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Digital competences framework for seafarers: a case study of navigation officers

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DIGITAL COMPETENCES FRAMEWORK FOR SEAFARERS: A CASE STUDY OF NAVIGATION OFFICERS

By

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Declaration

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

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

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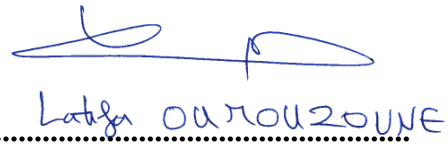

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(Date): **..... 20/09/2022.....**

Supervised by: **Michael Ekow Manuel**

Supervisor's affiliation**: Professor and Nippon Foundation Chair, Head of Maritime Education & Training**

Dedication

To my parents who are always there for me

My father; Mohammed OUMOUZOUNE, for his faith on me, encouragement, support and love

My mother; Fadma Ait Mouh, for her love, prayers, tenderness, generosity and patience

To my sisters and brothers, Fatima, Rekia, Yassine and Ahmed, who are my first supporters

To my friends, Fatima Zahra, Samira, Hayat, Naoual, Hassan and Walid for their unconditional support

To my special workmates' ladies: Leila, Houda, Mounia, Fatima Zahra and Sara, for creating a friendly working environment and for your encouragement.

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To my METcelence family (Faculty and colleagues), who have been part of this great adventure

To WMU Faculty and Staff for making my learning experience fulfilling and memorable

To all those who, by a word, gave me the strength to continue…

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Abstract

Title of Dissertation:	**Digital competences framework for seafarers: A case study of navigation officers**
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In the digital shipping paradigm envisioned by industry 4.0, seafarers are required to have digital competences to adapt to the changing workforce needs brought on by digitalization. This research aims to address the absence of a comprehensive digital competences framework for seafarers using navigation officers as a case study. The researcher used a "mixed method" approach to conduct the study. The researcher investigated existing digital competences frameworks using a scoping review. Based on the findings of this section, the researcher used and existing framework (the DigComp framework) as the basis for the development of a survey questionnaire used to analyse the needs of navigation officers in the digital area.

Following descriptive analyses and a discussion of the results within the context of the existing literature, it was determined that navigation officers require different proficiency levels of the five DigComp competences' areas. Information and data literacy, communication and cooperation, digital content creation, safety, and problem-solving are the building blocks of the suggested digital competences framework for navigation officers. The study recommends establishing proficiency levels for the proposed framework, extending it to all seafarers, and utilizing it to create curricula for seafarers. Creating a digital competences framework for instructors is also advocated. Additionally, it provides directions for future research to determine the order of importance of digital competences and to validate the suggested framework.

KEYWORDS: *Digitalization, Digital competences framework, Digital Competences, Digital literacy, Seafarers, Information and data literacy, Communication and collaboration, Digital content creation, Problem solving.*

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List of Abbreviation

AI	Artificial Intelligence
ALA	American Library Association
AM	Additive Manufacturing
AR	Augmented Reality
BDA	Big Data Analytics
CC	Cloud Computing
CFT	Competence Framework For Teachers
CIL	Computer And Information Literacy
CIPD	Chartered Institute Of Personnel And Development
COP	Community Of Practice
CPU	Central Processing Unit
DIGCOMP	Digital Competence
DLS	Department of Library Services
DQ	Digital Intelligence
ECDIS	Electronic Chart Display And Information System
EMSA	European Maritime Safety Agency
EU	European Union
FE	Further Education
ICILS	International Computer And Information Literacy Study
ICS	The International Chamber Of Shipping
ICT	Information And Communication Technologies
IEA	International Association For The Evaluation Of Educational Achievement
IEEE	Institute of Electrical and Electronics Engineers
IMO	International Maritime Organization
IOT	Internet Of Things
IR	Intelligent Robots And Automation
IS	Intelligent Simulation

ISO	International Organization For Standardization
IST	Information Society Technology
IT	Information Technology
ITU	International Telecommunication Union
MET	Maritime Education And Training
METI	Maritime Education And Training Institution
NAMLE	National Association For Media Literacy Education
NIST	National Institute Of Standards And Technology
OECD	Organization For Economic Co-Operation And Development
OER	Open Educational Resources
PS	Professional Standard
REC	Research And Ethics Committee
SDG	Sustainable Development Goals
SPSS	Statistical Package For The Social Sciences
STCW	International Convention On Standards Of Training, Certification And Watchkeeping For Seafarers, 1978, As Amended
UK	United Kingdom
UN	United Nations
UNCAD	United Nations Conference On Trade And Development
UNESCO	United Nations Educational, Scientific And Cultural Organization
UNICEF	United Nations International Children's Emergency Fund
US	United States
WMU	World Maritime University

1. Introduction

1.1 Background

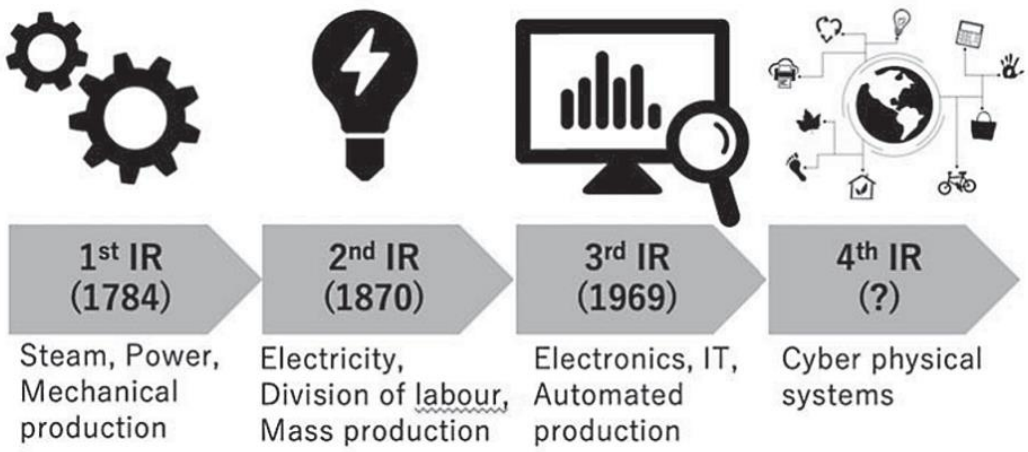
1.1.1 General background

The new "ocean economy," according to the Organization for Economic Co-operation and Development's (OECD) "Ocean economy in 2030" report, is fuelled by a combination of population growth, rising incomes, depleting natural resources, the effects of climate change, and cutting-edge technologies (OECD, 2016). The report also predicts that the growth in demand for shipping, shipbuilding, marine equipment, and related services will cause the ocean sectors' contribution to global value creation to double by 2030.

According to the International Maritime Organization IMO (2019), shipping is a critical component of any strategy for sustainable economic growth. More than 80% of the volume of the worldwide trade in goods is transported by sea, and this percentage is significantly higher in most developing countries (UNCTAD, 2022). It facilitates the movement of products, energy supplies, and is the lifeblood of maritime trade. This activity is supported by a large fleet and large worldwide port infrastructure and operated by a significant workforce estimated to be 1,647,500, including, on board ships, 774,000 officers and 873,500 ratings according to ICS (2022).

The OCED forecasts rely heavily on the growth of technology-based innovation. In particular, the Industry 4.0 paradigm is anticipated to form the basis of a future maritime ecosystem where certain cyber-physical systems as shown in Figure 1**,** characterised by new design standards and operational specifications, will take the place of conventional ships (Shipping 4.0) affording greater interconnectedness and higher levels of sustainability and efficiency.

Figure 1 Industrial revolutions' evolution
(Kitada & Baum-Talmor, 2019)



The shipping sector is undergoing a digital transformation as a result of increased technological development and digitization, which reflects the growing need for better data gathering, data processing, and data networking. As a result, the future of the shipping sector is dependent on the digital transformation process, which necessitates appropriate technologies for real-time gathering, transmission, storage, and analysis of large amounts of relevant data. The shipping industry is predicted to benefit significantly from the digitalization and intelligent networking of data, which will lower operational costs while increasing overall income and extending machine service life (Aiello et al., 2020).

Noticeable efforts to facilitate and increase the competitiveness of this sector are being made. Research into next-generation technologies such as autonomous ships has demonstrated a general need to increase the sector's overall awareness and use of digital technologies (Sullivan et al., 2021).

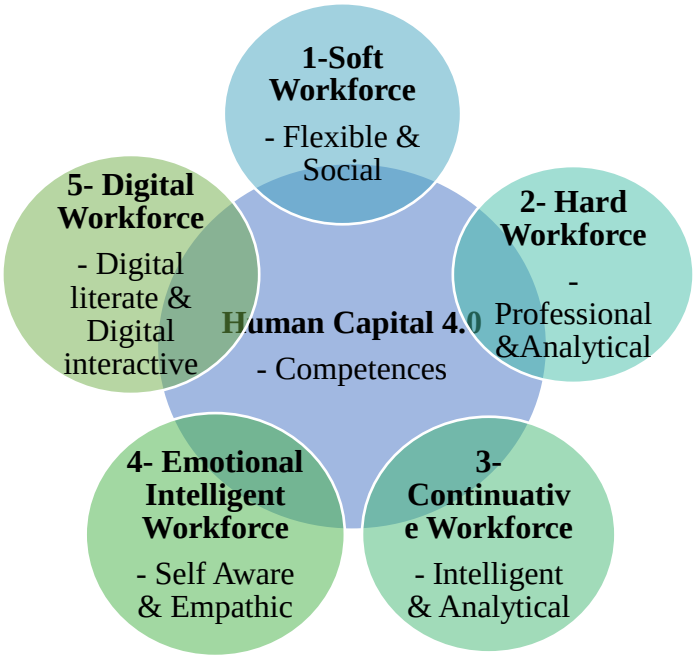
It is not denied that the introduction of digitalization technologies to the shipping industry will affect many of its aspects and stakeholders. Seafarers in charge of operating ships onboard would be the most affected stakeholders (Schroeder et al., 2019). This influence will be manifested at many levels related to seafarers' jobs, such as employment and career (Kitada & Baum-Talmor, 2019), competences, education, and training.

1.1.2 Competences for Industry 4.0

Industry 4.0 introduces new technology to make manufacturing more interconnected and computerized. It entails advanced automated, knowledge-based, information-based, and real-time production techniques (Zhang et al., 2021). Manufacturers, on the other hand, must overcome a number of obstacles, including a scarcity of trained personnel to design and run various high-tech systems. Because of this challenge, Industry 4.0 calls for a shift in the labour market, necessitating specifically trained workers with the Competences and abilities to survive in this new environment (Hernandez-de-Menendez et al., 2020).

The main competences required for Industry 4.0, according to a conceptual map developed by Kipper et al. (2021), are leadership, strategic vision of knowledge, self-organization, giving and receiving feedback, pro-activity, creativity, problem solving, interdisciplinarity, teamwork, collaborative work, initiative, communication, innovation, adaptability, flexibility, and self-management, as well as knowledge of contemporary fields (information and communication technology, algorithms, automation, software development and security, data analysis, general systems theory and sustainable development theory. On the other hand, Flores et al. (2020) created a new paradigm of future human capital competences and presented five enabling competences for human capital in Industry 4.0, as shown in Figure 2.

Figure 2 Five enabling Competences required for Human Capital in Industry 4.0
(Flores et al., 2020)



The soft, the hard, the cognitive, the emotional, and the digital workforces are included in this paradigm. The soft workforce will demonstrate connectedness and self-adaptability inside the organization through adaptable and sociable interactions. The hard workforce will exhibit improved proficiency in fundamental labour, such as industrial procedures or working techniques, but will also adopt advanced digitalization knowledge. The cognitive workforce will demonstrate self-autonomy and complexity management skills as they gain more knowledge and experience. The workforce of emotional intelligent will adapt to change through appropriate motivation and the creation of new perspectives. The understanding and use of digital tools will enable the digital workforce to do and accomplish all types of work activities in digital-context settings (Flores et al., 2020)

Digital skills for education and labour force take particular attention from researchers to respond to the digital transformation, which is according to Schroeder et al. (2019) a part of Industry 4.0. The European Union Council considers digital skills to be the most important sector for educational progress and Information and Communication Technologies ICTs are a fundamental component of the education reform specified in the Europe 2020 policy (Erro-garc & Hern, 2021). Moreover, The EU Commission's Directorate-General for Internal Policies expects that there will be an increased need within each occupation for e-skills which include "those skills needed to make use of Information and Communication Technologies (ICT) as well as those skills required to apply and develop them" (Valsamis, 2015). The latter study also breaks down the effects of digitization on the labour market into four categories: job dynamics, working conditions, required skills, and EU and national policies (Valsamis, 2015).

When it comes to the shipping sector, in this era of 'Industry 4.0' and digitalisation, seafarers may be required to become more digitally inclined, modifying the structure and nature of their skills. It has been argued that seafaring would be among the most affected jobs once autonomous or unmanned ships are deployed (Kitada & Baum-Talmor, 2019).

1.2 Problem statement

With the rapid advancement and use of technology, there is the risk that individuals will not be able to integrate into their new environment properly and carry out their everyday responsibilities. As data and analytical skills become more in demand, it is becoming increasingly vital to develop industry professionals with this in mind (Sullivan et al., 2021). This is also true in the context of the shipping industry. The transformation from traditional

shipping to the digital industrial paradigm envisioned by Industry 4.0 raises many questions related to digital skills of seafarers.

Currently, Maritime Education and Training for seafarers as regulated by the International Convention on Standards of Training, Certification and Watchkeeping (STCW) 1978, as amended, does not appear to explicitly cover digital competences for seafarers. However, in order to prepare for the future maritime skilled workforce in the digital age, it will be just as necessary to invest in human capital through training and career development as it will be to invest in technology (Kitada & Baum-Talmor, 2019).

There have been some inquiries into the need for digital skills for seafarers. Sharma et al. (2018), for example, look at how digital technologies are transforming the way people think about education and training, particularly in the maritime area. They also emphasize the importance of developing relevant digital skills, information processing abilities, and other nontechnical skills, as well as developing a conceptual roadmap that highlights some of the current advancements in Maritime Education and Training. Additionally, more focused studies have been conducted on maritime cyber risk management with several standards and frameworks developed. For instance, the United States (US) Coast Guard established Vessel Cyber Risk Management Work Instruction based on the IMO Maritime Safety Committee Resolution 428(98), "Maritime Cyber Risk Management in Safety Management Systems". Furthermore, Hopcraft (2021) asserts that seafarer training and maritime safety are inextricably linked. As a result, seafarers will need to obtain standardized digital Competences, the development of which must take into account the company-specific and operation-specific risk management practices. According to Hopcraft, using the US National Institute of Standards and Technology's (NIST) well-established cybersecurity framework, there is a feasible solution for maritime digital skills development.

However, a comprehensive digital Competences standard or framework for seafarers is still needed to respond to seafarers' digital needs for shipping digitalization, not only for cyber risk management but also for all operations and functions onboard. In this respect, this study finds its relevance in seeking to address this gap.

1.3 Aims and Objectives

This research focuses on the analysis of seafarers' (specifically navigation officers) needs in terms of digital Competences to respond to the skills change required for shipping industry digitalization. It tries to determine seafarers' challenges related to the digitization of ships and to suggest solutions to take on these challenges. This study aims to design a digital competences framework for seafarers to respond to shipping digitalization.

The specific objectives are:

1. To comprehend the existing digital competences' frameworks and explore how they may be adapted to the needs of navigation officers.
2. To analyze the needs of seafarers for digital competences using navigation officers as a case study.
3. To formulate a digital competences framework for navigation officers.

1.4 Research questions

1) What are the existing competences frameworks and how can they be adapted to explore navigation officers' needs?
2) What are the needs of navigation officers in terms of digital competences?
3) What are the building-block elements of the envisaged digital competences in term of knowledge, skills and attitudes?

1.5 Methodology

This study used a "mixed-methods" design that combines qualitative and quantitative research methods. The limitations of relying solely on quantitative or qualitative approaches gave rise to "mixed methods," which is now largely acknowledged as a viable alternative to these two traditional approaches (Doyle et al., 2009). The qualitative approach was chosen because it typically answers questions about participants' experiences, meanings, and perspectives; as a result, the data are typically not amenable to counting or measuring (Hammarberg et al., 2016). Quantitative research is based on the measurement of quantity or amount (Kothari, 2004). Accordingly, this approach was employed in this study to quantify certain aspect of the research topic in order to generate numerical data or data that could be turned into useful statistics.

A survey questionnaire (based on a Likert response format and with a number of open-ended questions) was used to collect the data. The questionnaire, after testing, was distributed among navigation officers, who serve as the study's target population.

Additionally, a scoping review was used to examine secondary data from the literature. A scoping review, as its name implies, is a useful tool for determining the depth or breadth of a body of literature on a specific topic. Additionally, it offers a clear image of the volume of research and studies currently available as well as a summary (extensive or comprehensive) of their important themes (Munn et al., 2018).

1.6 Scope and delimitation

The STCW Convection, 1978, as amended, defines for its standards of competence seven ship's functions namely: 1) Navigation, 2) Cargo handling and stowage, 3) Controlling the operation of the ship and care for persons on board, 4) Marine engineering, 5) Electrical, electronic and control engineering, 6) Maintenance and repair, 7) Radio-communications. Those functions are organized at three levels of responsibility: Management level, Operational level and Support level (IMO, 2017).

The navigation process, according to Kopacz et al., (2003) is divided into nine discrete, and thus more visible, sub-processes, and includes:

- Information and communication, but particularly the gathering, storing, updating, and retrieval of common navigational data,
- Planning of voyage,
- Reducing the ship's weather-related losses,
- Controlling the ship,
- Positioning the ship,
- When necessary, manoeuvring and managing the ship,
- When necessary, responding to distress signals and navigational emergencies,
- Controlling and supervising the navigation process, which includes keeping a close watch on the ship's navigational environment and its course, avoiding collisions and groundings, altering the course and speed as needed, and routinely inspecting the navigational systems, equipment, and safety systems,
- Recording navigational and voyage-related data for the ship.

The focus of this study is on the navigation function at the operational and management levels to address the rapidly growing use of digitalized bridge systems. Especially with the adoption of the concept of e-navigation in shipping, which involves the collection, integration, exchange, presentation, and analysis of marine information on and ashore via electronic means (IMO, 20019).

1.7 Ethical issues

The research received the World Maritime University's Research and Ethics Committee approval. All the norms of academic ethics and integrity were met including obtaining participants' informed consent prior to the administering of data collection instruments and respecting the confidentiality/privacy rights of participants. In the third chapter of this research, the methodological approach and particular methods are presented in depth.

2. Literature Review

Introduction

This chapter covers a presentation of the concepts related to Industry 4.0 as it constitutes the context within which this research is situated. A discussion of the relevant theoretical background and concepts associated with digital competences, and their application to seafarers is also included.

2.1 Definitions and notions around digitalization

In this section, the concepts of Industry 4.0, digitalization, and the digital transformation are defined and discussed as they serve as the foundation for this study, are interconnected, and are frequently used interchangeably.

2.1.1 Fourth industrial revolution (Industry 4.0)

The notion of Industry 4.0 is defined as "a growing digitalization of the whole value chain, as well as the interconnectedness of people, things, and systems through real-time data interchange" (Hecklau et al., 2016) . Despite Industry 4.0 offering numerous opportunities for businesses, it also brings with it several new issues and challenges (Hecklau et al., 2016).

It has been concluded by Sullivan et al. (2020) that based on several interpretations, Industry 4.0 is considered a collaborative digital end-to-end integration process that runs on a vertical and horizontally integrated production system. Their approach aims to increase the availability of data for decision-making in conjunction with the following technologies:

- Internet of Things (IoT)
- Intelligent Robots and Automation (IR)
- Cloud Computing (CC)
- Additive Manufacturing (AM)
- Big Data Analytics (BDA)
- Intelligent Simulation (IS)
- Augmented Reality (AR)

Sullivan et al. (2020) concluded that, the integrated adoption of digital processes and technologies in the design, development, building, operation, and service of vessels is referred to as Maritime 4.0. In other words, Maritime 4.0 is made up of the following elements, as

determined by a series of dialogues with industry practitioners and academics (Sullivan et al., 2020):

- The automated integration of real data into decision making;
- The adoption and implementation of connected technologies for design, production, and operation;
- Reduction of vessel environmental impact, related to production, operation, disposal (including emissions, underwater noise, and material utilization);
- Affordable and sustainable operation; and
- Reduction of risk, increasing safety and security.

2.1.2 Digitalization

The first time computerization was referred to in a modern context as "digitalization" appears to have been in a 1971 essay in the North American Review (Brennan and Kreiss, 2014). According to Trittin-Ulbrich et al. (2021), the word "digitalization" has received a great deal of attention recently in the fields of management and organization study and practice. The discussion, however, is lacking in a comprehensive definition, as is the case with other popular terms. Trittin-Ulbrich et al. (2021) view digitalization as a process of societal transformation that uses ubiquitous digital technology to link social areas together in a broad network. It significantly influences individual and collective behaviour since it facilitates an ever-increasing number of social and economic interactions and the simultaneous gathering, analysis, and manipulation of real-time digital data. In addition, the process of "digitalization" involves producing/collecting value in novel ways with the use of digital technologies, probably involving digitized data (Gobble, 2018). It enables, improves, and/or transforms operations, functions, processes, and/or activities by utilizing digitized data to get actionable knowledge with a specific benefit in mind (Agarwala et al., 2021).

