REGIONAL MARITIME TWIN SKILLS NEEDS ANALYSIS

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1. BACKGROUND:

As a key actor in global trade and transportation, the maritime industry is expected to play a significant role in achieving **the European Union's Green Deal targets** of reducing the greenhouse gas emissions by at least 55% by 2030 and making Europe the world's first climate-neutral continent by 2050.

Additionally, in relation to professional capacity building and training the EC has identified the need for increasing the **attractiveness of maritime professions, improving the training of seafarers, promoting lifelong professional prospects in maritime sectors and improving the image of shipping**. To support this dual goal the integration of decarbonization and digitalization efforts in the maritime industry through the development and application of new technologies and solutions that enable the efficient use of renewable energy sources, the optimization of vessel operations, and the reduction of emissions is crucial. The introduction of technologies such as IoT, blockchain, 5G, advanced navigation, fleet management systems for autonomous vessels, shipping and management operations and trade, finance and logistics is already changing the operation model of the industry and creates new business logic. However, the sector is categorized as a slow adopter of emerging technologies. This is due to a number of factors, including lack of technical expertise, resistance to change and concerns about data security.

It is anticipated that the Twin Transition will have a substantial impact on various aspects of life in the short, medium, and long term, and it is currently the most pressing issue on the EU's agenda. Although a green transition and a digital transition are distinct in that they are each subject to unique dynamics, their twinning, or their ability to reinforce one another, warrants further investigation. The global community recognizes digital technologies as a critical enabler in the pursuit of biodiversity restoration, pollution reduction, and climate neutrality. This is accomplished by monitoring pollution exposure and gaining access to environmental data. In addition, Ramesohl et al.2021, 2022) underscore the importance of digital solutions in the transformation of stakeholders' incentive systems, market structures, business models, and behavioural patterns as prerequisites for transformative changes towards sustainability and climate protection. Furthermore, this facilitating role is further enhanced by the necessity of multiple economic operators to achieve climate neutrality and energy efficiency by 2030, such as in data centres and cloud infrastructures. The greening of other technologies, such as the internet of things, blockchain, and big data analytics, will be facilitated by this.

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The maritime sector, in particular, is at a critical juncture, where the tandem transition is not only beneficial but also necessary. In order to accomplish sustainability objectives, the maritime industry must implement both green and digital transformations, as it is a substantial contributor to global greenhouse gas emissions. The sector's environmental footprint can be significantly reduced by the adoption of digital technologies, such as automated and data-driven systems for route optimisation and emissions monitoring. Additionally, the maritime sector must advance towards climate neutrality by integrating renewable energy sources and constructing clever port infrastructures. The broader objective of a sustainable blue economy will be bolstered by the combined efforts of environmental sustainability and digital innovation, which will also result in increased operational efficiencies and reduced pollution. In general, the twin transition, which seamlessly integrates digital and green initiatives, is a comprehensive strategy for resolving the multifaceted challenges of sustainability. It is indispensable for the advancement of the European Union's ambitious climate and energy objectives, as well as the cultivation of a sustainable, resilient future in a variety of sectors, including the critical maritime industry.

The role of skills, as well as the upskilling and reskilling requirements of the workforce, is one of the essential components for this transition. Skills are crucial for personal and professional success. They enable effective and efficient task performance, leading to better results in both work and daily life. Skills also play a significant role in career advancement, as employers often look for both technical and interpersonal skills when hiring or promoting candidates. Adaptability is essential in the constantly changing world, especially in technology and work environments. A diverse set of skills, coupled with the ability to learn new ones, allows individuals to adapt to new challenges and opportunities.

Problem-solving skills are essential for overcoming obstacles, whether it's technical know-how or critical thinking. Skilled individuals can boost confidence and independence, making them less dependent on others. Soft skills, like communication and empathy, are crucial for building and maintaining relationships, both personally and professionally. Developing new skills fosters a mindset of lifelong learning, keeping individuals curious, open-minded, and prepared for the future. In essence, skills are the building blocks that enable individuals to achieve their goals, succeed in their careers, and navigate life's complexities with confidence and competence.

The European Skills Index (ESI) is a composite indicator developed by Cedefop (2024) that assesses the performance of skills systems throughout the European Union. ESI comprises three fundamental components, namely skills development, activation, and matching. Each component assesses a distinct facet of a skills system. The foundation of the ESI consists of 15 distinct indicators derived from several worldwide sources (see *Figure 1*). The scores are computed on a global scale, specifically at the level of indicators. The scores are subsequently averaged over the several levels, resulting in the formation of the Index score. To provide an

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illustration, a score of 65 on the Index (or pillar, sub-pillar, etc.) indicates that the country has achieved 65% of the desired level of performance. Hence, there remains a potential for enhancement of 35% (100-65). Attaining a score of 100 is indicative of reaching the 'frontier', which represents an ambitious objective performance for the given indication. A score of zero represents the performance at its lowest point. The shaded portion of the graphs presented below illustrates the percentage of a country's score in relation to the ideal, while the dotted line represents the remaining distance to be covered until the highest level of performance is achieved.

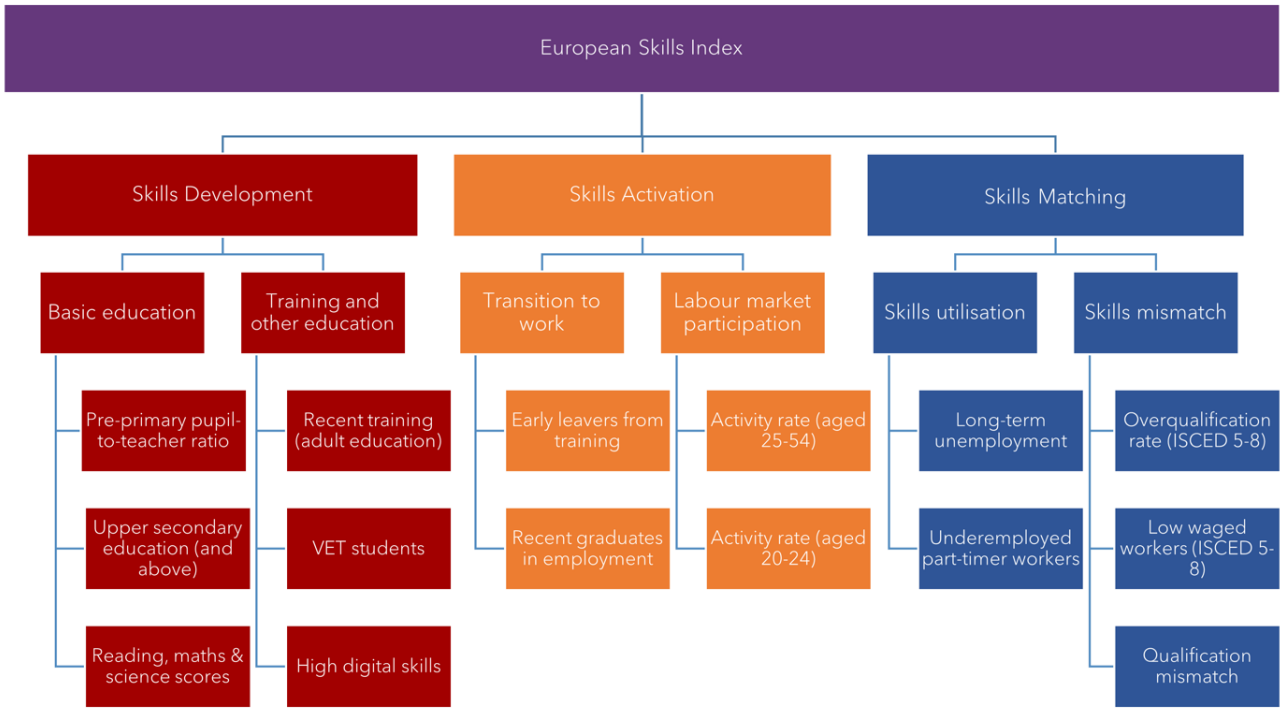

Figure 1 - European Skills Index (ESI)

The development of **targeted trainings that are based on INTRApreneurship models is an innovative tool** that will equip the employees with the skills and knowledge they need to use digital and green solutions effectively and securely. The Maritech Talent Project sees this as a necessary facilitator to overcome the challenges that the sector faces stepping on the Pact for skills and Blueprint Alliances which are already providing targeted support through upskilling and reskilling activities. Nevertheless, another challenge comes to building a buy-in and support **for both capacity building of the current workers and the adoption of the twin transformation solutions**. This is precisely the objective of the present project.

