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Digital tools and challenges in human resource development and its potential within the maritime sector through bibliometric analysis

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ABSTRACT

The maritime industry, a cornerstone of global trade and commerce, is currently undergoing a significant transformation, primarily driven by technological advancements. Human resource development (HRD) in maritime industry has become a focal point, aimed at improving operational efficiency, safety, and competitiveness. This research paper conducts an in-depth examination of digital tools and its challenges in the context of maritime HRD through bibliometric analysis. The findings indicate the presence of a variety of digital technologies, such as e-learning platforms (ELP), learning management systems (LMS), virtual reality (VR), augmented reality (AR), gamification, and artificial intelligence (AI) and machine learning (ML). Nevertheless, the maritime sector may encounter a range of obstacles including issues related to security concerns, skill gaps, strategic planning, change management, budget constraints, and regulatory compliance. To effectively address these difficulties, it is essential to adopt a comprehensive strategy that includes many components such as cybersecurity measures, efforts for talent development, strategic alignment, change management techniques, budgetary restraint, and legal scrutiny. The findings of this study have significant consequences for the maritime sector, governments, and the academic community. It is recommended that maritime sector can use digitization as a fundamental component of their competitiveness and safety measures.

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Introduction

In recent years, the marine industry, which plays a crucial role in facilitating global trade and commerce, has experienced a notable shift due to developments in technology (Lehto, 2020). The industry in question consistently strives to improve its operational efficiency, safety measures, and competitive advantage (Plomaritou & Jeropoulos, 2022). One significant aspect of this evolutionary process relates to the HRD practises within the maritime industry. The incorporation of digital tools and technologies has initiated a paradigm shift in the field of HRD, with the objective of enhancing training, skill enhancement, and workforce administration (Gökalp & Martinez, 2022; Mer & Virdi, 2023; Thite, 2022).

In the marine industry, there is a potential of growing trend of utilising digital tools for HRD (Autsadee et al., 2023). However, the current body of literature on this topic lacks a comprehensive and cohesive understanding, since it consists of fragmented insights. The absence of a comprehensive evaluation that systematically analyses the difficulties related to these technologies is notable. Moreover, considering the unique challenges of the maritime sector, it is imperative to discover customised digital solutions that can effectively cater to the special demands of this industry.

The primary objectives of this research article are to examine and analyse the overarching trends and patterns that are commonly found in the existing literature pertaining to digital tools and difficulties within the context of maritime HRD. Another objective is to offer practical suggestions that are tailored to meet the needs of maritime organisations, governments, and the academic community. The advice provided will be based on the research findings about the use of digital tools in marine HRD. These recommendations aim to solve the problems encountered and capitalise on the benefits observed.

The current study article conforms to the subsequent organisational framework. Section two encompasses a comprehensive examination of the existing body of literature. Section three provides a comprehensive overview of the research technique employed in this study. Sections four and five present the results of the bibliometric analysis, focusing on digital technologies in the field of marine HRD and discussing the problems that were encountered. Section six of the paper encompasses a comprehensive discussion that effectively

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integrates the research findings, so making a logical connection between the research objectives and the collected dataset. The implications for the marine sector are identified and practical proposals are carefully articulated. The conclusion is provided in section seven.

Literature review

The maritime industry serves as a fundamental pillar of international trade and business, enabling the transportation of various goods, resources, and individuals across the Earth's oceans (Chang, 2022). The domain under consideration comprises a wide range of activities, which include the transportation of goods, the management of ports, the coordination of logistics, and the execution of offshore operations (Notteboom et al., 2022). The maritime industry holds a crucial position in the global economy due to its inherent connection to international trade (Polejack & Machado, 2023). The industry in question is characterised by its dynamic nature and constant evolution, which are shaped by several variables such as geopolitical dynamics, environmental considerations, and notably, technological progress.

The significance of HRD in the marine industry cannot be overstated, given its complex and high-risk characteristics. Maritime HRD comprises a wide range of operations that are focused on the preparation and cultivation of a highly skilled and flexible staff (Pass & Ridgway, 2022; Piwowar-Sulej, 2021). The aforementioned activities involve several aspects such as training, education, competency evaluations, and career development (Khang et al., 2023; McGill et al., 2020). In a sector where prioritising safety, compliance, and efficiency is of utmost importance, the proficiency and welfare of both sailors and staff working on land are crucial considerations.

The incorporation of digital tools and technologies into HRD practices has emerged as a significant and influential factor within the maritime sector. The digital tools mentioned span a diverse array of applications, such as e-learning platforms, virtual reality simulations, data analytics, and digital communication systems (Castiblanco Jimenez et al., 2020; Wider et al., 2023; Zhang et al., 2022). The utilisation of these tools in HRD projects has greatly bolstered the sector's capacity to deliver training, promote the transfer of information, and assess employee performance (Jia et al., 2023; Kutieshat & Farmanesh, 2022).

