Theotokas *et al.*
Journal of Shipping and Trade (2024) 9:6
https://doi.org/10.1186/s41072-024-00165-0

Journal of Shipping and Trade

ORIGINAL ARTICLE Open Access

Challenges of maritime human resource management for the transition to shipping digitalization

Ioannis N. Theotokas[1], Ioannis N. Lagoudis[1*] and Konstantina Raftopoulou[1]

*Correspondence:
ilagoudis@unipi.gr

[1] Department of Maritime Studies, University of Piraeus, 80 Karaoli and Dimitriou Str., 18534 Piraeus, Greece

Abstract

The purpose of this paper is to discuss the challenges that appear in maritime human resource management, in the face of the digitalized environment in maritime business, due to the diffusion of new technologies, such as big data analytics, blockchain technology, and future MASS technology. The current study is based on a systematic review of the relevant literature attempting to respond to the analysis of the challenges described above. The study reveals that existing scientific interest concentrates on the training and education of the maritime workforce, the new skills required as well as the possible loss of traditional jobs and the creation of new ones, while mainly examining the seagoing personnel. However, limited attention has been paid to the practices of human resource management, which could facilitate the transition to the new era of maritime business. This study aims at contributing to the research in the field of Maritime HRM by revealing gaps in existing literature and suggesting areas for future research as well as new methodological approaches in addressing these gaps.

Keywords: Maritime human resource management, Digitalization, Culture, Big data analytics

Introduction

The emergence of the 4th Industrial Revolution also referred to as Industry 4.0 (I4.0), has disrupted existing business models (Coskun-Setirek and Tanrikulu 2021) and transformed the way businesses operate. Industry 4.0 is characterized by the adoption of advanced technologies such as the Internet of Things, blockchain, machine learning, big data analytics, robotics, cloud computing and augmented reality among others (Gallo and Santolamazza 2021; Zhong et al. 2017; Kerin and Pham 2019). Along with the 4th Industrial Revolution, the terms digitization, digitalization, and digital transformation occurred. Verhoef et al. (2021), approach the first two terms as different stages in the digital transformation process. In this way, digitization refers to the conversion of information and systems from analogue to digital, whereas digitalization "includes the cognitive, social, and institutional impacts of digital technologies" (Oliveira et al. 2021). Digital

Springer Open

© The Author(s) 2024, corrected publication 2024. **Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by/4.0/.

transformation encompasses both terms reflecting the process and implications of an organization's or sector's transition to an environment with increased digital capabilities.

Although the 4th Industrial Revolution was initially introduced to describe the transformation in the manufacturing industry, the term was later used to describe the process of digital transformation across different sectors. The maritime industry, as a predominantly globalized activity (Harlaftis and Theotokas 2020), could not be left untouched by business transformations occurring at a global level. For this reason, the term Maritime/Shipping 4.0 (Sullivan et al. 2020, 2021; Aiello et al. 2020) has been adopted to describe the changing environment geared towards the industry's digitalization.

Changes in the competitive environment of the different maritime sectors have intensified the efforts of organizations to increase competitiveness. In this environment, digitalization is considered as one of the drivers leading to change in the sectors. Sletmo (1989) describes shipping as an industry in constant change and identifies four stages in the evolution of shipping and its nature, namely, (1) the local and peripheral use of shipping, (2) the quest for maritime power and the use of shipping for expansion, (3) the transnationalization of shipping through flagging out, and (4) the development of new, more efficient markets which led to the development of the modern ship management company. Theotokas (2019), examining the way that technology will affect the development of shipping, defines digitalization as the fifth wave in the evolution of the industry.

While research on digitalization in the maritime sector is evolving, literature review reveals that research on maritime human resource management is rather limited. The main objective of this paper is to discuss the challenges maritime human resource management faces today, which stem from the industry's digital transformation, through a systematic literature review. In this direction, it aims at revealing the gaps in the literature and at contributing to the enrichment of the literature on the topic. Moreover, the review aims at proposing a general categorization of the effects of digitalization in human resource management, conceptualizing the main research themes arising in the literature.

The rest of the paper is structured as follows: Section "Digitalization and Maritime industry" discusses digitalization and the challenges it creates in the maritime industry, Section "Digitalization and human resource management" provides an overview of the effects of digitalization on human resource management, followed by Section "Methodology", where the methodology adopted in collecting, classifying, and analyzing the articles included in this systematic review is outlined. Section "Theoretical Framework" constitutes the main body of the paper, presenting the theoretical background of the existing scientific literature in the respective field, discussing key scientific contributions, and identifying research gaps. Finally, Section "Conclusions and avenues for future research" highlights the contributions of the study and presents insights of the review formulating future research directions.

Digitalization and maritime industry

Digitalization is a transformation that alters existing models of shipping companies' organizations, enhancing the change of their mindset and corporate culture (Theotokas 2018). Numerous internal and external factors are considered as drivers leading to the digital transformation of shipping companies. Ichimura et al. (2022), identify as motives

for companies cost reduction, increased competitiveness, and response to customer needs. Raza et al. (2023) identifies as motives customer requirements, operations and cost efficiency, competition, new technology/new business opportunities, and Covid-19. In parallel, they identified barriers that delay the digital transformation in shipping. These are grouped in organizational, governance, operational, and technological factors. People and culture, lack of resources and capabilities and lack of standardization are identified as the most important barriers in each category, respectively.

Technological advancement is apparent across the entire maritime sector with the adopted technologies being characterized by distinct levels of maturity. There are studies that link Industry 4.0, and the adoption of digital technologies with organizational and managerial dimensions in the maritime industry or the career trajectories for seafarers (Kaptan 2022; Baum-Talmor and Kitada 2022). Industry 4.0 in the context of the maritime industry will lead to the Maritime 4.0, which is characterized by the complete change in the management and organization of ships as well as the skills and qualities needed by the seafarers (Muslu 2020).

Research regarding the overall adoption of digital technologies and solutions in the maritime sector (de la Peña Zarzuelo et al. 2020, Lambrou et al. 2019, Gavalas et al. 2022) and the associated benefits (Del Giudice et al. 2021) is evolving. Areas under examination include the organizational, technological and environmental factors and the drivers influencing digital transformation (Jovic et al. 2022; Raza et al. 2023), specialized fields concerning the applications of blockchain technology (Czachorowski et al. 2019; Yang 2019, Pu and Lee Lam 2020), and big data analytics (Zhang and Lee Lam 2019) in the maritime industry and the role of shipping 4.0 technologies in controlling the risks related to ship accidents (Sepehri et al. 2022). The increasing number of publications in the fields reveal a trend similar to the one noticed in the bibliometric analysis conducted by Razmjooei et al. (2023) on Industry 4.0 research in the maritime industry. Their findings reveal that research on Industry 4.0 in maritime studies is a very recent phenomenon, noting that the number of publications in 2021 was ten times higher compared to 2011 (Razmjooei et al. 2023).

The lockdown due to the COVID-19 pandemic increased the interest in research on the role of digitalization in overcoming the disruption in organizations (see for example Al-Alawi et al. 2023; Minbaeva 2021) as well as the disruptions that COVID-19 created to logistics and supply chains and to the working model of shipping companies. Mishrif and Khan (2023) argue that companies innovate and use digitalization to tackle the consequences of the pandemic, pinpointing the positive impact of digitization on the operations and outputs of the logistics and supply chain sector. They also found that only 1.8% of the companies were able to fully digitize their operations, with the cost of technology being considered as the most important hindrance to the use of the necessary technology or the implementation of the relevant policy. In the same vein, Meyer et al. (2021) relate ports' ability to minimize the severe effects of the lockdown due to COVID-19 with the increase of deployment of digital technologies.

While maritime organizations are increasingly adopting digital-enabling technologies to embrace the emergence of the 4th Industrial Revolution, organizational aspects which will facilitate the transition to the new era are often overlooked. The same applies to the creation of a business model which will integrate key parameters

related to digitalization. However, technology itself cannot provide substantial benefits, unless incorporated within a successful business model (Chesbrough 2010). As a result, maritime digitalization creates the necessity to enrich the traditional business model and foster an environment where digitalized information will be fully employed, including methodologies and tools, which will successfully navigate shipping through the competitive landscape. In addition, in today's knowledge-based economy, where value is mainly generated from intangible assets such as a company's human capital (Bismuth and Tojo, 2008), digital transformation will be more dependent on people rather than on technology (Tabrizi et al. 2019). Due to the important contribution of an organization's human resources (Progoulaki and Theotokas 2010), the new business model generated in maritime business should be further extended to include organizational factors as well, associated with the contribution of the human element in the industry's digital transformation. It is contended that in "…the Industry 4.0 era the human resources management philosophy is getting higher for the maritime sector" (Muslu 2020).

Digitalization and human resource management

Numerous trends in the global economy, like the aging workforce, diversity, and the adoption of digital technologies (Stone and Deadrick 2015), pose constant pressures for change in the management of the human capital. As far as digitalization is concerned, the rapid diffusion of technological advancements is reshaping the workplace of the future and creates new requirements for organizations. Although business digitalization requires a holistic restructuring of the way human resource management is performed, spanning from core human resource functions like recruitment and training, to more strategic and developmental roles, the present analysis focuses mainly on three dimensions, proposing a conceptual model, as presented in Fig. 1. While the first dimension concerns the effects of digitalization in the future of work, the other two dimensions relate to the tools that human resource management can deploy to respond to these challenges from an organizational and operational standpoint.