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The MariTech Talent program aims to provide a standardized service for green and digital skilling and upskilling, tailored to address the industry's specific needs while making an exponential contribution to wider impacts under the "human-centered and ethical development of digital and industrial technologies" destination. It focuses on applying a systemic approach to the use of technologies within society and industry, with a particular emphasis on the needs of maritime companies and their workforce. It is an innovative training approach that provides standardized development of twin skills and competencies through technological adoption, thereby promoting the modernization of the maritime industry.

2. LITERATURE REVIEW AND ANALYSIS:

Many people have forecasted that the Fourth Industrial Revolution and Industry 4.0 technologies will present the largest wealth creation opportunity in the history of our planet[1].

Wholesale changes will come because of advances in technology and information. The maritime sector will not be spared or insulated from these changes. In fact, the Fourth Industrial Revolution has already set sail in the maritime sector as automated container ships, 3D Printing, artificial intelligence, automation, cybersecurity, robotics, smart ships, smart ports are all now disrupting the maritime sector.

These new technologies born out of the fourth wave of technological advancement are fundamentally changing most of what we know in the maritime sector as new insights are gained and deployed to transform most major shipping processes.

The paradigm change is focused on three key areas:

- developing a **whole of culture appreciation for the new STEM skills** needed to develop the industry 5.0 seafarer and continue lifelong learning to adequately meet our advancing technological society both on land and at sea;
- build societies that have a **civic and ethical understanding of the power of these new technologies** that will allow for safe and efficient use on behalf of all mankind;

and

- give opportunities for a wider range of people across societies to get a **maritime education using non-traditional teaching methods.**

[1] Understanding the paradigm shift in maritime education. The role of 4th Industrial Revolution technologies: an industry perspective Erica Simmons, Centre for Digital Innovation and Advanced Manufacturing, Caribbean Maritime University, Kingston, Jamaica, and Grace McLean Ministry of Education, Youth and Information, Kingston, Jamaica

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Due to technological advancements, the shipping industry is undergoing rapid transformation. Digitalization and advanced automation are driving significant changes in maritime operations, necessitating a re-evaluation of the role of seafarers. As shipping becomes increasingly technical, there is a growing demand for a highly skilled and specialized workforce capable of adapting to ever-evolving technologies. Educational institutions are tasked not only with preparing individuals for the present but also for future challenges. This requires a deep understanding of the impact of digitalization on the industry, the adoption of new curricula, and the integration of IT technology to enhance teaching and learning methods. Furthermore, it is essential to foster close collaboration between industry and educational institutions to identify and address gaps in the education system. A modern training approach must equip learners with the ability to effectively use information and understand the capabilities of automated systems. Traditional seafarer training, which emphasizes practical and cognitive skills, remains an integral part of applied sciences.

The global trend in maritime education and training is increasingly to link an essentially vocational education that provides specific and restricted competence outcomes with more general or deeper academic components leading to an academic qualification[2].

As technology makes significant advancements in enhancing existing shipping systems, it is equally important to elevate the quality of the crew through education and training. Ensuring the crew is well-equipped to operate the cutting-edge systems on board is crucial for their effective performance.

Hamburg School of Business Administration made a comprehensive study on **"Seafarers and Digital Disruption" in 2018**[3]. Dealing with the "human element" on board, this study revealed some first answers to the initial questions:

- Digital transformation will be a seamless process rather than a disruptive one.
- There will be no shortage of jobs for seafarers in the foreseeable future.
- There will be considerable additional jobs ashore.
- There will be significant training needs

And in that context few analyses and research papers are tackling the issue with the changing skills needs as regards maritime sector. They set the general framework and further define the need for twin skills among the seafarers.

[2] M. E. Manuel. Vocational and academic approaches to maritime education and training (MET): Trends, challenges and opportunities, WMU Journal of Maritime Affairs volume 16, 2017pages 473–483

[3] HSBA (Hamburg School of Business Administration). Seafarers and digital disruption, Lead Author: Prof Dr Max Johns HSBA Hamburg School of Business Administration for the International Chamber of Shipping. Hamburg/London, October 2018 https://www.ics-shipping.org/docs/default-source/resources/ics-study-on-seafarers-and-digital-disruption.pdf (Retrieved 12.04.2020)

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Main conclusions of some of the most concrete papers are presented in this chapter as an introduction to more detailed conclusions by the Maritech mapping and training needs analysis exercise.

European Skills Council for Maritime Technology Sector

The creation of European Skills Council for the Maritime Technology Sector is one of the recommendations of LeaderSHIP 2020 strategy, adopted by the European Commission and industry stakeholders in February 2013 and endorsed by the European Competitiveness Council in May 2013.

LeaderSHIP 2020 strategy contains the vision of the maritime technology sector for a strong, sustainable, and competitive European maritime industry in 2020, employment and skills being one of the pillars of the industry's 'strategic vision' for 2020

According to the Final Report of the EU-Funded Project “Creating a European Skills Council for the Maritime Technology Sector” (2014-2016), “the European maritime technology industry encompasses all the enterprises involved in the design, construction, maintenance and repair of all types of ships and other maritime structures, including the complete supply chain of systems, equipment and services, as well as research and educational institutions.”

The maritime technology industry is the key industry for achieving the goals of the Europe 2020 strategy for smart, sustainable and inclusive growth, in particular through 'blue growth'.

The “blue” economy represents around 5.4 million jobs and generates a gross added value of almost EUR 500 billion a year. However, further growth is possible, and the maritime technology industry is the key enabler, providing the technologies, vessels and structures needed to ensure the sustainable development of all the maritime activities (maritime transport of goods and passengers, promotion of oil and gas, offshore renewable energies, aquaculture and fisheries, security and defence, etc.).

The following objectives are seen as necessary to improve skills, employment and education in the sector:

- Improve the cooperation among different stakeholders all over Europe, mainly cooperation between education and training providers and the industry, in order to design programmes, which address the actual needs of the industry in terms of skills and knowledge. The adaptation of innovative programmes for the sector should include high education (university), VET and lifelong learning programmes.
- Harmonisation of certificates across Europe to improve the mobility of workers.

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Reports indicate a growing need for maritime professionals to acquire digital competencies, particularly in areas like automation, cybersecurity, and data analytics. This is driven by the integration of smart technologies and e-navigation systems onboard vessels, which require crews to be proficient in handling advanced software and communication systems

According to article "Maritime sector at verge of change: learning and competence needs in Finnish maritime cluster", published in Sprynger Link *„institutional pressure would widen the skills gap in environmental technology and automation in the maritime cluster"* as regards the need for skills.

The below chart [4]is presenting the results of survey, behind the article.

The future importance of competences in maritime logistics and the maritime industry

The chart shows the difference between the current state and the future view, the biggest change clearly being in "environmental regulations and technology" and "production methods and automation." Overall, the perceived importance of practically all competences under investigation will increase in the future.