In recent years, digitalization of the maritime sector has piqued interest as a means of improving safety, security, efficiency, and environmental sustainability. The economic benefits of digitalization and further optimization of maritime activities are significant (IMO, 2019).

2.1.3 Digitization

The concept of digitalization and digitization have the same meaning in the Oxford dictionary; they refer to the process of converting data into a digital format that can be easily read and processed by a computer. However, this significance is solely given to the concept of

digitization in the literature (see Agarwala et al. (2021) and Gobble (2018)). Digitization frequently depicts how a process is converted from manual to digital, replacing paper forms with online counterparts that are submitted directly to databases (Gobble, 2018).

Brennen & Kreiss (2016) consider that the process of digitization contains both symbolic and tangible components. Digitization transforms analogue signals into bits, which are represented symbolically by 1 and 0. Information created by digitization can thus be expressed in a wide variety of ways, on a wide variety of materials, and in a wide variety of systems. In the context of modern computers, transistors—devices that amplify and conduct electrical signals—are the fundamental building blocks of digitization. One central processing unit (CPU) can currently accommodate billions of transistors made of semiconducting components like silicon crystals.

2.1.4 Digital transformation

Scholars have expressed a great deal of interest in proposing a precise and thorough definition of digital transformation. However, despite the numerous systematic reviews conducted, the term still has no widely acknowledged definition.

Early on, digital transformation was defined by Castells (2010) as the digital representation of information and objects in binary code, which enables computer processing as a basic technology and fosters convergence among technical applications from various domains of application (Erro-garc & Hern, 2021). Subsequently, the term has been defined in a number of ways. Morakanyane (2017) examined and contrasted these definitions and suggested that the term relates to “an evolutionary process that leverages digital capabilities and technologies to enable business models, operational processes and customer experiences to create value” (Morakanyane, 2017, p. 437). Thus, Vial (2021) considers that in the process of "digital transformation," organizations seek to change the ways they create value while managing structural changes and organizational barriers that have an impact on both the process's positive and negative outcomes.

Recently, the term has been used to refer to Industry 4.0. The European version of digital transformation and digitalization is known as "Industry 4.0" (Agarwala et al., 2021). In addition, studies that are specifically focused on the idea of "Industry 4.0" can be considered to be examples of manufacturing organizations going through a digital transformation according to Tomaszewski (2021).

2.1.5 Conclusion

Scholars have extensively explored the three terms digitization, digitalization, and digital transformation to draw distinctions and boundaries between them. In summary and in a bid to remove ambiguity between the terms in this study, digitization is viewed as the process of transforming analog signals into digital or binary data. However, digitalization is understood to be the process of reorganizing domains of social interactions (such as organizations) centered on digital technology, media platforms, and communication to handle digitized information. Although digital transformation and digitalization share many features, it may be said that the former goes beyond the latter because it involves the digitalization of numerous aspects or domains of a particular organization or industry. Finally, Industry 4.0 is concluded to be a form of digitalization and digital transformation.

2.2 Overview of digital competences

2.2.1 Competence and Competency

In different contexts, competence and competency can mean different things. The STCW Convention, 1978, as amended, serves as the foundation for the definitions employed in this study for both concepts. The standard of competence indicates the minimum knowledge, understanding and proficiency that seafarers must demonstrate to gain certification, defined in the tables contained in part A of the STCW Code. The competency is the individual ability to perform and to carry out the tasks associated with competence (IMO, 2017).

2.2.2 Digital literacy

Literacy refers literally to the "the ability to read and write" according to the Cambridge dictionary. More broadly, literacy is defined as a knowledge of a particular subject, or a particular type of knowledge (Cambridge Dictionary, 2022). Digital literacy and its related terms as well as the challenges it poses to educational policy, teaching, and research have generated significant discussions from researchers (Lankshear & Knobel, 2005; Walton, 2016; Spante et al., 2018).

Gilster (1997) in his book called "Digital literacy", described the concept as:

> "the ability to understand and use information in multiple formats from a wide range of sources when it is presented via a computer".

Later, the idea of digital literacy was expanded upon and looked at in relation to various other specific digital literacies. Bawden (2001, 2008) presented the basic notion of literacy before expanding it to include forms of literacy that are more modern and suited to complex information environments. Some of these, like media, library, and computer literacy, are mostly dependent on specialized abilities yet extend in some ways beyond them. In addition to being dependent on the more basic skills-based literacies, they lead to more comprehensive concepts like information literacy and digital literacy that are based on knowledge, perceptions, and attitudes. Further, as the relationship between these literacies and the digital has become more obvious, it is believed by Martin (2006) that digital literacy is built on a convergence of these literacies: information literacy, media literacy, technological literacy, and visual literacy.

Similarly, several researchers have sought to operationalize the term and identify its constituent parts. Digital literacy can be understood according to Covello et al. (2010) and Reddy et al., (2020), as a synonym of ICT literacy, and includes six sub-disciplines or particular literacies as presented and defined in Table 1**:**

Table 1 Sub-Disciplines of Digital Literacy

Adapted from (Covello et al., 2010)

Sub-discipline	**Definition**
Information Literacy	Finding and locating sources, analyzing and synthesizing the data, determining the source's reliability, using and citing the source legally and ethically, concentrating on the issue, and creating research questions in a precise, effective, and timely manner are all required (Eisenberg et al., 2004; ALA, 1989) In digital area, information literacy refers to utilizing digital technology to find, locate, analyze, and synthesize information, assessing the reliability of those resources, using the right citation styles, adhering by the legal and moral constraints on their use, and creating research questions that are precise, effective, and time-effective (Reddy et al., 2020; Martin & Grudziecki, 2006; Ferrari et al., 2013)
Computer Literacy	It refers basically to the knowledge of practical computer and application software use (Martin & Grudziecki, 2006). Computer literacy is a concept that changed and developed over time

	(Childers, 2003), it is highly interconnected with other literacies such as information, media and internet literacies.
Media Literacy	Media literacy is defined as the "ability to access, analyze, evaluate, create, and act using all forms of communication" (NAMLE, 2019). Adams & Hamm (2001) defined media literacy as the capacity to integrate the visual and verbal signals that constantly consume from television, advertising, movies, and digital media with personal significance. It goes beyond merely encouraging students to decode information. They must be analytical thinkers capable of comprehending and contributing to the media culture that surrounds them. This definition can be extended to include all social media and web content and how users interact with.
Communication Literacy	Digital literacy also emphasizes effective communication. The same skills necessary for effective in-person communication apply when speaking online, including the capacity to articulate ideas effectively, ask pertinent questions, uphold respect, and foster trust (Western Sydney university, 2020). From the educational perspective, digital communication is the act of curating, and educators who use online teaching and learning must have the ability to curate at a sophisticated level, both in terms of information and visual appeal (Thompson, 2015). For the EU policies and frameworks, communication is associated with collaboration and both refer to the ability to interact through digital means for a given context (Vuorikari et al., 2022).
Visual Literacy	A set of skills that enable people to distinguish between and interpret the visible action, objects, and/or symbols, whether natural or artificial, that they encounter in their environment. The capacity to "read," interpret, and comprehend information presented in pictorial or graphic images (Stokes, 2002).
Technology Literacy	In the twenty-first century, technology literacy is a necessary element of both teaching and learning (Cydis, 2015). According to Pearson and Young (2002), Individuals that are technologically literate are better equipped to make educated

	decisions as consumers. There are countless goods and services available in the world that claim to make people's life simpler, more enjoyable, more effective, or healthier. A technologically literate person can learn enough about a product to use it effectively or to decide not to use it. He or she cannot fully understand how each new technology functions, its benefits and drawbacks, how to utilize it, etc.

In addition to these specific digital literacies, IT, ICT, and Internet literacies are emerging notions associated with digital literacy. Some academics believe that IT and ICT are the same as digital literacy, while others believe they are a component of it. Media literacy, communication skills, visual literacy, and information literacy are all closely related to internet literacy.

On the other hand, some researchers and policy-makers view the idea of digital literacy as a dynamic process. A more comprehensive set of digital behaviours, practices, and identities are described by digital literacy, which goes beyond basic IT abilities. Since what it means to be digitally literate can vary over time and between settings, digital literacies are fundamentally a collection of academic and professional contextual practices supported by a variety of ever-evolving technologies. An individual context, such as a university, college, service, department, topic area, or professional setting, can be utilized as a starting point to investigate what the key digital literacies are. Media, information, ICT, communication, collaboration, learning skills, digital scholarship, career management, and identity management are all part of digital literacy (JISC, 2014). In addition, digital literacy helps people grasp how digital technology works and how to utilize it successfully by building on their general literacy and reading skills. This includes the ability to evaluate information critically, be comfortable using a variety of devices, traverse the internet, and be aware of challenges related to digital technology, such as data privacy. The ability to efficiently navigate and use the internet environment is now recognized as being crucial in a world that is becoming more and more digital (Nicholson, 2017; Microsoft, 2022).

2.2.3 Digital competence

The concept of "digital competence" is a relatively emergent term and is connected to the advancement of technology as well as the objectives and demands of modern politics and citizenship. Its focus is on various areas, including media and communication, technology and

computing, literacy, and information science, and it comprises a number of skills and abilities (Ilomäki et al., 2011). Therefore, the four components of digital competence are 1) technical proficiency with the use of digital technologies, 2) the capacity to use digital technologies effectively for work, study, and other daily activities, 3) the capacity to critically assess the use of digital technologies, and 4) the desire to participate in the digital culture (Ilomäki et al., 2011). Similarly, Ferrari (2012), described the digital competence as:

> "A set of knowledge, skills, attitudes, abilities, strategies, and awareness that are required when using ICT and digital media to perform tasks; solve problems; communicate; manage information; collaborate; create and share content; and build knowledge effectively, efficiently, appropriately, critically, creatively, autonomously, flexibly, ethically, reflectively for work, leisure, participation, learning, and socialising" (Ferrari, 2012).

Additionally, the term is defined as an indicator of the quality of education in the 21st century (Maderick et al., 2016). It is considered, by the European Parliament and the Council (2006), one of the eight key competences for Lifelong Learning. Therefore, the following definition of digital competence is given:

> "Digital Competence involves the confident and critical use of Information Society Technology (IST) for work, leisure and communication. It (Ferrari, 2012) is underpinned by basic skills in ICT: the use of computers to retrieve, assess, store, produce, present and exchange information, and to communicate and participate in collaborative networks via the Internet" (European Parliament and the Council, 2006).

It is significant to highlight that the term "digital competence" is mostly used in Europe to refer to the competences needed to be effective in the digital age. In order to provide this concept with a precise description and a structure of reference, many frameworks were created. In Chapter 4, a scoping review of the existing frameworks for digital competences will be outlined.

2.2.4 Is digital literacy the same as digital competence?

According to the literature review carried out by Gallardo et al. (2015), examining the literature on digital competence and related terms, the concept of digital competence has several facets and has come from different backgrounds. There are still no precise standards for evaluating it because it is not yet a solid notion. several academics define digital competence more generally as knowledge application or 21st century skills, and some see it as the technical usage of ICT (Gallardo et al., 2015). Further, the review demonstrated that when authors and academics have

attempted to develop new concepts, they have provided numerous definitions, some of which are repetitive and some of which are significantly distinct. According to the analysis of Gallardo et al. (2015), digital literacy and digital competence are related but distinct from one another. “Digital literacy” is used mostly at international level and “Digital competence” is used within European context as a synonym of digital literacy.

2.3 Digital skills for seafarers

Digitalization is progressively introduced to the maritime industry, and all parties involved in seafarers’ education claim that specific skills linked to ship digitalization are required. It is demonstrated by Oksavik et al. (2020) that as the digitization of shipping progresses, seafarers' skills and capabilities must keep up with the pace of new technology, updating technical operations and personal skills regularly. In addition, Demirel (2020) concludes that for MET students to succeed in today's job market and thrive in tomorrow's industries, they must first identify their current and future adaptive skillsets. This will necessitate a careful balance and integration of education and training, with these critical concepts and skillsets infused throughout the curricula. The author suggested to introduce to the curricula courses on 1) Introduction to automation to understand how it is working, limitations and failures, 2) Data analysis to understand what data is and how it is collecting, and 3) Decision support systems to understand how data is the processed and used. Furthermore, Sullivan et al. (2021) recommends in their study that one of the elements that has to be addressed in future research is the identification and development of competences to support the realization of digital technology adoption in the maritime industry.

Adopting the same position, Nakazawa (2020) affirmed during his contribution to the second WMU Regional Conference for the Americas that seafarers need a fundamental knowledge of digitalization, robotics, artificial intelligence and big data used onboard and shore Thus, from their part, Schröder-Hinrichs et al. (2019) concluded that the advent of automation, including digital technology, will be gradual rather than revolutionary, and noted in their research that:

- It is critical to identify the skills required for the essential adaption process in a country or a mode of transportation early on.
- The introduction of automation and technology in transportation will necessitate a massive wave of retraining of the global transportation workforce.

- Transportation professionals must adapt to changing work environments and acquire new skills and competences. Digital skills such as data fluency, digital operation, and fundamental software engineering are examples.
- It is critical to recognize that training and education take years to grow from an initial concept to a fully established and implemented program that consistently provides graduates with the necessary skills and knowledge in a given region.

In addition, there have been a lot of conversations about the present and future digital knowledge that seafarers would need. A core competence will be the ability to interact with computer systems that respond to challenges in autonomous systems, according to Oksavik et al. (2020) in their research for the SkillSea project. The authors believe that technological advancements will make it difficult for complex autonomous systems and the crew to interact. Further, Cicek et al. (2019) consider that with the rising digitalization of the maritime industry, information and data processing, and programming skills will become critical competences for seafarers.

On the other hand, Hopcraft (2021) has claimed that it is difficult to develop a set of standardized digital skills due to the variations among the many types of maritime activities. It is anticipated that the IMO will incorporate digital competences within its regulatory instruments in the near future due to its obligations as the UN organization responsible for maintaining maritime safety. Therefore, it is crucial that in developing standardized skills important industry stakeholders are involved so as to ensure that differences within maritime operations are taken into account.

Conclusion

In the first section of this chapter, it is concluded that Industry 4.0 is a form of digitalization and digital transformation. A distinction between digital competence and digital literacy is provided in the second section. It was concluded from the literature that despite being related, they are separate from one another. Digital competence is used as a synonym for "digital literacy" in the European context whereas "digital literacy" is used more frequently at the international level. Based on the third part of this chapter, the literature commonly agreed on the need of digital competences for seafarers to respond to the challenges imposed by the digitalization of shipping. However, as mentioned above, it does not appear to offer a clear framework or map of the required competences. This gap highlights the necessity of the

ongoing research. The paper uses a case study of navigation officers to achieve this goal and aims to develop a digital competences framework for them.

3 Research Methodology and Methods

Introduction

Research methodology is a way to systematically solve the research problem. It can be viewed as a science that studies how scientific research is conducted. It enables the examination of many approaches typically used by researchers in analysing their research questions, as well as the reasoning behind them (Kothari, 2004). On the other hand, research methods can be viewed as any method or technique used to do research. Thus, the term "research methods" or "research techniques" describes the processes that researchers apply when doing their research (Kothari, 2004).

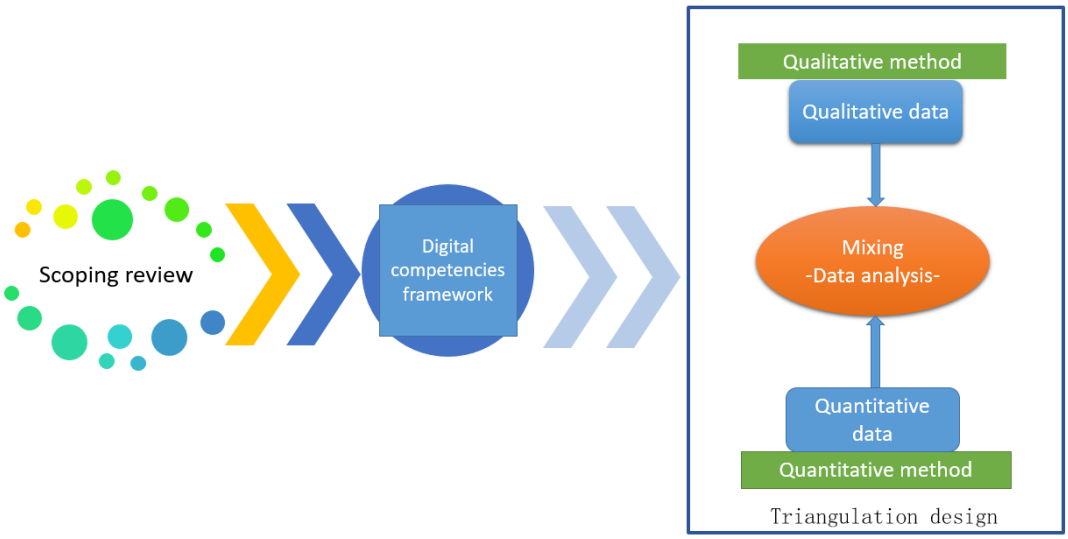
The proposed methodology for the current research is covered in this chapter, along with the methodological approach, data collection, data analysis, reliability and validity, ethical considerations, and finally the limitations of the research's methodology.

3.1 Methodological approach

Making the decision on the research approach is a challenging stage in the research process (Walker, 1997). The discipline of the study, the objectives, and the expected outcomes all influence the choice of research methodology. Multiple research types may be used to address one research problem (Bairagi & Munot, 2019).

In this study, the researcher used a scoping review to comprehend the frameworks already in place for digital competences and how they could be utilized to explore the needs of navigation officers in the digital area. The purpose of this first stage was to gain a clear conceptual understanding of digital competences and define a framework for developing the data collection instruments that was then employed in the second phase of the research process which used a mixed method approach using simultaneous triangulation design including both qualitative and quantitative methods. Figure 3 provides a synopsis of the methodology and research strategy employed to carry out the current study.

Figure 3 Research approach and methods



3.1.1 Scoping review

Recently, scoping reviews have gained popularity as a method of reviewing the literature (Pham et al., 2014; Munn et al., 2018). They may be conducted instead of systematic reviews when the purpose is to identify knowledge gaps, scope a body of literature, clarify concepts, or investigate research methods (Munn et al., 2018). A scoping review is an important tool in the arsenal of evidence synthesis approaches that is ever expanding (Munn et al., 2018). Nevertheless, a scoping review should be conducted in a systematic manner, with a rigorous approach. It often includes a protocol, a systematic and comprehensive search, and well-documented methods. In some cases, it can serve as a precursor to a full systematic review (Charles Sturt University, 2022).

Understanding frameworks and concepts linked to digital competences as well as adopting a clear description and connection between each component are essential to carrying out the current study. The results of the scoping review highlights existing competences' frameworks and how they should be adapted to better understand the needs of navigation officers, who make up the target population of the research.

The methodology used for this scoping review is based on Arksey and O'Malley (2005), who provide a five-stage framework that follows a strict transparency method, allowing replication of the search strategy and boosting the validity of the study's findings. The five stages of Arksey and O'Malley's approach are as follows: (1) identifying the initial research questions, (2)

identifying relevant studies, (3) study selection, (4) charting the data and collating (5) summarizing and reporting the results.

3.1.1.1 Identifying the initial research questions

The scoping review, as used in this study, is a sort of research synthesis that tries to comprehend and discuss the literature, policies and documents on digital competences frameworks. Therefore, this section aims to answer the research question:

- What are the existing competences frameworks and how can they be adapted to explore navigation officers' needs?

3.1.1.2 Identifying relevant studies

The search strategy was founded on academic research, frameworks and policies established by international organizations or States, as well as deliverables delivered by specialized private companies working in the digital industry. Google Scholar was used as the primary academic literature database for this work. Organizational and official websites also served as data sources.

The initial keywords for identifying studies included: "Digital competence", "Digital literacy", "Digital skills", "ICT skills", "ICT literacy", "Digital Competence framework", "Digital skills framework"

3.1.1.3 Study inclusion and exclusion criteria

Thirty-three frameworks are cited in the initial research, including academic papers, frameworks and policy documents, and companies' deliverables. The procedure for selecting the studies involved first screening the title, abstract, summary, and conclusion, followed by a full-text review. Inclusion and exclusion criteria, presented in Table 2, were taken into account in this examination.