The term future of work (Jain and Ranjan 2020), refers to issues related to job creation and destruction due to automation (Colombo et al. 2019), future workforce structure and skills in need (van Laar et al. 2017; Nair 2019), while also including constructs related to "job quality, wage inequality and social protection systems"

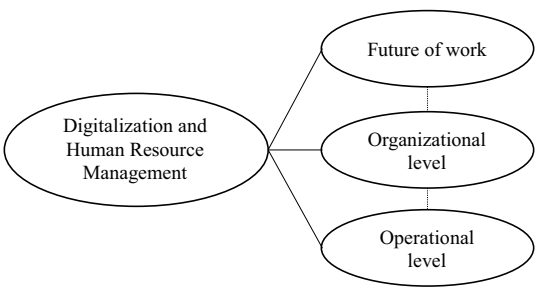


Fig. 1 Business digitalization and human resources management. Source: Authors

(Santana and Cobo 2020). For the purposes of this research, when discussing about the future of work, authors will be referring hereafter to work automation as well as to the required future skills.

From an organizational perspective, changes brought to organizations through the adoption of digital technologies are enormous. These changes affect all functions of organizations, with human resource management being one of them. DiRomualdo et al. (2018) examine the ways digital transformation will change the human resource management model and transform its processes and services. Digitalization has been related with the flexibility in the management of the workforce structure, as it motivates firms to employ unconventional employment formats and to use ICT tools to strengthen their HRM brand (Zavyalova et al. 2022). Ravarini and Martinez (2019), examining the organizational transformation of an organization and the transition from the hierarchy to holacracy, pinpoint the possible role of e-HRM, which is consisted of three pillars, namely, the Information System, the HRM Process and the Organizational Culture. The prominent role of organizational culture is highlighted in driving business outcomes related to the successful implementation of digital transformations. Organizational culture has been widely recognized as an important organizational construct which affects almost every aspect of the business. Due to its importance, many researchers have studied the role of culture in business environments (Hofstede et al. 1990; Wallach 1983; Deshpandé and Webster Jr 1989; O'Reilly and Chatman 1996; Hofstede 2001). Researchers have also attempted to create a typology for explaining differences in cultural contexts (Harrison 1972; Deal and Kennedy 1982; Quinn and McGrath 1985; Handy 1993). In addition, there is a body of knowledge examining the link between culture and organizational change (Oram and Wellins 1995). In the case of digital transformations, organizational culture is "often cited as the most critical factor in successful technology assimilation" (Cabrera et al. 2001). Digital culture (Martínez-Caro et al. 2020; Proksch et al. 2021) refers to "an emerging set of values, practices and expectations regarding the way people (should) act and interact within the contemporary network society" (Deuze 2006).

Initiatives from an operational perspective concern the way technology has the potential to enable human resource management to deliver value in the digital era. Big data analytics (Kwon et al. 2014; Gandomi and Haider 2015) are featured as a new source of value generation, with business analytics being the term that responds to the evidence-based approach in identifying and solving business-related problems (Holsapple et al. 2014). Data analytics and HRM practices have been found to contribute to the profitability of the firms (Erro-Garces and Aramendia-Muneta 2023) People analytics (Gal et al. 2020), also referred to as human resources analytics (Rasmussen and Ulrich 2015; Margherita 2021), or human capital analytics (Andersen 2017), or workforce analytics (Simón and Ferreiro 2018; McIver et al. 2018) or talent analytics (Davenport et al. 2010, N'Cho 2017), is the application of big data analytics in the human resources management function. The field of human capital analytics has exponentially grown during the last few years and multiple definitions have been employed to describe the term (Lawler et al. 2004; Ulrich and Dulebohn 2015; Marler and Boudreau 2017). Although with different perspectives, it could be argued that human resources analytics is an evidence-based approach for making people-related decisions (Bassi 2011) leveraging data and information instead of relying on intuition.

Methodology

Research methodology

The current study is based on a systematic review, seeking to bring together articles dealing with the effects of digitalization on human resource management, focusing on the maritime industry. Systematic reviews were first introduced for health-related sectors; however, their use is constantly gaining ground in social sciences (Snyder 2019) and its process is strongly associated with the development of an evidence-based approach in management (Tranfield et al. 2003). The need for conducting a systematic literature review in the respective field of study, derives from the increasing use of digitalization in the maritime sector and the associated challenges it poses. For this reason, the main scientific contributions in the respective field are presented, while aspects which have not been extensively researched yet are discussed.

The review follows a systematic process to collect the data using predefined keywords and specific inclusion and exclusion criteria. This type of review presupposes the detailed recording of research steps, so that other researchers can replicate the search process (Grant and Booth 2009). After the collection of data, a qualitative approach is used to assess the scientific papers retrieved. Through this methodology, the paper attempts to create a conceptual framework, proposing methodological tools that will respond to the analysis of the challenges described above.

Data collection and analysis

The methodological approach adopted for this review includes the collection of relevant articles, in which authors had full access, published in dedicated maritime, transportation, business and technology-focused academic journals as a priority, written in English with a special focus in the period between 2015 and 2023. The set time frame is attributed to the increased interest of the academic body of knowledge in the respective field from 2015 onwards without however excluding articles beyond this timeframe which constitute academic milestones in the field of maritime human resource management. At the same time, analysis includes articles published during December 2023, to capture the latest research findings in the field. The methodology of the review is grounded in a four-stage process, as presented in Fig. 2.

In the first stage, digital databases and search terms were defined. Totally five databases were selected, namely Emerald, Scopus, Springer Open, MDPI and Sciencedirect, using combined keywords reflected in titles or abstracts. The search process was constrained to exclude articles which were not in English. The exact search terms used were ("human resources" AND (maritime OR shipping) AND (digitization OR digitalization

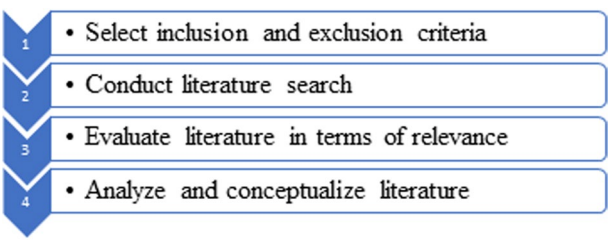


Fig. 2 Methodology steps. Source: Authors

OR "digital business" OR "digital transformation")) or any other combination of these words. However, due to spelling differences, the terms "digitization" and "digitalization" were also included.

The second stage included the search process of peer-reviewed articles on the predefined databases. In addition, authors conducted a manual search in maritime journals, using the same keywords as described before, to ensure that relevant publications would not be excluded due to unavailability in the selected databases. Precisely, the journals that were more extensively used were Maritime Policy and Management, Maritime Business Review, Marine Policy, Journal of Shipping and Trade, WMU Journal of Maritime Affairs, Maritime Economics and Logistics, and International Journal of Shipping and Transport Logistics. Through this first set of articles, authors also identified additional articles, which cited or were cited by the initial papers.

During the third stage, abstracts from publications retrieved in the second stage were reviewed to assess their relevance with the examined thematic area. The most relevant studies were chosen for further research, while the irrelevant ones were eliminated. Through this process, the final set of papers resulted in a total number of 36.

The last stage incorporates the analysis of the literature, to be classified into sub-categories. As stated by Fish and Block (2018), systematic literature reviews are preferred to be "concept-centric" instead of being presented chronologically or alphabetically. Following this direction, the current review categorizes research papers in terms of thematic foci and research methods employed, attempting to create a conceptual framework, which will respond to the analysis of linking maritime digitalization with human resource management.

Although authors have made every effort to examine all articles in the respective field of study, issues related to unavailability in the databases, or to the fact that search terms used were not reflected in the titles or abstracts of the papers retrieved, may have constrained the article identification process.

Theoretical framework

Articles retrieved during the literature review process are categorized across the three broadly defined research themes, presented in Section "Digitalization and human resource management". It is important to note that although industry reports and research projects on the subject are presented, only articles in peer-reviewed journals are included and analyzed thoroughly in tables and figures.

Thematic foci

In terms of thematic concentration, it is observed that research interest has focused on the analysis of the future skills needed in the maritime profession and the associated changes in training needs, as well as on concerns regarding the future of employment due to increased automation. However, there is a significant smaller amount of works related to maritime digitalization at organizational level, while research outputs in maritime human resource management at operational level were hardly found. As indicated in Table 1, from the total number of 36 papers under review, the majority (28 papers) fall under the category of "future of work", including works on maritime digitalization and future skills (5 paper), the effects of Maritime Autonomous

Surface Ships in the automation of work (8 papers) and the future skills (7 papers) as well as the reconsideration of maritime education and training (7 papers) while, 8 papers examine the effect of factors at organizational level in establishing better prospects for digital transformation in shipping.

