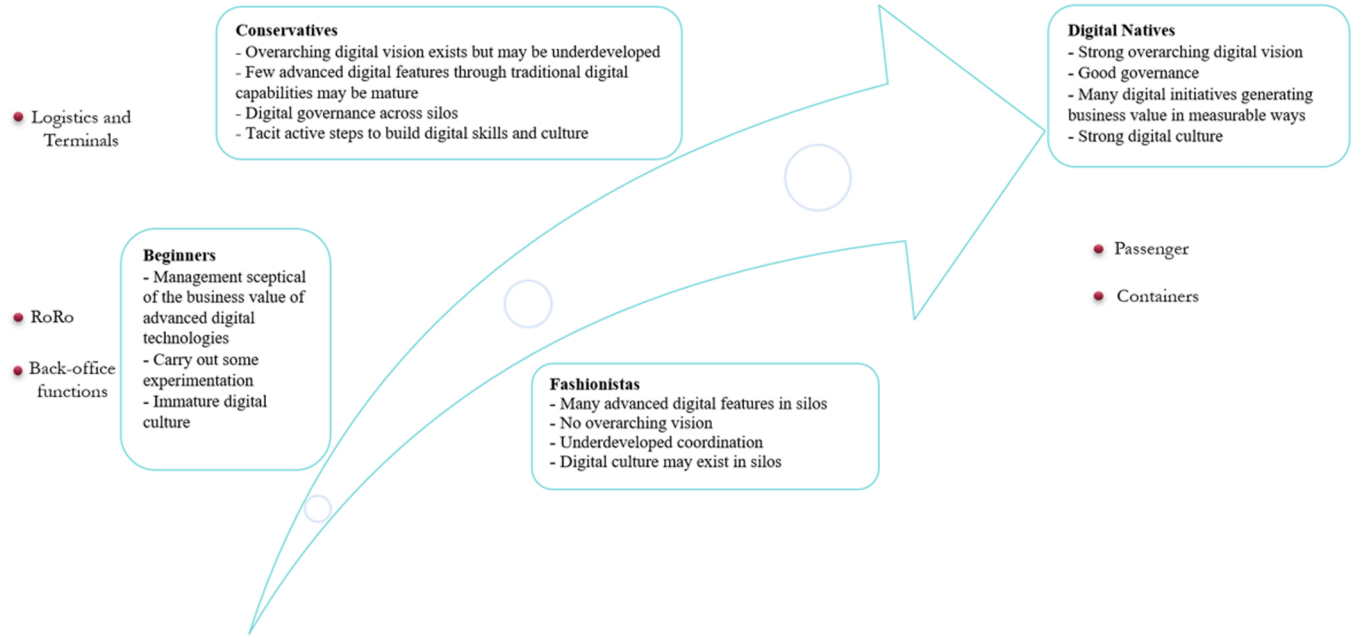

Fig. 4. Digital maturity status of business segments of respondent shipping companies.
Source: Authors, based on expert interviews and Westerman et al. (2014).

improving efficiencies, they hesitate when it comes to platform technologies or technologies that require information-sharing commitments. They seek a governing organization instead of a competitor uniting them all on a blockchain platform. Furthermore, in an industry which is led by a relatively small number of large organizations such as liner shipping, it is difficult to be an "Amazon".

4.4. Digital maturity status of shipping firms

The digital maturity of an organization plays a significant role in achieving competitive advantage, efficiency and increased profitability. The findings reveal that our respondent companies vary in their digital maturity level, and these differences are vivid across their different business segments, as shown in Fig. 4.

Our analyses suggest that it is not possible to classify an entire company under one maturity level. Instead, different functions of liner shipping organizations will demonstrate varying levels of digital maturity. Passenger and container segments of the respondent companies are at the beginning phase of becoming digital natives. While some of the companies are still striving to ensure an organization-wide digital culture, logistics and terminal segments of their business are conservatives, while RoRo and back-office functions (e.g. HR, accounting, finance) in these companies are still assessed as beginners by some of the interviewees. Compared to other industries, there are not many fashionistas in the shipping industry, as C1 explains:

> *We are in general very limited to be a fashionista. In shipping we have a very, very tight budget, so we don't have the money to be fashionista which is very lucky because otherwise we could have created a huge mess*. (C1)

Availability of resources and customer size, type, and their requirements are some of the main factors behind the differences in digital maturity across the different segments and business functions of the shipping companies. It is easier to maintain manual working practices in the logistics business area where there are fewer large customers. However, when the shipping service is mass marketed, then digitalization becomes a higher need and developments are more visible.