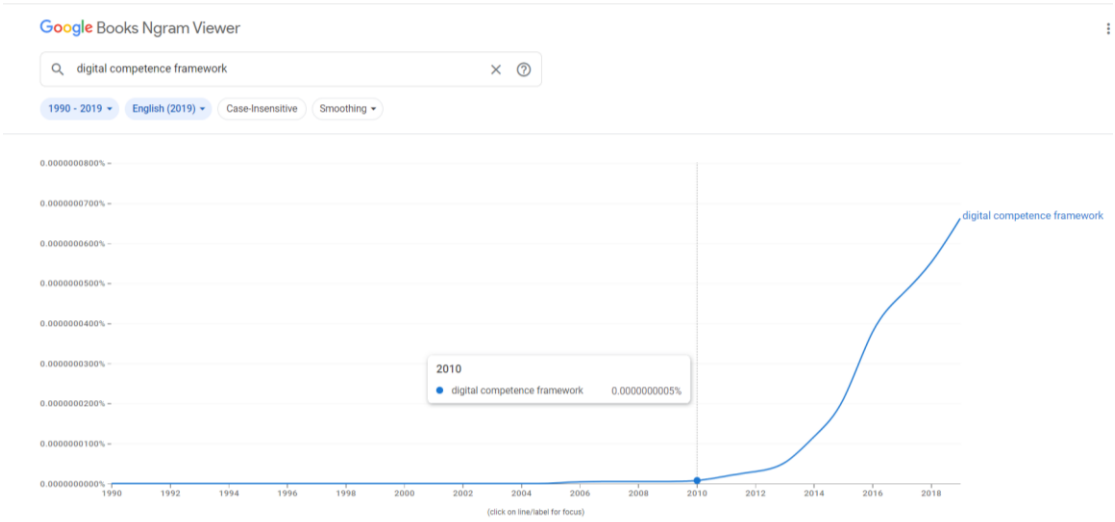
Table 2 Inclusion and exclusion criteria of the scoping review

Criteria	Policy/Framework	Company deliverable
Inclusion	- is designed for adults - educational and professional background - is produced between 2010 and 2022 - has been published as a final version.	- is designed for adults - educational and professional background - related to digital Competence, digital literacy or digital skills - is from expert and specialist companies of IT field
Exclusion	- is designed for children - is not produced between 2010 and 2022 - is not published into its final version - is not published in English	- is not from educational or professional background - is not from expert and specialist companies of IT field - is not published in English

The established selection criteria are justified as following:

- The population targeted by the research study is navigation officers. As a result, it is conducted from an andragogy perspective, which focuses on adult education and learning (Loeng, 2018). The selection of documents and frameworks is thus restricted to those developed for adults.
- Digital competences are a crucial skill for the twenty-first century (European Parliament and the Council, 2006), and endeavours to understand the concept date back to the last decade (Pettersson, 2018). Several conceptual frameworks have been developed over the past few years to express different aspects of digital Competence and digital literacy, which has caused confusion about terminology (Erstad et al., 2021).
- Figure 4 shows that, according to Google Books Ngram Viewer, research on digital competence frameworks increased significantly from 2010; Thus, the frameworks published from this date was considered in this review.

Figure 4 Frequencies of research on digital competence framework from 1990 to 2019 (Google Books Ngram Viewer, 2022)



- The expertise and technical knowledge that IT specialized companies possess justifies the consideration of their outputs in relation to digital competences.
- All academic articles are peer reviewed and published in English. This is very crucial for the integrity of research findings according to Campbell (2006).
- All frameworks and deliverables are published in their final version to have a comprehensive understanding and discussion of the document.

The resulting dataset was screened/filtered for duplication; as a result, the current review is founded on:

- Twelve digital competences' frameworks
- Four IT companies' outputs - private initiatives for digital competences

3.1.2 Mixed Methods - Triangulation method

"Mixed methods" is the third paradigm in methodological or research thinking (Creswell et al.,2003). It involves the gathering or analysis of both quantitative and qualitative data in a single study where the data are gathered concurrently or sequentially, are given priority, and entail the integration of the data at one or more stages in the research process (Creswell et al.,2003).

According to Greene et al. (1989) there are five most important rationales or purposes for mixed research. They include 1) Triangulation, 2) Complementarity, 3) Development, 4) Initiation and 5) Expansions. The triangulation design is likely the most traditional and well-known type of

mixed methods study (Creswell et al.,200). It can be categorized as simultaneous or sequential, according to Field & Morse (1985). Utilizing both qualitative and quantitative methods at once is known as simultaneous triangulation. Although there is not much interaction between the two datasets in this scenario during data collection, the findings at the end of the study are complementary. If the outcome of one approach is crucial for organizing the next, sequential triangulation is used (Morse, 1991).

The current study combines quantitative and qualitative methods using a simultaneous triangulation approach. Data were gathered simultaneously by the researcher using a survey questionnaire, and after that, data analysis conducted.

3.2 Data collection

3.2.1 Data collection instruments

A questionnaire with four elements was developed by the researcher as a tool for data collection for the current study. The first section of the questionnaire collected respondents' demographic data. The second component of the survey looked into the navigation officers' training experiences for digital competences. The DigComp framework served as the foundation for the questionnaire's third section. The decision to employ the Digcomp framework was taken on the basis of the results of the scoping review completed as part of the study methodology. This third component was intended to measure how navigation officers perceive their digital competences. The forty items of this part are dispersed throughout the five areas, which are classified as following:

- Competence area 1: Information and data literacy (five items)
- Competence area 2: Communication and collaboration (thirteen items)
- Competence area 3: Digital content creation (ten items)
- Competence area 4: Safety (five items)
- Competence area 5: Problem solving (seven items)

The responses were scored using a six-point Likert response format. Respondents gave the following ratings to statements about their knowledge and use of various digital technological aspects: 1 for "Strongly disagree," 2 for "Disagree," 3 for " Slightly disagree," 4 for " Slightly agree," 5 for "Agree," and 6 for "Strongly agree." Several technological components of the five areas of competences were referenced in each statement. Accordingly, the more respondents agreed with a statement, the more proficient they perceived themselves to be regarding that

particular area of technology, whereas the less they agreed, the less proficient they deemed themselves to be.

The last component of the survey questionnaire was dedicated to seeking information about access to and use of ICTs onboard ship by the participants. This section also had three open-ended questions as a part of the study's qualitative data collection.

3.2.2 Selection and recruitment of participants

The research used navigation officers as a case study to discuss the framework for digital competences for seafarers. Navigation officers around the world were therefore the population targeted for participation in the survey.

The researcher used her academic and professional contacts, who are all tied to the maritime industry and WMU's status as the IMO's main centre of excellence for maritime postgraduate education, research, and capacity building, to recruit participants for data collection.

3.2.3 Pilot test

To increase the reliability and validity of the data collection instruments, the researcher conducted a pilot test with volunteers from WMU and outside the institution. The survey questionnaire was distributed to five participants in order to assess its accessibility, time needed to completion, and linguistic clarity.

3.3 Data analysis

The most critical phase of any research is the data analysis. Data analysis summarizes collected data. It entails the analysis of acquired data using logical and analytical reasoning to spot trends, relationships, or patterns (DLS, 2022). A descriptive data analysis approach and normative analysis were applied to examine the data obtained. In descriptive statistics, trends in the responses of the individuals in a sample are summarized. The three main methods of doing and presenting descriptive analysis are tabular, graphical, and statistical (Vaus, 2013). On the other hand, the process of normative analysis includes considering the evaluative (e.g., good, bad, better than) and deontic (e.g., right, wrong, just, unjust, required, banned) elements of behaviours, policies, and institutions in a systematic way. Finding and analysing normative arguments, supporting data, and arguments for a subject are included (Viens, 2019).

3.4 Reliability and validity

Fitzner (2007), stated that when an instrument is reliable, it can be measured consistently (i.e., results are the same for each method provided the object of measurement does not change). Validity, on the other hand, is achieved when the researcher successfully measures the variable they are actually trying to measure.

The mixed-method approach adopted in this study gave significant insights and information about the study's goals and objectives. It involved using a simultaneous triangulation design to collect both qualitative and quantitative data at the same time, and then the combined data was analysed to determine the digital competences that may be deemed necessary for navigation officers to have. This methodology-based approach enabled the researcher to overcome any single method-related limitations.

The development of data collection instruments was carried out after the scoping review that aimed to reach an understanding of existing digital competences and how they can be adopted to investigate digital competences among seafarers. The survey questionnaire was established based on the EU framework for digital Competences DigComp. According to Kluzer & Priego (2018), the DigComp framework is well known to have received contributions from numerous specialists and approval at European level. Due to the participation of numerous reputable specialists and the broad consensus reached during its creation, it is recognized and accepted as a "high quality product" by many stakeholders. It has been demonstrated to be an effective tool for education and training actions as well as a reference framework. Further, the DigComp framework is a high quality, flexible, and adaptive product (Kluzer & Priego, 2018). It is widely used and tested from the andragogy perspective, as a basis of several frameworks for professionals such as DigCompEdu (Redecker, 2017), Digital Teaching Professional Framework (Couros, 2018.). , a Global Framework of Reference on Digital Literacy Skills for Indicator 4.4.2 (Law et al., 2018)), and the Digital skills toolkit (Coward and Fellows, 2018).

3.5 Ethical consideration

In any research endeavour, ethical considerations are as crucial as choosing the appropriate research methodological approach (Fleming & Zegwaard, 2018). The researcher followed the WMU Research and Ethics Committee and research (REC) ethics guidelines to conduct the current study. The following items were highly considered:

- WMU Research Ethics Committee (REC) approval: The request for the World Maritime University (WMU) Research Ethics Committee (REC) approval was submitted after the development of the data collection instrument and its validation by the researcher's supervisors. The WMU research protocol, data collection instruments, consent forms for each instrument, and the research proposal were all included in this request submission. After a thorough examination of the request and any supporting paperwork, the REC gave its approval on 06 July 2022, after which data collection began.
- Informed consent: To confirm participant approval prior to participating in the survey-questionnaire, the online survey employed a checkbox for the first question.
- Anonymity, confidentiality and privacy: anonymity of participants was kept. During the course of the study, only the researcher had access to participant information, including demographic data.
- Academic integrity approach: The researcher kept a professional and academic attitude throughout the whole research process. This approach helped to avoid misrepresenting and misinterpreting of any gathered the data.

3.6 Methodological limitations

The methodology followed to conduct the current study presents some limitations. First, the researcher acknowledges a scoping review limitation. The review of the existing digital competences frameworks, is not exhaustive.

Second, the survey questionnaire was administered using Google Form and used self-reported views, opinions, beliefs, feelings, and practices as a foundation. Consequently, the data collected do not fully reflect the perception of navigation officers worldwide, and tends to deviate from reality because self-reports are subject to much subjectivity. Further, the survey questionnaire was open and did not require an email sign-in in order to make it simpler and incurring for participants. As a result, it runs the little probability of receiving duplicate responses. Careful responses' filtering as well as a notice in the information section that respondents shouldn't respond to the survey more than once helped to reduce this.

4 Data Analysis

The gap filled by the current study was introduced in the preceding chapters, along with the research methodology. The purpose of this chapter is to present the data analysis and the findings of the current study.

Two sections constitute this chapter. The scoping review and its findings are to be presented in the first section. In part two the findings derived from the survey questionnaire are presented.

4.1 Scoping review results

4.1.1 Charting, collation and reporting of data

A competence or competency framework is a structure that outlines and defines each specific competence needed by individuals working for an organization or a division of that organization, depending on the job or profession's field (CIPD, 2021). The frameworks gathered through this review serve as both reference and description of how digital competences can be organized and defined in order to establish educational strategies and create curricula, training courses, and training programs in the digital area.

In the tables provided in Appendix A and Appendix B, the selected frameworks are summarized and mapped. The tables indicate the name of the framework, the year it was published, its place of origin, its type and background, the intended target, and a summary of the framework's structure. The frameworks for digital competences that were chosen are presented in Appendix A, and the IT private initiatives to address digital competences are presented in Appendix B.

An overview of each of the frameworks that have been chosen, as well as a synopsis of its key features, main objective, and targeted population are summarized below in the Table 3.

Table 3 Overview of frameworks

Name and Target population	Description
Frameworks designed for citizens	
DigComp 2.2. The Digital competence Framework for **citizens**. With new examples of knowledge, skills and attitudes	DigComp is organized into five competence areas :Information and data literacy, Communication and collaboration, Digital content creation, Safety, and problem solving (Vuorikari et al., 2022).
Framework for digital competence for **citizens**	Digital competences include: digital technology skills, digital for learning, information literacy, collaboration, communication, content production, inclusion and diverse needs, development of the individual, problem solving, critical thinking, ethical citizen, innovation and creativity (Ministry of Education and Higher Education, 2019)
Digital competence framework DFC for **citizens**	The framework includes four components: Citizenship (digital identity), interacting and collaborating, producing, and data & computational thinking (Hwb, 2022).
DQ (Digital Intelligence) Global Standard on Digital Literacy, Digital Skills, and Digital Readiness (IEEE 3527.1™ Standard) for **citizen**	DQ comprises 24 digital competences. It focuses on 8 critical areas of digital life: identity, use, safety, security, emotional intelligence, literacy, communication, rights. These 8 areas can each be developed at three levels: citizenship, creativity, and competitiveness (Bejdić, 2021; DQ Institute, 2022).
A Global Framework of Reference on Digital Literacy Skills for Indicator 4.4.2 For **youth/adults**	These framework competences are organized as follow: • Devices and software operations: • DigComp (5 competence areas), in addition to Computational thinking • Career-related competences (Law and Wong, 2018)
IEA International Computer and Information Literacy Study 2018 - Preparing for life in a digital world- IEA ICILS for **students/youth/ adults**	The framework is composed of four strands that frame the skills and knowledge assessed: understanding, gathering, producing, and communicating information digitally (Fraillon et al., 2019)
Specialized and contextualized frameworks	
The Essential Digital Skills **for Everyone in the UK involved in supporting adults to improve their essential digital skills**	This framework defines five categories of essential digital skills: communication, handling information and content, transacting, problem solving, and being safe and legal online (Bank, 2018)
Building digital capabilities: The six elements defined for **students, instructors and staff**	The six elements defined by this framework are: digital proficiency and productivity, information, data and media literacies, digital creation, problem solving and

	innovation, digital communication, collaboration and participation, digital learning, development and teaching, and digital identity and wellbeing (JISC; Beetham et al., 2017)
Digital teaching professional framework for **professional continuous education/further education**	Was established based on (DigCompEdu, PS and JISC). As adapted, the Digital Teaching Professional Framework defines three Competence levels: • Stage 1: Exploring – practitioners assimilate new information and develop basic digital practices. • Stage 2: Adopting – practitioners apply their digital practices and expand them further. • Stage 3: Leading – practitioners pass on their knowledge, critique existing practice and develop new practices (Couros, 2018.). *PS is The Professional standard, composed by The three following domains of practice: professional values and attributes, professional knowledge and understanding, professional skills (Education & Training Foundation, 2022)*
UNESCO ICT CFT: ICT competence Framework for **Teachers**	According to the Open Education Resources (OER) (2022), this framework covers the following six areas: understanding ICT in education, curriculum and assessment, pedagogy, application of digital skills, organization and administration, and teacher professional learning.
Digital skills toolkit for **all stakeholders being part of digital skills strategy**	This toolkit is based on DigComp and is organized into three levels: basic, intermediate and advanced skills (Coward and Fellows, 2018).
IT private companies' outputs for digital competences	
Intel® Education Digital Wellness Curriculum for **citizens**	It is designed to help individuals build skills and inculcate values which will prepare them to navigate safely in cyberspace, act in a balanced and responsible manner while using the Internet, cultivate respect in their interactions with others, and create a cyber-culture that is healthy (Intel corporation, 2014).
K–12 Computer Science Framework for **citizens**	The framework consists of: ***Five concepts**:* 1. Computing systems 2. Networks and the internet 3. Data and analysis 4. Algorithms and programming 5. Impacts of computing ***And seven practices:***

	1. Fostering an inclusive computing culture 2. Collaborating around computing 3. Recognizing and defining computational problems 4. Developing and using abstractions 5. Creating computational Artifacts 6.Testing and refining computational Artifacts 7. Communicating about computing (K12 computer science, 2022).
Common Sense's Digital Citizenship Curriculum for **citizens**	Digital Citizenship Curriculum covers 6 core topics: • Media Balance & Well-Being • Privacy & Security • Digital Footprint & Identity • Relationships & Communication • Cyberbullying, Digital Drama, & Hate Speech • News & Media Literacy (James et al., 2019; Common Sense, 2020)
Google Digital Literacy & Citizenship Curriculum-iKeepSafe for **citizens**	This curriculum is organised based on three parts (iKeepSafe, 2022): • become an online sleuth • manage your digital reputation • identify tricks and scams

To sum up, information and data literacy, collaboration, communication, creation of digital Content, safety, problem-solving, critical thinking, and creativity are all included as essential competences in all frameworks, whether developed for the public or contextualized for a specific profession. These shared competences can be organized into the five digital competence area of DigComp framework: Information and data literacy, communication and collaboration, digital content creation, safety and problem-solving. On the other hand, it is essential to note that the four IT private companies' initiatives covered in this review are conceived for the public and focused on safety and awareness about digital identity and reputation.

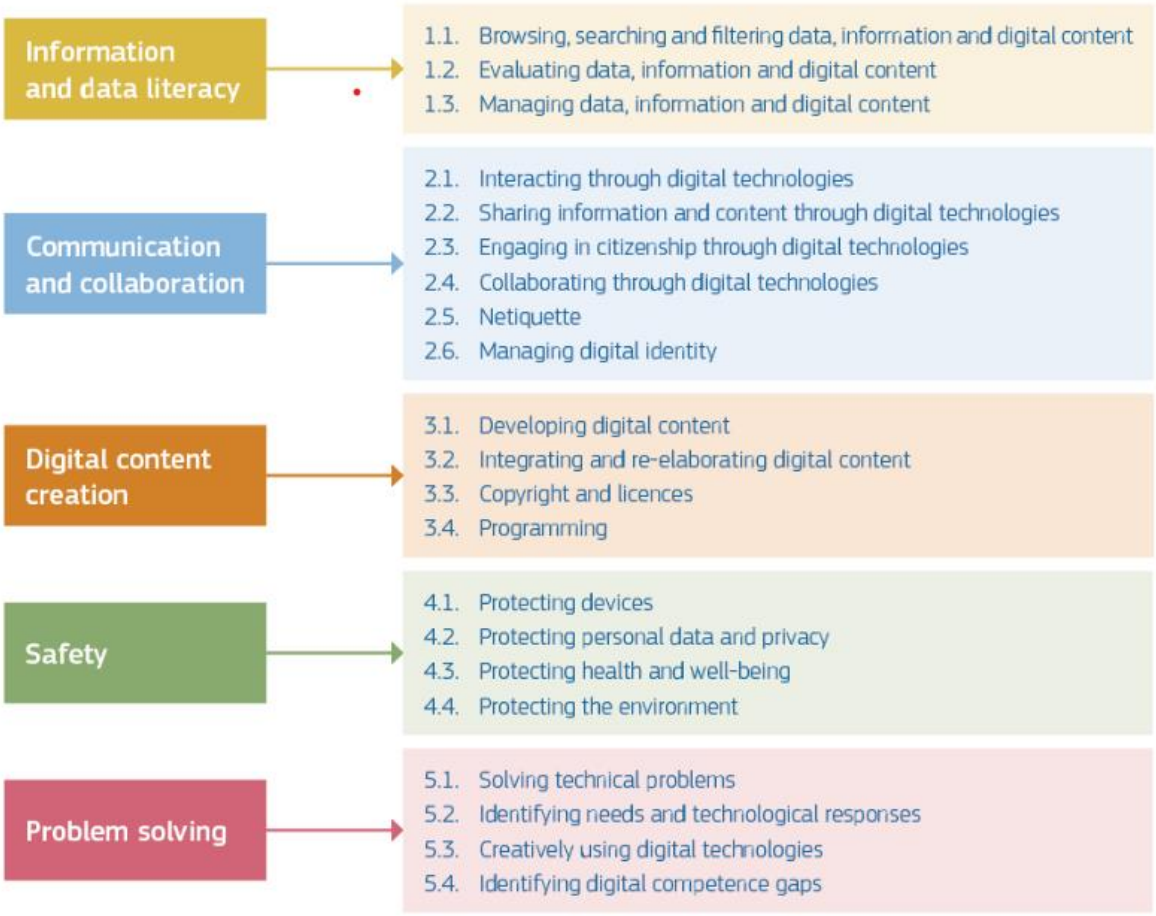
4.1.2 DigComp overview

The European Commission initially released DigComp in 2013, which stands for the Digital Competence Framework for Citizens. It is a tool for enhancing citizens' digital competence, assisting policymakers in developing policies that support the development of digital competence, and planning programs for education and training to enhance the digital competence of particular target groups. DigComp also gives a uniform terminology for identifying and describing the main domains of digital competence, serving as a point of reference for the entire European Union (Vuorikari et al., 2016)

DigComp 2.2 framework is organized into five dimensions:

- Dimension 1: Competence areas, which consist, as it is shown in Figure 5, of information and data literacy, communication and collaboration, digital content creation, safety and problem solving.
- Dimension 2: Competences that are pertinent for each area, it includes twenty-one Competences in total (Figure 5)
- Dimension 3: Proficiency levels (Foundation, Intermediate, Advanced and Highly specialised)
- Dimension 4: Examples of knowledge, skills and attitude
- Dimension 5: Use cases.