Despite the potential benefits of utilising digital tools, the marine industry has various obstacles when it comes to successfully adopting HRD initiatives. The primary concern that persists is the matter of crew retention and recruitment (Ben-Zvi & Luftman, 2022; Davies, 2021). The continuous issues in the maritime industry are attributed to the combination of high turnover rates and the demanding nature of the work (Mallouppas & Yfantis, 2021). In addition, the requirement for ongoing training and certification in order to comply with industry norms and safety requirements imposes a burden on both human and financial resources (Cihon, 2019; Islam et al., 2020). Furthermore, the maritime industry functions within a worldwide framework, hence requiring the implementation of strategies to effectively manage cultural and linguistic diversity within HRD initiatives (Lee et al., 2023; Österman & Boström, 2022).

The utilisation of digital tools has yielded a multitude of advantages in effectively tackling HRD difficulties encountered by the maritime industry. One of the most prominent benefits is in the inherent flexibility and widespread accessibility of training and educational resources (Mahmud et al., 2022). The emergence of e-learning platforms can provide seafarers and marine professionals with the opportunity to conveniently access training modules, hence minimising the necessity for extended periods of leave and travel (Kennard et al., 2022). In addition, the utilisation of digital tools facilitates the construction of immersive training environments, exemplified by virtual reality simulations, hence amplifying experience learning and the cultivation of skills (Alkhabra et al., 2023; Cardenas-Robledo et al., 2022). Furthermore, the utilisation of data analytics and performance tracking systems offers significant insights into the proficiency of individuals and organisations, hence enabling the implementation of customised HRD initiatives (Fitria et al., 2023; Malik et al., 2023).

It can be seen that prior scholarly investigations in the domain of digital tools in maritime HRD have established the fundamental knowledge necessary for comprehending the possibilities and obstacles associated with the integration of technology within this industry. Numerous scholarly investigations have been conducted to examine the efficacy of particular digital instruments, such as simulation training, in augmenting marine proficiencies. Furthermore, scholarly investigations have explored the significance of digital tools in mitigating concerns related to crew wellbeing and retention.

Nevertheless, notwithstanding the advancements achieved, notable disparities continue to exist within the body of scholarly work. Firstly, it is important to conduct a full bibliometric analysis in order to systematically evaluate the current level of research in this particular field. This analysis has the capacity to discern the principal themes and patterns within the realm of HRD research. Furthermore, although previous research has examined the advantages of utilising digital technologies, there is a scarcity of scholarly investigations that thoroughly examine the unique obstacles and hindrances experienced during the process of implementing these tools. Comprehending these problems is of utmost importance in the formulation of efficacious tactics. The continual evaluation of the shifting nature of technology is crucial in the maritime sector's efforts to adapt to emerging digital tools and tactics.

The importance of the maritime industry in international trade, along with the intricate nature of its activities, highlights the crucial role of HRD. The incorporation of digital instruments has initiated a novel epoch, presenting resolutions to enduring obstacles while also generating fresh prospects. However, in order to have a thorough comprehension of this revolutionary process, it is necessary to conduct a methodical review of current research, delve into the obstacles that arise, and consistently evaluate the latest digital tools that are being developed. By addressing these identified deficiencies, the maritime industry can enhance its capacity to fully leverage technology in HRD, thereby solidifying its position as a fundamental component of global commerce.

Research methodology

In this research, the principal bibliometric data source employed is Scopus, a well acknowledged and all-encompassing database of scholarly publications (Verheul & Dückers, 2020). Scopus provides a comprehensive compilation of scholarly resources encompassing academic articles, conference papers, and other scholarly materials across diverse disciplines (Pranckutė, 2021). The utilisation of Scopus can guarantee the acquisition of a comprehensive and inclusive selection of scholarly publications pertaining to digital tools, problems, and advantages in the field of HRD.

The process of selecting articles for analysis adheres to a rigorous standard in order to guarantee both relevance and correctness. The inclusion criteria pertain to works that have been published between the years 1993 and 2023, with the intention of capturing recent advancements and patterns within the area. Furthermore, the selection of articles is contingent upon their direct pertinence to the research subject matter, with particular emphasis placed on those that explore the utilisation of digital technologies, the obstacles encountered, and the advantages derived within the field of HRD. Languages other than English are omitted from the selection of articles.

The present study utilises bibliometric analytic methods, with a particular focus on co-word analysis. Co-word analysis, a type of network analysis, is employed to identify and quantify the relationships between terms (referred to as keywords) utilised within the chosen articles (Dhiman et al., 2023). Through the analysis of keyword co-occurrence, this methodology unveils discernible patterns, thematic elements, and the interrelatedness of concepts within the realm of inquiry (Autsadee et al., 2023). The utilisation of co-word analysis offers significant contributions in understanding the organisation of information and the progression of research topics across a given period (Pereira & Bamel, 2021).