The findings show that firms in the maritime industry and in maritime logistics have similar views on the current and future importance of different competences. The two competences that will increase most in importance in both sectors concern environmental regulations and technology and production methods and automation. Both of these could be associated with ongoing major changes in the maritime sector. The shipping business has already faced a series of new

[4] https://link.springer.com/article/10.1007/s13437-021-00228-0/figures/1

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environmental regulations, and tighter restrictions both in the IMO and the EU are likely to follow. Overall, the gap is wider on the vocational level than on the university level and is likely to increase. At the same time, neither of the sectors considers formal qualifications a major problem nor expects much increase in the desired level of formal education. This, as such, is an interesting finding, implying that firms in the industry see the need for a more competent workforce, but do not think the solution lies in formal education.

SkillSea Project

One of the most comprehensive analyses of the training needs in the maritime sector has been elaborated within the SkillSea Project.

While designing the methodological approach the Maritech Team also used the conclusions from the SkillSea Project gap analysis as a basis further narrowing the questionnaire and channeling the approach to its creation.

According to the SkillSea Project report "*Ships will be smarter, data driven, connected and greener with a variety of power systems. The future maritime activity will integrate people and digital technology in a way that transform how we operate and interact. New operation paradigm needs to be created. The maritime experts also highlight the importance of transversal skills, sea-land mobility, and innovation*."

In a report, prepared by the same project the following main conclusions are presented:

- Current and future challenges faced by the maritime sector will create significant pressure on the present **model of education, training and manning of the maritime industry**, both on ships and ashore. There are strong indications that new technologies and the resulting social interactions will significantly affect the required core skill sets, the modes of acquiring skills, and the relationships among key stakeholders, those being active in the labour market(s) as well as others.
- The importance of the availability of a skilled workforce, onboard and ashore, for the efficient development of the maritime sector has been identified in the past.
- The **accelerating transformation of the sector** can be recognised in all sources investigated. It is, therefore, beyond any doubt that the maritime industry is facing significant challenges.
- These changes **will inevitably alter the required skill sets** for both onboard and shore-based jobs and positions. Consequently, effective knowledge maintenance and expertise transfer regarding shipboard operations needs to be assured if the present position of the EU maritime sector is to be maintained

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- The maritime sector comprises highly dynamic industries exposed to numerous external influences. At the same time, it is a highly regulated sector, particularly shipping, at international, regional and national levels.
- Identifying key skills and competencies required to sustain further development of the maritime sector is a demanding task, mostly due to complex interactions among stakeholders and the international nature of the sector.
- Maritime education and training (MET) institutions offering education and training at all levels can generally respond to the industry needs and fill the skill gaps. However, the ability to provide different skills, particularly high-level skills, within the time and quality constraints may vary significantly between institutions and countries.
- Due to the different positions and levels of development of MET institutions in different countries, their uniform response to changes and challenges is not easy to ensure. It will depend on the scope of education required, capacities and expertise available at an institution, and financial incentives provided in each case.
- In almost all EU member states, the university-level study programmes dealing with international shipping and logistics, maritime law and business, and port management (i.e. programmes for the shore-based maritime industry) are identified.
- Thanks to ever-accelerating technological development and the increasing number of high-tech companies that accumulate expertise, the number of education and training providers for dedicated applications is expected to increase significantly, thus changing the institutional position of the traditional MET providers.
- New delivery modes (blended learning, distance learning and similar) are expected to increase their share.
- The number of specialised courses aiming to upgrade or re-skill adult workers associated with the maritime industry and who have already earned degrees is expected to increase in numbers and scope.
- Minimal requirements of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW Convention) does not refer to digital or green skills. Computer literacy is deemed an optional tool (in the Model Courses) to support acquiring core professional skills. The STCW Convention contains only general references to pollution prevention. References mainly deal with the proper handling of onboard equipment; there is no supporting information on the causes and effects of pollution, consequences and environmental protection principles.
- The STCW Convention does not prescribe competencies required for shore jobs at the management level in the maritime industry or competencies needed to manage sophisticated ships. Education for these jobs must include subjects significantly beyond STCW requirements, either as a part of regular education or upgrading courses.

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- Considerable skill gaps are identified in the subject areas: ships operations, maritime economy and law, and transitional and digital skills – practically in areas only marginally included in the STCW Convention and associated Model Courses.
- The most important subject areas dealing with the maritime economy and business, and requiring upskilling, are safety and risk management, ship operations and crew management, and marine operation and maintenance management.
- Substantial technological changes are expected within the next 10 years, requiring seafarers and shore-based personnel to **upgrade existing and adopt new digital skills.**
- Further environmental protection measures are expected within the next 10 years, leading to considerable changes in the mode of operations of all major players and requiring **considerable upskilling of seafarers and shore-based personnel**.
- Removing identified skill gaps requires the development and implementation of numerous measures, ranging from amending existing education and training programmes to introducing new educational and training programmes, methods of delivery and tools, and actions aiming to disseminate and promote new professional standards.

The key future skills of seafarers and expectations from the industry as per the

- Seafarers are expected to be able to analyse data, enabling them to advise the captain and crew on navigation, weather patterns, fuel consumption, and port arrival.
- Seafarers should know **how to interact with the computer systems** to respond to challenges in the operation of autonomous ships, such as knowing specific cultures and laws in specific areas
- Seafarers are expected to be able to help banks and insurance companies to prevent loss, **to estimate energy use, to improve pollution and reduce fuel emissions**.
- It is important **to use digital approach** to enable lifelong learning programmes that enable seafarers to work across industries and services in the maritime shipping sector
- Seafarers need a **flexible, scalable training system**, and it is important that maritime training institutions encourage specialization.
- The interface between seagoing and shore-based jobs should be improved to help seafarers building up transversal competences and skills in the maritime sectors, i.e, software development, technology-based sales, and marketing.

According to the survey, concluded under the SkillSea project the following topics are considered the most valuable to seafarers:

- Regarding digital skills:
  - Data analytics
  - Human/machine interface
- Regarding green skills:

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- Logistics and optimisation methods to achieve high utilisation of ships
- Advanced routeing, considering wind, current, and waves
- Operation of complex hybrid and zero emission machineries
- Calculation and documentation of emissions
- Control centres supporting ships with optimisation services, remote control and autonomy
- Performance management systems

The SkillsSea project has also developed some training materials, that can be utilised by the MariTech Talent Programme users and would be linked in the maritime collaboration node in order to ensure that further dissemination of available trainings and extended access to knowledge is available.

It is clear, that effort has been made towards assessment of the importance of the twin skills. Few reports are reporting the definite need for upskilling of the maritime workers to ensure they meet the changing requirement of the maritime business.

Across the three partnering countries, the maritime VET system is trying to adapt to the global shift towards digitalization, environmental sustainability, and compliance with international maritime safety standards. The European Union's emphasis on the blue economy has further motivated modernizing VET systems, including those in the maritime sector, to better align with industry needs.

However, to detail and further identify the precise skills, needed for the maritime sector, the Maritech project has developed a questionnaire and implemented a survey on the specific training needs among the maritime representatives in Bulgaria, Cyprus and Greece.

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3. Feedback from face-to-face meetings

During one day participatory events in each of the partnering countries, discussions were held with key players from the maritime sector in each country.

The main conclusions and the target audience are presented below:

Cyprus

The workshop in Cyprus took place on the 15th of April in Limassol, in collaboration with the Blue Innovation Centre of the Municipality of Limassol. Stakeholders from both the ship management and the port operation sectors attended the workshop. In-person meeting between CUT and the relevant stakeholders also took place after the workshop, to dive deeper into the needs of the various sectors.

Greece

The **workshop in Greece** was organised under the auspices of the Ministry of Maritime Affairs and Insular Policy of Greece, the Goulandris Natural History Museum, the UN Sustainable Development Solutions Network Global Climate Hub and the Alliance of Excellence for Research and Innovation on Aeiphoria (AE4RIA) aiming to explore pathways to accelerate the Greek Shipping Sector. **Titled "Net-Zero and Climate-Resilient Shipping: Can Greece Lead the Race?"** the event took place on Friday, May 31st, 2024, from **18:00 to 20:30 EEST in Athens, Greece**, at the Goulandris Natural History Museum. The goal of this event was to accelerate the transformation of the Greek Shipping Sector by working with the community of stakeholders to develop ground-breaking innovation with positive economic, social and environmental impacts, while also promoting the contribution of the wider sector to the global Sustainable Development Goals (SDGs).