Figure 5 The DigComp 2.2 conceptual reference model
(Vuorikari et al., 2022)

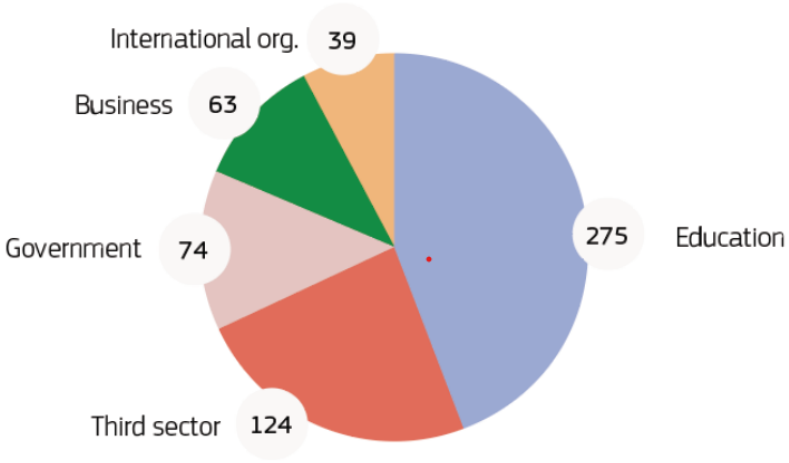


DigComp has demonstrated its ability to be flexible and adaptive as a reference to develop policies, training initiatives, and educational programs for the general public as well as for specialized professionals at the national, regional, and international levels (Vuorikari et al., 2022). To facilitate the implementation of DigComp, a number of tools and guidelines were developed. Among them, it can be presented : DigComp into Action: Get inspired, make it happen (Kluzer & Priego, 2018), DigComp at work (Stefano et al., 2020), DigComp at Work Implementation Guide (Clara Centeno, 2020). Further, according to Vuorikari et al. (2022), international organisations reviewed the DigComp frameworks and used it as a basis to develop more specific digital Competences frameworks such as ”A global framework of reference on digital literacy skills for SDG indicator 4.4.2 ” by the UNESCO (Law and Wong, 2018), ”Digital Literacy for Children: exploring definitions and frameworks” by UNICEF and ” Digital Skills: Frameworks and Programs” by World Bank (Bashir & Miyamoto, 2020). Finally, the DigComp is widely translated and adapted at national level by numerous EU

members such Spain, Italy, Estonia, Lithuania, Greece and others, and at national, regional and sectorial levels such as the Austrian Federal Ministry Digital and Economic Affairs Department, the French Ministry of Education National, and the Murcia Regional Government - School of Public Administration in Spain. A list of recent adaptations and link to frameworks details is provided by Vuorikari et al., (2022) in the report DigComp 2.2, page 55.

DigComp has been shown to be adaptable to different professions and contexts, and Figure 6 exhibiting the framework's "Community of Practice" CoP[1] demonstrates this.

Figure 6 Community of practice COP of DigComp
(Vuorikari et al., 2022)



Given the preceding, it is appropriate to adapt DigComp to seafarers, notably navigation officers, in order to examine their needs in terms of digital competences. This is crucial, particularly in light of the lack of a thorough understanding of the requirements of seafarers, especially navigation officers, and how they interact with digital competences while at sea.

[1] *By the beginning of 2022, there were 575 members of the DigComp CoP from 57 different nations, mostly in Europe. Educational organizations, particularly university lecturers, researchers, and students, make up the largest group (190 members). Nearly half (51) of Third Sector organizations are represented by digital competence centers, including a number of All Digital members (Vuorikari et al., 2022)*

4.2 Analysis of the survey questionnaire

4.2.1 Data collection and preparation for analysis

The survey study was carried out in 2022 between July 16 and August 22. The questionnaire was distributed to navigation officers globally using an online Google Form. 116 responses were received. To ensure that participants met the criteria of the population targeted for this instrument, responses were filtered and carefully examined. 12 replies were eliminated, including a deck cadet who had no prior sea experience, 5 engine officers, 3 non-seafarers, and 4 seafarers who were not navigation officers. The remainder—104 responses, representing 89.6% of the total number of responses—were used for the study.

The data were prepared for statistical analysis by the researcher and then imported into the SPSS® Statistics 28.0.1 file. Higher recorded scores reflect strong agreement to each statement. A number of statement were negatively phrased and thus were reversed coded in the analysis. In order to confirm that all the data were collected accurately and to extract the demographic details of the respondents, numerous descriptive analyses were carried out using SPSS.

4.2.2 Reliability test

Every study using measurement optimally needs reliability test. Measurement consistency and the absence of error are two aspects of reliability. Indices of reliability come in a variety of forms. An indicator of a measure's consistency is internal reliability, which is quantified by Cronbach's alpha (Molina et al., 2013), which is the most widely used indicator of scale reliability (Petreson, 1994).

Cronbach's alpha coefficient (Cronbach, 1951) reliability is based on a value of 0.60; Nunnally (1978) recommended a minimum level of .7. The instrument is quite reliable because it received a Cronbach alpha score of 0.925 for the entire forty items questionnaire that was utilized to collect data for the current study.

4.2.3 Normality test

The normality test is an important step in selecting the central tendency measures and statistical analysis for continuous data analysis. When the data have a normal distribution, parametric tests are used to compare the groups; otherwise, nonparametric methods are employed. There are many ways to test the normalcy of data, including numerical and visual methods (Mishra et al., 2019).

All independent and dependent variables' skewness and kurtosis were evaluated for the current study's data. The mean, standard deviation, skewness, and kurtosis of the whole set of data are listed in Table 6, and according to competences areas in Table 4. The skewness value provides information about the distribution's symmetry. On the other side, kurtosis offers details on the distribution's "peakedness." If the distribution is absolutely normal, skewness and a kurtosis value of 0 are required (Pallant and Manual, 2016). However, it's quite unlikely for this to happen. As a result, the following is the general rule of thumb, as recommended by Bulmer (1979):

- Skewness less than −1 or more than +1, the distribution is highly skewed.
- Skewness between −1 and −.5 or between + .5 and +1, shows distribution is moderately skewed.
- Skewness between −.5 and + .5, the distribution is approximately symmetric.

Table 4 Descriptive analysis of the digital competences of navigation officers per area (n=104)

Areas of digital competencies		Digital content creation	Problem-solving	Information and data literacy	Safety	Communication and collaboration
Minimum	Statistic	1	2	2	2	2
Maximum	Statistic	6	6	6	6	6
Mean	Statistic	3.86	4.26	4.53	4.57	4.74
Std. Deviation	Statistic	0.898	0.785	0.712	0.896	0.742
Skewness	Statistic	-0.446	-0.169	-0.483	-0.893	-0.56
	Std. Error	0.237	0.237	0.237	0.237	0.237
Kurtosis	Statistic	0.165	-0.091	1.108	0.872	0.376
	Std. Error	0.469	0.469	0.469	0.469	0.469

According to the current analysis result presented in Table 4, skewness reported to Digital content creation (-0.446), Problem solving (-0.169), and Information and data literacy (-0.483) are between −.5 and + .5, therefore those three competences areas are normally distributed. Safety (-0.893), and communication and collaboration (-0.560) are moderately skewed.
A normality test per item is presented in the Appendix D.

4.2.4 Descriptive analysis: Profiles of respondents

A total of 104 responses were analysed. Total percentage of male respondents was 94.2% and of female was 5.8% as shown in Table 5.

Table 5 Characteristics of participants (N= 104)

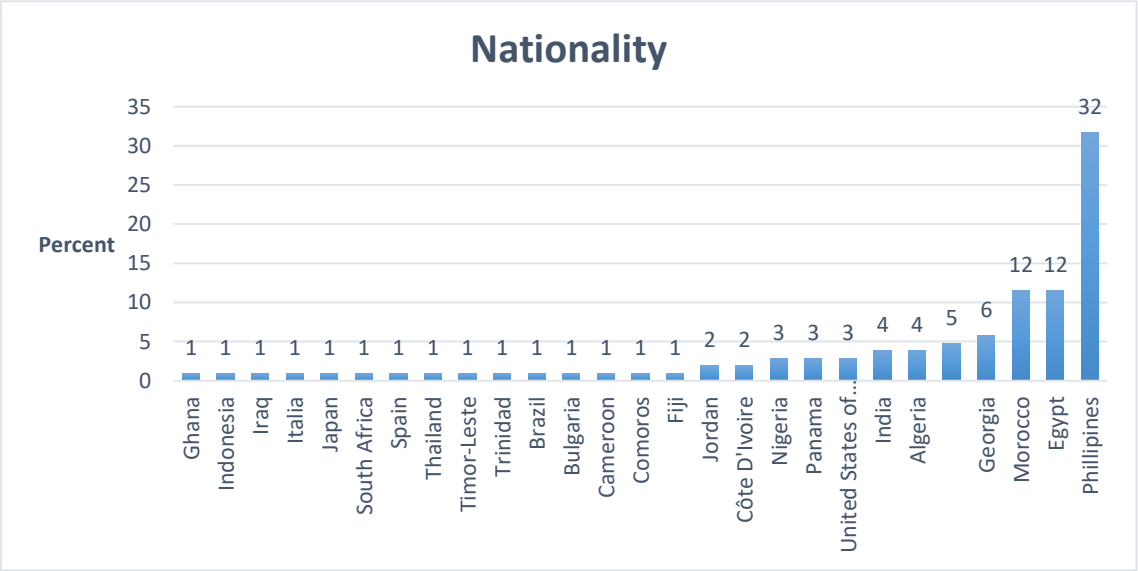
		Mean	Min	Max	Freq	%
Age		33	20	56		
Gender	Male				98	94.2%
	Female				6	5.8%
Rank	Master				20	19.2%
	Chief officer				17	16.3%
	Second officer				39	37.5%
	Third officer				18	17.3%
	Fourth officer				1	1.0%
	Officer in charge				3	2.9%
	Deck Cadet				6	5.8%
Seafaring experience	11-15 years				20	19.2%
	16-20 years				7	6.7%
	5-10 years				38	36.5%
	Less than 5 years				31	29.8%
	More than 20 years				8	7.7%
Current or last vessel type boarded	Bulk carriers				19	18.3%
	Container ships				14	13.5%
	General Cargo ships				2	1.9%
	Livestock carrier				1	1.0%
	LPG Carrier				1	1.0%
	Navy vessel				2	1.9%
	Offshore ships				11	10.6%
	Passenger/Cruise				6	5.8%
	Reefer				1	1.0%
	RO-RO ships				12	11.5%
	Special purpose ships				6	5.8%
	Tankers				27	26.0%
	Training Ship				1	1.0%
	Trawler				1	1.0%
Current location	Approaching port				2	1.9%
	Ashore				75	72.1%
	Onboard				27	26.0%

ICT learning experience	No			50	48.1%
	Yes			54	51.9%

The youngest participant is 20 years old, and the oldest is 56 years old; the average age of the participants is 33 years. The survey respondents indicated personnel on tankers (26.0%), bulk carriers (18.3%), and container ships (13.5%) as the vessel type currently and recently boarded.

Figure **7** presents the nationalities of participants.

Figure 7 Nationality of participants



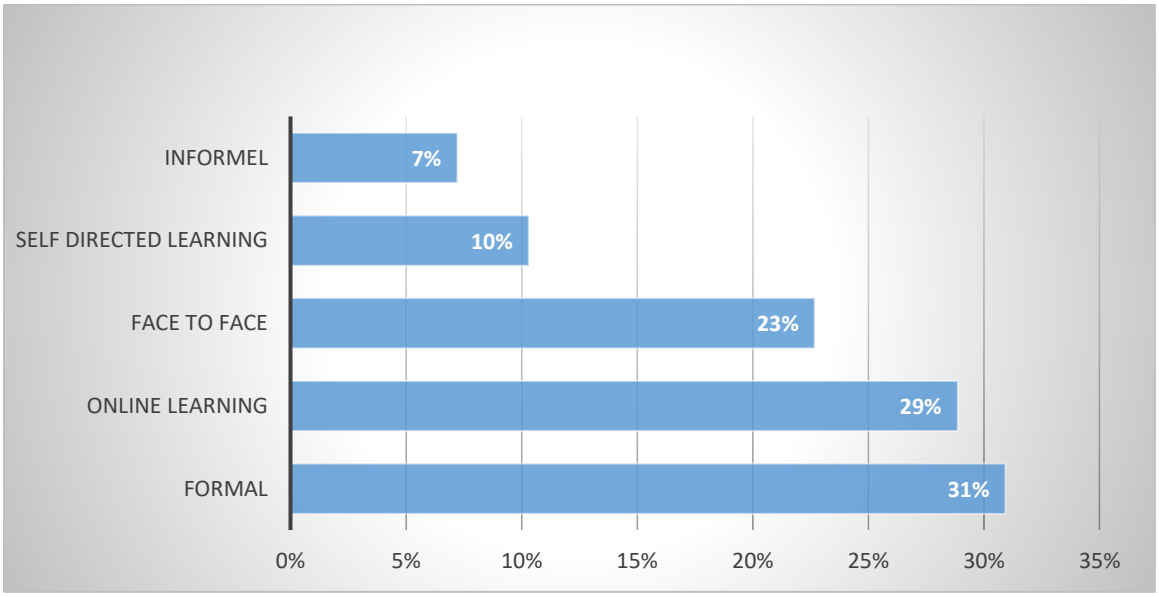
Navigation officers from 26 countries, participated in the survey with a high participation rate from Philippines representing 32%, followed by Morocco and Egypt with 12% each. Furthermore, 37.5% are second officers and 19.2% are masters. 72.1% of respondents were ashore when responding to the questionnaire while 26.0% were onboard ships. The distribution also shows that 36.5% of respondents had 5 to 10 years seafaring experience and 7.7% had more than 20 years. Last and not least, around 51.9% of respondents had already an ICT related training.

4.2.5 Descriptive analysis: ICT training experience

More than 50% of respondents, according to the analysis shown by Table 5, had already completed ICT training. 31% of those navigation officers completed formal training, which included both in-person and online courses. 10% of participants said the training they received

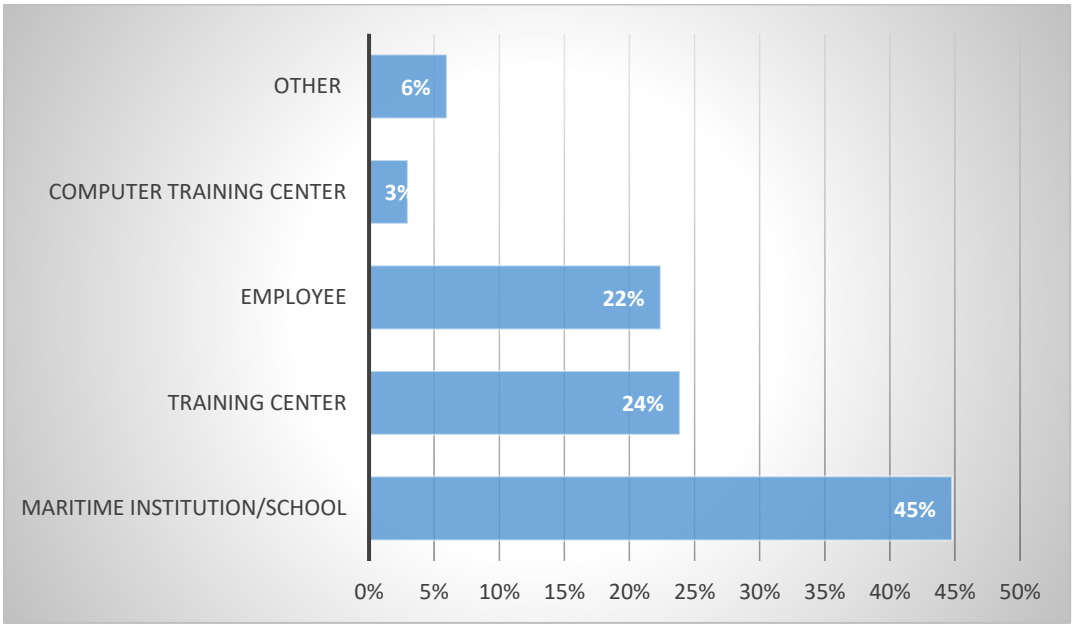
was self-directed. and 7% received informal learning. Those results are reflected by the Figure 8.

Figure 8 Type of ICT training followed by respondents



According to Figure 9, maritime institutes (45%), training facilities (24%) and shipping companies (22%) are the main providers of formal training. The 6% of participants who presented that they have other options to receive ICT training mentioned EMSA-provided training as well as informal training from peers onboard.

Figure 9 Respondents' top choice for ICT training providers



4.2.6 Descriptive analysis: Digital competences

Navigation officers' replies to the questionnaire on digital competence were summarized in Table 5 in the areas of information and data literacy, communication and collaboration, digital content creation, safety, and problem-solving. the detailed responses per item are presented by the Table 6.

When the data in Table 5 were examined, it was seen that the average response of navigation officers in the areas of "communication and collaboration", "safety", "information and collaboration" and "problem solving" was 4.26 and above. However, the area of "digital content creation" had the lower mean value 3.86.

The examination of the Table 6, indicates that 5 items had relatively lower response average. The item 23 "I can code/program at least in one coding/programming language" of the area of "Digital content creation" has the lowest average (M=2.77; SD=1.509). Further, the item 22 "I know how different types of licences apply to the information and resources I use and create" of the same area had an average of response (M=3.36; DS=1.379). The item 3 "I distinguish reliable information from unreliable information" in the area of "information and data literacy" had an average of response equal to 3.22. Around the same average response, the item 38 "I can take part in innovative actions through the use of technologies" of the area of "problem solving", and the item 10 "I can actively share information, content and resources with others through online communities, networks and collaboration" of the area "collaboration and communication" had respectively the response average of (M=3.23; SD=1.436) and (M= 3.63; SD=1.613). All the item of the area "safety" had average of response above 4.03.

Overall, it can be said that navigation officers' digital competences were above average when all item averages were considered.

Table 6 Descriptive analysis of the digital competences of navigation officers (n=104)

Areas of digital competences	Digital competences' survey items	Mean M	Std. Deviation SD	Skewness		Kurtosis	
		Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Information and Data literacy	1- I am able to modify my search tactics to fit a certain search tool, application, or device.	4.87	1.112	-.871	.237	.682	.469

	2- I can monitor the information I receive.	5.11	1.014	-1.641	.237	4.094	.469
	3- I distinguish reliable information from unreliable information.	3.22	1.501	.281	.237	-.776	.469
	4- I can apply different methods and tools to organize files, content, and information (categorizing and classifying data, storage devices, back-ups, cloud storage, etc).	4.86	1.118	-1.026	.237	.984	.469
	5- I can deploy a set of strategies for retrieving the content I or others have organized and stored.	4.62	1.017	-.292	.237	-.311	.469
Communication and collaboration	6- I can use a wide range of tools for online communication (emails, chats, SMS, instant messaging, blogs, VoIP, video-conference, etc).	5.12	1.086	-1.275	.237	1.550	.469
	7- I can adopt digital modes and ways of communication that best fit the purpose.	5.09	1.080	-1.400	.237	2.057	.469
	8- I can customize the format and communication methods to suit my audience.	4.78	1.070	-.854	.237	.544	.469
	9- I can manage the different forms of communication I receive.	4.98	.965	-.886	.237	.818	.469
	10- I can actively share information, content and resources with others through online communities, networks and collaboration platforms.	3.63	1.613	-.035	.237	-1.128	.469
	11- I can access a number of relevant networks and communities for different purposes (Education and training, technical, safety, security, VTS, ports services, etc).	4.64	1.269	-.898	.237	.498	.469
	12- I can use the different functionalities of digital technologies (e.g. networks, media, or online services).	4.94	1.013	-.912	.237	1.232	.469
	13- I can use social media for different collaborative purposes.	4.71	1.290	-.799	.237	.041	.469

	14- I am aware of cultural diversity while using online communication (Cultural diversity refers to all differences based on racial, sexual, organizational, linguistic, professional and national heterogeneity).	5.02	1.052	-1.162	.237	1.587	.469
	15- I am aware of generational diversity while using online communication (Generational diversity refers to the existence and inclusion of people from all generations).	5.07	.968	-.922	.237	.814	.469
	16- I can manage several digital identities according to the context and purpose (personally and professionally).	4.75	1.197	-1.269	.237	2.022	.469
	17- I can monitor the information and data I produce through my online interaction.	4.74	1.097	-.679	.237	.307	.469
	18- I know how to protect my digital reputation.	4.14	1.458	-.390	.237	-.764	.469
Digital content creation	19- I can produce digital content in different formats, platforms and environments (text, audio, numeric, images, etc).	4.42	1.320	-.722	.237	.160	.469
	20- I can use a variety of digital tools for creating original multimedia outputs.	4.37	1.344	-.551	.237	-.346	.469
	21- I can combine different types of content to make new ones.	4.38	1.287	-.672	.237	-.018	.469
	22.I know how different types of licences apply to the information and resources I use and create.	3.36	1.379	.012	.237	-.545	.469
	23- I can code/program at least in one coding/programming language.	2.77	1.509	.437	.237	-.816	.469
Safety	24- I frequently update my security strategies.	4.03	1.397	-.423	.237	-.467	.469
	25- I use digital devices onboard to ensure required security levels for digital networks, servers and applications.	4.42	1.405	-.878	.237	.164	.469
	26- I can prevent cyber-attacks and decide on actions to be taken (preventive and reactive measures).	4.18	1.606	-.577	.237	-.717	.469

	27- I often change the default privacy settings of online services to enhance my privacy protection.	4.31	1.469	-.663	.237	-.315	.469
	28- I have an informed and wide understanding of privacy issues.	4.06	1.433	-.405	.237	-.731	.469
	29- I am familiar with cybersecurity risk assessment onboard ship *(cyber security risk assessment refers to determine the likelihood of vulnerabilities being exploited by external threats to ship systems, and/or inappropriate use of digital technologies onboard).*	4.93	1.302	-1.246	.237	.823	.469
	30- I am familiar with cybersecurity risk management procedures applied onboard ship.	4.86	1.273	-1.193	.237	.836	.469
	31- I protect my personal data and privacy.	5.13	1.115	-1.470	.237	1.932	.469
	32- I am aware of the health risks (physical and psychological) derived from the incorrect use of technology *(such as bad ergonomic posture, spending time on social media and internet while it is time to rest and get proper sleep, emotional impact from digital communication like emails and social media…)*	5.02	1.174	-1.469	.237	2.134	.469
	33- I am aware of the impact of Information and Communication Technology ICT on the environment.	4.71	1.171	-.561	.237	-.414	.469
Problem solving	34- I can solve a wide-range of problems that arise from the use of technology.	4.12	1.209	-.226	.237	-.363	.469
	35- I am aware of new technological developments.	4.51	1.182	-.473	.237	-.096	.469
	36- I understand how new tools work and operate.	4.45	.984	-.206	.237	.008	.469
	37- I can critically evaluate which tool serves my purposes the best.	4.68	1.151	-.906	.237	.883	.469
	38- I can take part in innovative actions through the use of technologies.	3.32	1.436	.285	.237	-.660	.469
	39- I proactively collaborate with others to produce creative and innovative outputs.	4.38	1.332	-.665	.237	.138	.469

40- I frequently update my digital Competence needs.	4.38	1.271	-.452	.237	-.490	.469

4.2.7 Descriptive analysis- Exploring differences between groups

When determining whether there is a statistically significant difference between various groups, another family of statistics can be used. The parametric analysis work well with interval-scaled data and scores that follow a normal distribution. If the data are not normally distributed, the non-parametric alternative is utilized (Pallant & Manual, 2016).