Table 1 Main thematic topics in maritime human resource management in relation to digitalization

Main thematic areas	Thematic sub-areas	No. of articles	Publications
Future of work	Maritime digitalization and future skills	5	Cicek et al. (2019)
			Muslu (2020)
			Shahbakhsh et al. (2022)
			Baum-Talmor and Kitada (2022)
			Narayanan et al. (2023)
	MASS and work automation	8	Wahlström, et al. (2015)
			Ahvenjärvi (2016)
			Mallam et al. (2019)
			Jo and D'agostini (2020)
			Kooij and Hekkenberg (2020)
			Poulis et al. (2020)
			Boguslawski et al. (2022)
			Theotokatos et al. (2023)
	MASS and future skills	7	Jo et al. (2020)
			Kim and Mallam (2020)
			Kilpi et al. (2021)
			Saha (2021)
			Sharma and Kim (2021)
			Chan et al. (2022)
			Emad and Ghosh (2023)
	Maritime training and education	8	Deling et al. (2020)
			Demirel (2020)
			Nasur and Bogusławski (2020)
			Simmons and McLean (2020)
			Smith Johnson (2020)
			Meyer et al. (2021)
			Li et al. (2022)
			Turkistanli (2023)
	Subtotal	28	
Organizational level		8	Shin and Shin (2019)
			Gupta et al. (2022)
			Jovic et al. (2022)
			Kaptan (2022)
			Lipis and Schislyaeva (2022)
			Przybylowski et al. (2022)
			Autsadee et al. (2023)
			Lu et al. (2023)
	Subtotal	8	
Operational level		–	
	Subtotal	(–)	
Total		36	

Source: Authors

Future skills and automation in the maritime industry

As digitalization and task automation in the maritime sector advances, traditional jobs may become obsolete while new ones will be created. Apart from the adoption of digital technologies and solutions, smart and autonomous ships, ranging from some form of autonomy to fully autonomous vessels, are about to transform the maritime industry. This transformation receives criticism as regards to the way it will affect shipping industry's identity. In this context, automation in the form of unmanned vessels is considered to pose a threat to the identity of the shipping industry as it will be a shift to "non-seafarer-centric shipping" (Poulis et al. 2020). Likewise, changes in the nature of work of the seafaring profession and among maritime professionals in general, necessitate the development of new skills related to digital technologies and manifest the importance of lifelong learning.

Researchers, responding to the constant and impetus technological disruptions, recognized the immediate need to improve current skills, and therefore focused on the identification of specific competences, which will be necessary for the technologically advanced environment in maritime business. Shahbakhsh et al. (2022) examined the role of seafarers in autonomous shipping and found that the challenges they will face in the transition to the new environment are numerous, with those related to unknown skills and competencies to be included among them. They conclude their analysis by proposing several relevant questions that future research should examine. Li et al. (2022) analysed skills and competencies considered as critical to shore-based executives in the maritime logistics sector in the digital era. They concluded that in descending order, the most important skills are the business skills, the logistics skills the management skills, and the digitalisation skills. Researchers, emphasize the fact that business skills were considered of secondary importance. In the last group of skills are ranked in terms of importance the factors of Information Search and Processing, Digital Communication and Collaboration, Digital Problem-Solving skills, Cyber-security and Hardware and Software Knowledge. Baum-Talmor and Kitada (2022) proposed a human-centered approach and discussed the way Industry 4.0 and digitalization affect skills, training and support mobility in the career of seafarers.

Cicek et al. (2019), synthesized skills defined in previous works to identify essential competences that seafarers will need to possess. Skills were defined and classified into four categories, namely technical, social, methodological, and personal (Hecklau et al. 2016). In relation to digitalization, technical skills refer to capabilities linked to computing and digital skills such as programming and data processing, whereas the rest relate more to behavioral and cognitive characteristics like emotional intelligence, teamwork, and leadership. Such findings are in alignment with the research project "Skillsea" (Oksavik et al. 2020), which was conducted to identify the skills and competences of maritime professionals for the future maritime industry. Specifically, skills directly related to the capability of using technology and data analytics as well as familiarity with computer systems, in combination with soft skills development, are evolving into essential competencies for the future.

As mentioned in Section "Digitalization and Maritime industry", disruptions, like COVID-19, increase the interest of organizations for new technologies and their contribution to overcoming or minimizing difficulties. This framework of analysis is employed

by Meyer et al. (2021) in the analysis of the ability of small and medium sized ports in the Baltic Sea Region to keep the severe effects of the lockdown due to COVID 19 to the minimum via the increase in deployment of digital technologies. Based on this analysis, they suggested a conceptual capacity building framework for port employees, which improves their competence and skills thus fostering the digital transformation of ports.

Like any change, the introduction of Maritime Autonomous Surface Ships (MASS) creates mixed reactions from those who will mainly be affected, i.e. seafarers (Theotokatos et al. 2023; Boguslawski et al. 2022). At the same time, the introduction of *MASS* (Ringbom 2019; Kim et al. 2020), has created consensus among stakeholders for the essential need for modification of the training framework (Theotokatos et al. 2023) and have initiated a conversation around the current situational awareness of seafarers (Chan et al. 2022) and the skills required in an almost completely autonomous or unmanned environment. Sharma and Kim (2021), examined the extent to which the International Convention on Standards of Training, Certification and Watchkeeping (STWC), covers the required competences of navigators due to degree 2 MASS development, that is a situation where a ship is controlled remotely, but seafarer's presence on board remains. The results of the study indicated that while some of the traditionally defined competences remain relevant, there is a need to update existing regulations to include hard and soft skills related to the development of MASS. Hard skills refer to information technology competences as well as to technical knowledge related to equipment, systems and operating procedures. For the non-technical competences of navigators as described by Fjeld et al. (2018), researchers identified the ability to maintain situational awareness as well as leadership skills, as the most important competences in the MASS era. Other researchers have examined the skills needed in a situation where a greater degree of autonomy on board the ship will become feasible. Saha (2021) investigated the competences that future shore control operators will need to possess to "monitor and control" unmanned ships from onshore infrastructure. Emad and Ghosh (2023), identified essential skills and competencies, which they propose to be used for the reform of STCW. In their research they reveal that many current skills will still be used in the era of autonomous shipping, while new skills linked with the future adopted technologies will be needed. In the process of transition to autonomous and unmanned ships, traditional training for seafarers will be implemented before the upskilling of the maritime human resources.

Maritime Education and Training in the context of digitalization and training methods and tools applied for the training of maritime human resources attract the increased interest of the research community. Turkistanli (2023) conducted bibliometric research on the digitalization of education and modern trends and found an increase in interest in learning tools and models in Maritime Education and Training with publications and citations growing impetuously after 2017. Human factor issues are found to be a dominant narrative, with the emphasis on the improvement of nontechnical skills. Many researchers have highlighted the importance of soft skills which are highly acknowledged from industry professionals as well. Kim and Mallam (2020), using a Delphi technique with 36 experts, analyzed and ranked leadership skills essential for the future, distinguishing among other factors important in crewless remotely operated ships and those necessary for ships operating with some extent of autonomy with crew on board. Hence, different levels of automation require different competences to some extent. Via

a survey, Kilpi et al. (2021), asked participants to assess 16 competencies in terms of importance in their organization, currently and in the medium-term. The results indicated that innovation, change, project management, flexibility and problem solving have been identified as key competences among participants. Furthermore, the research showed that the competence gap is estimated to increase in the future, necessitating accordingly immediate responses related to human resources re-skilling and up-skilling.

In addition, researchers have also examined the awareness of students pursuing maritime-related degrees regarding autonomous shipping. Survey research by Jo et al. (2020) examined the perceptions of students of the Korea Maritime and Ocean University regarding the possible competency-based changes of seafaring jobs due to MASS development. Although there were differences among the opinions of participants, the overall outcome of the research was that significant changes will occur in needed competences with regards to MASS development. In the same vein, Nasur and Bogusławski (2020), conducted a survey among students at maritime universities, to examine their familiarity and perceptions on MASS. Through questionnaires, the research concluded that maritime students have an average understanding of the MASS framework, while there is a low satisfaction regarding the coverage of the topic in Maritime Education and Training (MET). As a result, due to the rapid technological advancements in maritime business, maritime education and training should adapt accordingly to meet the higher level of technical, digital, and soft skills requirements (Deling et al. 2020; Simmons and McLean 2020; Smith Johnson 2020; Demirel 2020).

Maritime Education and Training can create the framework for the enhancement of gender diversity, a term almost fully neglected in maritime digitalization. Naranayan et al. (2023) focus their research on the factors affecting female seafarers' participation in the male-dominated seafaring profession, examining their potential for participation in the evolving workplace. The result of their research reveals that the ongoing technological advances onboard ships might improve female seafarers' participation, provided that there will be a level playing field and gender neutral access for the acquisition of the needed IT skills and competencies.

Apart from the consequent shift in skills in need, driven by the development of autonomous shipping, changes in the employment context are likely to occur. The development of autonomous ship technology has been introduced to respond to the shortage in the supply of the seafaring labor market, which is expected to further worsen in the future as indicated by BIMCO/ICS (2015), and has since been driven by economic and environmental factors (Munim 2019). The arguments in favor of unmanned vessels include the increased safety and the reduction of operational costs, both associated with the absence of the human element. Specifically, one of the arguments relate to the fact that a reduction in the number of seafarers needed on board, will increase a ship's cargo capacity, thus increasing its revenues, leading therefore to an improvement in a firm's competitiveness. In addition, it is argued that the human factor is the main contributor in many maritime casualties and therefore its absence will increase maritime safety and decrease environmental disasters (Hogg and Ghosh 2016). Conducting qualitative research based on 100 maritime accident reports related to navigational safety, Wróbel et al. (2017), revealed that although unmanned vessels might reduce the number of accidents related to safety hazards,

non-navigational accidents can be expected to increase with crewless voyages. This could be justified from the fact that in urgent and unexpected situations, human's creativity and adaptability can be proven valuable in minimizing the effects of a maritime accident (Mallam et al. 2019). In response to the argument of increased safety of unmanned ships due to the absence of the human element, Ahvenjärvi (2016) reasoned that the human element cannot be eliminated. Even fully autonomous ships with no crew onboard will require remote shore-based control centers operated and monitored by humans. Moreover, software and decision support systems on board the ship are designed by humans and are therefore subject to errors.