It appears that the stark difference in digital maturity level of the container and RoRo sectors is also due to the type of value chain, size of the industry segment and initiatives such as the Digital Container Shipping Association (DCSA) which help the container sector to become digital natives, as C3 emphasizes:

> *Compared to the RoRo industry, it's a bit different in the container industry, as container value chains are far more mature and their inbound flows are different. For RoRo and automotive, there is a huge maturity gap. We are very supportive of the work of DCSA and expanding that to our RoRo industry segment*. (C3)

Reaching a more advanced level of digital maturity or becoming a digital master is not the end of the DT process, as there is always a risk that organizations may settle back into old routines. Therefore, to maintain the momentum and compete in an evolving digital environment, organizations need to continuously invest in innovations and refine their capabilities in digitalization and change management. Organizations need to use their business intelligence and scan for the key digital trends and opportunities for future growth which can help them sustain their DT journey.

The key challenges that are hampering our respondent companies and their different business segments to move to the next level in their digital maturity are detailed in the next section.

4.5. Challenges to digital transformation in shipping

Our findings show that a successful DT in the shipping industry is challenged by several factors. Based on the nature of these factors and their comparative effect in hindering the process of DT, we have categorized these factors into three main areas, namely organizational/governance, operational and technological. The analysis of the interview data reveals (as shown by the relevant frequencies in Table 3) that, in contrast to technological challenges, the organizational/governance as well as operational challenges are the top barriers delaying DT in shipping. This is also very much in line with avoiding "paving the cow paths" by the means of digitalization. C3 emphasized:

> *My fundamental view is that the technology is available, but it's a question of how you use it. There are no technology impediments in the next three years for digitizing shipping and logistics. It's all there and our competitors are doing far more complicated things than us with the existing technology. The bigger challenge is how we adapt processes and ways of working and develop standards to embrace what is already available. New tech with old processes, in my view, is rarely transformative*. (C3)

4.5.1. Governance and organizational challenges

The respondent companies unanimously agree that "resistance to change" and "organizational culture" in the shipping industry are the chief obstacles that hamper the implementation of DT. Old ways of working dominate the culture in the shipping organizations which in turn hamper the ability to create a digital culture and will to transform. This is exacerbated by "competency traps and fear of job loss" where people do not want to lose control of the daily processes they manage. They do not trust digitalized processes even though they understand the value DT would bring to the organization. The strong dedication to legacy systems hinders building trust and people tend to continue doing things "*the way they have been doing them for so long*". Our findings reveal that despite all the effort and investment in technology some of the interview participants were still struggling to create a digital culture in their respective organizations. Lack of agility and traditional ways of "working in silos" towards achieving long-term organizational goals are further discouraging adoption of DT in the shipping industry. According to C1,

> *Siloed organization and slow or partial decision-making are the key challenges. People do things differently in silos in every part of the company. So, you must basically persuade people in siloed organizations to collaborate with one another. Whether there are internal or external siloes doesn't matter because it's the same cultural change. Dealing with this has been difficult because sometimes people are harder than things to change. Culturally our organization likes to hear lots of different views and tries to find the best middle way which hinders the pace of DT*. (C1)

Moreover, our findings indicate that traditional project management approaches with long-term milestones are a hindering factor for DT projects. C3 explains:

> *The waterfall monolithic thinking process or very engineering mindset to solving problems and a desire for perfection cannot be used in any transformation or DT projects. This is where our company has struggled for years where we set this three-year transformation goal with milestones and followed the waterfall project management approach, but I have never ever seen one final outcome delivered with this approach. It just becomes too complicated, too difficult and too high risk to go for large long-term milestones with the traditional approach*. (C3)

In addition to these challenges, age becomes a critical factor as the industry is characterized by a labour force that has been specialized in shipping for a long time and equipped with traditional skills. This is true for many industries, but a particular aspect of the shipping industry is the tradition that master mariners serving onboard the vessels tend to transfer to the company's offices when the itinerant seafarer life gets difficult to combine with family life. As shipping lines value the industrial experience of master mariners, they tend to cater for the onboard staff's continuing land-based career. Nevertheless, the tradition adds to the average age at the offices, and it is not well aligned with DT that

Table 3
Challenges to digital transformation in shipping.