According to the normality test per item (see Appendix D), twenty-seven out of forty items are not normally distributed. Therefore, a non-parametric analysis was carried out.

Non-parametric analysis- Kruskal-Wallis test

Skewed distributions are analyzed using non-parametric methods. The skewness reduces the power of the parametric tests since the mean, which was formerly the best indicator of central tendency, is now significantly influenced by the extreme values. However, nonparametric tests are effective with skewed distributions and distributions that are better captured by the median (Corporate finance institute, 2022).

Non-parametric tests do involve some assumptions, although they are less strict. Independent observations and random samples are needed (Pallant and Manual, 2016). The non-parametric substitute for a one-way between-groups analysis of variance is the Kruskal-Wallis Test, often known as the Kruskal-Wallis H Test. It enables comparison of the results for three or more groups on a certain continuous variable. This alternative requires two variables: a continuous dependent variable and a categorical independent variable with three or more categories (Pallant and Manual, 2016).

In this study, Hypothesis tests were conducted to determine the significant difference in perception of the navigation officers to their digital competences based on their age groups as defined by the Table 7. Kruskal-Wallis Test, was used to test the null hypothesis for age groups for the twenty-seven items presenting skewed data (Appendix D). The initial null hypotheses were that the data distribution of each item is the same across age groups.

Table 7 Definition of age groups

Age groups	Range	Frequency
Group 1	20-25 years	11
Group 2	26-30 years	33
Group 3	31-35 years	30
Group 4	36-40 years	12
Group 5	41-45 years	9
Group 6	46-50 years	3
Group 7	50-56 years	6
Total number of participants		104

The Table 8 shows the results of the research Hypothesis Testing per Item (only rejected hypotheses).

Table 8 Results of the Research Hypothesis Testing per Item (only rejected hypothesis)

N° (Item)	Null Hypothesis	Test	Sig.[a,b]	Decision
H 14	The distribution of 14- I am aware of cultural diversity while using online communication (Cultural diversity refers to all differences based on racial, sexual, organizational, linguistic, professional and national heterogeneity) is the same across categories of Age groups.	Independent-Samples Kruskal-Wallis Test	0.030	Reject the null hypothesis.
H 26	The distribution of 26- I can prevent cyber-attacks and decide on actions to be taken (preventive and reactive measures). is the same across categories of Age groups.	Independent-Samples Kruskal-Wallis Test	0.032	Reject the null hypothesis.
H 27	The distribution of 27- I often change the default privacy settings of online services to enhance my privacy protection. is the same across categories of Age groups.	Independent-Samples Kruskal-Wallis Test	0.023	Reject the null hypothesis.

The conclusion that can be drawn from the findings analysis presented in Table 8 is that H 14, H 26, H 27, were rejected, whereas the twenty-four other hypotheses were supported. The findings indicated that there were no significant differences in how navigation officers of different ages regarded their level of digital competence. H 14, H 26, H 27, on the other hand, showed notable variations.

Variation of respondents' perception to their digital competences across age groups

H 14- I am aware of cultural diversity while using online communication (Cultural diversity refers to all differences based on racial, sexual, organizational, linguistic, professional and national heterogeneity).

Table 9 Pairwise Comparisons of Age groups H14 (only Asymptotic significances level ≤0.05)

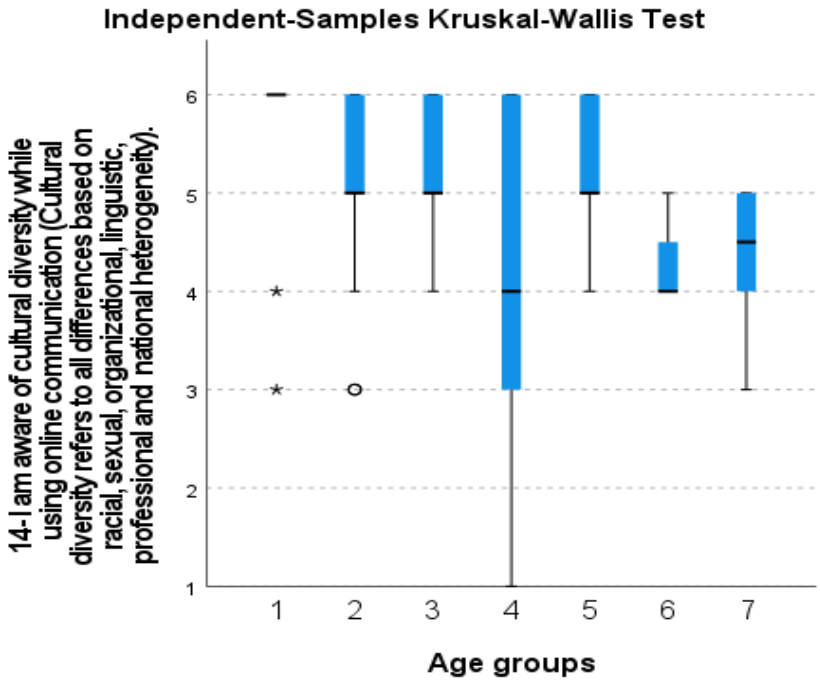
Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.[a]
6.00-1.00	42.833	18.565	2.307	.021	.442
7.00-2.00	25.205	12.650	1.992	.046	.973
7.00-1.00	40.417	14.466	2.794	.005	.109
4.00-1.00	32.167	11.898	2.704	.007	.144

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .050.

Significance values have been adjusted by the Bonferroni correction for multiple tests.

Table 9 reveals that young navigation officers (20–25 years old) have very different perceptions of their understanding of cultural diversity while utilizing online communication than do officers in groups 7 (50–56 years old), group 4 (36-40 years), and group 6 (46-50 years). Additionally, it should be highlighted that groups 2 (26-30 years) and 7 (50-56 years) evaluate their awareness in this regard less differently.

Figure 10 Independent-Samples Kruskal-Wallis Test for H 14



When using online communication, young navigation officers (20–25) report being more aware of cultural diversity than officers over the age of 26 years do, according to the Figure 10. Nevertheless, all other age groups scored above average.

H 26- I can prevent cyber-attacks and decide on actions to be taken (preventive and reactive measures). across Age groups

Table 10 Pairwise Comparisons of Age groups H26 (only Asymptotic significances level ≤0.05)

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.[a]
3.00-1.00	35.232	10.406	3.386	<.001	.015
4.00-1.00	29.515	12.324	2.395	.017	.349
2.00-1.00	26.076	10.279	2.537	.011	.235

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .050.

a. Significance values have been adjusted by the Bonferroni correction for multiple tests.

When compared to officers in groups 2 (26-30 years old), 3 (31-35 years old), and 4 (36-40 years old), there is a substantial difference in how young officers in group 1 (20-25 years old) perceive their abilities to prevent cyberattacks and take the appropriate measures according to the Table 10.

Figure 11 Independent-Samples Kruskal-Wallis Test for H 26

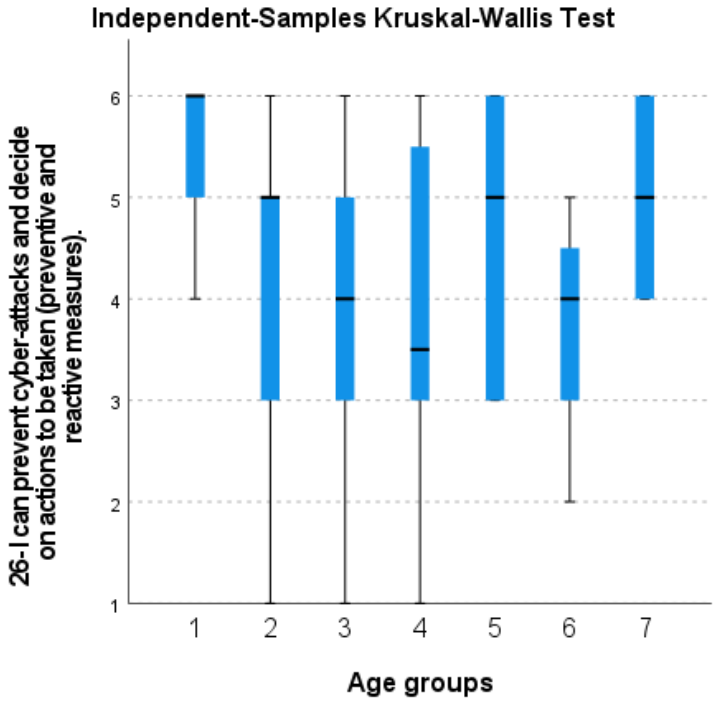


Figure 11 demonstrates that young navigation officers rate their own capacity to prevent and respond to cyberattacks higher than other officers do. Groups 2, 5, and 7 members gave their capacity in this area relatively high ratings. Officers from groups 3 and 6 perform on average, while group 4 is thought to have the lowest score.

H 27- I often change the default privacy settings of online services to enhance my privacy protection. across Age groups

Table 11 Pairwise Comparisons of Age groups H27 (only Asymptotic significances level ≤0.05)

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.[a]
3.00-1.00	37.438	10.377	3.608	<.001	.006
4.00-1.00	32.455	12.288	2.641	.008	.174
2.00-1.00	26.621	10.249	2.597	.009	.197

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .050.

a. Significance values have been adjusted by the Bonferroni correction for multiple tests.

Table 11 demonstrates that there is a significant difference in how young officers in group 1 (20–25 years old) update the privacy settings of online services to enhance their privacy

protection when compared to officers in groups 2 (26–30 years old), 3 (31–35 years old), and 4 (36–40 years old).

Figure 12 Independent-Samples Kruskal-Wallis Test for H 27

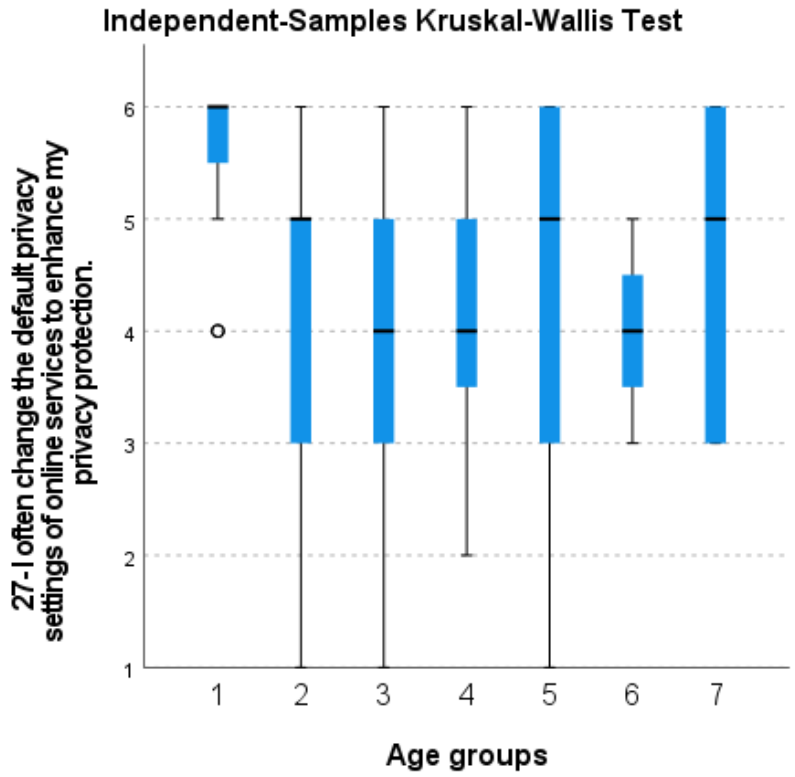


Figure 12 demonstrates that young navigation officers (20-25 years old) reported that they often update their privacy setting. the officers from groups 2, 5, and 7 rate their frequency to update the privacy setting relatively high while officers of groups 3, 4 and 6 are on the average.

4.2.8 Access to/ and use of ICT onboard ships

The analysis of the respondent's ownership and use of digital devices onboard indicated that over 91% of the participants in this research have smartphones and computers as it is presented by Table 12, and 41% have other smart devices, such as (tablets, smart watch and e-reader...). Desktop computers are owned by 44% of them.

Table 12 Devices owned by the respondents

	Frequency	Percentage %
Desktop computer	46	44%
Laptop	95	91%
Smartphone	100	96%
Tablet device	38	37%
Smart watch	2	2%
Kindle-E-reader-	2	2%

According to Table 13, 90% of the respondent are allowed to use their smart phones and smart digital devices (tablet, smart watch, e-reader…) while 10% reported that thy are not allowed to. 72% of participants indicated that they have access to desktop computers onboard.

Table 13 Digital devices allowed to use onboard

	Desktop computer	Laptop	Smart phones (including smart devices)
Yes	72%	5%	90%
Yes, I use my personal device onboard	13%	5%	
No, my work place (ship/company) does not allow me to use these	10%	8%	10%

Figure 13 shows the access of navigation officers to other electronic devices onboard, excluding personal devices. 57% of participant reported having access to navigation equipment, while 38% had no access. The navigation equipment reported in this respect includes ship system computers, ECDIS, bridge communication devices, security cameras, electronic charts, etc.

Figure 13 Access to any other digital devices onboard

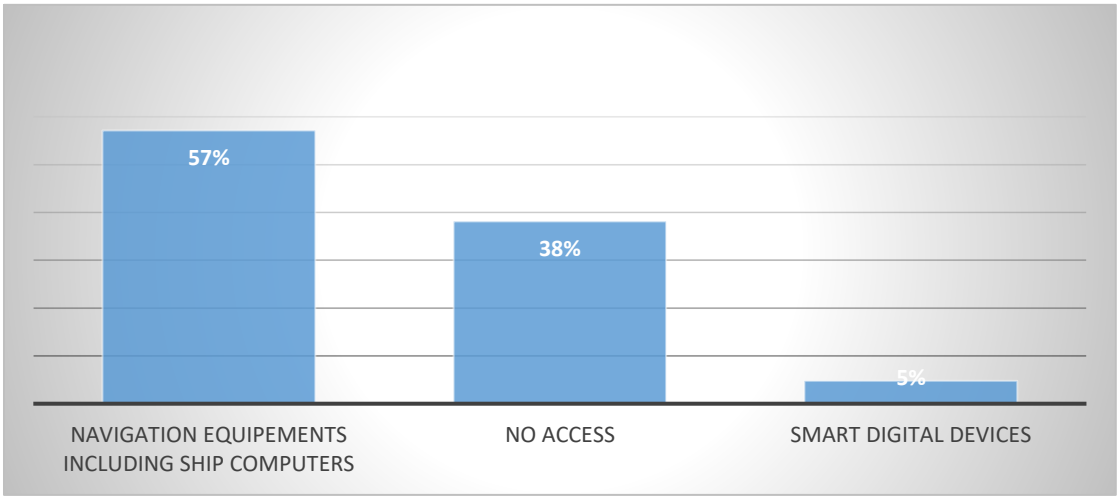


Table 14 shows respondents' perceptions of their access to the Internet onboard. Most respondents—about 80%—have access to the internet while onbroad. 38.5% of navigation officers who responded to the survey said that internet access is free onboard, compared to 18.3% who said it is expensive and 13.5% who said the cost is reasonable. In addition, 62.5% of participants use the internet every day, with 36.5% of respondents using it for one to two hours a day and 19.2% for less than an hour.

Table 14 Acces and use of internet onboard

		Frequency	%
3- Do you get Wi-Fi/wireless Internet connectivity on your ship?	No	23	22.1%
	Yes	81	77.9%
4- The access to Wi-Fi/wireless Internet connectivity on your ship is:			
	Affordable	14	13.5%
	Cheap	2	1.9%
	Expensive	19	18.3%
	Free	40	38.5%
	Very expensive	6	5.8%
6- I use the Internet onboard ship			
	Alternate day	12	11.5%
	Daily	65	62.5%
	Irregularly	3	2.9%
	Rarely	1	1.0%

7- On average, how much time do you spend on Internet-related activities (email, browsing, social media, etc) daily?	< 1hour	20	19.2%
	> 5 hours	7	6.7%
	1-2 hours	38	36.5%
	3-5 hours	16	15.4%

The survey's three open-ended questions were the subject of a thematically oriented qualitative analysis to examine the responses. The three questions concerned the purpose of using digital technologies, especially the internet, onboard. A request for any more helpful comments for the study was made in the final question. The participant's practices for using the digital technology onboard are depicted in Figure 14. 41% of officers cited communication as their focus, including personal and professional communication with 22% and 21% respectively. Following this, in order of significance for each purpose, are learning (12%), information and research (12%), work task (10%), leisure (8), and news (6%). Digital technologies are used by 4% of participants for online services and personal businesses.