Bulgaria

15 experts took part in the first day of the workshop in Bulgaria (19th April 2024), representatives of Implementing Agency Maritime administration, State company “Port Infrastructure”, 2 port operators, Naval academy in Varna, Bulgarian Shipowners Association.

In the three meetings discussions were initiated regarding the existing training opportunities for professionals in maritime sector in the three countries. It was a common conclusion, that outside of the formal education (schools and universities), the available trainings are mostly focused on acquiring specific professional skills, that are needed for the everyday work of the employees. However, what is lacking is higher level trainings, focused on the managerial staff bringing new skills related to planning and development of green and digital policies in their companies.

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The challenges for the maritime sector have been discussed and the following main challenges identified for the maritime sector, not only in the partnering countries, but in general for Europe, as most of the participants in the events are part of wider networks and in ongoing discussions on the subject.

- Investments in new technology, such as scrubbers, ballast water treatment systems, and fuel-efficient engines, represent substantial costs, particularly for smaller port operators.
- Transitioning to low-carbon fuels like LNG, hydrogen, ammonia, electricity, and biofuels poses technical and infrastructural challenges, especially with supply chain development.
- The development of autonomous vessels and digitalized port operations promises efficiency but requires significant investment, training, and regulatory adaptation.
- As maritime operations increasingly rely on digital systems, the sector becomes more vulnerable and cybersecurity has become a critical focus;
- Recruiting and retaining skilled workers. With increased automation and digitalization, there is a growing need for training programs to upskill workers in handling new technologies and cyber threats, while the sector is difficult, and the general interest is not so high.

The conclusions from the meetings led us to defining the key questions for the next step of the mapping and needs analysis – the Maritech survey.

4. MARITECH SURVEY

Methodology

The purpose of this study is to investigate the responses to two major questions: What the deficiencies are in the job market within these sectors and if there is a scarcity of green and digital skills in these occupations, which skills should educational and training programmes prioritize.

This study is founded on two parts, the desk and the field research. The first step included narrowing down the maritime value chain by concentration on its core sectors. We conducted a thorough examination of the marine industry, attempting to categorise it into specific sectors using a variety of authoritative sources in the field of maritime studies and industry reports, including the (IMO, 2024; Stopford, 2009; UNCTAD, 2023). We identified 10 sectors as presented

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in Table 1. However, Maritech Talent project partners decided to focus on 5 out of these 10 sectors for the analysis conducted in Task 2.1., namely, (a) Shipping, (b) Ports and terminals, (c) Shipbuilding and ship repair, (d) Maritime logistics and supply chain management, and € Marine technology and equipment.

Table 1 - Sectors within the Maritime Industry

SECTOR	*DESCRIPTION*
Shipping	Including container shipping, bulk shipping (such as oil tankers and dry bulk carriers), and passenger cruise lines, this encompasses the transportation of products and passengers via ships.
Ports and terminals	The port is a critical centre for maritime activities, which include the loading and unloading of cargo, as well as the provision of a variety of services, including warehousing, storage, and logistics.
Shipbuilding and ship repair	Shipyards, naval architects, marine engineers, and associated manufacturing and service providers are all involved in the construction, repair, and maintenance of ships, which are substantial sectors of the maritime industry.
Maritime logistics and supply chain management	This entails the coordination of a variety of activities that are associated with the movement of products via sea routes, such as cargo handling, warehousing, transportation, and distribution.
Marine technology and equipment	The development, manufacturing, and sale of marine apparatus and technology, including navigation systems, communication equipment, propulsion systems, and safety devices, are all included in this sector.
Offshore oil and gas industry	Maritime infrastructure, vessels, and services are essential for offshore exploration, drilling, and production operations in offshore locations.
Fisheries and aquaculture	The maritime sector also includes activities related to fishing, fish farming, and aquaculture, which contribute to the production and distribution of seafood products.
Marine tourism and recreation	This sector encompasses activities such as recreational boating, yachting, sailing, and cruise tourism, which rely on maritime infrastructure and services for leisure and travel purposes.
Maritime law and insurance	Legal and insurance services specific to maritime activities play a crucial role in ensuring compliance, risk management, and financial protection for stakeholders involved in the maritime sector.
Maritime education and training	Institutions and organizations offering education, training, and research related to maritime studies, including maritime law, maritime engineering, naval architecture, and maritime management.

To ascertain the occupations and skills associated with these five sectors, we utilised the ESCO Classification, which is a multilingual classification system that categorises European Skills,

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Competences, and Occupations (European Commission, 2024). ESCO is a component of the Europe 2020 strategy, which is the European plan for intelligent, sustainable, and inclusive economic expansion. The ESCO categorization system defines and categorises skills, competences, and jobs that are relevant for the labour market and education and training in the European Union. ESCO encompasses a total of 3008 professions at Level 0. It is based on the International Standard Classification of professions (ISCO-08), which provides the hierarchical framework for ESCO's occupations pillar. Occupations are categorised into four levels: Level 1, Level 2, Level 3, and Level 4. Each level corresponds to a different number of occupation groups: 10 groups for Level 1, 42 groups for Level 2, 126 groups for Level 3, and 426 groups for Level 4. ESCO's skills pillar offers an extensive inventory of knowledge, skills, and competences that are pertinent to the European labour market. The dataset consists of 13,896 concepts, including 10,831 skills/competences and 3,059 knowledge concepts, organised in a hierarchical framework with four sub-classifications.

A systematic review was performed to map the ESCO Occupations (level 3) onto the five maritime sectors, namely, (a) Shipping, (b) Ports and terminals, (c) Shipbuilding and ship repair, (d) Supply chain management and maritime logistics, (e) Marine technology and equipment. The review led to the identification of 33 occupations. These occupations were then grouped in two categories, "blue-collar" and "white-collar" jobs, with “blue-collar” workers do physically demanding manual tasks in manufacturing, construction, mining, and maintenance and they may work outdoors or operate heavy gear; while “white-collar” professionals may work at desks in clerical, administrative, management, or executive roles. Unlike blue-collar workers, white-collar workers rarely labour physically (Investopedia, 2024).

In ESCO v1.1.2, the skills pillar is organized in a hierarchical structure that consists of four sub-classifications:

- Knowledge
- Language skills and knowledge
- Skills
- Transversal skills

The skills pillar in the ESCO database differentiates between skill/competence concepts and knowledge concepts by specifying the skill type. There is no differentiation between skills and competences. The Skills and Knowledge concepts are categorized into three levels: Level 1, Level 2, and Level 3. Level 1 corresponds to 8 groups of skills and 11 groups of Knowledge Concepts. Level 2 corresponds to 74 groups of skills and 29 groups of Knowledge Concepts. Level 3 corresponds to 296 groups of skills and 86 groups of Knowledge Concepts.

The ESCO system also identifies talents categorised as green to facilitate the transformation of the EU labour market towards a more environmentally sustainable model. In order to address

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the requirement of decreasing emissions in working practices, it has become necessary for workers to possess a skill set that can effectively respond to this demand. As a result, the Skills/Competences pillar has been enhanced by incorporating new information at the skill level, which allows for the differentiation of green skills and knowledge ideas (European Commission, 2022). In order to develop and deploy the net-zero technologies necessary to achieve climate neutrality by 2050, sought to identify the new set of Green Digital Skills that will define the present and future course of action required to skill and upskill individuals within the EU and beyond.