Governance/organizational	Frequency	Operational and others	Frequency	Technological	Frequency
• People and culture	29	• Complexity of logistics' ecosystem	13	• Old legacy systems	9
• Siloed functions	11	• Lack of resources and capabilities	17	• Lack of standardization ("no IATA")	14
• Waterfall working approach	5	• Continued M&A	5	• Data security and privacy	6

Source: Authors, based on expert interviews.

requires a younger labour force that is equipped with digital skills. The young and digitally skilled are rather difficult to find and attract, whereas the former master mariners are rather difficult to transform. According to C2:

> *There are issues regarding getting the right competence on board both IT experts who can develop tools and people who are experts in specifying and mapping the customer journey and solutions that we would like to offer to our customers. So, a lot of new competence and people in different roles to support this DT journey are needed, but this competence and talent is in high demand across various industries compared to low supply and this remains a challenge for us*. (C2)

Respondents state that the current workforce is afraid of disruption that will accompany DT, but they also emphasize that "*if the industry does not disrupt itself, someone else* [from the outside] *will*".

4.5.2. Operational challenges

The involvement of multiple actors in the maritime logistics industry, each with varying size and requirements, increases the level of complexity and in some cases makes it difficult to embrace DT at full speed. In addition, the shipping industry grows with mergers and acquisitions which extend the complexity of structures with overlapping processes and digitalization efforts. C1 highlights the intricacy of this system:

> *We are a company that has grown by acquisitions and continues to grow by acquisitions, and if you have 19 versions of a process, it costs more to digitize them than if you have one version. So that is still one of the biggest issues for us. The acquired companies need integration to our existing network or systems but if you are constantly developing or using all your resources to keep the existing operations afloat and to add new acquisitions, you have very limited time left for transformational work*. (C1)

Furthermore, customers of different sizes have different digitalization requirements and skills which makes customization of digital customer service experience difficult. As C6 states,

> *We have different customer segments and when it comes to shipping you can still see that some shippers are very conservative and still would like to send a fax and have manual and paper-based processes*. (C6)

Our analysis shows that all our respondent shipping companies are struggling to find the right "talent" and have to deal with "lack of resources" to implement DT initiatives. C4 comments:

> *Despite having very experienced staff who know how to perform routine tasks, they do not necessarily know how to transform things and manage change. After a review of our strategy a year ago, we found that our main challenge is that we didn't have the capability or resources to implement the change we were envisioning*. (C4)

4.5.3. Technological challenges

Old legacy systems, lack of standardization and cybersecurity are key technological challenges to DT as highlighted by our respondents. C2 refers to this challenge:

> *We are living in old core systems. Of course, it's not impossible to change that, but they are creating a hurdle and adding to the total time needed to put out the new solutions and features for process optimizations for the end customers. The complexity of dealing with these traditional systems is, of course, not making the journey easier*. (C2)

Ports being central nodes in maritime logistics networks play an indispensable role in increasing efficiency, reducing costs and enhancing the competitiveness of shipping in contrast to alternative traffic modes. Lack of standardized processes and operations across ports and shipping segments create hurdles for a smooth DT of the maritime logistics industry.

The issue here is not only about the standardization of seaport interfaces or operational processes. It is also about the standardization of digital systems. A range of different IT systems and software, including different blockchain platforms, raise concerns regarding standardization. Each big player is creating their own system and trying to impose that system on the entire industry creates doubts towards interlocking shipping companies to such technologies. This creates a tendency for individual liner shipping companies to invest in and develop their own digital technologies, thus becoming a hindrance for standardization and connectivity in the end. The individual systems of separate organizations cannot communicate with each other and create a barrier which blocks seamless information sharing.

The challenges involving cybersecurity and privacy have also garnered more attention in the recent past, particularly since some of the largest ports and shipping companies have been the victims of cyberattacks. Even without a cyberattack, simply sharing flow data with several platforms creates a competitiveness risk because this data is valuable and marketable information for those parties that want to understand trade patterns or customer demand. When threatened with cyberattacks, the risk becomes huge. As C7 states,

> *We have a massive number of different platforms that we're working on, and that is a bit scary because we're also so dependent on them*. (C7)

The strategies or the pathways to overcome some of these challenges and embrace DT are elaborated in the next section.

4.6. Pathways to a successful digital transformation

Our findings point to a set of pathways that might increase the chance of a successful DT in the shipping industry. Based on the interviews and the NVivo analysis, the rendering on pathways that may lead to a successful DT is divided into strategy, organization, people and culture, technology and, finally, a partnered ecosystem.

4.6.1. Strategy

Our findings suggest that the DT process starts with establishing a new strategy and a vision which focuses on finding new ways for creating value using digital technologies. To this end, leadership commitment in an organization plays an indispensable role as a fundamental driver of the DT process. Top leadership can play an important role to increase the pace of DT through development of a digital strategy and vision, allocating investments, setting clear aspirations and by acquiring infrastructures and capabilities to support the transformation across the entire business.