Figure 14 Navigation officers' use of digital technologies

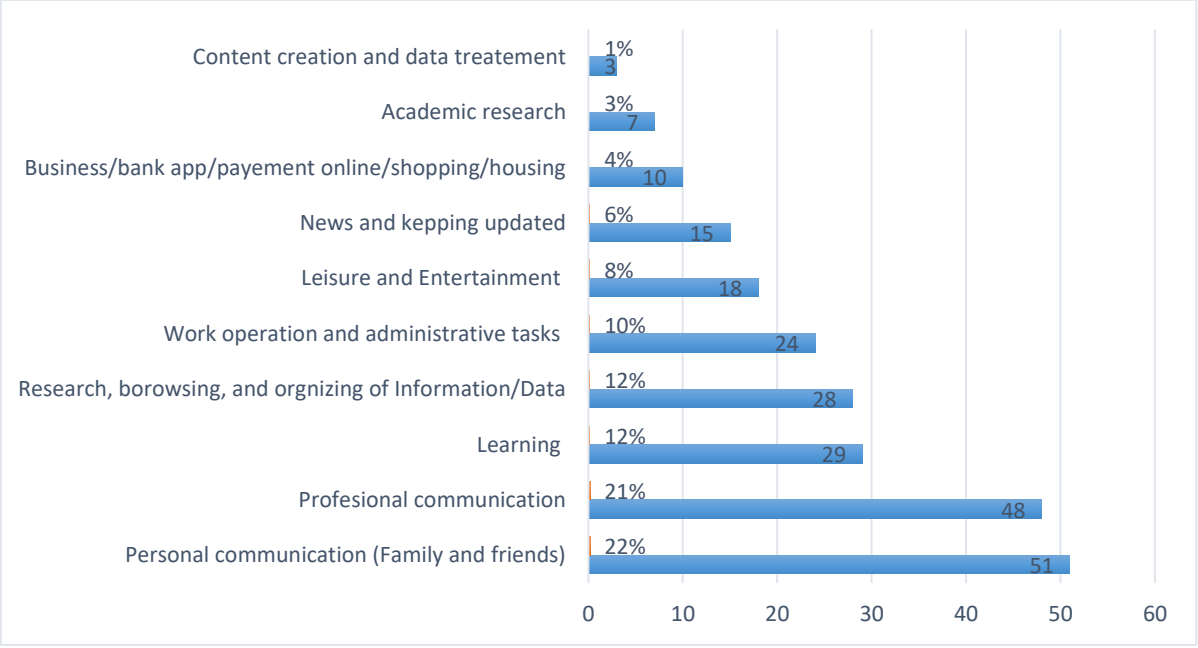
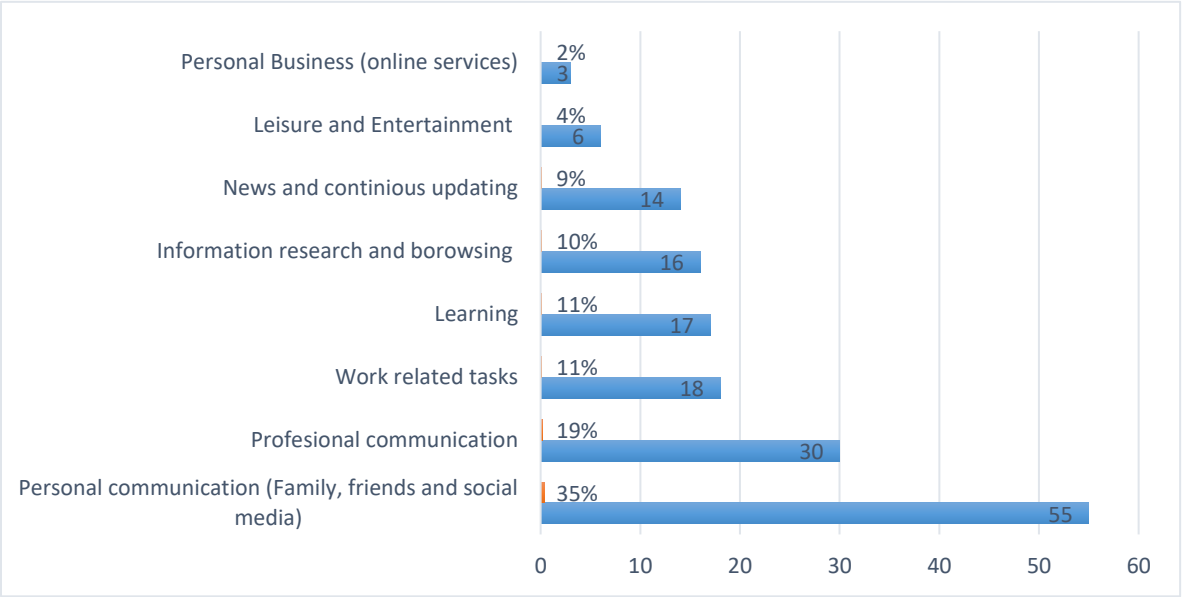


Figure 15 shows that, with a proportion of 35%, participants use social media and the Internet mostly for personal communication with their families and friends. Additionally, 19% of participants use the Internet for professional communications (emails exchange). 11%, 11% and 10% of persons use the internet respectively for work-related tasks, learning, and information research. Finally, 9% of users use the internet to stay updated and 4% do so for fun and entertainment.

Figure 15 Navigation officers' use of Internet



4.3 Summary of the main findings

This study examines the digital competences' needs for navigation officers in order to assist them connect their skills with the digitization of shipping. The results of the study, which were attained through a scoping review and a mixed methods approach, are listed below.

1. The researcher selected DigCom framework to create the data collection tool. Five areas of digital competences were examined to assess the needs of navigation officers: information and data literacy, communication and collaboration, digital content creation, safety, and problem-solving.
2. The descriptive analysis of the second part of the survey questionnaire indicates that over 50% of respondents have completed ICT training mostly in a formal way, including both face-to-face and online modes. The training is generally provided by Maritime Education and Training Institutions (METIs) and shipping companies, although, it is important to mention that some navigation officers completed training in the digital area in an informal way.
3. The study's findings suggest that navigation officers scored higher on the digital competences' items for information and data literacy, communication and collaboration, and safety than on the items for problem-solving and digital content creation.
4. The findings indicate that there were no significant differences in how navigation officers of different ages regarded their level of digital competences. However, there was significant

variation in how navigation officers according to age groups perceive their digital competences for the following items:

- 14- I am aware of cultural diversity while using online communication (Cultural diversity refers to all differences based on racial, sexual, organizational, linguistic, professional and national heterogeneity). Young navigation officers (20–25) claim to be more conscious of cultural diversity while communicating online than officers over the age of 26. However, all other age groups performed better than average.
- 26- I can prevent cyber-attacks and decide on actions to be taken (preventive and reactive measures). The ability of young navigation officers to protect against and respond to cyberattacks is rated higher by them than by other officers. Members of groups 2 (26-30 years old), 5 (41-45 years old), and 7 (50-56 years old) rated this capacity rather high scores. In general, officers from groups 3 (31-35 years old) and 6 (46-50 years old) perform well, with group 4 (36-40 years old) reportedly performing least.
- 27- I often change the default privacy settings of online services to enhance my privacy protection. Twenty to twenty-five-year-old navigation officers said they frequently change their privacy settings. Officers from groups 2 (26-30 years old), 5 (41-45 years old), and 7 (50-56 years old) rated how frequently they update the privacy setting as rather high, compared to average for officers from groups 3 (31-35 years old), 4 (36-40 years old), and 6 (46-50 years old).

5. The study's findings show that navigation officers have access to the internet onbroad, and that access is either free or reasonably priced. More over half of the participants reported using the internet every day, with use intervals ranging from one to two hours. Further, officers connect to the Internet and utilize digital tools mostly for communication, both personal and professional. Personal communication is the term used to describe communication with close friends and family as well as on social media. Professional communication refers mainly to email exchange. Additionally, navigation officers use digital devices and internet connectivity for a variety of purposes, including learning, informational and research, operational and administrative work operations, and news. A few people also mentioned personal business and online services.

The next chapter examines in depth the study’s findings in the light of literature. In addition, it provides conclusion, limitations and recommendations for further research.

5 Discussion and Conclusion

5.1 Discussion of study findings

Research question 01: What are the existing competences frameworks and how can they be adapted to explore navigation officers' needs?

According to the scoping review findings, it was decided to adapt DigComp to seafarers, notably navigation officers, in order to examine their needs in terms of digital competences.

Research question 02: What are the needs of navigation officers in terms of digital competences?

1- Training experience of navigation officers

Over 50% of respondents have completed ICT training, mostly formally, face-to-face and online. The training is generally provided by METIs and shipping companies. This result seems logical given that there are no requirements for digital competences for the seafarers' profession according to the STCW convention, 1978, as amended. However, METIs and shipping companies ensure training and educational programmes for working and aspiring seafarers in the digital area. In addition, the study results showed that self-learning in the digital area is an option for navigation officers and other opportunities provided by peers or organisations operating in the maritime industry. This outcome is consistent with Demirel's (2020) finding that MET students must define their current and future adaptive skill sets in order to excel in the labour market of today and thrive in the heavily digitalized industries of tomorrow.

2- Digital competences for navigation officers

In comparison to other digital competence knowledge and skills like communication and collaboration, information and data literacy, and safety, the navigation officers' knowledge and skills, particularly in developing content in simple forms using digital technologies and solving technical problems when using digital media and devices, recorded lower average scores. This is possibly due to predominance of mobile phones and social media platforms because of the importance of digital connectivity in seafarers' security perceptions as concluded by Jensen (2021), as well as a lack of practice for content creation and technical problems in digital environment. Additionally, the use of digital technology in daily life in accordance with social media and internet surfing may be the reason that navigation officers feel more advanced in the areas of information and data literacy, communication and collaboration, and safety. Today's seafarers rely on digitally linked technologies and networks in addition to the continued significance of radio and satellite phones (ITU, 2021). This fact is consistent with the findings of the analysis of the respondents' use of digital technologies. They typically use digital devices, mostly smartphones, laptops, and at lesser extent desktop computers, for communication especially with family and friends, information and internet browsing, tasks connected to their jobs, learning, and news.

It is also important to note that overrated self-reporting can explain this result. According to studies comparing self-reported computer skills to objective exams, there is a significant over-

rating of skills, especially among non-representative groups of people (Palczyńska & Rynko, 2021).

a. Communication and collaboration

The competence that received the respondents' highest scores was communication and collaboration. this reflects how respondents generally perceive their level of expertise in this field. Studies comparing self-reported computer skills to objective tests have shown that there is significant over-ratting of skills, particularly among non-representative groups of people (Palczyńska & Rynko, 2021).

On the other hand, being competent in communication and collaboration means being able to interact through a variety of digital devices and applications, understanding how digital communication is distributed, displayed, and managed, understanding appropriate ways to communicate through digital means, referring to different communication formats, and adapting communication modes and strategies to the specific audience, according to the DigCom framework by Vuorikari et al. (2022). The competence "Collaborating through digital channels," as it is reflected in the DigCom framework (Figure 5) for communication and collaboration, received the lowest average score. This shows that navigation officers have limited competences to use technologies and media for teamwork, collaborative processes, co-construction and co-creation of resources, information, and content. However, according to the majority of researcher, including Kipper et al. (2021), being able to work with teams in remote places and having excellent communication skills are among the most crucial human competences needed in the near future (Demirel, 2020). More particularly, the author came to the conclusion that seafaring officers should be prepared as high-tech system users who can collaborate with others.

b. Safety

Respondents gave a high rating to the digital safety area. According to the DigComp framework, this area comprises the protection of devices, personal data, health, and the environment. In the case of mariners, cyberattack risk prevention and evaluation are added to these competences. In spite of this area's excellent score, the literature demonstrates the opposite. Seafarers are required to deal with an increase in cyber risks on ships (Heering et al. (2021) and possess clear digital safety capabilities for their personal devices and data, as well as for the equipment and networks onboard. Only 15% of seafarers who participated in a

Futurenautics survey of 6,000 seafarers reported having undergone any kind of cybersecurity training, which is often delivered by crewing and manning agencies before the seafarer embarks on his or her subsequent contract (Futurenautics, 2018); Additionally, several standards and frameworks for cyber risk management have been developed, including the United States (US) Coast Guard Vessel Cyber Risk Management Work Instruction, and the US National Institute of Standards and Technology's cybersecurity framework.

c. Information and data literacy

Although respondents reported a good level of information and data literacy, this result may be explained by their comprehension of the concept and their usage of the internet primarily in this area for browsing and research as necessary, as the research's findings show. According to the DigComp framework, the information and data literacy competence area comprises browsing, searching and filtering information, assessing information, and storing and retrieving information. These skills are not restricted to online research; they apply to all kinds of digital information and data, including those processed by navigation officers from various human-machine interfaces on board ships. Additionally, the findings demonstrate that the competence "Evaluating data, information, and digital content" had the lowest average in this area. Demirel's (2020) study, which emphasizes the necessity for seafarers to have sufficient automation knowledge to define reliable and incorrect data, supports this finding by citing the consensus of research on the need to provide seafarers with a data management training.

d. Problem solving

Problem solving competence area recorded a relatively low score compared to the previous, especially for the item 38 “I can take part in innovative actions through the use of technologies” reflecting limited competence in “Innovating and creatively using technology”. Kipper et al. (2021) consider that creativity and problem solving are among the main competences for Industry 4.0.

e. Digital content creation

The digital content creation competence area was noticed as the lowest average score by respondents. More specifically, the items related to developing digital content and programming competences. This outcome is a result of the operational nature of the seafaring work and emphasis on digital devices and machine-human interface use.

3- *Significant difference between age groups*

The perceptions of navigation officers' digital proficiency varied significantly by age group for the following competences:

- Netiquette (Communication and collaboration area): The ability to protect oneself and others from potential online threats (such as cyberbullying) requires knowledge and understanding of behavioural norms in online/virtual interactions. It also requires awareness of cultural diversity aspects (Vuorikari et al., 2022). Young navigation officers (those between the ages of 20 and 25) assert that they are more sensitive to cultural diversity while communicating online than officers over the age of 26. All other age groups, however, performed better than average.
- Protecting devices (Safety area): To protect personal devices, comprehend online risks and threats, and know safety and security measures (Vuorikari et al., 2022). The ability of young navigation officers to protect against and respond to cyberattacks as well as the frequency of privacy update are rated higher by them than by other officers. Participents of groups 2 (26-30 years old), 5 (41-45 years old), and 7 (50-56 years old) rated this capacity rather high scores. In general, officers from groups 3 (31-35 years old) and 6 (46-50 years old) perform well, with group 4 (36-40 years old) reportedly performing least.

  Officers from groups 2 (26-30 years old), 5 (41-45 years old), and 7 (50-56 years old) rated how frequently they update the privacy setting as rather high, compared to average for officers from groups 3 (31-35 years old), 4 (36-40 years old), and 6 (46-50 years old).

The difference per age groups for those competences is due to lack of training standard for digital competences for navigation officers, and every generation lives differently, which results in differing degrees of Internet familiarity as Cotton et al. (2011) concluded. Additionally, those competences are highly specialized and demand for incredibly advanced skills; how well a generation assimilates the relevant knowledge depends on how comfortable they are using digital technologies. Furthermore, young navigation officers who are less than 26 years belong to Generation Z and are digital natives. Therefore, they are open minded and aware toward all diversities on online setting. They are also familiar with privacy issues and know how to deal with (Singh & Dangmei, 2016).

4- *Use of digital technologies and internet access by navigation officers*

The study found that navigation officers onboard enjoy free or affordable internet access. Over half of the participants use the internet daily for one to two hours. Officers use digital technologies for personal and professional contact online. Personal communication includes talking to family and friends and using social media. Professional communication mostly involves email exchange. Navigation officers use digital devices and the internet for learning, research, work operations, and news. Personal businesses and online services were mentioned.

Communication

According to Kenney et al. (2022), seafarers' access to the Internet is essential for attracting and retaining them, with 92% agreeing that it strongly influences their employment decisions. This justifies the agreement of the respondents about the main purpose of their use of digital Technologies and internet access is communication especially with families and friends. Operational communication as one of navigation functions is also reported by the respondents. Therefore, the areas composing this use are communication and collaboration, safety and problem solving.

Work tasks

This refers to the ability to create document (e.g. for reporting) and any kind of digital content, to interact with different navigation equipment, and to communicate either at operational level or at administrative level (e.g. email and content exchange). Those competences belong at different extent to all areas of DigComp framework as it is explained in the Table 15.

Information and research

Navigation officers reported that they use digital technologies to look for information and data research when it is needed. This purpose is mostly reflected by the information and data literacy competence area, and relatively to digital content creation and safety areas.

News

The respondents use digital technologies and internet access to keep themselves updated about different topics. They need to keep getting accurate, up-to-date information about key topics, which can help reduce uncertainty and ensure their well-being (Kenney et al., 2022). The competence areas involved in this respect are information and data literacy, safety and digital content creation.

Online learning

Online training is one of the reasons navigation officers use digital technologies, as the maritime industry requires constant competence updating. The literature offers strong support for this claim. First, new opportunities for upskilling are being created by digital technologies, which also give seafarers access to innovative and interesting training options (Kenney et al., 2022). Second, using the simulator remotely for training in bridge resource management (BRM) seems to be a good option (Hiroaki et al., 2022).

According to Youssef et al. (2022), ICT use intensity is generally influenced by digital competences, and vice versa. It is widely acknowledged that the impact of ICTs on student performance rely on the intensity of their use; low and infrequent use does not increase academic achievement. However, extensive use for educational purposes (looking up bibliographical references, utilizing translation tools, participating in forums and chats, etc.) encourages interest in studies and leads to improved performance and skills.

Consequently, to ensure the success of online training, it can be concluded that a specific set of skills and knowledge in the digital age is needed. those competences are covering the five digital competence areas of DigComp framework as it is shown in the Table 15.

Online services and leisure

All services offered online, including those for housing, banking, shopping, etc., are referred to as "online services" in this study. The findings, which are consistent with the literature in this regard, demonstrated that navigation officers use online services to a lesser extent. All internet services have the potential to offer opportunities to improve the health and wellbeing of seafarers (Kenney et al., 2022). According to the authors, these services include telehealth,

relationship facilitation, and reporting, particularly anonymous reporting to shipping companies. The fourth competence in the communication and collaboration area, "Engaging in citizenship with digital technologies," according to the DigComp framework, includes using both public and private digital services to engage in society. The safety issue including protection of devices and personal data is also crucial for all type of online services as explained by Table 15.

Research question 03: What are the building-block elements of the envisaged digital competences in term of knowledge, skills and attitudes?

In this study, a standardized and validated framework – DigComp was used to measure digital competences of the navigation officers. The result indicate that the navigation officers rate their digital content creation competences along with the problem-solving skills lower than their skills in information and data literacy, communication and collaboration, and safety.

The identification of navigation officers' uses of digital technologies and Internet, the previous discussion, and Table 15, proved that navigation officers require varying levels of the digital competences listed for each of the five areas of the DigComp framework. The Table displays how the online technologies used by the navigation officers align with DigComp dimensions 1 and 2.

Consequently, it is concluded that the five competence areas of DigComp framework can constitute the building block of the envisaged digital competences framework. Thus, DigComp framework can serve as a digital competences framework for navigation officers.

Table 15 Navigation officers' use of digital technologies explained by DigCom framework

DigComp framework		**Navigation officers' needs in digital Competences**							
Dimension 1	**Dimension 2**	Communication	Online learning	Information and research	Administrative work	Operational work	News	Leisure	Online services
DigComp Area	DigComp Competences								
1- Information and digital literacy	1-1 Browsing, searching and filtering information		x	x		x	x	x	
	1-1 Evaluating information		x	x	x	x	x	x	
	1-1 Storing and retrieving information		x	x		x		x	
2- Communication and collaboration	2-1 Interacting through technologies	x	x		x				
	2-2 Sharing information and content	x	x						
	2-3 Engaging in online citizenship	x	x						x
	2-4 Collaborating through digital channels	x	x		x				
	2-5 Netiquette	x	x					x	
	2-6 Managing digital identity	x	x						

3- Digital content creation	3-1 Developing content		x		x	x				
	3-2 Integrating and re-elaborating		x		x	x				
	3-3 Copyright and licences		x	x	x	x	x	x		
	3-4 Programming				x					
4- Safety	4-1 Protecting devices	x	x	x	x	x		x	x	
	4-2 Protecting personal data	x	x	x	x	x		x	x	
	4-3 Protecting health	x		x			x	x		
	4-4 Protecting the environment									
5- Problem solving	5-1 Solving technical problems	x				x				
	5-2 Identifying needs and technological responses	x				x				
	5-3 Innovating and creatively using technology	x				x				
	5-4 Identifying digital Competence gaps	x				x				

5.2 Conclusion

This research was undertaken in order to address the lack of a comprehensive standard for digital competences for seafarers. It aimed to analyze the digital competences that seafarers—specifically, navigation officers—need to adapt to with regards to the changing workforce needs brought on by the digitalization of the shipping industry. In order to prepare navigation officers for the digitalization of shipping, a framework for digital skills was developed after research into how navigation officers interact with and use digital technologies onboard.

The study used a mixed method approach as its methodological paradigm. With the aid of the scoping review, the researcher was able to explore the literature on existing digital competence frameworks. Based on the results of this investigation, the researcher chose to utilize the DigComp framework as the basis of the data collection instrument used to investigate the needs of navigation officers in the digital area. The goal of this tool, a survey questionnaire, was to collect qualitative and quantitative data for the mixed method approach.

Following a descriptive analysis of the collected data and a discussion of the results within the context of the current body of research, it was determined that navigation officers require varied degrees of the digital competences mentioned for each of the five domains of the DigComp framework. These include information and data literacy, communication and cooperation, the development of digital material, safety, and problem-solving. As a direct result, the DigComp framework can be employed to serve as a digital competences framework for navigation officers.

5.3 Limitation of the study

In addition to the methodological limitations discussed in the sub-section 3.7 of chapter 3, the current research has some limitations.

1- The researcher studied the research topic based on the perspectives of navigation officers. The analysis is solely based on feedback from navigation officers who responded to the survey questionnaire. Those inputs should not be viewed as an exhaustive representation of how digital competences for navigation officers may be. The picture would be more comprehensive if relevant stakeholders were involved, such as METIs, shipping companies, and specialists in the field of digital competences' development.
2- The nationality, culture, and regional origins of the participants and how those factors may have affected their perceptions of their digital competences were not taken into account in this study. The regional aspect is more likely to be the most impacting factor due to the so-called digital divide[2].
3- The suggested framework may be further augmented. The study supplied only the building blocks for the framework and not the level of proficiency for each block.
4- The study was based on subjective self-reporting assessment of digital competences, which may lead to overrating (or underrating) of skills by respondents.

[2] The perceived disadvantage of individuals who are either unable to use digital technologies in their daily lives or do not prefer to do so has been labeled as the "digital divide" (Cullen, 2001).