Bibliometric analysis offers a methodical and evidence-based way to comprehending the current state of research and identifying areas where knowledge is lacking (Li et al., 2022; Qamar & Samad, 2022). This analysis will then guide the remaining portions of this research paper.

Digital tools in HR development

The integration of digital tools has revolutionized HRD practices within the maritime sector, ushering in a new era characterized by enhanced training, skill development, and workforce management (Piwowar-Sulej, 2021). The following section explores a range of tools and platforms that have significantly transformed HRD practices throughout industries, including the maritime industry, in response to the ongoing advancements in technology. Utilising many technological advancements, including learning management systems (LMS), e-learning (EL), virtual reality (VR), augmented reality (AR), gamification, and artificial intelligence (AI) and machine learning (ML), as identified through co-word analysis (refer to Figure 1).

Learning management systems (LMS) are technology solutions that have been specifically built to facilitate the management and implementation of training and development programmes within enterprises. The aforementioned function serves as a centralised digital infrastructure that effectively enables the generation, dissemination, monitoring, and evaluation of educational materials and tasks (Dlamini & Ndzinisa, 2020). According to Panda (2020), the platform provides a user-friendly interface that enables the efficient uploading and structuring of various educational materials, including online courses, multimedia resources, and assessments, for the goal of organisational management. According to Alam (2022), the system offers employees the opportunity to conveniently access training materials, track their progress, and engage in interactive learning activities. In addition, administrators have the capacity to supervise learners' performance, generate reports, and analyse data to make educated decisions about the effectiveness of training and identify areas that may need improvement (Perry, 2022). The application of LMS technology enables organisations to enhance the delivery of customised learning opportunities, thereby improving the skills and knowledge of their employees, fostering career growth, and promoting overall organisational growth.

E-learning (EL) has emerged as powerful tools for delivering digital learning experiences to individuals. According to Mikołajczyk (2022), these tools enable firms to offer online courses, webinars, and interactive modules that can be accessed remotely by their personnel. According to Alam (2022), EL offer employees the flexibility to access training materials, allowing them to learn at their own convenience and pace. A wide range of educational materials, including as films, presentations, quizzes, and simulations, are

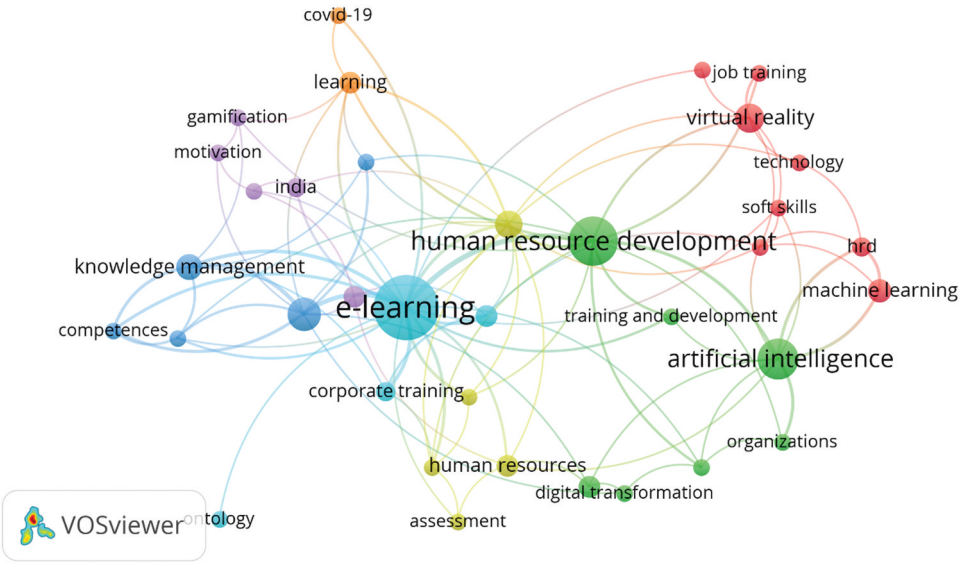

Figure 1. Co-words analysis the digital tools in HR development. Source: Adapted from various sources

provided to cater to different learning preferences. Moreover, EL often incorporate features that promote collaboration and active participation among students, including platforms for interactive discussions, chat functionalities, and collaborative tasks (Puig et al., 2020). According to Liao et al. (2022), the aforementioned practice fosters a sense of community and enhances the acquisition of information among colleagues by means of shared experiences. It may be inferred that the utilisation of EL allows institutions to offer engaging and accessible instructional programmes that promote continuous education and professional growth among their staff members.