- **Green skills** are defined by the European Centre for the Development of Vocational Training (Cedefop) as "the knowledge, abilities, values, and attitudes required to reside in, foster, and develop a resource-efficient and sustainable society" (Cedefop, 2012). Green skills are the skills required to mitigate environmental impacts and facilitate economic restructuring in order to achieve cleaner, more climate-resilient, and efficient economies that maintain environmental sustainability and offer acceptable work conditions.
- **Digital skills** are a collection of skills that enable individuals to access and manage information through the use of digital devices, communication applications, and networks. They allow individuals to generate and distribute digital content, communicate, collaborate, and resolve issues in order to facilitate effective and innovative learning, work, and social activities (UNESCO, 2018). Entry-level digital skills, which are fundamental functional skills necessary for the basic operation of digital devices and online applications, are widely regarded as a critical element of a new set of literacy skills in the digital era, in addition to traditional reading, writing, and numeracy skills. Higher-level abilities that enable users to leverage digital technologies in transformative and empowering ways, such as the utilisation of artificial intelligence (AI), machine learning, and big data analytics, are located at the advanced spectrum of digital skills (Koundouri et al., 2023).

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Table 2 - Top 15 Green, Digital and Green and Digital Skills/ Knowledge Groups (Level 3). Source: (Koundouri et al., 2023)

Green Skills	Score
handling and disposing of waste and hazardous materials	100.000
environmental sciences	90.000
environmental protection technology	86.667
complying with environmental protection laws and standards	84.444
natural environments and wildlife	80.000
advising on environmental issues	65.517
forestry	62.500
disposing of non-hazardous waste or debris	47.619
monitoring environmental conditions	47.619
electricity and energy	36.905
designing electrical or electronic systems or equipment	35.000
social and behavioural sciences not elsewhere classified	33.333
crop and livestock production	32.143
community sanitation	30.435
handling and disposing of hazardous materials	29.730
Digital Skills	
browsing, searching and filtering digital data	100.000
resolving computer problems	100.000
setting up computer systems	100.000
using word processing, publishing and presentation software	100.000
using computer aided design and drawing tools	100.000
using digital tools for collaboration, content creation and problem solving	100.000
programming computer systems	100.000
working with computers	100.000
computer use	100.000
information and communication technologies not elsewhere classified	100.000
managing, gathering and storing digital data	98.413
software and applications development and analysis	97.436
protecting ict devices	95.833
using digital tools for processing sound and images	93.750
designing ict systems or applications	93.548
Green and Digital Skills	
environmental protection technology	6.667
complying with environmental protection laws and standards	4.444
operating agricultural or forestry equipment	3.846
using precision measuring equipment	3.333
designing electrical or electronic systems or equipment	2.500
monitoring environmental conditions	2.381
computer use	2.381
electricity and energy	2.381
analysing scientific and medical data	1.724
maintaining electrical, electronic and precision equipment	1.563
electronics and automation	1.333
analysing and evaluating information and data	1.220
database and network design and administration	0.935
disposing of non-hazardous waste or debris	0.000
handling and disposing of hazardous materials	0.000

The maritime sector's green and digital skills-gap was identified through the development of an online survey. The survey is divided into four sections. The survey collects data on personal and organizational characteristics, as well as occupations and skills need. It evaluates the presence of these 33 occupations on the payroll, the challenges associated with recruiting employees within

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these groups, and the level of interest in full-time employment within these groups. The top 15 green and digital skills (level 3) identified by Koundouri et al. (2023) were employed to evaluate the most critical Green & Digital skills gaps that should be addressed by educational/training programs in the context of the skills-gap review. In addition, other questions address the frequency with which the skills and training requirements of their employees are reviewed, the vacancies that are currently available, the challenges in replacing vacant positions and the minimum education and training requirements for each occupational group for the above-mentioned occupations. The survey was distributed to 150 stakeholders in Bulgaria, Cyprus and Greece via Survey Hero[5] and it was available between April and June 2024.

Results

Descriptive statistics

Major industry stakeholders, such as associations, government departments, and large shipping firms located in these three countries, were among those who participated in the survey. Their responses gave significant and representative viewpoints on the issues that the sector is currently facing and the requirements that it will have in the future.

A total of 33 respondents were utilised for the analysis after a data cleansing process in which we eliminated respondents with a very low response time, response inconsistencies, and very low variance across the various questions. Table 3 displays the frequency distribution of socio-demographic characteristics of the sample. The frequency distribution of the socio-demographic characteristics of the sample shows that it is sufficiently heterogeneous. The study sample comprised more females (60%), and consequently fewer males (40%). In terms of age, the frequency distribution across the five categories is quite balanced. However, people aged less than 25 were underrepresented (4%). Furthermore, the majority of the respondents hold a master's degree or an MBA (60%), while 32% has a PhD, thus implying an underrepresentation of the lower educated people. Lastly, the majority of respondents are employed in a freelance status or in a position of top or intermediate management.

Table 3 - Frequency distribution of socio-demographic characteristics of the sample.

Highest degree of education	
BSc	8%

[5] https://www.surveyhero.com/c/7pyp3zqf

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MSc/MBA	60%
PhD	32%
Position in the company	
Top Management	28%
Middle Management	36%
Professional	28%
Administrative Staff	8%
Age	
Above 55	16%
Between 46 and 55	28%
Between 36 and 45	36%
Between 26 and 35	16%
Up to 25	4%
Gender	
Male	40%
Female	60%

Table 4 illustrates the organisation information statistics of the survey sample. The heterogeneity of the organisations' profiles is evident in their frequency distribution. The frequency distribution across the five categories is quite balanced in terms of the number of personnel within the organisation, as defined by OECD (2020). Nevertheless, the majority seems to be small and medium-sized enterprises (SMEs) that employ fewer than 250 people (60%), while giant enterprises are well represented (28%). There are 16,5% (weighted average) of employees who are under the age of 30. Additionally, the ports and terminals sectors are over-represented (51,5%), while the Maritime logistics and supply chain (15.2%) and Marine technology and equipment sector (6.1%) is under-represented. This is due to the fact that ports and terminals appear to be more cognisant of the EU legislation regarding green and digital challenges, which has piqued their interest in participating in comparable studies and initiatives. The sample of the survey consisted of a greater number of responses from Bulgaria (50%), compared to 25% and 25% from Greece and Cyprus, respectively. This is probably due to the fact that Bulgarian shipping companies might be smaller or more centralized, facilitating quicker decision-making processes

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regarding survey participation compared to larger, more complex organizations in Greece and Cyprus.

Table 4 - Organisation information statistics, survey results

Number of employees within the organisation	
1-9 persons employed	12%
10-19 persons employed	16%
20-49 persons employed	12%
50-249 persons employed	32%
250 or more persons employed	28%
Sector	
Shipping	27,3%
Ports and Terminals	51,5%
Maritime logistics and supply chain	15,2%
Marine technology and equipment	6,1%
Country	
Bulgaria	50%
Cyprus	25%
Greece	25%
Geographic Market	
National	40,0%
Regional	3,3%
European	23,3%
Global	33,3%
Share of <30 year-old employees	
Less than 10%	52%

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10-25%	28%
25-50%	16%
Over 50%	4%
Existance of ESG report	
Yes	12,5%
No	25,0%
I don't know	62,5%

The majority of respondents (62.5%), consisting primarily of representatives from shipping companies and port authorities, indicated that they are unaware of the existence of an Environmental, Social, and Governance (ESG) report within their organization. This lack of cognizance implies that either ESG reporting is not a common practice within these maritime entities or that such reports are not effectively communicated to employees and stakeholders. It may also indicate a discrepancy in the prioritization of ESG frameworks within the sector, sustainability engagement, or organizational transparency. The potential consequences for organizations operating in national (40%), European (23.3%), and global (33.3%) markets are substantial due to the lack of awareness regarding ESG. Companies that are oblivious of or do not actively engage with ESG reporting may encounter difficulties in securing business opportunities, partnerships, and investments due to the growing regulatory requirements and stakeholder expectations of ESG compliance. This knowledge deficit could impede competitiveness, restrict access to funding, and generate reputational risks in European and global markets, where ESG regulations and sustainability standards are more stringent. Additionally, organizations that neglect to incorporate these practices may encounter challenges in expanding beyond national markets and satisfying the sustainability expectations of international stakeholders as ESG compliance becomes a critical criterion for clients, investors, and regulatory bodies.