5.4 Recommendations and future research

Given that the research topic is a matter of ongoing discussion and has been approached from various angles, as well as the significance of seafarers integrating the digital era and carrying out their responsibilities in digitalized shipping, the researcher, based on her study, recommends that researchers, policy makers, educators, seafarers and other stakeholders endeavour to:

1) validate and test the suggested framework by objectively measuring navigation officers' digital competences to avoid self-reporting assessment bias;
2) investigate each competence area on its own will provide more objectivity and clarity in the research data collection from the participants' side;
3) determine the order of importance of digital competences for navigation officers using statistical tools such as factor analysis.
4) establish the level of proficiency for each competence area of the suggested framework;
5) explore the application of the framework to other operational areas of seafaring (e.g., engineering officers) and also for all seafarers;
6) use the suggested framework to effectively plan and design training and educational programs for navigation officers and then for all seafarers to equip them with the appropriate digital competences.
7) explore the establishment of a digital competences framework for seafarers' instructors.

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Appendices

Appendix A: Charting of digital Competences frameworks

Appendix B: charting of private initiatives for digital Competences

Appendix C: Survey questionnaire

Appendix D: Normality test per Item

Appendix E: Non parametric test results

Appendix A: Digital Competences frameworks

Author(s)	Framework	Target population	Location	Type and background	Overview
(Vuorikari et al., 2022)	DigComp 2.2. The Digital Competence Framework for Citizens. With new examples of knowledge, skills and attitudes	All citizen	EU	Policy making Education and training Profession and employment	DigComp outlines what the digital Competence involves in 5 Competence areas: Information and data literacy, communication and collaboration, Digital content creation, safety and problem solving. The framework is organized into five dimensions: Dimension 1: Competence areas (5 areas) Dimension 2: Competences for each Competence area (21 Competences) Dimension 3: Proficiency levels (Foundation, Intermediate, Advanced and Highly specialised) Dimension 4: Examples of knowledge, skills and attitude Dimension 5: Use cases
(Redecker, 2017)	European framework for the digital Competence of educators: DigCompEdu	Educators at all levels of education, from early childhood to higher and adult education, including general and vocational education and training, special needs education, and non-formal learning context	EU	Policy making Education and training	Diverse facets of educators' professional activity are covered by the six DigCompEdu areas: 1. Professional Engagement: Using digital technologies for communication, collaboration and professional development. 2. Digital Resources: Sourcing, creating and sharing digital resources. 3. Teaching and Learning: Managing and orchestrating the use of digital technologies in teaching and learning

					4. Assessment: Using digital technologies and strategies to enhance assessment. 5. Empowering Learners: Using digital technologies to enhance inclusion, personalisation and learners' active engagement 6. Facilitating Learners' Digital Competence (DigiComp): Enabling learners to creatively and responsibly use digital technologies for information, communication, content creation, wellbeing and problem-solving.
(Ministry of Education and Higher Education, 2019)	Framework for digital Competence	All citizen	Quebec, Canada	Policy making Education and training	**This framework** is available in twelve key dimensions: Digital Technology Skills, Digital for Learning, Information literacy, Collaboration, Communication, Content production, Inclusion and Diverse Needs, Development of the individual, Problem solving, Critical thinking, Ethical citizen, Innovation and creativity.
(Hwb, 2022)		All citizens	Welsh	Policy making	The framework includes four components organized into three steps of progression:

	Digital Competence framework DFC	Education and training	**Citizenship**: Through this component, learners will be exposed to what it means to be a conscientious digital citizen who both positively contributes to the digital environment around them and critically evaluates their place in it. They will have developed strategies and resources to help them as they transition to becoming independent consumers and producers, and they will be ready to face both the advantages and disadvantages of being a digital citizen.it includes four elements: • Identity, image and reputation • Health and well-being • Digital rights, licensing and ownership • Online behaviour and online bullying **Interacting and collaborating:** Through the elements of this component, learners can examine several forms of technological communication and determine which ones are the most efficient. Learners will also efficiently employ cooperation strategies to store data. this component includes: Communication, collaboration, and storing and sharing **Producing:** The elements of this composition address the iterative processes of planning (including gathering information from various sources), producing, assessing, and improving digital material. Although other parts of the process may also use this approach, developing digital content is where it is most crucial. However, it is equally important to understand that creating digital content can be a very creative process, and this creativity is not meant to be constrained. The creation of text, graphics, audio, video, and any combination of these for use in digital material is covered. As a result, this will cover a variety of activities in a variety of settings. These elements are:

					• Sourcing, searching and planning digital content • Creating digital content • Evaluating and improving digital content **Data and computational thinking:** Combining problem-solving, critical thinking, and scientific inquiry are all components of computational thinking. Learners must first comprehend the issue and the approaches to tackling it before they can use computers to solve challenges. Learners will examine features of collection, representation, and analysis as well as the significance of data and information literacy through the use of these components. In order to equip learners with the necessary abilities for the contemporary dynamic workplace, they will examine how data and information relate to our digital environment. The elements of this component are: • Problem-solving and modelling • Data and information literacy
(Bank, 2018)	The Essential Digital Skills	Everyone in the UK involved in supporting adults to improve their essential digital skills.	UK	Policy making Education and training	The abilities required to safely take advantage of, participate in, and contribute to the digital environment of now and tomorrow are defined by the Essential Digital Skills Framework. For life and work, there are five categories of **essential digital skills**: • Communicating • Handling information and content • Transacting • Problem Solving • Being safe and legal online

(JISC; Beetham et al., 2017)	Building digital capabilities: The six elements defined	Students, instructors and staff	UK	Policy making Educational and professional background	The JISC framework was first developed in 2011, and since then, various JISC initiatives focusing on improving digital literacies, effective learning analytics, increasing student employability, the digital student, and digital capabilities have culminated in it. It was established, together with higher education and further education institutions, government agencies, industry groups, trade organisations, and other stakeholders. In order to improve the skills of faculty and students, many universities are currently using the current Digital Capability Framework, which is widely accepted. For ease of use, clarity, and quick access, it breaks down the six overlapping components of digital capacity for faculty and students into 15 subcategories. **Digital proficiency and productivity:** Using digital devices, applications, services, and tools effectively and productively, while paying attention to quality. **Information, data and media literacies:** *Finding, evaluating, managing, and sharing digital information and data, as well as critically receiving and responding to digital messages*. **Digital creation, problem solving and innovation:** Designing and creating digital content, utilizing digital evidence to answer questions, and adopting and developing new practices. **Digital communication, collaboration and participation:** the ability to participate in digital teams and working groups, communicate effectively through digital media, and create digital networks. **Digital learning, development and teaching:** the ability to take advantage of digital learning possibilities while assisting and developing others in environments rich in technology.

					Digital identity and wellbeing: the capacity to create and portray a positive digital identity, control one's online reputation, and take care of one's own health, relationships, safety, and work-life balance.
(Couros, 2018).	DIGITAL TEACHING PROFESSIONAL FRAMEWORK	Professional Continuous education/Further Education	UK	Policy making Profession and employment Education	The Digital Teaching Professional Framework is a Competence framework for teaching and training practitioners in the Further Education FE and Training sector. Was established based on (DigCompEdu (Redecker, 2017) , PS and Jisc), As adapted from the DigCompEdu JRC Science for Policy Report, the Digital Teaching Professional Framework defines three Competence levels: • Stage 1: Exploring – practitioners assimilate new information and develop basic digital practices. • Stage 2: Adopting – practitioners apply their digital practices and expand them further. • Stage 3: Leading – practitioners pass on their knowledge, critique existing practice and develop new practices. *The Professional Standards for Teachers and Trainers were created with the support of professionals and the field's experts to inspire and motivate the workforce's professional growth. The Standards were established in 2014, and an update was made in 2022. The standard is composed by The three following domains of practice:* ***Professional Values and Attributes, Professional Knowledge and Understanding***, ***Professional Skills*** *(Education &Training Foundation, 2022)* Practitioners could use the Digital Teaching Professional Framework for: A) Palming, B) Approaches to teaching, C) Supporting learners to develop employability skills, D) Subject and industry-specific teaching, E) Assessment, F) Accessibility and inclusion, and G) Self-development

(OER, 2022)	UNESCO ICT CFT: ICT Competence Framework for Teachers	Teachers	International	Policy making Educational and Professional background	The Framework is organized using three main teaching philosophies. Knowledge Acquisition, allowing pupils to use ICT more effectively for learning. Knowledge Deepening, which enables students to gain in-depth understanding of their academic courses and apply it to challenging, real-world issues. Students, citizens, and the workforce they become can develop the new information needed for more peaceful, contented, and wealthy communities through knowledge creation. According to the Open Education Resources (OER) (2022), this framework covers the following six areas: • Understanding ICT in Education • Curriculum and Assessment • Pedagogy • Application of Digital Skills • Organization and Administration • Teacher Professional Learning
(Law and Wong, 2018)	A Global Framework of Reference on Digital Literacy Skills for Indicator 4.4.2	Youth/Adults	International	Policy Making Educational and professional background	This framework Competences are organized as follow: **0. Devices and software operations**: To identify and use hardware tools and technologies. To identify data, information and digital content needed to operate software tools and technologies *(0.1. Physical operations of digital devices, 0.2. Software operations in digital devices)* **DigComp (5 Competence areas**), in addition to Computational thinking *(To process a computable problem into sequential and logical steps as a solution for human and computer systems)*

					6. Career-related Competences: To operate specialised digital technologies and to understand, analyse and evaluate specialised data, information and digital content for a particular field.
(Fraillon et al., 2019)	IEA International Computer and Information Literacy Study 2018 - Preparing for life in a digital world- IEA ICILS	Students/Youth/ Adults	International	Study report Educational and professional background	IEA International Computer and Information Literacy Study (ICILS), was created to address a pressing issue of the day: how well-equipped are students for academics, employment, and daily life in the digital age? A person's capacity to use computers for research, creation, and communication, in order to participate effectively at home, at school, in the workplace, and in the community, is measured as part of the study's analysis of differences in student computer and information literacy (CIL) across different international contexts. The CIL framework is composed of four strands that frame the skills and knowledge assessed: understanding, gathering, producing, and communicating information digitally. **Understanding computer use** It refers to the basic technological know-how and abilities that support the effective use of computers as tools for handling information. This covers a person's general knowledge and comprehension of computer features and operations. The two components that make up understanding computer use are its foundations and its conventions. **Gathering information** incorporates the organizational and receptive aspects of information processing and administration. This encompasses two aspects: managing information and accessing and assessing it. **Producing information** emphasizes the use of computers as tools for creative and analytical thought. Information transformation and information creation are two elements of it.

					Digital communication emphasizes information sharing in social networks (and larger web-based information sharing spaces), as well as the social, legal, and ethical obligations related to information sharing and using information safely and securely.
(Coward and Fellows, 2018)	Digital skills toolkit	All stakeholders being part of digital skills strategy	International	Policy making Education and training	**This toolkit** provides guidance to stakeholders on creating a digital skills strategy. Along with collaborators from the private sector, non-governmental groups, and academia, policymakers are the target audience. Its main objective is to make it easier for nations to build comprehensive digital skills strategies. This framework can also be used to concentrate on particular priorities that call for a new approach. Digital skills include a range of behaviours, experience, knowledge, work habits, character qualities, dispositions, and critical understandings that range from basic to more advanced according to *Broadband Commission for Sustainable Development (2017). Working Group on Education: Digital skills for life and work.* This toolkit is based on DigComp and is organized into three levels: **Basic skills**: cover hardware, software, and basic online operations **Intermediate skills**: give us the ability to employ digital technologies even more effectively and meaningfully, including the capacity to analyse technology or produce content. Since they include the abilities required to carry out tasks relevant to employment, such as desktop publishing, digital graphic design, and digital marketing, these are effectively job-ready skills.

					Advanced skills: are those that professionals in ICT fields like network administration and computer programming require. In the upcoming years, there will be tens of millions of occupations that require strong digital skills globally. The development of mobile apps is one of them. These include artificial intelligence (AI), big data, coding, cybersecurity, and the Internet of Things (IoT). Some economies anticipate a talent gap for workers with advanced digital skills, while others list ICT specialists among their fastest-growing professions.
(Bejdić, 2021; DQ Institute, 2022)	DQ (Digital Intelligence) Global Standard on Digital Literacy, Digital Skills, and Digital Readiness (IEEE 3527.1™ Standard)	All citizen	International	Policy making Education and Training Professional background	DQ comprises 24 digital Competences. It focuses on 8 critical areas of digital life Identity, Use, Safety, Security, Emotional Intelligence, Literacy, Communication, Rights. These 8 areas can each be developed at three levels: citizenship, creativity, and competitiveness. **Citizenship** focuses on basic levels of skills needed to use technologies in responsible, safe, and ethical ways. **Creativity** allows problem-solving through the creation of new knowledge, technologies, and content. **Competitiveness** focuses on innovations to change communities and the economy for broad benefit. DQ 24 Competences are a practical way to build future-readiness skills step-by-step, and Contributes to OECD's 11 Areas of Well-Being and UN'17 SDGs.

Appendix B: Private initiatives for digital Competences

Author(s)	Framework	Target population	Type and background	Initiative overview
(Intel corporation, 2014)	Intel® Education Digital Wellness Curriculum	All citizens	Education	The Intel® Education Digital Wellness curriculum focuses on promoting and enjoying a healthy and safe cyber-environment. This workshop is designed to help individuals build skills and inculcate values which will prepare them to navigate safely in cyberspace, act in a balanced and responsible manner while using the Internet, cultivate respect in their interactions with others, and create a cyber-culture that is healthy.
(K12 computer science, 2022)	K–12 Computer Science Framework	All citizens	Education	Introducing the K–12 Computer Science Framework comes at a time when education systems are adapting to a 21st century vision of students who are not just computer users, but also computationally literate creators proficient in the concepts and practices of computer science. This framework can be used by states, districts, and organizations to develop standards and curriculum, build capacity for teaching computer science, and implement computer science pathways (K12 computer science, 2022). The framework consists of: ***Five concepts**:* 1. Computing Systems 2. Networks and the Internet 3. Data and Analysis 4. Algorithms and Programming 5. Impacts of Computing ***And seven practices:*** 1. Fostering an Inclusive Computing Culture 2. Collaborating Around Computing 3. Recognizing and Defining Computational Problems

				4. Developing and Using Abstractions 5. Creating Computational Artifacts 6. Testing and Refining Computational Artifacts 7. Communicating About Computing k12cs.org – K–12 Computer Science Framework
(James et al., 2019; Common Sense, 2020)	Common Sense's Digital Citizenship Curriculum	All citizens	Education	In the fast-changing world of media and technology, Common Sense's Digital Citizenship Curriculum addresses critical issues facing children. As a result of the innovative lessons, students are taught to think critically and develop habits of mind for navigating digital dilemmas in their everyday lives. Digital Citizenship Curriculum covers 6 core topics: • Media Balance & Well-Being • Privacy & Security • Digital Footprint & Identity • Relationships & Communication • Cyberbullying, Digital Drama, & Hate Speech • News & Media Literacy
(iKeepSafe, 2022)	Google Digital Literacy & Citizenship Curriculum-ikeepsafe	All citizens	Education	IKeepSafe aims to educate families about online safety. Thus, Google developed curriculum that educators can use to teach what it means to be a responsible digital citizen in the classroom. This curriculum is organised based on three parts: • Become an Online Sleuth • Manage Your Digital Reputation • Identify Tricks and Scams

Appendix C: Survey questionnaire

Dear Participant,

Thank you for agreeing to participate in this research survey, which is carried out in connection with a dissertation which will be written by the interviewer, in partial fulfilment of the requirements for the degree of Master of Science in Maritime Affairs at the World Maritime University in Malmo, Sweden. The survey seeks to invite responses from navigation officers about how they experience digital Competences onboard ships.

The topic of the dissertation is: Digital Competences framework for seafarers: A case study of navigation officers.

The information provided by you in this survey will be used for research purposes and the results will form part of a dissertation, which will later be published online in WMU's digital repository (maritime commons) and made available to the public subject to final approval of the University. Your personal information will not be published. You may withdraw from the research at any time, and your personal data will be immediately deleted.

Anonymized research data will be archived on a secure virtual drive linked to a World Maritime University email address. All the data will be deleted as soon as the degree is awarded.

Filling out this form should take no more than 30 minutes. Your participation in the survey is highly appreciated.

Student's name	Latifa OUMOUZOUNE……
Specialization	Maritime Education and Training…….
Email address	w1010673@wmu.se……..

* * *

I consent to my personal data, as outlined above, being used for this study. I understand that all personal data relating to participants is held and processed in the strictest confidence, and will be deleted at the end of the researcher's enrolment.

Name:	……
Signature:	……
Date:	……

Part 01: participant profile

Name (optional)	
Nationality (optional)	
Age	
Gender	□ Female □ Male □ Other
Rank onboard	□ Management level (*please indicate rank, **for example chief officer**,* _____) □ Operational level (*please indicate rank, **for example second officer**,* _____)
Seafaring experience	□ less than 5 years □ 5-10 years □ 11-15 years □ 16-20 years □ More than 20 years
Current or last vessel type boarded	
Current location	□ Onboard □ Loading/discharging □ Approaching port □ Ashore

Part 02: Training experience for digital Competences

ICT Information and Communications Technology

1- Have you undertaken any ICT-related training before?

- ☐ YES
- ☐ NO

2- If your answer to the previous question is YES *(to consider when creation of the google form)*

- What type of the training was it? *(Select all that apply)*

  - ☐ Formal
  - ☐ Informal
  - ☐ Self-directed learning
  - ☐ Face to face
  - ☐ Online learning
  - ☐ Other (please describe) _____

- Which entity/institution provided this training?

  _____

  - ☐ Your employee
  - ☐ Maritime institution/school
  - ☐ Training center
  - ☐ Other (please specify): _____

- Please give any other information that could help us better understand the kind of ICT-related training you undertook?

  _____

Part 03: Perception to digital Competences taught by Seafarers

Please read the statements below and indicate your level of agreement in a scale of 1 to 6 where

1= Strongly disagree 2= Disagree 3= Slightly disagree	4= Slightly agree 5= Agree 6= Strongly agree

Digital Competence		**1**	**2**	**3**	**4**	**5**	**6**
1-Information and data literacy							
1.	I can adapt search strategies to a specific search tool, application or device						
2.	I can monitor the information I receive						
3.	I have limitations in selecting reliable information from unreliable information						
4.	I can apply different methods and tools to organize files, content, and information *(categorizing and classifying data, storage devices,, back-ups, cloud storage,…….)*						
5.	I can deploy a set of strategies for retrieving the content I or others have organized and stored.						
2- Communication and collaboration							
6.	I can use a wide range of tools for online communication *(emails, chats, SMS, instant messaging, blogs, VoIP, video-conference, ...)*						
7.	I can adopt digital modes and ways of communication that best fit the purpose						
8.	I can adapt the format and communication methods to suit my audience.						
9.	I can manage the different forms of communication I receive.						
10.	I am limited in my ability to share information, content and resources with others through online communities, networks and collaboration platforms						
11.	I can access a number of relevant networks and communities for different purposes *(Education and training, technical, safety, security, VTS, ports services, etc.)*						
12.	I can use the different functionalities of digital technologies (e.g. networks, media, or online services)						
13.	I can use social media for different collaborative purposes						
14.	I am aware of cultural diversity while using online communication *(Cultural diversity refers to all differences based on racial, sexual, organizational, linguistic, professional and national heterogeneity).*						
15.	I am aware of generational diversity while using online communication. *(Generational diversity refers to the*						

	existence and inclusion of people from all generations.)						
16.	I can manage several digital identities according to the context and purpose *(personally and professionally)*						
17.	I can monitor the information and data I produce through my online interaction,						
18.	I often face difficulty in protecting my online reputation.						
3- Digital content creation							
19.	I can produce digital content in different formats, platforms and environments *(text, audio, numeric, images, etc.)*						
20.	I can use a variety of digital tools for creating original multimedia outputs						
21.	I can combine different types of content to make new ones.						
22.	I do not know how different types of licences apply to the information and resources I use and create.						
23.	I cannot code/program in any coding/programming language						
4- Security							
24.	I frequently update my security strategies						
25.	I use digital devices onboard to ensure required security levels for digital networks, servers and applications.						
26.	I can prevent cyber-attacks and decide on actions to be taken *(preventive and reactive measures)*						
27.	I often change the default privacy settings of online services to enhance my privacy protection.						
28.	I have limited understanding of privacy issues						
29.	I am familiar with cybersecurity risk assessment onboard ship *(cyber security risk assessment refers to determine the likelihood of vulnerabilities being exploited by external threats to ship systems, and/or inappropriate use of digital technologies onboard)*						
30.	I am familiar with cybersecurity risk management procedures applied onboard ship						
31.	I protect my personal data and privacy						
32.	I am aware of the health risks (physical and psychological) derived from the						

	incorrect use of technology *(such as bad ergonomic posture, spending time on social media and internet while it is time to rest and get proper sleep, emotional impact from digital communication like emails and social media…)*						
33.	I am aware of the impact of Information and Communication Technology ICT on the environment						
5- Problem-solving							
34.	I can solve a wide-range of problems that arise from the use of technology						
35.	I am aware of new technological developments.						
36.	I understand how new tools work and operate						
37.	I can critically evaluate which tool serves my purposes the best						
38.	I face challenges in taking part in innovative actions through the use of technologies.						
39.	I proactively collaborate with others to produce creative and innovative outputs						
40.	I frequently update my digital Competence needs						

Part 04: Access to and Use of Information and Communication Technologies (ICTs) onboard ship.