The utilisation of VR and AR technology has brought about a significant transformation in the field of HRD. These technologies have introduced immersive learning experiences that effectively simulate real-world situations. In terms of VR, it involves the creation of a computer-generated environment that enables users to engage in interactive experiences. On the other hand, AR entails the superimposition of digital information onto the physical world (Sala, 2021). These technological advancements facilitate the participation of employees in authentic simulations, allowing them to hone their abilities within a secure and regulated setting. According to Sepasgozar (2020), the utilisation of virtual or augmented worlds can effectively immerse employees, enabling them to acquire practical experience and receive prompt feedback. This immersive approach contributes to the improvement of learning outcomes and the development of essential skills. Both VR and AR have been found to facilitate active learning, as individuals actively engage in the learning process instead of passively receiving knowledge (Khandelwal & Upadhyay, 2021; Lalić et al., 2020). According to DiNatale et al. (2020), the use of VR and AR technology fosters an interactive environment that effectively engages multiple senses. This interactive aspect of VR and AR contributes to enhanced information retention and transferability. Furthermore, the efficacy of these technologies has been demonstrated in the teaching of intricate jobs, including medical procedures, industrial operations, and dangerous situations (Xie et al., 2021). Therefore, through the use of VR and AR in HRD, enterprises have the ability to provide employees immersive and influential learning opportunities that improve their skills, better their performance, and contribute to the overall success of the organisation.

Gamification, a widely recognised technology within the field of HRD, encompasses the use of game design elements and mechanics into educational endeavours. Gamification seeks to optimise training programmes by leveraging the inherent incentive and engagement that games offer, so rendering them more pleasurable, engaging, and gratifying for employees (Larson, 2020). According to Jayalath and Esichaikul (2022), gamification is the integration of game-like aspects, such as points, levels, badges, leaderboards, and awards, into training sessions. This incorporation of game components aims to create immersive and dynamic journeys for learners. Gamification leverages the innate human inclination towards accomplishment, rivalry, and advancement to engender active involvement, enhance information retention, and heighten learner engagement (Zainuddin et al., 2020). According to the findings of Ryan and Rigby (2019), the implementation of gamification in the workplace has been shown to cultivate a perception of autonomy and mastery among employees. This is achieved through the ability for employees to monitor their progress, receive prompt feedback, and derive a sense of achievement from their participation. Therefore, the use of gamification in the field of HRD not only fosters a favourable learning atmosphere but also serves as a catalyst for encouraging employees to

consistently improve their competencies and expertise. This, in turn, contributes to their individual career growth and the general prosperity of the company.

The utilisation of AI and ML technologies has been prominent within the domain of HRD, presenting notable progressions in the realm of personalised learning encounters and adaptive training (Graßmann & Schermuly, 2021). According to Jaiswal and Arun (2021), HRD experts have the ability to provide customised learning content and experiences to individual employees by utilising AI and ML algorithms. These technologies possess the capability to assess extensive volumes of data, encompassing employee performance, learning history, and feedback, with the purpose of identifying precise areas for enhancement and generating tailored learning trajectories. In addition, the use of AI and ML has the potential to facilitate adaptive assessments by dynamically modifying the complexity and substance of the examinations in accordance with the learner's level of proficiency and advancement (Gardner et al., 2021). This facilitates a personalised and immersive educational experience that optimises the acquisition of knowledge and the development of skills. Furthermore, Javed et al. (2021) demonstrated that AI and ML algorithms have the capability to offer astute content recommendations. These recommendations entail offering pertinent learning resources and materials by taking into account the learner's profile and previous interactions. The incorporation of AI and ML into the field of HRD enables firms to strategically maximise learning results, bolster employee engagement, and efficiently cater to the varied learning requirements present among their workforce.

Therefore, the primary technologies facilitating HRD include LMS, EL, VR and AR, gamification, AI, and ML. These technologies enable HRD experts to optimise operational procedures, provide tailored learning opportunities, automate repetitive work, make evidence-based judgements, and improve the overall efficiency and influence of HRD endeavours. Organisations can strategically utilise these technologies to embrace digitalization in the field of HRD and maintain a competitive edge in an evolving digital landscape.

Challenges in HR development

The utilisation of digital tools in the field of HRD offers a multitude of advantages. However, it also poses several challenges and obstacles that businesses must confront in order to ensure its implementation. This section examines the primary obstacles that organisations may face while implementing digitalization in the context of HRD.

The incorporation of digitalization within the realm of HRD presents a plethora of issues, with a particular emphasis on security concerns. The implementation of digital technologies in HRD procedures gives rise to novel concerns regarding the safeguarding and confidentiality of sensitive employee data, encompassing personal information, performance assessments, and remuneration particulars (Bieńkowska et al., 2022). Therefore, it is essential for organisations to adopt strong cybersecurity protocols, protect against possible data breaches, and adhere to applicable privacy legislation in the realm of digital human resource development (Teoh et al., 2018). The maintenance of data integrity and confidentiality in the digital era is contingent upon the successful resolution of these security concerns (Stanca & Tarbujaru, 2022).