Muslu (2020) examined the way Maritime 4.0 will define the next generation of seafarers, supporting the idea of Nordseth (2018) that the seafarer of the future will not be the outcome of the traditional categories namely, deck, engine and catering, but instead, the seafarer of the future will be able to do everything. It should be noted that the idea of dual officer (officers who will be trained as both deck and engine officers) as the trend of the future, has been supported by Theotokas and Wagtmann (2011). Although fully autonomous ships are at early stages of development, technology currently enables a large degree of autonomy, lowering the number of seafarers needed on board. Due to accelerating technological advancements, the interest of researchers regarding the future of the seafarer profession is constantly growing. Wahlström et al. (2015), in one of the earliest studies on the respective field, attempted to present some of the human factor challenges and opportunities associated with the future shore control centers of unmanned vessels, leveraging evidence from other industries such as military, aviation and space operations, among others.

Kooij and Hekkenberg (2020), analyzed the implications autonomous shipping will have on crew size. They concluded that the number of the crew on board will not decrease significantly if only some of the tasks become automated. The results would be diversified in the case that a larger number of operating tasks on board could be automated. Jo and D'agostini (2020) conducted scenario-based research examining four different scenarios between 2018 and 2035, to assess the possible effects of maritime autonomous surface ships (MASS) on the maritime workforce in Korea. They estimated that, although some seafaring jobs will be lost due to automation, there will be a significant increase in shore-based jobs leading to a positive impact in the sector's employment. Some of these new shore-based positions will be probably connected with the market of information technology professionals. In general, researchers reason that standardized tasks are more likely to be outplaced by technology. Similarly, the World Maritime University (2019) estimated that task automation is more likely to occur in low and medium skilled jobs rather than in high skilled ones. To estimate the potential automation of a number of 702 occupations, Frey and Osborne (2017) argued that marine engineers and naval architects present a low probability (0.01) of their jobs being automated (with 0 indicating non-computerizable occupations and 1 indicating occupations which are most likely to be automated). However, occupations within the spectrum of the transportation sector overall, present high probability of being outplaced by technology.

Organizational level dimensions and shipping digitalization

Digitalization and digital transformation are considered factors that define the potential for increase in the performance of organizations. Lu et al. (2023) link digital transformation with the sustainability performance of organizations. The findings of their survey in a sample of 187 maritime professionals in Singapore, propose that sustainability innovation can be positively influenced by digital capabilities, digital technology and business strategy alignment, which along with sustainability exploration innovation, sustainability exploitation innovation and digital flexibility are considered in descending order as the key drivers for the sustainability performance. Jovic et al. (2022) in their examination of the factors influencing digital transformation in the maritime transport sector, state the importance of organizational factors, along with the practices for the management of human resources and the structure of the organizations to be among the important ones. At the same time, they consider the Human Resource Management as an area that benefited from digitalization. Autsadee et al. (2023) recommend that the maritime sector can use digitization as a tool for competitiveness. Their research investigates various digital tools in the fields of Human Resource Development (HRD) in the marine industry and pinpoints their adoption, role, and benefits. At the same time, they examine the problems in implementing these tools and technologies and emphasize the necessity for the adoption of a strategy to digitization within the field of HRD, which will contribute to the resolution of difficulties and problems and to the full leverage of the tools and technologies. Lipis and Schislyaeva (2022) employ a framework of analysis, which considers digital transformation as one of the most important factors for the competitiveness of contemporary organizations, examines the quality and the mobility of human resources as a key factor for the success of digital transformation and identifies the methods and means for the update of the competencies of human resources, focusing more about the form than the content of the training. Przybylowski et al. (2022), relate digitalization with the efforts of shipping companies to transit to new working models, which are either based on remote work or combine traditional mode and remote work. Apart from the acquisition of new skills and the development of new competencies for maritime labour, new technologies will alter human resources practices (Kaptan 2022). Dimensions related with the climate and the leadership in organizations that foster digitalization have been found to affect employees' motivation. Li et al. (2022) found that the combination of healthy organizational climate, supportive co-workers and authentic leadership in the context of digitalisation and automation, boost seafarers' phycological capital.

Organizational culture has been analyzed as one of the factors that determine the organizational structure of maritime companies (Theotokas 2018). Previous research regarding organizational culture in the maritime context has addressed issues regarding safety culture (Håvold 2005; Nævestad 2017), which "reflects individual, group and organizational attitudes, values, and behaviors concerning safety" (Ek et al. 2014) and its importance in minimizing the occurrence of accidents related to the human factor (Nævestad et al. 2019). In addition, issues deriving form multicultural teams onboard, including communication difficulties related to the lack of a common language (Theotokas and Progoulaki 2007), and the occurrence of maritime accidents (Laursen et al. 2008; Uğurlu, et al. 2017), have been examined as well. Progoulaki and

Theotokas (2016), combining different theoretical approaches created a model of distinct strategies to address the management of cultural diversity of maritime human resources.

However, for the purpose of the current work only two articles linking culture and digitalization in the maritime sector and specifically in liner shipping was retrieved. Shin and Shin (2019), explored the type of culture and strategy that best fits an organization that undergoes an organizational change related to innovative technology adoption. Specifically, following the typology of Quinn and McGrath (1985), they found that liner shipping companies that incline towards the developmental or rational type of culture, have better prospects in successfully adopting the technologies of the 4th Industrial Revolution. Gupta et al. (2022) examined the manpower readiness for Industry 4.0 in the context of the Indian logistics sector. Based on the literature review they identify the factors that contribute to talent building and by using the FAHP approach they rank them and find that organizational factors are the most dominant, with the behavioral and technological factors to follow. In the context of each group of factors the most important sub-factors were prioritized. The most important organizational subfactors were found to be the organizational culture and top management support and commitment for digitalization. In relation to behavioral factors, those of training on functional skill development and building competency for implementing digital business models appear to stand out, while in relation to technological factors the development of capabilities for integration of technological platforms and capabilities for sharing and data storing are considered crucial.

Operational level dimensions and shipping digitalization

As far as the operational aspects of digitalization are concerned, the rapid diffusion of digital technologies has created new sources of value generation. The large amount of data generated from digital systems and technologies on board the ship and ashore, have permitted the creation and storage of information that was previously hard or impossible to locate and track. These data, if used well, could be valuable for the maritime business, improving the decision-making process. Big data analytics and artificial intelligence research in the maritime context include among other their application in the evaluation of ship collision risk (Zhang et al. 2021), in energy efficiency and vessel performance (Munim et al. 2020) and in the application of Automatic Identification Systems data (Yang et al. 2019).

During recent years, a growing number of industry reports stress out the need of fully exploiting and leveraging the opportunities of digital technologies and these of the vast amount of data stored, yet only a substantially small amount of generated data is analyzed thoroughly. While studies examining the role of big data and analytics applications in the maritime industry as well as their significance in contributing to economic and environmental issues are increasing, academic research regarding the application of analytics in the maritime human resource management function is significantly lagging. Thus, there is a need to research the potential use of analytics in making people-related decisions in the maritime industry, as a way of relying more on evidence-based decision-making and fully exploiting the benefits that technology can provide.

Research methods used

From the total number of 38 articles, 13 are review articles while the rest (25), are empirical. Table 2 provides an overview of the distinct research methods used in the empirical research papers. Review articles do not contain research methods since they are assembling and summarizing the results of previously published literature, thus are not included in the table. Empirical studies deploy different methodologies, relying on quantitative analysis, qualitative research methods or following a mixed methods approach.

In the case of quantitative analysis, survey is the main method for the empirical data collection. In these cases, articles address questionnaires either to students pursuing maritime-related degrees, or to representatives from maritime companies or to other stakeholders, including maritime logistics and research organizations, as well as maritime education professionals. Most quantitative research papers rely on online questionnaires. In one out of the 13 articles using quantitative methods, authors based their research on case study methodology using algorithms to estimate changes in the crew numbers. In another work, a system dynamics methodology is used, which is a way for quantitatively analyzing real-world problems (Lyneis 1999).

As far as papers using qualitative research methods are concerned, authors conduct semi-structured interviews. These interviews were addressed to maritime industry professionals and academia researchers, with one of the papers using thematic analysis as well. Thematic analysis is a qualitative methodological approach for describing and classifying common categories within data (Braun and Clarke 2006).

Regarding studies using the mixed methods approach, a diverse set of methodological tools is used in each article. Specifically, one of the papers utilizes the Q methodology which constitutes of a research tool suitable for exploring the participants' subjective viewpoints. Q methodology combines quantitative and qualitative approaches, with the quantitative part lying in the statistical analysis of the collected data while the qualitative part refers to the interpretation of the results (Haua et al. 2021). Three papers use a survey instrument to collect both quantitative and qualitative data, while the third paper combines Delphi survey methodology with Analytical Hierarchy Process. Delphi technique is a method, conducted in a series of rounds, for achieving consensus among the experts of a panel using questionnaires (Dalkey and Helmer 1963). In every round, group members can reassess and modify their answers until their opinions converge (Hsu and

Table 2 Research methods used

Research methods		No. of articles
Empirical articles (total)		(25)
Qualitative	Interviews	5
Quantitative	Surveys	12
	Case study (algorithm)	1
	System dynamics	1
Mixed methods	Q methodology	1
	Questionnaires (qualitative and quantitative)	3
	Case study and AHP	1
	Delphi technique and AHP	1

Source: Authors

Sandford 2007). Analytical Hierarchy Process constitutes a "multiple criteria decision-making tool" (Vaidya and Kumar 2006) to quantitatively analyze complex problems (Podvezko 2008).