1- Do you own any of these devices?

- ☐ Desktop computer
- ☐ Laptop
- ☐ Smartphone
- ☐ Tablet device (e.g. iPad)
- ☐ Other (please specify): _____

2- Do you have access to any of these devices on your ship?

Device	Yes	Yes, I use my personal device in the ship	No, my work place (ship) does not allow me to use these
Desktop computer			
Laptop			
Smartphone			
Tablet device *(e.g. iPad)*			

Other *(please specify : _____)*			

3- Do you get Wi-Fi/wireless Internet connectivity on your ship?

- Yes
- No

If the answer to the previous question is yes. (to consider when creation of the google form)

4- The access to Wi-Fi/wireless Internet connectivity on your ship is:

- Free
- Cheap
- Affordable
- Expensive
- Very expensive

5- Which device do you use most frequently to access the Internet onboard ship?

- Desktop computer
- Laptop
- Smartphone
- Tablet *(d*evice *(e.g. iPad*)
- Other *(please specify : _____)*

6- I use the Internet onboard ship:

- Daily
- Alternate day
- Once a week
- Irregularly
- Rarely
- Never

7- On average, how much time do you spend on Internet-related activities (email, browsing, social media) daily?

- < 1hour
- 1-2 hours
- 3-5 hours
- > 5 hours

- Do not use daily

8- I generally use digital technologies for:

_____

9- I use the internet mainly for:

_____

10- Please give any other information that could help us better understand your use of digital technologies onboard.

_____

End of the questionnaire

Appendix D: Normality test per Item

Digital Competences' survey items	Mean Statistic	SD Statistic	Skewness Statistic	Std. Error	Kurtosis Statistic	Std. Error	Normality
			1				
			0.5				
23- I can code/program at least in one coding/programming language.	2.77	1.509	0.437	0.237	-0.816	0.469	Approximately symmetric, Normally distributed
38- I can take part in innovative actions through the use of technologies.	3.32	1.436	0.285	0.237	-0.66	0.469	
3- I distinguish reliable information from unreliable information.	3.22	1.501	0.281	0.237	-0.776	0.469	
22.I know how different types of licences apply to the information and resources I use and create.	3.36	1.379	0.012	0.237	-0.545	0.469	
10- I can actively share information, content and resources with others through online communities, networks and collaboration platforms.	3.63	1.613	-0.035	0.237	-1.128	0.469	
36- I understand how new tools work and operate.	4.45	0.984	-0.206	0.237	0.008	0.469	
34- I can solve a wide-range of problems that arise from the use of technology.	4.12	1.209	-0.226	0.237	-0.363	0.469	
5- I can deploy a set of strategies for retrieving the content I or others have organized and stored.	4.62	1.017	-0.292	0.237	-0.311	0.469	
18- I know how to protect my digital reputation.	4.14	1.458	-0.39	0.237	-0.764	0.469	
28- I have an informed and wide understanding of privacy issues.	4.06	1.433	-0.405	0.237	-0.731	0.469	
24- I frequently update my security strategies.	4.03	1.397	-0.423	0.237	-0.467	0.469	
40- I frequently update my digital Competence needs.	4.38	1.271	-0.452	0.237	-0.49	0.469	
35- I am aware of new technological developments.	4.51	1.182	-0.473	0.237	-0.096	0.469	
			-0.5				
20- I can use a variety of digital tools for creating original multimedia outputs.	4.37	1.344	-0.551	0.237	-0.346	0.469	Moderately skewed,

33- I am aware of the impact of Information and Communication Technology ICT on the environment.	4.71	1.171	-0.561	0.237	-0.414	0.469	not normally distributed
26- I can prevent cyber-attacks and decide on actions to be taken (preventive and reactive measures).	4.18	1.606	-0.577	0.237	-0.717	0.469	
27- I often change the default privacy settings of online services to enhance my privacy protection.	4.31	1.469	-0.663	0.237	-0.315	0.469	
39- I proactively collaborate with others to produce creative and innovative outputs.	4.38	1.332	-0.665	0.237	0.138	0.469	
21- I can combine different types of content to make new ones.	4.38	1.287	-0.672	0.237	-0.018	0.469	
17- I can monitor the information and data I produce through my online interaction.	4.74	1.097	-0.679	0.237	0.307	0.469	
19- I can produce digital content in different formats, platforms and environments (text, audio, numeric, images, etc).	4.42	1.32	-0.722	0.237	0.16	0.469	
13- I can use social media for different collaborative purposes.	4.71	1.29	-0.799	0.237	0.041	0.469	
8- I can customize the format and communication methods to suit my audience.	4.78	1.07	-0.854	0.237	0.544	0.469	
1- I am able to modify my search tactics to fit a certain search tool, application, or device.	4.87	1.112	-0.871	0.237	0.682	0.469	
25- I use digital devices onboard to ensure required security levels for digital networks, servers and applications.	4.42	1.405	-0.878	0.237	0.164	0.469	
9- I can manage the different forms of communication I receive.	4.98	0.965	-0.886	0.237	0.818	0.469	
11- I can access a number of relevant networks and communities for different purposes (Education and training, technical, safety, security, VTS, ports services, etc).	4.64	1.269	-0.898	0.237	0.498	0.469	
37- I can critically evaluate which tool serves my purposes the best.	4.68	1.151	-0.906	0.237	0.883	0.469	
12- I can use the different functionalities of digital technologies (e.g. networks, media, or online services).	4.94	1.013	-0.912	0.237	1.232	0.469	
15- I am aware of generational diversity while using online communication (Generational diversity refers to the	5.07	0.968	-0.922	0.237	0.814	0.469	

existence and inclusion of people from all generations).							
			-1				
4- I can apply different methods and tools to organize files, content, and information (categorizing and classifying data, storage devices, back-ups, cloud storage, etc).	4.86	1.118	-1.026	0.237	0.984	0.469	Highly skewed, Not normally distributed
14- I am aware of cultural diversity while using online communication (Cultural diversity refers to all differences based on racial, sexual, organizational, linguistic, professional and national heterogeneity).	5.02	1.052	-1.162	0.237	1.587	0.469	
30- I am familiar with cybersecurity risk management procedures applied onboard ship.	4.86	1.273	-1.193	0.237	0.836	0.469	
29- I am familiar with cybersecurity risk assessment onboard ship *(cyber security risk assessment refers to determine the likelihood of vulnerabilities being exploited by external threats to ship systems, and/or inappropriate use of digital technologies onboard).*	4.93	1.302	-1.246	0.237	0.823	0.469	
16- I can manage several digital identities according to the context and purpose (personally and professionally).	4.75	1.197	-1.269	0.237	2.022	0.469	
6- I can use a wide range of tools for online communication (emails, chats, SMS, instant messaging, blogs, VoIP, video-conference, etc).	5.12	1.086	-1.275	0.237	1.55	0.469	
7- I can adopt digital modes and ways of communication that best fit the purpose.	5.09	1.08	-1.4	0.237	2.057	0.469	
32- I am aware of the health risks (physical and psychological) derived from the incorrect use of technology *(such as bad ergonomic posture, spending time on social media and internet while it is time to rest and get proper sleep, emotional impact from digital communication like emails and social media…)*	5.02	1.174	-1.469	0.237	2.134	0.469	

31- I protect my personal data and privacy.	5.13	1.115	-1.47	0.237	1.932	0.469	
2- I can monitor the information I receive.	5.11	1.014	-1.641	0.237	4.094	0.469	

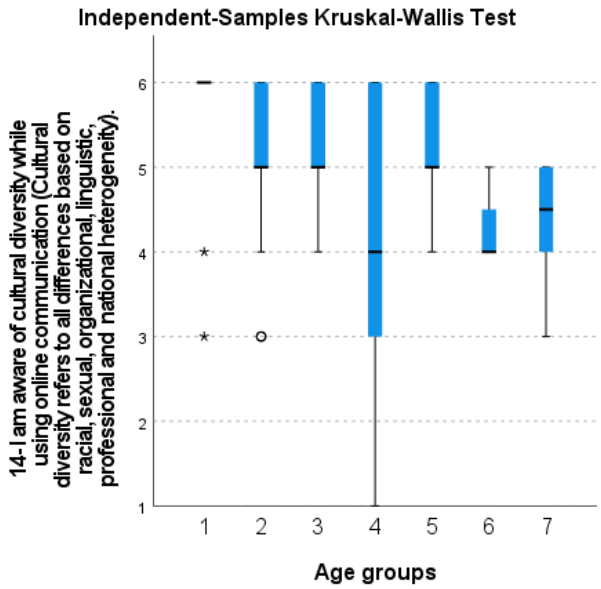
According to the rule of thumb, as recommended by Bulmer (1979):

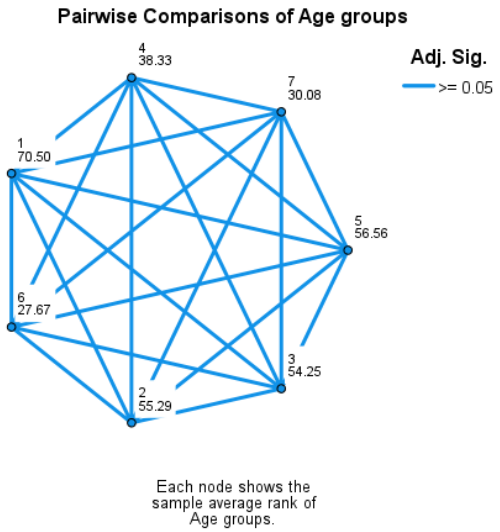
- Skewness less than −1 or more than +1, the distribution is highly skewed.
- Skewness between −1 and −.5 or between + .5 and +1, shows distribution is moderately skewed.
- Skewness between −.5 and + .5, the distribution is approximately symmetric.

This table shows that out of forty items, twenty-seven are not normally distributed.

Appendix E: Non parametric test results

14- I am aware of cultural diversity while using online communication (Cultural diversity refers to all differences based on racial, sexual, organizational, linguistic, professional and national heterogeneity). across Age groups

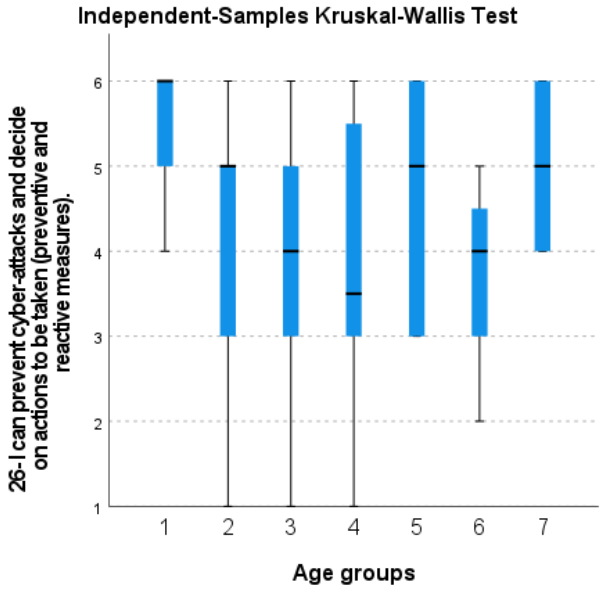


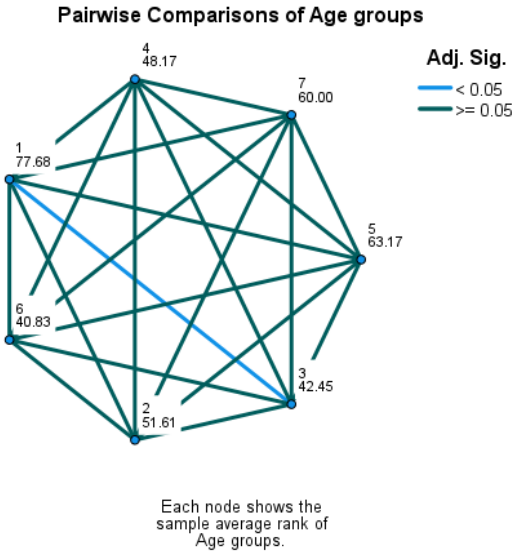


Pairwise Comparisons of Age groups (only for Asymptotic significances ≤0.05)					
Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.[a]
6.00-1.00	42.833	18.565	2.307	.021	.442
7.00-2.00	25.205	12.650	1.992	.046	.973
7.00-1.00	40.417	14.466	2.794	.005	.109
4.00-1.00	32.167	11.898	2.704	.007	.144
Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same. Asymptotic significances (2-sided tests) are displayed. The significance level is .050.					
a. Significance values have been adjusted by the Bonferroni correction for multiple tests.					

Pairwise Comparisons of Age groups					
Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.[a]
6.00-7.00	-2.417	20.154	-.120	.905	1.000
6.00-4.00	10.667	18.398	.580	.562	1.000
6.00-3.00	26.583	17.259	1.540	.123	1.000
6.00-2.00	27.621	17.188	1.607	.108	1.000
6.00-5.00	28.889	19.002	1.520	.128	1.000
6.00-1.00	42.833	18.565	2.307	.021	.442
7.00-4.00	8.250	14.251	.579	.563	1.000
7.00-3.00	24.167	12.747	1.896	.058	1.000
7.00-2.00	25.205	12.650	1.992	.046	.973
7.00-5.00	26.472	15.022	1.762	.078	1.000
7.00-1.00	40.417	14.466	2.794	.005	.109
4.00-3.00	15.917	9.735	1.635	.102	1.000
4.00-2.00	16.955	9.608	1.765	.078	1.000
4.00-5.00	-18.222	12.568	-1.450	.147	1.000
4.00-1.00	32.167	11.898	2.704	.007	.144
3.00-2.00	1.038	7.190	.144	.885	1.000
3.00-5.00	-2.306	10.833	-.213	.831	1.000
3.00-1.00	16.250	10.047	1.617	.106	1.000
2.00-5.00	-1.268	10.718	-.118	.906	1.000
2.00-1.00	15.212	9.923	1.533	.125	1.000
5.00-1.00	13.944	12.811	1.088	.276	1.000
Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same. Asymptotic significances (2-sided tests) are displayed. The significance level is .050.					
b. Significance values have been adjusted by the Bonferroni correction for multiple tests.					

26- I can prevent cyber-attacks and decide on actions to be taken (preventive and reactive measures). across Age groups





Pairwise Comparisons of Age groups					
Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.[a]
6.00-3.00	1.617	17.877	.090	.928	1.000
6.00-4.00	7.333	19.057	.385	.700	1.000
6.00-2.00	10.773	17.803	.605	.545	1.000
6.00-7.00	-19.167	20.876	-.918	.359	1.000
6.00-5.00	22.333	19.682	1.135	.256	1.000
6.00-1.00	36.848	19.229	1.916	.055	1.000
3.00-4.00	-5.717	10.084	-.567	.571	1.000
3.00-2.00	9.156	7.448	1.229	.219	1.000
3.00-7.00	-17.550	13.203	-1.329	.184	1.000
3.00-5.00	-20.717	11.220	-1.846	.065	1.000
3.00-1.00	35.232	10.406	3.386	<.001	.015
4.00-2.00	3.439	9.952	.346	.730	1.000
4.00-7.00	-11.833	14.761	-.802	.423	1.000
4.00-5.00	-15.000	13.018	-1.152	.249	1.000
4.00-1.00	29.515	12.324	2.395	.017	.349
2.00-7.00	-8.394	13.103	-.641	.522	1.000
2.00-5.00	-11.561	11.102	-1.041	.298	1.000
2.00-1.00	26.076	10.279	2.537	.011	.235
7.00-5.00	3.167	15.560	.204	.839	1.000
7.00-1.00	17.682	14.983	1.180	.238	1.000
5.00-1.00	14.515	13.270	1.094	.274	1.000

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .050.

a. Significance values have been adjusted by the Bonferroni correction for multiple tests.

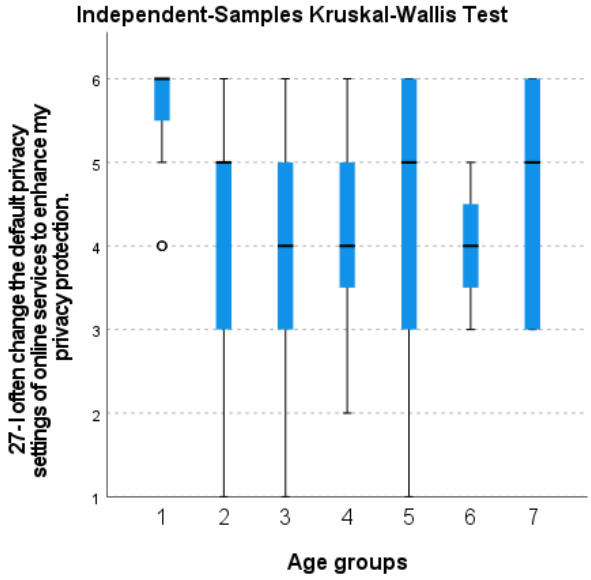
Pairwise Comparisons of Age groups (only for Asymptotic significances ≤0.05)

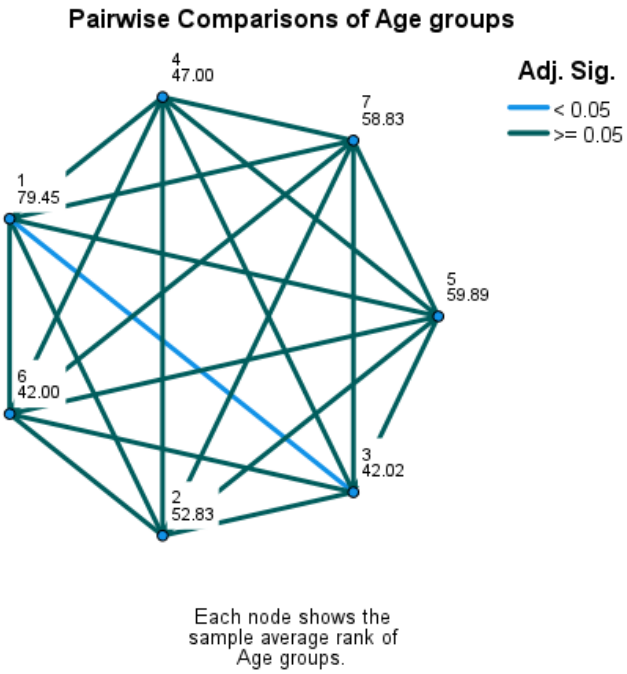
Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.[a]
3.00-1.00	35.232	10.406	3.386	<.001	.015
4.00-1.00	29.515	12.324	2.395	.017	.349
2.00-1.00	26.076	10.279	2.537	.011	.235

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .050.

a. Significance values have been adjusted by the Bonferroni correction for multiple tests.

27- I often change the default privacy settings of online services to enhance my privacy protection. across Age groups





Pairwise Comparisons of Age groups					
Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.[a]
6.00-3.00	.017	17.826	.001	.999	1.000
6.00-4.00	5.000	19.003	.263	.792	1.000
6.00-2.00	10.833	17.752	.610	.542	1.000
6.00-7.00	-16.833	20.816	-.809	.419	1.000
6.00-5.00	17.889	19.626	.911	.362	1.000
6.00-1.00	37.455	19.175	1.953	.051	1.000
3.00-4.00	-4.983	10.055	-.496	.620	1.000
3.00-2.00	10.817	7.426	1.457	.145	1.000
3.00-7.00	-16.817	13.165	-1.277	.201	1.000
3.00-5.00	-17.872	11.188	-1.597	.110	1.000
3.00-1.00	37.438	10.377	3.608	<.001	.006
4.00-2.00	5.833	9.924	.588	.557	1.000
4.00-7.00	-11.833	14.719	-.804	.421	1.000
4.00-5.00	-12.889	12.981	-.993	.321	1.000
4.00-1.00	32.455	12.288	2.641	.008	.174
2.00-7.00	-6.000	13.065	-.459	.646	1.000
2.00-5.00	-7.056	11.070	-.637	.524	1.000
2.00-1.00	26.621	10.249	2.597	.009	.197
7.00-5.00	1.056	15.516	.068	.946	1.000
7.00-1.00	20.621	14.941	1.380	.168	1.000
5.00-1.00	19.566	13.232	1.479	.139	1.000

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .050.

a. Significance values have been adjusted by the Bonferroni correction for multiple tests.

Pairwise Comparisons of Age groups (only for Asymptotic significances ≤0.05)					
Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.[a]
3.00-1.00	37.438	10.377	3.608	<.001	.006
4.00-1.00	32.455	12.288	2.641	.008	.174
2.00-1.00	26.621	10.249	2.597	.009	.197

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .050.

a. Significance values have been adjusted by the Bonferroni correction for multiple tests.