Demand for White- and Blue-collar Jobs in the maritime industry

Figure 2 and Figure 3 present the demand for white- and blue-collar jobs respectively. The color-coding is organized as follows. The boxes marked in red indicate that no one selected this option, while the boxes marked in orange indicate that less than 40% of the respondents selected it. The boxes marked in green indicate that more than 40% of the respondents selected this answer. Almost all white- and blue-collar occupations are represented within the respondents' organisations, with the exception of Business Services Managers, which validates the initial desk work mapping of “blue” occupations for the five selected sectors. The open-ended question

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regarding the presence of any additional occupational groups among employees of their organization did not indicate any new occupational group of Level 3.

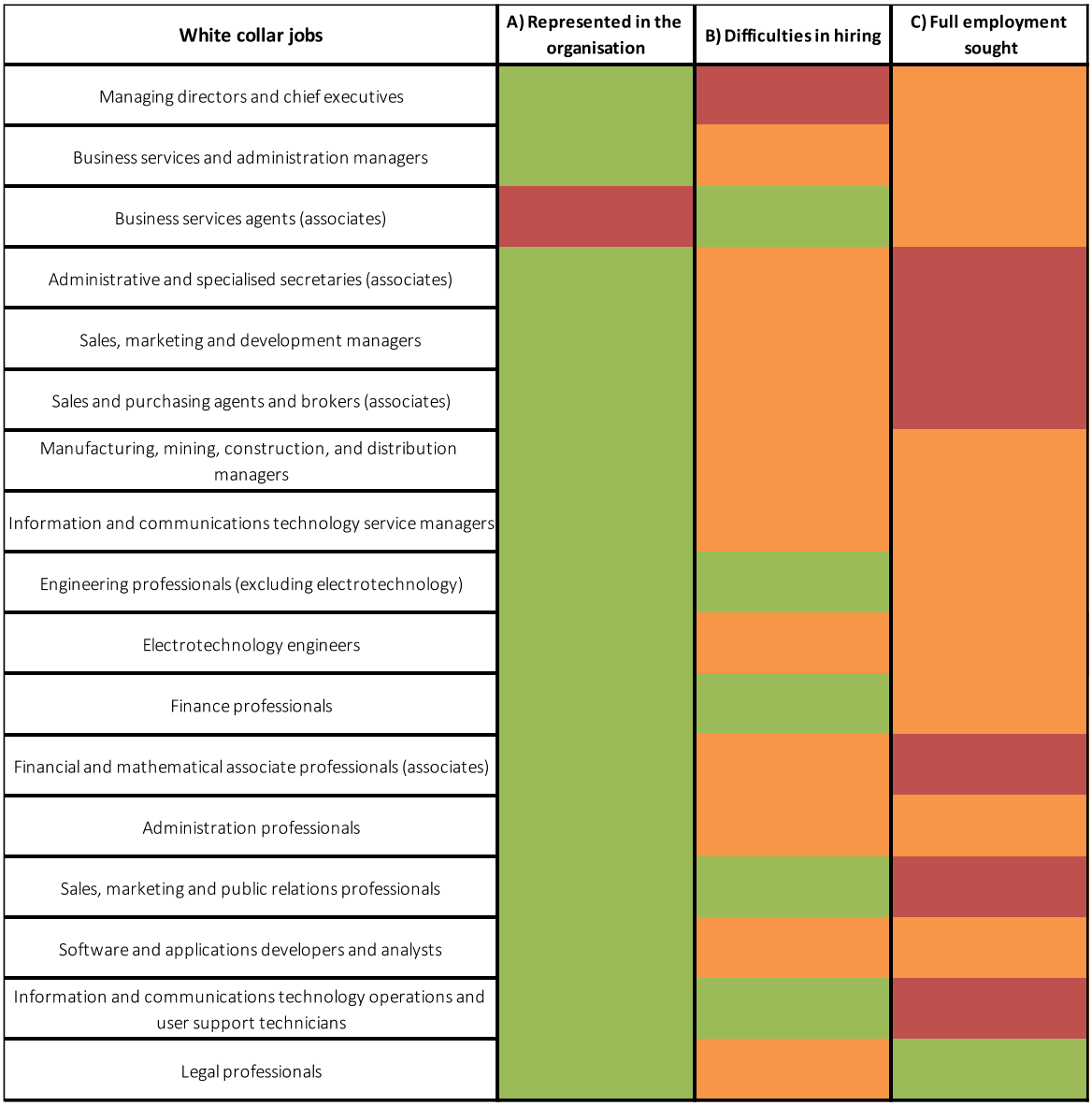

Figure 2 – White-collar jobs demand mapping in the maritime industry (Level 3)

As we can see, some of the occupations seem to be challenging in terms of hiring. This is due to the fact that there are insufficient candidates who are suitable for these positions. It is also evident that certain occupations appear to be difficult to secure full-time employment. For example, the respondents stated that their organisation is not currently seeking full-time employment for "Sales, marketing, and development managers." This implies that they are either

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seeking part-time employment or are not interested in filling a specific position at this time. Nevertheless, the company may encounter certain obstacles, primarily due to the scarcity of this profession in the market, if it intends to fill this position. Thus, these two tables illustrate the professions that are currently in high demand, despite the obstacles they encounter in filling these positions.

Blue collar jobs	A) Represented in the organisation	B) Difficulties in hiring	C) Full employment sought
Physical and engineering science technicians			
Mining, manufacturing and construction supervisors			
Mining and mineral processing plant operators			
Process control technicians			
Ship and aircraft controllers and technicians			
Sheet and structural metal workers, moulders and welders, and related workers			
Blacksmiths, toolmakers and related trades workers			
Machinery mechanics and repairers			
Electrical equipment installers and repairers			
Wood treaters, cabinet-makers and related trades workers			
Metal processing and finishing plant operators			
Rubber, plastic and paper products machine operators			
Ships' deck crews and related workers			
Mining and construction laborer			
Manufacturing laborer			
Transport and storage laborer			

Figure 3 – Blue-collar jobs demand mapping in the maritime industry (Level 3)

The European Centre for the Development of Vocational Training's online tool, CEDEFOP Skills Intelligence, employs labour market data analysis to estimate the future employment prospects

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of Level 1 and Level 2 occupations in the EU27 for the years 2022-2035 (CEDEFOP, 2024). The anticipated employment growth estimates in demand for specific occupations (Level 1) are summarised in Table 5. As we can see, Professionals, Associate Professionals and Managers, as well as Elementary workers are expected to be of high demand in the next ten years in Europe.

Table 5 - Future employment growth (%) by occupations in EU27 in 2022-2035. Source: CEDEFOP.

Occupations	Value
Professionals	**17,68**
Associate professionals	**8,26**
Managers	**3,07**
Elementary workers	**1,38**
Service and sales workers	1
Operators and assemblers	0,75
Trades workers	-4,98
Clerks	-7,05
Farm and related workers	-32,26

The survey developed for Maritech Talent purposes classified maritime professions in two groups. Blue-collar jobs encompass technicians and associate professionals, craft and related trades workers, plant and machine operators and assemblers, and elementary occupations, while white-collar jobs encompass professions from three ESCO Level 1 groups: managers, professionals, and technicians and associate professionals.

Classification of Green and Digital Occupations in the maritime industry

By utilising the setup presented above and the classifications and hierarchies provided by the ESCO API, we have created a framework that categorises occupations according to their level of "Greenness", "Digitalisation", and "Greenness and Digitalisation". We applied the data-driven methodology used in (Koundouri et al., 2023), which is available in **Error! Reference source not found.** and involves the calculation of a score that ranges from 0 to 100. This score is defined as the proportion of green, digital, and jointly green and digital skills and knowledge concepts in each occupation or occupation group. Table 6, which adheres to our methodology, displays the

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classification of the top 15 occupations at Level 3 in accordance with their scores on “Greenness”, "Digitalisation”, and "Greenness and Digitalisation”, individually. In alignment with Table 5, the vast majority of the top green and digital occupations are white-collar and correspond to the ESCO groups 1, 2 and 3. Table 5 - Future employment growth (%) by occupations in EU27 in 2022-2035. Source: CEDEFOP.