Further analysis on the research methods reveals that over time, there is an increase in empirical research articles compared to review papers. Specifically, in 2019 two out of three papers are empirical with the same applying for the year 2021. In 2020 seven out of 10 papers under review are empirical. In 2022 the empirical papers are seven out of nine, while in 2023 are five out of six. This increase in empirical research indicates the interest of stakeholders from the maritime community to seek empirical evidence to address issues related to the sector's digitalization.

Publication outlets

As shown in Table 3, papers on the respective field appear to be published in many journals, despite the limited research on the subject and the specificity of the topic under review. More than half of the papers are published in journals, which aim at generating research outputs directly related to the maritime industry, including publications concerned with the organizational, business and management aspects of the maritime industry. Maritime energy, marine resources, pollution, and environment topics are

Table 3 List of journals and numbers of articles in each journal

No	Journal titles in alphabetical order	No. of articles found
1	American Journal of Water Science and Engineering	1
2	Computer Applications in Engineering Education	1
3	Contemporary Global Issues in Human Resources Management	1
4	Ergonomics	1
5	Handbook of Research on the Future of the Maritime Industry	1
6	International Journal of Manpower	1
7	Journal of European Studies	1
8	Journal of International Maritime Safety, Environmental Affairs, and Shipping	1
9	Journal of Shipping and Trade	1
10	Marine Policy	2
11	Maritime Economics and Logistics	4
12	Maritime Policy and Management	1
13	Procedia Computer Science	1
14	Procedia Manufacturing	1
15	Sustainability	2
16	Technological Forecasting & Social Change	1
17	Technology in Society	1
18	The Asian Journal of Shipping and Logistics	1
19	Transnav: The International Journal of Maritime Navigation and Safety of Sea Transportation	3
20	Transportation Research Interdisciplinary Perspectives	1
21	Transportation Research Procedia	1
22	Universal Journal of Educational Research	1
23	WMU Journal of Maritime Affairs	5
24	Worldwide Hospitality and Tourism Themes	2

Source: Authors

covered as well. Apart from dedicated maritime journals, papers on the respective field appear also in journals of different scopes, such as educational, societal or technology driven.

Evolution of publications over time

Figure 3 shows the evolution of publications over time. As indicated, while the first papers in the field appear in the year 2015, there is a progressive evolution of research in the respective field since 2019 onwards. More specifically, the literature search retrieved one article for each of the years 2015 and 2016, while there is a decreasing trend for the years 2017 and 2018. However, during the following years a substantial increase in publications is observed. In the year 2019 three articles were published on the topic, while most papers are published in 2020, resulting in ten articles in total. For the following years the number of publications varies, remaining at notable levels, though, six in 2021, nine in 2002 and six in 2023. The increase in publications since 2019, could be explained by the extensive adoption of digital technologies by maritime companies over time and the growing interest on behalf of the academic community, industry professionals and decision-makers on the impact maritime digitalization will have upon individuals and organizations.

Conclusions and avenues for future research

The current review contributes to the academic body of knowledge by attempting to provide a holistic framework of the publications in the field of maritime human resource management considering the industry's direction towards digitalization and to present organizational and operational aspects related to the topic. Given the scarcity of publications in the respective field, the paper also attempts to leverage information from related industries to create a framework capable of analyzing the challenges created in the industry.

Following a systematic literature review methodology, the paper presents the primary areas of focus in academic research, concerning the effects of digitalization in human

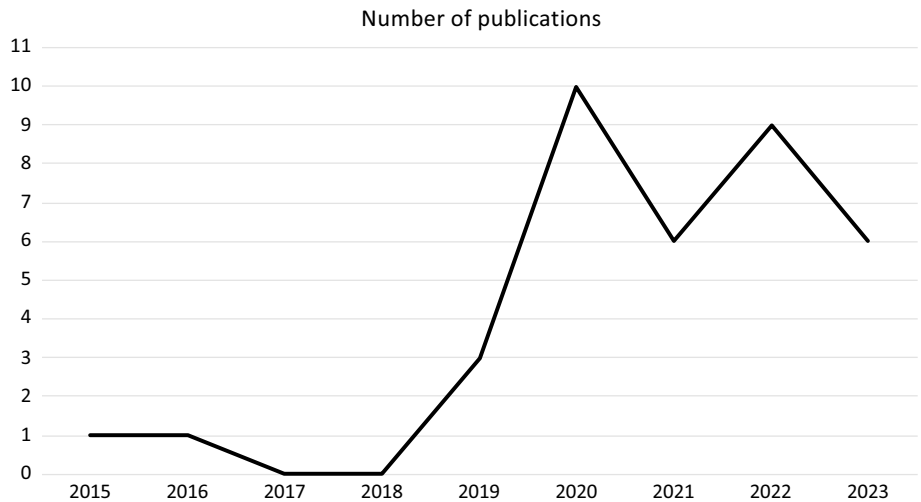


Fig. 3 Evolution of publications over time. Source: Authors

resources with a special focus on the maritime industry. It should be noted that the current review examined publications related to the three areas of focus, namely, the future of work, organizational culture and human resources analytics.

As extensively analyzed, there is significant research output regarding the possible implications on the adoption of digital technologies and solutions as well as the development of MASS technologies may have on the future of maritime employment. Furthermore, researchers are concerned about the skill gap created between existing and future competences. Therefore, maritime digitalization poses two serious challenges for human resource management. The first, relates to the need for workforce reskilling and upskilling through continuous learning and training in both hard and soft skills related to digitalization, while the second refers to organizational and operational parameters that need to be considered when redefining the way human resource management can create value for organizations and individuals. Thus, human resource management functions should reconsider planning for the future needs of the workforce, via adopting practices that will act as facilitators for the industry's digital transformation journey and via developing a human resource strategy, suitable for providing additional support to the change process. Another observation relates to the fact that publications are mainly concentrated in the seafaring labor market, while the field lacks significant research regarding the effects of shipping digitalization on shore-based employees.

Although human capital constitutes a main source of competitiveness for maritime organizations, there are limited research findings on the human resource management practices that should be employed to address these challenges and on the initiatives that should be undertaken to prepare the workforce for the constantly changing maritime business environment. However, from the evolution in the number and the variety of approaches in research papers, it could be argued that a distinct scientific field is beginning to formulate. Thus, there is the need to conduct further research and extend the current scientific knowledge so that the field can be developed.

Overall, existing studies on human resource management in the maritime field remain scarce compared to those of other industries, creating great opportunities for researchers to explore new topics and expand on existing scientific knowledge. Among the future research opportunities, possible topics, which could be explored relate to (1) the effects of digitalization on maritime shore-based employees, (2) the integration of maritime human resource management practices between sea and shore-based human capital in the light of shipping digitalization, as well as (3) the reconsideration of human resource management functions to respond to the challenges the new era introduces.

In addition to the above, challenges appear at the policy level as well. Since there is not a dominant design for MASS technologies or technologies related to software applications, following the digital trends for policy makers is a challenge. Regulating on operational issues such as safety and security ringfencing the wellbeing of those on board and on shore, as well as the physical environment has become a conundrum. There is plenty of room for research in exploring regulatory frameworks, which can be related to Maritime Education and Training (MET) encouraging the use of such technologies. This can be achieved via providing the necessary tools to human resource management departments of shipping companies and organizations to design and develop HRM systems

focused on diversity based on factors leading to digitalization and motivate employees in the use of innovative technologies.

Finally, among the limitations of the present study, is the lack of focus on issues examining the relationship between automation in shipping and safety management on, as well as issues exploring the impact of automation on the wellbeing of seafarers. Both areas are of critical importance in the future direction of the maritime industry thus mapping the extend these have been examined and the different perspectives used, will add value at academic, industry and policy level.

Acknowledgements
This work has been partly supported by the University of Piraeus Research Center.

Author contributions
IT conceptualized the problem under investigation, structured the theoretical framework and proofread the document. IL has been evolved in the write up and the proofreading of the document along with the validation of the results and conclusions. KR was involved with collection of the literature and write up of the methodology. All authors read and approved the final manuscript.

Funding
The research project was supported by the Hellenic Foundation for Research and Innovation (H.F.R.I.) under the "1st Call for H.F.R.I. Research Projects to support Faculty Members & Researchers and the Procurement of High-and the procurement of high-cost research equipment grant" (Project Number: 3701).

Availability of data and materials
Not applicable.

Declarations

Competing interests
The authors declare that they have no competing interests.