DT is complex and challenging; hence it requires a set of capabilities and specialized talent to make that transformation happen. In many organizations, it starts with setting a "Digital Control Tower" with a dedicated chief digital officer (CDO), a chief information officer (CIO) or

a transformation officer who is accountable for creating value for the entire organization leveraging opportunities offered by DT. In addition to skills or extensive knowledge in digitalization, a CDO should be equipped with a crucial capability of transformation or change management. To drive change a CDO must be provided with substantial decision-making power, sufficient budget, and support from the senior leaders of various business functions. The CDO can in turn set key performance criteria for DT, cultivate new behaviours to support DT, enhance business-IT relationships and increase transparency and accountability across all levels in an organization. All our respondent companies have a dedicated CDO, CIO or an equivalent person who is knowledgeable and leading DT in their respective companies, as is pointed out by C6:

> *As a part of DT strategy, we now have a new Chief Information Officer who is the first woman in our board of directors in 175 years of company history and has substantial experience in digital transformation and business analytics across various industries. So that's a big step towards digitalization.* (C6)

C4 qualifies the type of person needed to facilitate DT:

> *The new team we want to employ are not the technical people, but these are the people who have organizational experience in change, in working with stakeholders, working with technology teams to really make and implement the change and make it sustainable.* (C4)

4.6.2. Organization

Instead of merely throwing money into random DT projects, our respondents emphasize that firms should start by addressing the problems or the opportunities which digitalization can assist in resolving or leveraging, respectively. C3 explains the importance of ideation:

> *The absolute first step of any DT process is to define the need, the problem and the opportunity and really understand it and potentially reframing it. Internally, we have used the technique of ideation, so before we launch into technical solutions we spend a number of rounds ideating. I always really focus on the problem. Shall we take another round on the problem? I don't think that we have really understood it yet.* (C3)

The consensus among the respondents is that the success of any DT initiative substantially depends on an agile working approach and cross-functional teams who are willing to collaborate with each other and create value together. The respondents highly emphasized the importance of agile ways of working and increasing the pace of decision-making. Short but frequent meetings, and quick decision-making to resolve challenges related to DT are the norm at companies that are successful in their path to DT. In such organizations, speed and a quick decision-making mindset follows the rationale that a bad decision is better than no decision at all.

Our findings indicate that there are no bulletproof, long-term solutions to digitalize the shipping industry. Success rather depends on concurrently running several close-range cheap experiments in multiple areas of the business. Value created by these experiments should be measured instantaneously, and experiments with no value should be defunded while increasing the funding and support for successful experiments. All these mini experiments may lead to a major transformation. Excerpts from our interviews shed light on the importance of experimentation. As C1 states:

> *Introducing the idea of placing bets and doing cheap experiments was one strategy that we used quite successfully. Measuring value as early as you can, finding some way to measure what you are doing and to demonstrate that it adds value. I think that was really important as a strategy and probably one of the hardest things to do, especially at the beginning of a digital journey because you are essentially spending a lot of money and not getting much value in the beginning.* (C1)

In contrast to a waterfall or an engineering approach with zero defects, a test-and-learn approach through experimentation increases the probability of success in DT programs. This also goes well in line with the agile development approach that has dominated the IT industry in recent decades.

4.6.3. People and culture

People and culture are at the centre of any DT program across all industries and sectors. This is evident by the fact that all our respondents indicated employee resistance-to-change and a culture of working in silos as the biggest challenges to DT. DT is about change, hence its success requires new ways of working, new talent strategies and a fundamentally new culture. Our results show that to embrace DT, our respondent companies have allocated funding not only to upskill, reskill and redefine the roles and responsibilities of the existing staff but also to attract new talent from other industries who were equipped with capabilities in digital and change management. C4 explains this approach:

> *To drive DT you need different skill sets and different people in the organization compared to our existing traditional and more experienced people. The role of strategy is to train our staff at our headquarters and across the countries. Then we aim to hire people who bring new perspectives from other industries, such as aviation, and then train the existing people to make sure they are with us on this journey. That's why we are recruiting new leaders in our teams, new talent, expertise and experience and people with diverse backgrounds into the organization who can help us in making this transformation happen. For example, data scientists and teams were recruited in our eastern European office and the change management team was recruited for our European head office.* (C4)

Our results show that "communication and knowledge dissemination" across all levels in an organization are the key tools which play an important role in alleviating employee resistance to change. Companies need to create change stories describing for their employees the company's digital vision, as well as the purpose and importance of all the changes happening in the organization as part of their DT program. Another key success factor is to acknowledge the individual and team efforts of the workforce through soft rewards as well as through increased payouts and recognizing their efforts in social media and at company events. C1 explains how external training and knowledge-sharing helped their company:

> *Having and building our own internal team was important to disseminating knowledge internally. Then, of course, we backed that up with educating key people. We started with the executive management team and VP group, and we sent the whole VP group on an external education session for a week to try to get them to hear it from outside that this DT is important.* (C1)

A "cultural change" is a prerequisite to successfully embracing DT. Our findings reveal that as a part of digital culture organizations need to cultivate a new set of behaviours which encourage employees to collaborate across different functions, take risks, experiment, fail and continuously learn from their failures.