The adoption of digital HRD requires a workforce that possesses digital literacy and technical skills (Barrett, 2013; Craig et al., 2022; Haryani et al., 2017). Nevertheless, it is not uncommon for skill gaps to arise within the field of HRD, since current HRD workers may lack the necessary proficiency in digital technologies, analytics, and data management (Mangla et al., 2019; Osatis & Asavanirandorn, 2022; Sensuse et al., 2020). As a result, it is imperative for businesses to give utmost importance to allocating resources towards comprehensive training and development initiatives that are specifically designed to enhance the skills and capabilities of HRD professionals. These programmes are intended to provide HRD professionals with the necessary knowledge and competencies to adeptly navigate the digital terrain and effectively address the identified gaps in skills and expertise (Hubschmid-Vierheilig et al., 2020). Strategic investments in employee development play a crucial role in guaranteeing a skilled HRD staff that can effectively utilise digital technology to improve HRD processes and achieve desired outcomes (Simic & Nedelko, 2019; Thornley et al., 2017; Wieringa, 2019; Wu & Kao, 2022).

Additionally, the establishment and execution of a digital HRD plan may provide notable obstacles. The process involves the alignment of digital activities with the overarching goals of HRD in organisations, as well as the smooth integration of digital tools and systems with current HRD procedures (Collou et al., 2021). The achievement of alignment and integration requires the implementation of strategic planning, change management, and effective stakeholder involvement (Honarvar, 2008; Munyeka & Maharaj, 2022). It is imperative for organisations to engage in meticulous planning and strategic mapping of their digital HRD strategy, while duly considering the distinctive requirements and goals of the HRD function (Thornley et al., 2017). In addition, it is essential for organisations to utilise change management strategies in order to effectively implement digital HRD practices. This includes addressing any potential resistance and promoting employee acceptance and support (Van Gramberg et al., 2014). Furthermore, the active participation and support of many stakeholders, such as human resource experts, managers, and employees,

play a vital role in the effective execution of the digital HRD strategy. This is emphasised by Alnamrouti et al. (2022) and Munyeka and Maharaj (2022).

The implementation of digitalization in the field of HRD has the capacity to cause significant disruptions to conventional work processes, hence requiring adaptations in the execution of HRD responsibilities (Mangla et al., 2019; Munyeka & Maharaj, 2022). Potential modifications could face opposition from personnel who are familiar with traditional manual or paper-oriented procedures (Ahmad et al., 2019; Marek et al., 2019). In order to effectively traverse these disturbances in work processes, it is imperative for firms to implement strong change management strategies (Gustafsson et al., 2021). This involves the successful management of the shift towards digital HRD practices, including the proficient communication of the advantages of digitalization to employees, as well as the provision of essential assistance and resources to ensure a seamless transition. According to Newman and Ford (2021), it is imperative for organisations to acknowledge and attend to employee concerns, offer appropriate training and assistance on the implementation of new digital tools and systems, and foster a supportive environment that promotes employee engagement and active involvement in the process of digital HRD transformation.

In addition, the successful integration of digital transformation in the field of HRD requires significant financial commitments towards technology infrastructure, software systems, and training initiatives. Nevertheless, the financial constraints faced by organisations might provide a substantial obstacle when attempting to use digital tools and platforms (Ahmad et al., 2019; Demirkesen & Tezel, 2022; Haryani et al., 2017). In order to effectively manage limited financial resources, companies must strategically allocate their investments by identifying critical domains where the implementation of digitalization can yield substantial benefits in terms of HRD procedures and outputs. It is advisable to investigate cost-effective alternatives, such as open-source software or cloud-based platforms, that have the potential to decrease initial expenses (Ichnowski et al., 2022). Furthermore, it is imperative for businesses to provide evidence of the return on investment (ROI) associated with digital HRD projects. This may be achieved by quantifying the advantages in terms of heightened efficiency, diminished administrative expenses, improved decision-making capabilities, and heightened employee satisfaction (Craig et al., 2022). The provision of evidence-based reasons can play a crucial role in securing the required financing and resources for digital HRD transformation projects (Correia et al., 2021).

Finally, it is imperative to take into account the adherence to regulatory requirements while implementing digitalization in HRD procedures. Human resource development (HRD) initiatives are governed by many rules, such as data privacy legislation, equal employment opportunity mandates, and labour statutes (Craig et al., 2022; Honarvar, 2008; Sensuse et al., 2020). In order to achieve adherence, firms must possess a thorough comprehension of the legal ramifications and obligations associated with HRD data management and privacy, as stated by Esposito et al. (2018). This involves the implementation of suitable data protection mechanisms, including encryption, access controls, and secure storage, in order to ensure the protection of employee data. Organisations must also uphold transparency in their data management procedures, which include the obligation to inform employees about the objectives and extent of data collecting, ensuring compliance with consent requirements, and establishing systems for data accessibility and rectification (Tikkinen-Piri et al., 2018). Organisations can establish trust, minimise legal liabilities, and safeguard the privacy rights of their employees by complying with regulatory obligations.