Table 6 - Top 15 Green, Digital and Green and Digital Occupations in the maritime industry

Green Occupations	**Blue-/White-Collar Job**	**Score**
Business services and administration managers	White	8,743812
Managing directors and chief executives	White	8,124147
Engineering professionals (excluding electrotechnology)	White	7,335767
Financial and mathematical associate professionals	White	6,91959
Business services agents	White	6,355862
Electrical equipment installers and repairers	Blue	5,040044
Electrotechnology engineers	White	4,972895
Finance professionals	White	4,972895
Machinery mechanics and repairers	Blue	3,766835
Sheet and structural metal workers, moulders and welders, and related workers	Blue	3,545557
Information and communications technology operations and user support technicians	White	3,249207
Metal processing and finishing plant operators	Blue	3,249207
Blacksmiths, toolmakers and related trades workers	Blue	3,018712
Sales, marketing and development managers	White	2,521322
Legal professionals	White	1,234145
Digital Occupations		
Electrotechnology engineers	White	28,1393

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Engineering professionals (excluding electrotechnology)	White	12,30742
Blacksmiths, toolmakers and related trades workers	Blue	8,068908
Electrical equipment installers and repairers	Blue	8,068908
Managing directors and chief executives	White	7,102754
Information and communications technology service managers	White	7,102754
Legal professionals	White	7,102754
Manufacturing, mining, construction, and distribution managers	White	7,102754
Financial and mathematical associate professionals	White	7,102754
Machinery mechanics and repairers	Blue	7,102754
Sales, marketing and public relations professionals	White	6,54191
Electrical equipment installers and repairers	Blue	5,786213
Mining, manufacturing and construction supervisors	Blue	3,891142
Metal processing and finishing plant operators	Blue	3,891142
Process control technicians	Blue	3,679313
Green & Digital Occupations		
Electrotechnology engineers	White	0,252881
Engineering professionals (excluding electrotechnology)	White	0,231481
Information and communications technology service managers	White	0,173913
Business services agents	White	0,059102
Finance professionals	White	0,046083
Financial and mathematical associate professionals	White	0,046082
Managing directors and chief executives	White	0,046081
Sales, marketing and development managers	White	0,04608
Sales, marketing and public relations professionals	White	0,046079

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Software and applications developers and analysts	White	0,046078
Physical and engineering science technicians	Blue	0,046077
Mining, manufacturing and construction supervisors	Blue	0,046076
Manufacturing, mining, construction, and distribution managers	White	0,046075
Process control technicians	Blue	0,046074
Ship and aircraft controllers and technicians	Blue	0,046073

Highest-demand occupations and their corresponding twin skills

The findings of sections 3.2. and 3.3. suggest a statistically significant and unambiguous positive correlation between the demand of occupations and their degree of digitalisation and greenness. Additionally, the demand for digital and green capabilities has increased significantly from 2016 to 2022. Based on the survey results regarding the maritime industry's requirements, Table 7 displays the five most sought-after maritime occupations and their most critical complementary skills.

Table 7 - Top 10 demanded occupations in the maritime industry and their corresponding top skills

Engineering professionals (excluding electrotechnology)	conducting academic or market research	0,044407895
	using computer aided design and drawing tools	0,039802632
	designing industrial materials, systems or products	0,038980263
	analysing business operations	0,037993421
	designing systems and products	0,035032895
Finance professionals	analysing financial and economic data	0,11829653
	providing financial advice	0,087539432
	managing budgets or finances	0,074921136
	monitoring financial and economic resources and activity	0,071766562
	performing risk analysis and management	0,065457413
Sales, marketing and public relations professionals	developing professional relationships or networks	0,067875648
	developing financial, business or marketing plans	0,05492228
	conducting academic or market research	0,039378238
	planning events and programmes	0,034196891
	analysing business operations	0,033678756

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Legal professionals	advising on legal, regulatory or procedural matters	0,135842881
	mediating and resolving disputes	0,085106383
	advocating for individual or community needs	0,06710311
	presenting information in legal proceedings	0,052373159
	protecting privacy and personal data	0,049099836
Physical and engineering science technicians	creating artistic designs or performances	0,098579041
	installing wooden and metal components	0,0477842
	complying with health and safety procedures	0,047591522
	interpreting technical documentation and diagrams	0,041811175
	monitoring quality of products	0,036223507
Information and communications technology operations and user support technicians	protecting ict devices	0,164794007
	managing, gathering and storing digital data	0,112359551
	creating artistic designs or performances	0,08254717
	setting up computer systems	0,059925094
	working with computers	0,056179775
Business services agents	preparing documentation for contracts, applications, or permits	0,042335116
	technical or academic writing	0,04144385
	ensuring compliance with legislation	0,040998217
	communicating with colleagues and clients	0,040552585
	managing budgets or finances	0,038770053
Machinery mechanics and repairers	installing wooden and metal components	0,081980519
	interpreting technical documentation and diagrams	0,068181818
	repairing and installing mechanical equipment	0,0625
	complying with health and safety procedures	0,047077922
	maintaining operational records	0,040584416
Mining and mineral processing plant operators	complying with health and safety procedures	0,078636959
	installing wooden and metal components	0,070773263
	operating mining, drilling and mineral processing machinery	0,070773263
	operating lifting or moving equipment	0,03931848
	maintaining operational records	0,038007864
Transport and storage labourers	loading and unloading goods and, materials	0,075848303
	operating lifting or moving equipment	0,055888224
	moving or lifting materials, equipment, or supplies	0,045908184
	marking materials or objects for identification	0,03992016
	storing goods and materials	0,03992016

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Twin Skills-gap

In the final segment of the survey, participants were asked to identify the skills that are lacking within their organisation and should be the focus of educational/training programs in relation to Green & Digital skills (as defined in ESCO). Table 8 displays the order based on which isolated twin skills are demanded by the industry. As we can see “complying with environmental protection laws and standards”, “environmental protection technology” and “monitoring environmental conditions” are the dominant green and digital skills in the maritime industry as a whole. The shipping industry is a significant contributor to environmental pollution, which includes the discharge of hazardous substances into oceans, oil spills, and carbon emissions. It also poses a threat to marine life by causing disturbances to marine habitats, noise pollution, and the discharge of ballast water. Specialised expertise in environmental protection measures is necessary to adhere to more stringent environmental regulations, including the International Maritime Organization's MARPOL Convention and emission control areas. In order to mitigate environmental impact, the maritime sector is implementing new technologies, including energy-efficient ship designs, alternative fuels, and emission-reducing systems. Additionally, ship operations are being optimised through the implementation of digitalisation and monitoring, necessitating that employees possess both digital and green competencies. The demand for green and digital skills in the shipping sector is being driven by sustainability demands and alignment with global sustainability objectives.