Received: 17 October 2023 Revised: 3 March 2024 Accepted: 5 March 2024
Published: 15 March 2024

References

Ahvenjärvi S (2016) The human element and autonomous ships. TransNav Int J Mar Navig Saf Sea Transp 10(3):517–521. https://doi.org/10.12716/1001.10.03.18

Aiello G, Giallanza A, Mascarella G (2020) Towards Shipping 4.0. A preliminary gap analysis. Proc Manuf 42:24–29. https://doi.org/10.1016/j.promfg.2020.02.019

Al-Alawi AI, Messaadia M, Mehrotra A, Sanosi SK, Elias H, Althawadi AH (2023) Digital transformation adoption in human resources management during COVID-19. Arab Gulf J Sci Res 41(4):446–461. https://doi.org/10.1108/AGJSR-05-2022-0069

Andersen MK (2017) Human capital analytics: the winding road. J Organ Eff People Perform 4(2):133–136

Autsadee Y, Jeevan J, Mohd Salleh NHB, Othman MRB (2023) Digital tools and challenges in human resource development and its potential within the maritime sector through bibliometric analysis. J Int Marit Saf Environ Affairs Shipp 7(4):2286409. https://doi.org/10.1080/25725084.2023.2286409

Bassi L (2011) Raging debates in HR Analytics. People Strategy 34(2):14–18. https://doi.org/10.1108/hrmid.2012.04420baa.010

Baum-Talmor P, Kitada M (2022) Industry 4.0 in shipping: implications to seafarers' skills and training. Transp Res Interdiscip Perspect 13:100542. https://doi.org/10.1016/j.trip.2022.100542

BIMCO/ICS (2015) Manpower report: The global supply and demand for seafarers in 2015. Marisec Publications, London

Bismuth A, Tojo Y (2008) Creating value from intellectual assets. J Intell Cap 9(2):228–245. https://doi.org/10.1108/14691930810870319

Bogulawski K, Gil M, Nasur J, Wrobel K (2022) Implications of autonomous shipping for maritime education and training: the cadet's perspective. Marit Econ Logist 24(2):327–343. https://doi.org/10.1057/s41278-022-00217-x

Braun V, Clarke V (2006) Using thematic analysis in psychology. Qual Res Psychol 3(2):77–101. https://doi.org/10.1191/1478088706qp063oa

Cabrera Á, Cabrera EF, Barajas S (2001) The key role of organizational culture in a multi-system view of technology-driven change. Int J Inf Manage 21(3):245–261. https://doi.org/10.1016/S0268-4012(01)00013-5

Chan JP, Norman R, Pazouki K, Golightly D (2022) Autonomous maritime operations and the influence of situational awareness within maritime navigation. WMU J Marit Aff 21(2):121–140. https://doi.org/10.1007/s13437-022-00264-4

Chesbrough H (2010) Business model innovation: opportunities and Barriers. Long Range Plan 43(2–3):354–363. https://doi.org/10.1016/j.lrp.2009.07.010

Cicek K, Akyuz E, Celik M (2019) Future skills requirements analysis in maritime industry. Proc Comput Sci 158:270–274. https://doi.org/10.1016/j.procs.2019.09.051
Colombo E, Mercorio F, Mezzanzanica M (2019) AI meets labor market: exploring the link between automation and skills. Inf Econ Policy 47:27–37. https://doi.org/10.1016/j.infoecopol.2019.05.003
Coskun-Setirek A, Tanrikulu Z (2021) Digital innovations-driven business model regeneration: a process model. Technol Soc 64:101461. https://doi.org/10.1016/j.techsoc.2020.101461
Czachorowski K, Solesvik M, Kondratenko Y (2019) The application of blockchain technology in the maritime industry. Green IT engineering: social, business and industrial applications. Stud Syst Decis Control 171:561–577
Dalkey N, Helmer O (1963) An experimental application of the Delphi method to the use of experts. Manag Sci 9(3):458–467
Davenport TH, Harris J, Shapiro J (2010) Competing on talent analytics. Harv Bus Rev 88:52–58
De La Peña Zarzuelo I, Freire Soeane MJ, López Bermúdez B (2020) Industry 4.0 in the port and maritime industry: a literature review. J Ind Inf Integr 20:100173. https://doi.org/10.1016/j.jii.2020.100173
Deal TE, Kennedy AA (1982) Corporate cultures: the rites and rituals of corporate life. Penguin, London
Del Giudice M, Di Vaio A, Hassan R, Palladino R (2021) Digitalization and new technologies for sustainable business models at the ship–port interface: a bibliometric analysis. Marit Policy Manag 49(3):410–446. https://doi.org/10.1080/03088839.2021.1903600
Deling W, Dongkui W, Changhai H, Changyue W (2020) Marine autonomous surface ship—a great challenge to maritime education and training. Am J Water Sci Eng 6(1):10–16. https://doi.org/10.11648/j.ajwse.20200601.12
Demirel E (2020) Maritime education and training in the digital era. Universal Journal of Educational Research 8(9):4129–4142. https://doi.org/10.13189/ujer.2020.080939
Deshpandé R, Webster FE Jr (1989) Organizational culture and marketing: defining the research agenda. J Mark 53(1):3–15. https://doi.org/10.2307/1251521
Deuze M (2006) Participation, remediation, bricolage: considering principal components of a digital culture. Inf Soc 22(2):63–75. https://doi.org/10.1080/01972240600567170
Diromualdo A, El-Khoury D, Girimonte F (2018) HR in the digital age: how digital technology will change HR's organization structure, processes and roles. Strateg HR Rev 17(5):234–242. https://doi.org/10.1108/SHR-08-2018-0074
Ek Å, Runefors M, Borell J (2014) Relationships between safety culture aspects—a work process to enable interpretation. Mar Policy 44:179–186. https://doi.org/10.1016/j.marpol.2013.08.024
Emad GR, Ghosh S (2023) Identifying essential skills and competencies towards building a training framework for future operators of autonomous ships: a qualitative study. WMU J Marit Aff 22:1–19. https://doi.org/10.1007/s13437-023-00310-9
Erro-Garces A, Aramendia-Muneta ME (2023) The role of human resource management practices on the results of digitalisation. From Industry 4.0 to Industry 5.0. J Organ Change Manag 36(4):585–602. https://doi.org/10.1108/JOCM-11-2021-0354
Fish C, Block J (2018) Six tips for your (systematic) literature review in business and management. Manag Rev Q 68:103–106. https://doi.org/10.1007/s11301-018-0142-x
Fjeld GP, Tvedt SD, Oltedal H (2018) Bridge officers' non-technical skills: a literature review. WMU J Marit Aff 17:475–495. https://doi.org/10.1007/s13437-018-0158-z
Frey CB, Osborne MA (2017) The future of employment: How susceptible are jobs to computerisation? Technol Forecast Soc Chang 114:254–280. https://doi.org/10.1016/j.techfore.2016.08.019
Gal U, Jensen TB, Stein M-K (2020) Breaking the vicious cycle of algorithmic management: a virtue ethics approach to people analytics. Inf Organ 30(2):5. https://doi.org/10.1016/j.infoandorg.2020.10030
Gallo T, Santolamazza A (2021) Industry 4.0 and human factor: How is technology changing the role of the maintenance operator? Proc Comput Sci 108:388–393. https://doi.org/10.1016/j.procs.2021.01.364
Gandomi A, Haider M (2015) Beyond the hype: big data concepts, methods, and analytics. Int J Inf Manage 35(2):137–144. https://doi.org/10.1016/j.ijinfomgt.2014.10.007
Gavalas D, Syriopoulos T, Roumpis E (2022) Digital adoption and efficiency in the maritime industry. J Shipp Trade 7(1):11. https://doi.org/10.1186/s41072-022-00111-y
Grant MJ, Booth A (2009) A typology of reviews: an analysis of 14 review types and associated methodologies. Health Info Libr J 26(2):91–108. https://doi.org/10.1111/j.1471-1842.2009.00848.x
Gupta A, Singh RK, Gupta S (2022) Developing human resource for the digitization of logistics operations: readiness index framework. Int J Manpow 43(2):355–379. https://doi.org/10.1108/IJM-03-2021-0175
Handy C (1993) Understanding organizations. Penguin Group, London
Harlaftis G, Theotokas I (2020) Maritime Business: a paradigm of global business. In: Oxford research encyclopedia of business and management
Harrison R (1972) Understanding your organization's character. Harv Bus Rev 50(3):119–128
Haua R, Wolf A, Harrison J, Aspden T (2021) Q methodology: an underutilised tool in pharmacy practice research. Res Social Adm Pharm 18(10):2178–2183. https://doi.org/10.1016/j.sapharm.2021.04.008
Håvold JI (2005) Safety-culture in a Norwegian shipping company. J Safety Res 36(5):441–458. https://doi.org/10.1016/j.jsr.2005.08.005
Hecklau F, Galeitzke M, Flachs S, Kohl H (2016) Holistic approach for human resource management in Industry 4.0. Proc CIRP 54:1–6. https://doi.org/10.1016/j.procir.2016.05.102
Hofstede G (2001) Culture's Consequences. Sage publications, USA
Hofstede G, Neuijen B, Ohavy DD, Saunders G (1990) Measuring organizational cultures: a qualitative and quantitative study across twenty cases. Adm Sci Q 35(2):286–316. https://doi.org/10.2307/2393392
Hogg T, Ghosh S (2016) Autonomous merchant vessels: examination of factors that impact the effective implementation of unmanned ships. Aust J Marit Ocean Affairs 8(3):206–222. https://doi.org/10.1080/18366503.2016.1229244
Holsapple C, Lee-Post A, Pakath R (2014) A unified foundation for business analytics. Decis Support Syst 64:130–141. https://doi.org/10.1016/j.dss.2014.05.013