In conclusion, the integration of digitalization in HRD poses various issues pertaining to security, skill deficiencies, strategic deployment, interruptions in work processes, financial limitations, and adherence to regulatory requirements. The primary authors who exemplify the principal challenges are also depicted in Table 1. To effectively tackle these difficulties, a comprehensive approach is necessary, encompassing cybersecurity protocols, initiatives for enhancing skills, strategic planning, change management methods, appropriate budget allocation, and compliance procedures. The ability to overcome these problems allows firms to effectively utilise digitalization in the field of HRD and achieve favourable results for their employees.

Discussion

Within this particular area, the research findings, consolidating the knowledge acquired from the bibliometric analysis of digital tools, as well as the problems and advantages associated with HRD within the maritime industry shall be explored and examined. The analysis conducted has yielded significant insights pertaining to the current state of research within this particular subject. It has shed light on the primary themes and trends that have emerged, as well as the obstacles encountered by organisations when attempting to apply digitalization in the context of HRD. The objective of this discourse is to derive significant findings and ramifications for maritime entities, policymakers, and the scholarly community.

The bibliometric analysis yielded significant discoveries and trends in the field of maritime HRD pertaining to digital tools. The initial analysis emphasised the significance of EL and LMS in the field of maritime HRD research. These technologies have garnered significant interest as a result of their ability to offer adaptable and

Table 1. Challenges in adapting digital in HRD.

Challenges	Authors
Security - Data security - Cybersecurity	Bieńkowska et al. (2022); Stanca and Tarbujaru (2022); Teoh et al. (2018).
Skill gaps - Technical and soft skills - Digital Skills	Barrett (2013); Craig et al. (2022); Haryani et al. (2017); Hubschmid-Vierheilig et al. (2020); Mangla et al. (2019); Osatis and Asavanirandorn (2022); Sensuse et al. (2020); Simic and Nedelko (2019); Thornley et al. (2017); Wieringa (2019); Wu and Kao (2022).
Strategic and implementation - Strategic planning - Change management -Stakeholder engagement	Alnamrouti et al. (2022); Collou et al. (2021); Honarvar (2008); Munyeka and Maharaj (2022); Sensuse et al. (2020); Thornley et al. (2017); Van Gramberg et al. (2014).
Work process disruptions Resistance change manual or paper-based processes	Ahmad et al. (2019); Gustafsson et al. (2021); Mangla et al. (2019); Marek et al. (2019); Munyeka and Maharaj (2022); Newman and Ford (2021).
Budget constraints - Technology infrastructure - Software systems - Training facilities	Ahmad et al. (2019); Craig et al. (2022); Correia et al. (2021); Demirkesen and Tezel (2022); Haryani et al. (2017); Ichnowski et al. (2022).
Regulation compliance - Data protection laws equal - Employment opportunity requirements - Labor regulations	Craig et al. (2022); Esposito et al. (2018); Honarvar (2008); Sensuse et al. (2020); Tikkinen-Piri et al. (2018)

Source: Author.

easily accessible training resources, as well as their facilitation of learner progress tracking. Maritime institutions have progressively embraced these instruments in order to optimise training procedures and augment the proficiency of their personnel. Prominent instances encompass Kongsberg Maritime's K-Sim Connect and Videotel's CBT (Computer-Based Training) modules (Wu et al., 2022; Žuškin et al., 2013). These platforms have become prominent, providing a flexible and easily available method for distributing training and educational resources to both seafarers and professionals situated on shore. The platforms additionally offer a flexible learning environment that caters to diverse learning styles and interests.

Furthermore, the utilisation of VR and AR technology has emerged as highly influential instruments for the advancement of HRD in the maritime industry. Immersive technologies provide authentic simulations that allow employees the opportunity to engage in skill-building exercises within secure environments. The participatory aspect of these activities has been found to improve the retention of knowledge and the development of skills, especially in tasks that are complicated in nature (Kasneci et al., 2023). The available literature suggests an increasing inclination towards the utilisation of VR and AR in the domain of marine training. An instance of this may be observed in the collaboration between Maersk Training Centre and VR developers, wherein they have built a training programme for crane operators that utilises VR technology (Li & Han, 2021; Sousa et al., 2022). The software application provides a highly accurate representation of crane operations conducted on cargo vessels (Angeloudis & Bell, 2011; Han et al., 2022). Trainees can get the opportunity to engage in practical exercises involving the operation of cranes under diverse conditions, thereby augmenting their proficiency and mitigating the likelihood of untoward incidents. The efficacy of this novel strategy in enhancing the proficiency of crane operators has attracted considerable attention.