4.6.4. Technology

Our findings show that investments in digital technologies and solutions, in addition to good governance, leadership commitment and a cultural change, are indispensable for reaping the advantages offered by DT. All our respondent companies have significantly invested in various digital solutions, including cloud computing, data-driven decision-making, IoT devices, and AI. The impact of different digital solutions on different business areas and the corresponding value provided by each solution has been detailed under the heading "Key digital trends in shipping" in an earlier section of this paper.

4.6.5. Partner ecosystem

Shipping is a complex industry as it involves multiple actors across

the entire maritime logistics industry, each having different needs. Customers of shipping companies are increasingly demanding lower freight rates, increased end-to-end visibility and lower emissions on their freight transport. To survive in a rapidly changing and competitive market, shipping companies should allocate adequate resources and develop partnerships with stakeholders to understand and satisfy customer needs using digital technologies. Our findings suggest that developing partnerships with customers, suppliers and even competitors to identify and leverage the opportunities offered by digitalization is a key success factor. In addition to developing in-house digital solutions, shipping companies should opt for open innovation by establishing joint ventures with startups, joining incubators and accelerators to screen for innovative ideas and digital solutions. C2 suggests:

> *I think that understanding and being part of creating a digital ecosystem with your customers, competitors and suppliers is part of DT. External partnerships can play an important role in the digitalization journey of an organization.* (C2)

Many successful organizations across various industries have opted for a build–operate–transfer approach to create new business offerings as well as to provide solutions to their current business challenges. As a part of their DT efforts, shipping companies should take inspiration and follow this approach by establishing a separate and independent business unit or a digitalization team that focuses on creating and scaling new solutions which can be later transferred to the main company. As C3 explains:

> *The digital accelerator program has been very successful in taking some of this stuff out of our traditional liner organization. The argument is to just go out and spin out some counter teams as other companies have taken the approach to just externalizing it completely and spin out their own start up in a different building down the road. This is the approach that makes you successful in a rapidly changing digital environment.* (C3)

As shown in Fig. 5, the results of the content analysis using NVivo and the above rendering resulted in the factors shipping companies should consider for each of the five major categories that may lead to a successful DT.

5. Discussion and conclusion

Digital transformation has changed the business dynamics of various industries by offering numerous opportunities. However, in contrast to other industries – such as media, telecom, banking, retail and even other transport modes – the shipping industry, which is often family-owned, self-organized and a network-centric industry, has historically been conservative in adopting innovations. Hence, it lies far behind in embracing digitalization and transforming its operations. In this paper, we address the call from Tijan et al. (2021) for more empirical research on the DT of maritime logistics by assessing the current digital maturity of liner shipping companies, identifying the barriers to DT, highlighting the key drivers and digital technologies of DT, and the pathways or strategies which can lead to a successful DT of the shipping industry. The findings extend the previous research on DT and provide insights to managers in both the liner shipping segment and the larger maritime logistics industry.

Our findings suggest that various organizational, operational and technological challenges are impeding DT in liner shipping. In our research organizational culture, employees' resistance to change, siloed functions, lack of appropriate talent and the complexity of the maritime logistics industry's ecosystem have appeared as the major obstacles to DT. In line with previous research (Gunasekaran et al., 2017; Mathauer and Hofmann, 2019; Westerman et al., 2014) which focused on the larger logistics industry, our results indicate that resistance to change by people and organizational culture are the biggest challenges to DT in liner shipping. Similarly, Agrawal et al. (2020) argue that resistance to change and inertia hinder the implementation of DT as in incumbent

Fig. 5. Pathways to a successful digital transformation.
Source: Authors, based on expert interviews. Bulb icon is from Intera (2022).

organizations the existing culture, organizational identity, capabilities, processes and relationships act as a barrier to change and adoption of radical innovations. However, in another study, Cichosz et al. (2020) report that resistance to change and culture are not the top barriers in the logistics service-providing companies. They further explain that resistance to change is caused by several factors which include innovation fatigue triggered by frequent introduction of new technologies and systems in an organization, competency traps, fear of job loss, rigid existing processes allowing less flexibility in the face of change, and lack of visibility regarding the benefits offered by DT.