Hsu C-C, Sandford BA (2007) The Delphi technique: making sense of consensus. Pract Assess Res Eval 12(1):10. https://doi.org/10.7275/pdz9-th90
Ichimura Y, Dalaklis D, Kitada M, Christodoulou A (2022) Shipping in the era of digitalization: mapping the future strategic plans of major maritime commercial actors. Dig Bus 2(1):100022. https://doi.org/10.1016/j.digbus.2022.100022
Jain A, Ranjan S (2020) Implications of emerging technologies on the future of work. IIMB Manag Rev 32(4):448–454. https://doi.org/10.1016/j.iimb.2020.11.004
Jo S, D'agostini E (2020) Disrupting technologies in the shipping industry: How will MASS development affect the maritime workforce in Korea. Mar Policy. https://doi.org/10.1016/j.marpol.2020.104139
Jo S, D'agostini E, Kang J (2020) From seafarers to E-farers: maritime cadets' perceptions towards seafaring jobs in the industry 4.0. Sustainability. https://doi.org/10.3390/su12198077
Jovic M, Tijan E, Vidmar D, Pucihar A (2022) Factors of digital transformation in the maritime transport sector. Sustainability 14(15):9776. https://doi.org/10.3390/su14159776
Kaptan, M., 2022, Future Requests of Maritime Labour and Solution Suggestions: Human Resources Practices. In Handbook of Research on the Future of the Maritime Industry (pp. 212–231). IGI Global.
Kerin M, Pham DT (2019) A review of emerging industry 4.0 technologies in remanufacturing. J Clean Prod 23:7. https://doi.org/10.1016/j.jclepro.2019.117805
Kilpi V, Solakivi T, Kiiski T (2021) Maritime sector at the verge of change: learning and competence needs in Finnish maritime cluster. WMU J Marit Aff 20:63–79. https://doi.org/10.1007/s13437-021-00228-0
Kim T, Mallam S (2020) A Delphi-AHP study on STCW leadership competence in the age of autonomous maritime operations. WMU J Marit Aff 19:163–181. https://doi.org/10.1007/s13437-020-00203-1
Kim M, Joung T-H, Jeong B, Park H-S (2020) Autonomous shipping and its impact on regulations, technologies, and industries. J Int Marit Saf Environ Affairs Shipp 4(2):17–25. https://doi.org/10.1080/25725084.2020.1779427
Kooij C, Hekkenberg R (2020) The effect of autonomous systems on the crew size of ships—a case study. Marit Policy Manag 48(6):860–876. https://doi.org/10.1080/03088839.2020.1805645
Kwon O, Lee N, Shin B (2014) Data quality management, data usage experience and acquisition intention of big data analytics. Int J Inf Manage 34(3):387–394. https://doi.org/10.1016/j.ijinfomgt.2014.02.002
Lambrou M, Watanabe D, Iida J (2019) Shipping digitalization management: conceptualization, typology and antecedent. J Shipp Trade 4:1. https://doi.org/10.1186/s41072-019-0052-7
Laursen LH, Hansen HL, Jensen OC (2008) Fatal occupational accidents in Danish fishing vessels 1989–2005. Int J Inj Contr Saf Promot 15(2):109–117. https://doi.org/10.1016/j.techfore.2023.1228600503
Lawler EE, Levenson A, Boudreau JW (2004) HR metrics and analytics: use and Impact. Hum Resour Plan 27(4):27–35
Li X, Seah R, Wang X, Yuen KF (2022) Investigating the role of sociotechnical factors on seafarers' psychological capital and mental well-being. Technol Soc 71:102138. https://doi.org/10.1016/j.techsoc.2022.102138
Lipis E, Schislyaeva E (2022) Qualification and mobility of transport complex personnel in the digitalization of shipbuilding. Transp Res Proc 63:2138–2150. https://doi.org/10.1016/j.trpro.2022.06.240
Lu HT, Li X, Yuen KF (2023) Digital transformation as an enabler of sustainability innovation and performance–Information processing and innovation ambidexterity perspectives. Technol Forecast Soc Chang 196:122860. https://doi.org/10.1016/j.techfore.2023.122860
Lyneis JM (1999) System dynamics for business strategy: a phased approach. Syst Dyn Rev 15(1):37–70. https://doi.org/10.1002/(SICI)1099-1727(199921)15:1%3c37::AID-SDR158%3e3.0.CO;2-Z
Mallam SC, Nazir S, Sharma A (2019) The human element in future maritime operations—perceived impact of autonomous shipping. Ergonomics 63(3):334–345. https://doi.org/10.1080/00140139.2019.1659995
Margherita A (2021) Human resources analytics: a systematization of research topics and directions for future research. Hum Resour Manag Rev. https://doi.org/10.1016/j.hrmr.2020.100795
Marler JH, Boudreau JW (2017) An evidence-based review of HR analytics. Int J Hum Resour Manag 28(1):3–26. https://doi.org/10.1080/09585192.2016.1244699
Martínez-Caro E, Cegarra-Navarro JG, Alfonso-Ruiz FJ (2020) Digital technologies and firm performance: the role of digital organisational culture. Technol Forecast Soc Change. https://doi.org/10.1016/j.techfore.2020.119962
Mciver D, Lengnick-Hall ML, Lengnick-Hall CA (2018) A strategic approach to workforce analytics: integrating science and agility. Bus Horiz 61(3):397–407. https://doi.org/10.1016/j.bushor.2018.01.005
Meyer C, Gerlitz L, Henesey L (2021) Cross-border capacity-building for port ecosystems in small and medium-sized Baltic ports. TalTech J Eur Stud 11(1):113–132. https://doi.org/10.2478/bjes-2021-0008
Minbaeva D (2021) Disrupted HR? Hum Resour Manag Rev 31:4. https://doi.org/10.1016/j.hrmr.2020.100820
Mishrif A, Khan A (2023) Digitization policy design and implementation in the logistics and supply chain sector during the time of Covid-19. J Int Logist Trade 21(3):135–158. https://doi.org/10.1108/JILT-10-2022-0053
Munim ZH (2019) Autonomous ships: a review, innovative applications and future maritime business models. Supply Chain Forum Int Forum 20(4):266–279. https://doi.org/10.1080/16258312.2019.1631714
Munim ZH, Dushenko M, Jimenez VJ, Shakil MH, Imset M (2020) Big data and artificial intelligence in the maritime industry: a bibliometric review and future research directions. Marit Policy Manag 47(5):577–597. https://doi.org/10.1080/03088839.2020.1788731
Muslu A (2020) The future of seafarers and the seafarers of the future from the perspective of human resources management. In: Turkmenoglu MA, Cicek B (eds) Contemporary global issues in human resource management. Emerald Publishing Limited, Leeds, pp 219–237. https://doi.org/10.1108/978-1-80043-392-220201016
N'Cho J (2017) Contribution of talent analytics in change management within project management organizations the case of the French aerospace sector. Proc Comput Sci 121:625–629. https://doi.org/10.1016/j.procs.2017.11.082
Nævestad T-O (2017) Safety culture, working conditions and personal injuries in Norwegian maritime transport. Mar Policy 84:251–262. https://doi.org/10.1016/j.marpol.2017.07.019
Nævestad O, Phillips RO, Størkersen KV, Laiou A, Yannis G (2019) Safety culture in maritime transport in Norway and Greece: exploring national, sectorial and organizational influences on unsafe behaviours and work accidents. Maine Policy 99:1–13. https://doi.org/10.1016/j.marpol.2018.10.001