Table 8 - Top 10 Green and Digital Skills for the maritime industry, as revealed by sector experts

1. Complying with environmental protection laws and standards
2. Environmental protection technology
3. Monitoring environmental conditions
4. Electronics and automation
5. Database and network design and administration
6. Designing electrical or electronic systems or equipment
7. Computer use
8. Analysing and evaluating information and data
9. Electricity and energy
10. Maintaining electrical, electronic and precision equipment

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Figure 4 indicates the minimum education required for the 10 most demanded (both white- and blue-collar) jobs. The red boxes denote that no one selected this option, while the orange boxes denote that less than 40% of the respondents selected it. The green boxes denote that this response was selected by more than 40% of the respondents. Advanced degrees are often required for certain professional roles due to their complexity, specialized knowledge, and critical thinking skills. Engineering professionals, such as civil, chemical, and mechanical engineering, require a Master's degree for specialized study in complex areas like systems design, materials science, and project management. Finance professionals, particularly in investment banking, risk management, and economic analysis, often require an MBA or Master's degree in finance, economics, or accounting. Sales, Marketing, and Public Relations professionals often require MBAs or other advanced business degrees for higher-level roles, covering strategic skills like market analysis, consumer behavior, and data-driven decision-making. ICT Operations and User Support Technicians, particularly those involving system design, network security, or data management, increasingly demand specialized MSc degrees in information technology or cybersecurity. Legal professionals, like JDs, LLMs, require advanced degrees for a sophisticated understanding of the law, legal precedents, and courtroom procedures.

However, a bachelor's degree or vocational education and training (VET) degree is typically required for roles such as Physical and Engineering Science Technicians, Mining and Mineral Processing Plant Operators, Machinery Mechanics and Repairers, and Transport and Storage Laborers. These positions require technical skills and specialized knowledge to perform safely and effectively. Physical and Engineering Science Technicians assist engineers and scientists in conducting tests, collecting data, and analyzing results. Mining and Mineral Processing Plant Operators handle heavy machinery, complex equipment, and hazardous materials, requiring training in mining technology, environmental safety, and machinery operations. Machinery Mechanics and Repairers have a detailed understanding of mechanical systems, hydraulics, and electronics, requiring hands-on training and theoretical knowledge for troubleshooting and maintenance. Transport and Storage Laborers manage logistics, organize inventory, and handle materials, often requiring training in forklift operation, warehousing technology, and inventory software.

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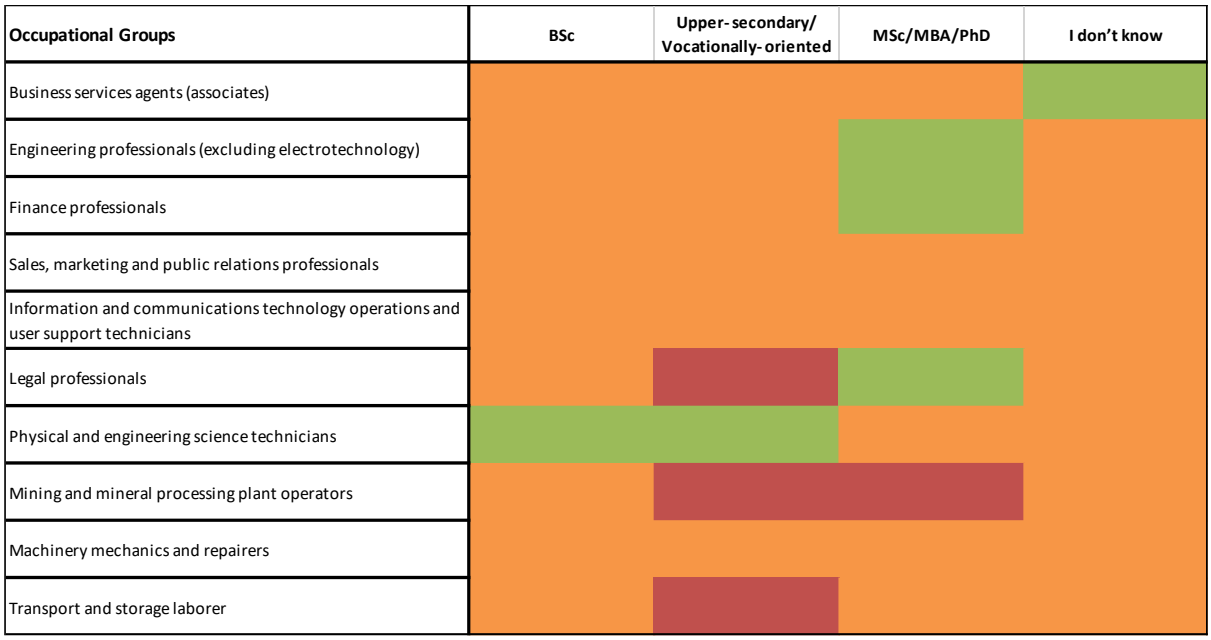

Figure 4 - Minimum education required for the 10 most demanded jobs (Level 3)

The MariTech Talent program is intended to provide a standardised service for green and digital skilling and upskilling that is tailored to the industry's distinctive needs. It also endeavours to make a substantial contribution to the "human-centered and ethical development of digital and industrial technologies" destination. It focusses on the implementation of a systemic approach to the utilisation of technologies in industry and society, with a particular emphasis on the needs of maritime companies and their personnel. This training approach is innovative in that it standardises the development of tandem skills and competencies through technological adoption, thereby promoting the modernisation of the maritime industry.

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Figure 5 - Minimum education demanded for Blue-collar jobs (Level 3)

The MariTech Talent program is designed to offer a standardised service for green and digital skilling and upskilling that is customised to meet the industry's unique requirements. It also aims to make a significant contribution to the "human-centred and ethical development of digital and industrial technologies" destination. It concentrates on the application of a systemic approach to the utilisation of technologies in society and industry, with a particular emphasis on the requirements of maritime companies and their personnel. This training approach is innovative in that it promotes the modernisation of the maritime industry by standardising the development of twin skills and competencies through technological adoption.

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5. Conclusions

The twin transition is a comprehensive strategy for addressing the multifaceted challenges of sustainability, as it seamlessly incorporates digital and ecological initiatives. In addition to the cultivation of a sustainable, resilient future in a variety of sectors, including the critical maritime industry, it is essential for the advancement of the European Union's ambitious climate and energy objectives. The maritime sector is significantly impacted by the Twin Transition, which integrates digital and ecological transformations, as the analysis emphasises.

This is essential for the realisation of more comprehensive sustainability objectives. The maritime sector is a significant contributor to global greenhouse gas emissions, and the adoption of digital technologies and green initiatives is not only beneficial but also indispensable. It is expected that these transformations will lead to substantial changes in the industry's operational landscape, including the integration of renewable energy sources, the development of smart port infrastructures, and the implementation of automated systems for emissions monitoring and route optimisation. The reduction of the environmental impact of maritime activities and the advancement towards the EU's ambitious climate and energy objectives will be contingent upon these modifications.

The objective of this study was to assess the responses to three research questions: Which maritime occupations are in the highest demand, which are the most prominent in terms of digital and green skills, and what is the minimum educational requirement for the most sought-after professions in the maritime industry. The survey revealed that the most in-demand occupations today are Business services agents, Engineering professionals, Finance professionals, Sales, marketing, and public relations professionals, Information and communications technology operations and user support technicians, Legal professionals, Physical and engineering science technicians, Mining and mineral processing plant operators, Machinery mechanics and repairers, and Transport and storage laborers.

Furthermore, this study underscores the importance of confronting the skills deficit in the maritime industry, with a particular focus on digital and green competencies. Personnel that is adequately prepared to navigate the industry's changing requirements is necessary for the integration of these twin transitions into maritime operations. By identifying specific occupations and skill sets that are essential for the sector's adaptation to these changes, the analysis

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emphasizes the necessity of targeted educational and training programs. The top ten demanded occupations in the maritime industry and their corresponding top skills are displayed in *Table 7*.

The maritime industry is facing the complexities of the Twin Transition. This shift is aiming to overhaul traditional operations, promoting advanced, sustainable practices while integrating digital innovation. Equipping the workforce with the necessary competencies is crucial for addressing these demands. A minimum education standard, such as a bachelor's degree for technical roles and advanced degrees for professionals in engineering and finance, ensures employees can understand and adopt these innovations. This aligns with the maritime sector's goal of a sustainable blue economy, prioritizing economic growth, ocean health, and sustainable resource use. Higher education levels prepare the workforce to innovate and lead responsible maritime practices.

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