Our findings show that lack of agility, working in silos and slow decision-making are amongst the key challenges to DT. These results are consistent with the findings of Agrawal et al. (2020) who assert that today's supply chains are struggling to fulfil the wide range of customers' demands because they involve a series of discrete and siloed steps, ranging from suppliers to ultimate customers and including product development, production and marketing. Another key barrier that emerged in our research is the lack of financial resources, human talent, capabilities in change management and in the effective deployment of digital technologies and solutions in the maritime industry. Smaller size shipping companies face financial hurdles to invest in digital technologies and to acquire new talent from competing startups which are often generously funded by venture capital firms, are famous for their entrepreneurial culture and offer high rewards to their employees. This barrier is also highlighted by Cichosz et al. (2020) who argue that innovative technology often requires significant up-front investment and that financial institutions are not willing to lend their money for risky projects involving technological solutions to smaller-size companies operating in a low-margin industry.

5.1. Recommendations for business leaders

In our research we have identified multiple pathways or strategies (as presented in Fig. 5 in the previous chapter) that may guide managers in shipping companies to overcome some of the challenges mentioned previously and successfully implement DT. These pathways or recommendations for managers and leaders responsible for DT both in liner shipping segment and the larger maritime logistics industry are elaborated below.

5.1.1. Establish a tangible vision and a new business strategy with DT at heart

The results of our research suggest that leadership commitment plays an indispensable role as a fundamental driver of the DT process and that leaders in the shipping industry should develop a digital strategy and vision for embracing DT. As corroborated by Tijan et al. (2021) and Osmundsen et al. (2018), a clear vision and a digital business strategy can support an organization in transforming and achieving the intended objectives of DT by emphasizing digital leadership abilities, agile and scalable digital operations, digitally enabled customer experiences and emerging digital innovations. To this end, top leadership plays an important role by creating a vision and crafting a new strategy to leverage the opportunities offered by DT. As verified in a study by McKinsey (2022), leaders in an organization need a strong vision of the company's digital opportunities and experience in the digital arena to give them credibility with employees. This is also shown in the findings of Vial (2019), who explains that organizational leaders must work to ensure that their organizations develop a digital mindset while being capable of responding to the disruptions associated with the use of digital technologies.

5.1.2. Establish new leadership roles such as CDO or CIO who have additional capabilities in change management

Our findings further propose that to support the organizational goal of DT, shipping companies should create a digital control tower with new leadership roles such a dedicated CDO or CIO, who is responsible for creating value for the organization by leveraging the opportunities offered by digital technologies. Vial (2019) argues that, like any other initiative that has the potential to profoundly alter the fabric of an organization, DT is associated with several important structural changes to business units and leadership roles. The creation of a CDO position signals the strategic nature of DT for the entire organization. CDOs are tasked with ensuring that digital technologies are properly leveraged and aligned with the objectives of the organization (Singh and Hess, 2017). They act as boundary spanners that can help to implement digital business strategy in a series of concrete actions that influence a firm's organizing logic and foster close collaboration between business and IT functions.

5.1.3. Support employee/team empowerment and continuous learning

We have found that DT is about change and hence requires new behaviours and a new culture. Our findings recommend that leaders in shipping companies should cultivate a culture that empowers employees, supports experimentation and continuous learning and enhances knowledge which can essentially increase the chances of success of DT initiatives. This is in line with recent research by Jović et al. (2022b)) and Haasis and Hapsatou (2022) who suggest that a stronger focus on the people and their cultural differences is essential to supporting the improvement of the logistics performance of companies. Thus, the employees in the maritime transport sector should be encouraged by managers to upgrade their knowledge through internal or external workshops and seminars which will consequently affect organizational agility. The findings of Kane et al. (2017) and McKinsey (2022) suggest that without the right culture, reinventing the business for the digital age will likely fail. Truly changing culture demands a shift from command-and-control style of leadership to having senior leaders set high-level direction and strategy. Giving considerable autonomy to teams charged with execution is prerequisite for a successful DT.

5.1.4. Embrace cheap hypothesis-driven experimentation on multiple fronts and encourage a fail-forward culture

Our findings propose that leaders at shipping companies need to encourage taking risks, conduct experiments and support a fail-forward culture. This is line with Agrawal et al. (2020), who suggest that by doing so firms can foster learning through small, incremental and iterative changes while maintaining their ability to adapt long-term plans based on the outcomes of such experiments as well as ongoing changes in their environment. This is crucial, as McKinsey (2022) claims that one of the biggest risks in a digital world is not taking risks. Taking risks does not mean organizations should take any risk. The amount of risk often depends on the size of the investment at stake. Digitalization opens the door to running multiple small-scale experiments that entail a limited cost in case of failure but can produce highly valuable discoveries.