Moreover, the concept of gamification has garnered acknowledgement due to its capacity to enhance the engagement and motivation levels within the field of HRD. By integrating gaming components, organisations have the ability to foster active engagement and enhance the retention of knowledge (Holbrey, 2020; Zeng et al., 2020). The implementation of gamification in the workplace cultivates a feeling of accomplishment and advancement, hence stimulating people to consistently improve their skill sets (Chen et al., 2023). For example, in the maritime company can implement a gamified training platform for its crew members. They can create a system where seafarers earn points and badges for completing safety training modules, participating in drills, and achieving certain performance milestones. This approach may not only increase participation but also foster healthy competition among crew members to excel in safety practices.

Besides, the utilisation of AI and ML is becoming more prevalent in the realm of maritime HRD, specifically in the context of personalised learning experiences. These technologies provide the customization of training content based on individual requirements, hence enhancing the effectiveness of learning results (Jaiswal & Arun, 2021; Yathiraju, 2022). Artificial intelligence (AI) and machine learning (ML) algorithms possess the capability to analyse data in order to discover areas that want enhancement and provide recommendations for pertinent learning resources (Aung et al., 2021; Entezari et al., 2023). In maritime sector may utilise AI and ML techniques to tailor training programmes to the specific needs of workers. The system can evaluate the past performance and individual learning preferences of each maritime professional.

Based on the provided data, it offers recommendations for particular courses and modules that can aid individuals in enhancing their skills. As an illustration, in the event that a maritime workers encountered challenges pertaining to navigation in previous experiences, the system may propose supplementary modules focused on navigation instruction.

Nevertheless, the analysis emphasised the significance of cybersecurity within the framework of digital HRD. As maritime organisations may undergo the process of digitising their HRD operations, they may encounter security challenges pertaining to the safeguarding of confidential employee information. The importance of safeguarding data privacy and adhering to regulatory requirements has become a crucial factor (Maniam & Singh, 2020). During the implementation of digital HRD systems, maritime sector may encounter a security incident that result in the unauthorised access and compromising of critical employee information. As a result of the possibility of this occurrence, maritime sector may make a substantial investment in cybersecurity protocols. The sector should employ a range of security measures, including multi-factor authentication, encryption, and periodic security audits, in order to safeguard employee data and maintain adherence to data protection rules.

The successful incorporation of digital tools within the field of HRD necessitates the presence of a proficient workforce equipped with the necessary competencies to effectively navigate the digital realm. Existing research suggests that organisations frequently face instances where there are deficiencies in the skill sets possessed by HRD experts (Bertello et al., 2022; Van den Broek et al., 2021). The implementation of proficient change management techniques is vital in effectively overseeing the shift towards digital HRD practices and mitigating any employee opposition (Abbasnejad et al., 2021; Gadzali et al., 2023). When maritime sectors make a decision to implement VR training for its workers, they may face opposition from their employees as a result of their limited exposure to VR technology. In response to this problem, maritime company may implement an internal training initiative aimed at enhancing the skill set of its workers in the field of VR technology. Maritime organisation can offer practical workshops and web-based courses to ensure the competency of their staff in utilising VR technology for the purpose of training. This methodology enables a seamless transition and mitigated opposition.

The presence of financial constraints can be a substantial obstacle in the implementation of digital technologies for HRD. Maritime sectors may be required to meticulously distribute resources and investigate cost-effective options. It is imperative to establish the return on investment (ROI) of digital HRD programmes in order to get necessary financing and resources. Some of maritime sectors may have financial limitations while contemplating the implementation of a digital such as LMS. In order to address this particular difficulty, the decision can be made to use a cloud-based LMS solution, resulting in a reduction of initial expenses. Following the implementation, a comprehensive monitoring process can be undertaken to painstakingly assess the influence of the LMS on many aspects including training efficiency, employee performance, and safety measures. Through the demonstration of substantial enhancements in these domains, maritime sectors can substantiate the initial investment and obtain supplementary financing for subsequent digital HRD efforts.

The outcomes derived from our study possess various ramifications for maritime entities. To maintain competitiveness and effectively address industry difficulties, it is imperative for maritime organisations to use digitalization in their HRD practices. The utilisation of digital tools, such as EL, LMS, VR, AR, gamification, and AI/ML, has the potential to augment the effectiveness of training programmes and improve the competence of the workforce. Furthermore, it is imperative to overcome talent gaps. It is recommended that organisations allocate resources towards the provision of training and upskilling opportunities for HRD professionals, in order to enhance their ability to effectively traverse the digital terrain. Ensuring employees have access to continuous learning opportunities is of equal importance in order to enable them to effectively utilise digital tools for their professional growth. Furthermore, it is imperative for organisations to formulate strategic plans for HRD that effectively integrate digital efforts in accordance with their overarching objectives. The implementation of effective change management methods is crucial in order to successfully address opposition and facilitate a seamless transition to digital HRD practices.