Nair K (2019) Overcoming todays' digital talent gap in organizations worldwide. Dev Learn Organ 33(6):16–18. https://doi.org/10.1108/DLO-02-2019-0044
Naranayan SC, Emad GR, Fei J (2023) Key factors impacting women seafarers' participation in the evolving workplace: a qualitative exploration. Mar Policy 148:105407. https://doi.org/10.1016/j.marpol.2022.105407
Nasur J, Bogusławski K (2020) Awareness and attitude of maritime students towards the introduction of autonomous merchant ships—preliminary results. TransNav Int J Mar Navig Saf Sea Transp 14(4):859–863. https://doi.org/10.12716/1001.14.04.10
Nordseth A (2018) We are going to need to think in a different structure than we do today. Informa Connect. Retrieved from https://informaconnect.com/andreas-nordseth-danish-maritime-authority-we-are-going-to-need-to-think-in-a-differentstructure-than-we-do-today/
Oksavik A, Hildre HP, Pan Y, Jenkinson I, Kelly B, Paraskevadakis D, Pyne R (2020) Future Skill and Competence Needs. Skillsea, Project Report 2020
Oliveira L, Fleury A, Fleury MT (2021) Digital power: value chain upgrading in an age of digitization. Int Bus Rev. https://doi.org/10.1016/j.ibusrev.2021.101850
Oram M, Wellins RS (1995) Re-engineering's missing ingredient: the human factor. Institute of Personnel and Development, London
O'reilly CA, Chatman JA (1996) Culture as social control: corporations, cults, and commitment. Res Organ Behav Annu Ser Anal Essays Crit Rev 18:157–200
Podvezko V (2008) Application of AHP technique. J Bus Econ Manag 10(2):181–189. https://doi.org/10.3846/1611-1699.2009.10.181-189
Poulis K, Galanakis GC, Triantafylloy GT, Poulis E (2020) Value migration: digitalization of shipping as a mechanism of industry dethronement. J Shipp Trade 5(1):1–18. https://doi.org/10.1186/s41072-020-00064-0
Progoulaki M, Theotokas I (2010) Human resource management and competitive advantage: An application of resource-based view in the shipping industry. Mar Policy 34(3):575–582. https://doi.org/10.1016/j.marpol.2009.11.004
Progoulaki M, Theotokas I (2016) Managing culturally diverse maritime human resources as a shipping company's core competency. Marit Policy Manag 43(7):860–873. https://doi.org/10.1080/03088839.2016.1173734
Proksch D, Rosin AF, Stubner S, Pinkwart A (2021) The influence of a digital strategy on the digitalization of new ventures: the mediating effect of digital capabilities and a digital culture. J Small Bus Manage 62(1):1–29. https://doi.org/10.1080/00472778.2021.1883036
Przybylowski A, Suchanek M, Miszewski P (2022) COVID-19 pandemic impact on a global liner shipping company employee work digitalization. TransNav Int J Mar Navig Saf Sea Transp 16(4):759–765. https://doi.org/10.12716/1001.16.04.18
Pu S, Lee Lam JS (2020) Blockchain adoptions in the maritime industry: a conceptual framework. Marit Policy Manag 48(6):777–794. https://doi.org/10.1080/03088839.2020.1825855
Quinn RE, McGrath MR (1985) The transformation of organization cultures: a competing values perspective. Organizational culture. Sage Publications, London, pp 315–334
Rasmussen T, Ulrich D (2015) Learning from practice: how HR analytics avoids being a management fad. Organ Dyn 44(3):236–242. https://doi.org/10.1016/j.orgdyn.2015.05.008
Ravarini A, Martinez M (2019) Lost in holacracy? The possible role of e-HRM In dealing with the deconstruction of hierarchy. In: HRM 4.0 for human-centered organizations (Advanced Series in Management, vol 23), Emerald Publishing Limited, Leeds, pp 63–79. https://doi.org/10.1108/S1877-636120190000023006
Raza Z, Woxenius J, Vural CA, Lind M (2023) Digital transformation of maritime logistics: exploring trends in the liner shipping segment. Comput Ind 145:103811. https://doi.org/10.1016/j.compind.2022.103811
Razmjooei D, Alimohammadlou M, Ranei Kordshouli HA, Askarifar K (2023) Industry 4.0 research in the maritime industry: a bibliometric analysis. WMU J Marit Aff 22(3):385–416. https://doi.org/10.1007/s13437-022-00298-8
Ringbom H (2019) Regulating autonomous ships—concepts, challenges and precedents. Ocean Dev Int Law 50(2–3):141–169. https://doi.org/10.1080/00908320.2019.1582593
Saha R (2021) Mapping competence requirements for future shore control center operators. Marit Policy Manag 50(4):415–427. https://doi.org/10.1080/03088839.2021.1930224
Santana M, Cobo MJ (2020) What is the future of work? A science mapping analysis. Eur Manag J 38(6):846–862. https://doi.org/10.1016/j.emj.2020.04.010
Sepehri A, Vandchali HR, Siddiqui AW, Montewka J (2022) The impact of shipping 4.0 on controlling shipping accidents: a systematic literature review. Ocean Eng 243:110162. https://doi.org/10.1016/j.oceaneng.2021.110162
Shahbakhsh M, Emad GR, Cahoon S (2022) Industrial revolutions and transition of the maritime industry: the case of Seafarer's role in autonomous shipping. Asian J Shipp Logist 38(1):10–18. https://doi.org/10.1016/j.ajsl.2021.11.004
Sharma A, Kim T (2021) Exploring technical and non-technical competencies of navigators for autonomous shipping. Marit Policy Manag 49(6):831–849. https://doi.org/10.1080/03088839.2021.1914874
Shin S-H, Shin Y-J (2019) The impact of organizational culture and strategy on shipping liner's awareness and utilization of the 4th IR technologies. Marit Policy Manag 49(1):78–96. https://doi.org/10.1080/03088839.2020.1843724
Simmons E, McLean G (2020) Understanding the paradigm shift in maritime education, The role of 4th industrial revolution technologies: an industry perspective. Worldw Hosp Tour Themes 12(1):90–97. https://doi.org/10.1108/WHATT-10-2019-0062
Simón C, Ferreiro E (2018) Workforce analytics: a case study of scholar–practitioner collaboration. Hum Resour Manage 57(3):781–793. https://doi.org/10.1002/hrm.21853
Sletmo GK (1989) Shipping's fourth wave: ship management and Vernon's trade cycles. Marit Policy Manag 16(4):293–303. https://doi.org/10.1080/03088838900000049
Smith Johnson EM (2020) Exploring the effects of technology and innovation on changing market requirements and the evolving maritime curriculum, A Jamaican Perspective. Worldw Hosp Tourism Themes 12(1):69–79. https://doi.org/10.1108/WHATT-10-2019-0065
Snyder H (2019) Literature review as a research methodology. J Bus Res 104:333–339. https://doi.org/10.1016/j.jbusres.2019.07.039

Stone DL, Deadrick DL (2015) Challenges and opportunities affecting the future of human resource management. Hum Resour Manag Rev 25(2):139–145. https://doi.org/10.1016/j.hrmr.2015.01.003
Sullivan BP, Desai S, Sole J, Rossi M, Ramundo L, Terzi S (2020) Maritime 4.0—opportunities in digitalization and advanced manufacturing for vessel development. Proc Manuf 42:246–253. https://doi.org/10.1016/j.promfg.2020.02.078
Sullivan BP, Arias Nava E, Desai S, Sole J, Rossi M, Ramundo L, Terzi S (2021) Defining maritime 4.0: reconciling principles, elements and characteristics to support maritime vessel digitalisation. IET Collab Intell Manuf 3(1):23–36. https://doi.org/10.1049/cim2.12012
Tabrizi B, Lam E, Girard L, Irvin V (2019) Digital transformation is not about technology. Harv Bus Rev 13:1–6
Theotokas I (2018) Management of shipping companies. Routledge, New York
Theotokas I, Progoulaki M (2007) Cultural diversity, manning strategies and management practices in Greek shipping. Marit Policy Manag 34(4):383–403. https://doi.org/10.1080/03088830701539198
Theotokas I, Wagtmann MA (2011) The potential for the use of single-versus dual-purpose officers in firms: a theoretical analysis based on resource-based, transaction cost and labour market economics. https://doi.org/10.4337/9781849806619.00021
Theotokas I (2019) Organization and Management of Shipping Companies, Alexandria, Athens (in Greek)
Theotokatos G, Dantas JLD, Polychronidi G, Rrentifi G, Colella MM (2023) Autonomous shipping—an analysis of the maritime stakeholder perspectives. WMU J Marit Aff 22(1):5–35. https://doi.org/10.1007/s13437-022-00290-2
Tranfield D, Denyer D, Smart P (2003) Towards a methodology for developing evidence-informed management knowledge by means of a systematic review. Br J Manag 14(3):207–222. https://doi.org/10.1111/1467-8551.00375
Turkistanli TT (2023) Advanced learning methods in maritime education and training: a bibliometric analysis on the digitalization of education and modern trends. Comput Appl Eng Educ 32(1):1–21. https://doi.org/10.1002/cae.22690
Uğurlu O, Kum S, Aydoğdu YV (2017) Analysis of occupational accidents encountered by Deck Cadets in maritime transportation. Marit Policy Manag 44(3):304–322. https://doi.org/10.1080/03088839.2016.1245449
Ulrich D, Dulebohn JH (2015) Are we there yet? What's next for HR? Hum Resour Manag Rev 25(2):188–204. https://doi.org/10.1016/j.hrmr.2015.01.004
Vaidya OS, Kumar S (2006) Analytic hierarchy process: an overview of applications. Eur J Oper Res 169(1):1–29. https://doi.org/10.1016/j.ejor.2004.04.028
Van Laar E, Van Deursen AJAM, Van Dijk JAGM, De Haan J (2017) The relation between 21st-century skills and digital skills: a systematic literature review. Comput Hum Behav 72:577–588. https://doi.org/10.1016/j.chb.2017.03.010
Verhoef PC, Broekhuizen T, Bart Y, Bhattacharya A, Dong JQ, Fabian N, Haenlein M (2021) Digital transformation: a multidisciplinary reflection and research agenda. J Bus Res 122:889–901. https://doi.org/10.1016/j.jbusres.2019.09.022
Wahlström M, Hakulinen J, Karvonen H, Lindborg I (2015) Human factors challenges in unmanned ship operations—insights from other domains. Proc Manuf 3:1038–1045. https://doi.org/10.1016/j.promfg.2015.07.167
Wallach EJ (1983) Individuals and organizations: the cultural match. Train Dev J 37:28–36
World Maritime University (2019) Transport 2040: Automation, technology, Employment - The Future of Work.
Wróbel K, Montewka J, Kujala P (2017) Towards the assessment of potential impact of unmanned vessels on maritime transportation safety. Reliab Eng Syst Saf 165:155–169. https://doi.org/10.1016/j.ress.2017.03.029
Yang C-S (2019) Maritime shipping digitalization: Blockchain-based technology applications, future improvements, and intention to use. Transp Res Part E Logist Transp Rev 131:108–117. https://doi.org/10.1016/j.tre.2019.09.020
Yang D, Lingxiao W, Wang S, Jia H, Li KX (2019) How big data enriches maritime research—a critical review of automatic identification system (AIS) data applications. Transp Rev 39(6):755–773. https://doi.org/10.1080/01441647.2019.1649315
Zavyalova E, Sokolov D, Kucherov D, Lisovskaya A (2022) The digitalization of human resource management: present and future. Foresight STI Gov 16(2):42–51
Zhang X, Lee Lam JS (2019) A fuzzy Delphi-AHP-TOPSIS framework to identify barriers in big data analytics adoption: case of maritime organizations. Marit Policy Manag 46(7):781–801. https://doi.org/10.1080/03088839.2019.1628318
Zhang M, Montewka J, Manderbacka T, Kujala P, Hirdaris S (2021) A big data analytics method for the evaluation of ship—ship collision risk reflecting hydrometeorological conditions. Reliab Eng Syst Saf. https://doi.org/10.1016/j.ress.2021.107674
Zhong RY, Xu X, Klotz E, Newman ST (2017) Intelligent manufacturing in the context of industry 4.0: a review. Engineering 3(5):616–630. https://doi.org/10.1016/J.ENG.2017.05.015

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.