Kane et al. (2017) suggest that experimentation and iteration alone, however, are not enough. Companies should use the results of such experiments, successes and failures to drive change across the organization. Companies with abundant resources – which is certainly the case for the container shipping companies after a period with excessive freight rates – may be tempted to just "throw money at the problem" of digital disruption, but that doesn't generally lead to continuous and actionable learning in the way that experimentation does. Instead, shipping companies should figure out how to experiment to compete in the future while also maintaining the core business so that it can perform in the present. DT cannot simply be a top-down mandate to change. Instead, it also involves creating the conditions under which existing employees start thinking and working differently and driving change from the bottom up.

5.1.5. Break down silos and focus on upskilling, reskilling, and knowledge dissemination

To overcome the challenges associated with employees' resistance to change and the slow pace of their DT efforts, our findings suggest that

shipping companies need to focus on creating cross-functional teams, breaking down siloes, employee reskilling and upskilling, recruiting new talent and disseminating knowledge. This disruptive push is particularly important for the maritime logistics industry with its tradition of fostering a second career for master mariners in its offices. These tactics are consistent with Agrawal et al. (2020) who argue that changes to the structure as well as the culture of an organization lead employees to assume roles that were traditionally outside of their functions where employees who are not part of the IT function take the lead on technology-intensive projects while members of the IT function are expected to become active, business-savvy participants in the realization of those projects. Our results further support the suggestions by McKinsey (2022) that digital organizations remove silos between departments, functions and reporting lines and instead create cross-functional teams that are self-organized, non-hierarchical and empowered to execute projects from start to finish.

5.1.6. Develop partnerships with customers, competitors and suppliers

Our findings suggest that shipping companies need to enable open innovation, by fostering collaboration and developing partnerships with suppliers, customers and start-ups which are the key drivers for a successful DT. To this end, the findings of Haasis and Hapsatou (2022) and Ichimura et al. (2022) reveal that innovation requires having knowledge outside the boundaries of a company in an active collaboration with external stakeholders for a DT to be successful. In this way, we support the results of previous researchers (Cichosz et al., 2020; Osmundsen et al., 2018) who suggest that building partnerships with start-ups, breaking silos and improving information exchange among different players and business units are key success factors for designing new business models, creating new digital value and enabling a seamless customer experience.

Concluding all the above recommendations, we believe that DT brings several opportunities for the maritime logistics industry. However, to leverage these opportunities, shipping companies need to transform existing processes and culture through employee empowerment, knowledge dissemination from top leadership to front-line employees, investing in technologies, fast decision-making and fostering an agile working approach. The temptation with any transformation effort is to play it safe and make incremental changes to the business. But incrementalism is the death of a rapid turnaround. Digitalization is by its nature disruptive, so the transformation needs to be disruptive as well. If shipping companies stay idle and fail to disrupt their businesses themselves, someone else will. Today technology is not the biggest challenge to DT; rather, companies adapt processes and ways of working and develop standards to embrace what is already available. Culture and change management are fundamental to any DT goal.

5.2. Limitations and implications

The digital maturity categories we apply to the maritime logistics industry provide an opportunity for practitioners in this industry to evaluate their business functions' digital maturity levels. Understanding the key drivers and challenges in the industry is a key to approaching digitalization problems and developing a healthy DT process. We present several strategies for practitioners in the industry to follow for achieving a successful DT.

Despite the valuable insights generated, our research has some limitations that need to be taken into account when interpreting the findings. The experienced interviewees from the case firms, who provided their expert opinions on the subject, could fairly represent the viewpoint of the entire maritime logistics industry. Such an approach is adequate for exploratory research in a field which has received limited scholarly attention. However, the findings of our study can be further analysed with an explanatory approach to discover the relationships between drivers, barriers, strategies and DT success in the maritime logistics industry and by extending the research to the different segments, actors that operate within this industry. Furthermore, to confirm the differences across industries, such studies can be extended to multiple industries and comparative analyses across cases would bring valuable insights about the varying maturity levels of different sectors. This is particularly important for understanding the differences between product supply networks and logistics and transport networks. The digital connections within and between these networks are essential for successful service provision, but research that explores the differences between DT processes of those is limited. In addition, research looking into digitalization patterns at the interface between supply chains and logistics and transport networks would also provide important insights into how these two layers which facilitate global trade interact via digital tools and processes.