Furthermore, in light of the digitization of HRD procedures, it is imperative for organisations to place a high level of importance on ensuring data security and adhering to pertinent regulatory requirements. It is crucial to implement robust cybersecurity measures, provide transparency in data handling practices, and establish privacy safeguards. Therefore, it is advisable for organisations to consider cost-effective digital solutions, such as open-source software and cloud-based platforms, in light of budgetary limitations. Illustrating the ROI of HRD projects can play a crucial role in obtaining necessary resources and substantiating the value of such expenditures.

This research makes a valuable contribution to the academic community by providing a thorough examination of the current state of research on digital technologies, as well as the obstacles and benefits associated with their use in maritime HRD. The trends and themes that have been identified can be utilised as a basis for future research within this particular field. Academics have the opportunity to expand upon these discoveries in order to go deeper into the efficacy of particular digital

instruments, devise tactics to tackle obstacles, and examine nascent technologies within the realm of marine HRD. Recognising the constraints of our study is of utmost significance. The present research is grounded in the extant literature, and it is important to note that the domain of digital tools in marine HRD is in a state of constant evolution. Future study may consider examining the practical application of digital technologies inside distinct marine organisations, conducting longitudinal studies to evaluate their enduring effects, and exploring the rising trends in HRD technology.

In summary, this research provides insights into the significant influence of digital tools on HRD in the maritime industry. These tools possess the capacity to augment training, skill acquisition, and workforce administration. Nevertheless, these advancements also provide a set of obstacles pertaining to security, skill acquisition, strategic implementation, change management, financial resources, and adherence to regulatory requirements. In order to effectively capitalise on the advantages of digitalization in HRD, maritime organisations must proactively address and overcome the problems associated with this process. This research enhances the marine industry's capacity to leverage technology for the ongoing advancement of its personnel and, consequently, its international competitiveness.

Conclusion

This research paper undertakes a thorough investigation of digital tools, problems, and advantages in the field of HRD specifically within the marine industry. Through our expedition, we gained a deep comprehension of the enormous impact that digitization may have on augmenting training, skill development, and labour management within this critical sector.

Throughout our investigation, a number of significant findings were identified. The marine industry has had a notable adoption of digital technologies, including e-learning platforms (ELP), learning management systems (LMS), virtual reality (VR), augmented reality (AR), gamification, and artificial intelligence (AI) and machine learning (ML). These tools have proven crucial in enhancing the efficiency of training procedures, promoting competency, and guaranteeing the safety and effectiveness of maritime operations. Concrete benefits of these technologies have been demonstrated through real-world examples provided by industry experts.

Furthermore, similar to any significant transformation in operating paradigms, various problems have emerged. Pivotal factors in the realm of cybersecurity encompass skill gaps, strategic planning, change management, budget limits, and compliance with legislation. The analysis conducted on these problems, along with the inclusion of case studies from maritime organisations, emphasises the necessity of adopting a comprehensive strategy to digitalization within the field of HRD. Organisations can fully leverage the promise of digital tools only through the effective resolution of these difficulties.

The research findings have significant consequences for maritime organisations. The adoption of digitalization is not solely a matter of preference, but rather an imperative in the current dynamic environment. The aforementioned approach serves as a means to uphold competitiveness, bolster safety measures, and guarantee adherence to regulations. Furthermore, it represents a dedication to the ongoing enhancement of the maritime labour force, which serves as a crucial foundation for international trade. Maritime organisations may navigate towards a future characterised by enhanced efficiency, competence, and resilience through the implementation of digital tools, the upskilling of its HRD professionals, the alignment of digital efforts with strategic objectives, the prioritisation of cybersecurity, the justification of investments, and the adherence to regulatory requirements.

The analysis highlights the significance of providing assistance and enabling the digitalization process within the maritime industry for policymakers. The statement underscores the importance of implementing policies that promote the adoption of digital HRD technologies and initiatives, facilitate cooperation between industry participants and educational establishments, and establish regulatory frameworks that protect the confidentiality and integrity of data.

Besides, the research provides a valuable basis for further investigations within the academic community. The text highlights important study issues and trends and encourages scholars to further investigate the efficacy of particular digital tools, ways for tackling HRD challenges, and emerging technologies within the marine industry.

In the final analysis of this research paper, vision encompasses a maritime industry that fully exploits the advantages of digitization. This industry would prioritise immersive and easily accessible training, prioritise competency, and maintain an unwavering commitment to safety. The pursuit of this vision entails numerous obstacles, yet it is a pursuit that holds significant value, as it leads to a marine industry that serves as both the foundation of international trade and commerce and a symbol of ingenuity, adaptability, and advancement.

In the dynamic and ever-changing marine domain, the forces of transformation are propelled by digital technologies. The intention of this research is to function as a navigational tool, providing guidance to maritime organisations, policymakers, and scholars as they embark on their journey towards a more promising future.

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