In our research, employee resistance has appeared as a key challenge to DT. Future researchers are encouraged to investigate in depth how DT triggers conflicts, discrepancies, uncertainty, and power struggles in an organization and the negative consequences of DT for management and employees. The need for change management has appeared as the key success factor for DT; future research needs to look at the ways to craft and implement an appropriate change management strategy as a part of the DT journey of shipping companies. Established models such as the Technology Acceptance Model (TAM) and its extensions would provide interesting insights into where and why employee resistance resides, and further analysis would enlighten ways to mitigate it.

CRediT authorship contribution statement

Z.R. planned the study, provided literature reviews, prepared and conducted interviews, and drafted the manuscript. J.W. reviewed, edited, conducted interviews and supervised the manuscript and lead the revision. CAV reviewed and edited the manuscript and conducted interviews. ML reviewed and edited the manuscript. All authors improved the manuscript by responding to the review comments. All authors read and approved the final manuscript.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

No data was used for the research described in the article.

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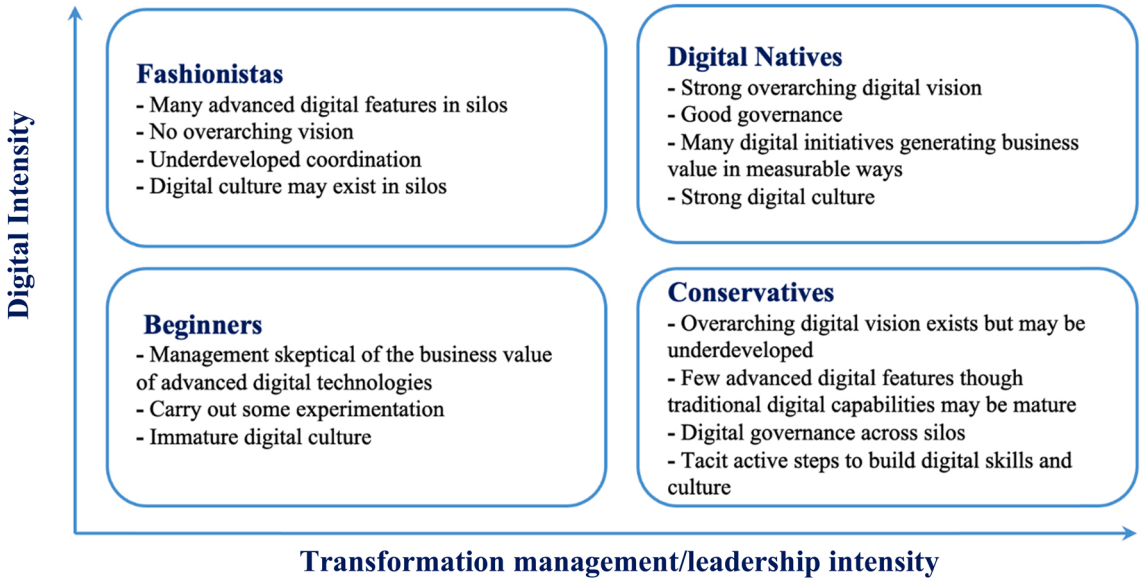
Appendix A: Interview Guide

1. Introduction – Digital transformation and digital maturity.

(1) Could you please briefly introduce yourself and your current position.
(2) What is your personal professional experience with digital transformation (DT)?
(3) What does digital transformation mean to you? Could you please name a few tools or concepts that come into your mind when you hear the term "digital transformation"?
(4) How would you characterize the digital maturity of your company using the below digital maturity matrix?

Digital maturity matrix (Adapted from Westerman et al. (2014)



(5) Is your whole company rather uniformly positioned in the above matrix or different business units are very different in their matrix positioning?

2. Digital Transformation – Drivers and technologies.

(1) What is driving DT in the maritime logistics industry, is it the changing customer behaviour, availability of new technologies, competitive landscape, or regulations?
(2) What are the most common digital solutions or technologies do you use in the business management areas such as:
- Planning
- Operations
- Commercial
- Support
(3) How do these digitalization tools help you with your processes or what are the benefits?
(4) To the best of your knowledge, which specific digital technologies will be the most important to your company in the future?

3. Digital transformation – Barriers, success factors and strategies.

(1) Which factors/strategies are important for a successful digital transformation?
(2) What specific challenges or barriers did your company face during the digital transformation of different processes?
(3) How did your company overcome these barriers?
(4) What are the next steps for extending the DT?

4. Final thoughts.

(1) When (in number of years) do you expect your company will get the most value out of its digital initiatives?
(2) In your opinion, what would be the potential impact of Covid on digital transformation in the maritime logistics industry?
(3) How do you see the role of digitalization in sustainability discussions?
(4) Is there anything that we haven't asked that we should have related to DT?

Thank you so much for your time and sharing your valuable perspectives.

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