SKILLS AND COMPETENCE GAPS
PRESENT AND FUTURE

SKILLSEA

This report was developed through the EC-funded Erasmus+ project **SKILLSEA** – Future-proof skills for the maritime transport sector.
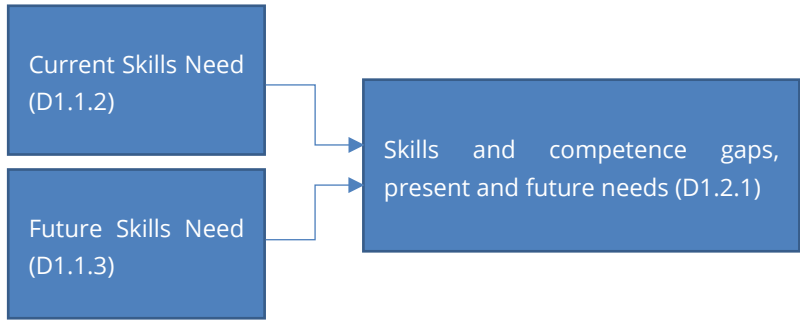
OBJECTIVE

Technology and digitalisation are transforming the shipping industry. 'Smart' ships are coming into service, creating demand for a new generation of competent, highly skilled maritime professionals. Europe is a traditional source of maritime expertise and the four-year SkillSea project was launched with the aim of ensuring that the region's maritime professionals possess key digital, green and soft management skills for the maritime labour market. It seeks to not only produce a sustainable skills strategy for European maritime professionals, but also to increase the attractiveness of the sector, their employability and opportunities to develop into positions that the shipping industry needs. Rather than simply increasing the number of employees/seafarers, it aims to to give seafarers a long-term perspective and thus retain them within the industry.

The project has been developed by the industry's social partners, the European Community Shipowners' Associations (ECSA) and the European Transport Workers' Federation (ETF), and is comprised of a consortium from national maritime authorities, shipping companies, shipowners' associations, maritime trade unions and maritime education providers from 16 countries in Europe.

Key aims and objectives include:

- Analysing the effect of technological developments on the industry's skills requirements
- Matching the industry's skills needs and the existing education and training of maritime professionals
- Overcoming barriers to the mobility of maritime professionals
- Improving cooperation and synergy between education providers, maritime authorities and the industry
- Ensuring that Europe retains world-leading access to maritime skills and experience for improved competitiveness

PROJECT: SkillSea   **PROJECT NO:** 601186

Document information	
Short description	In this report we have reviewed the results from *D1.1.2 Current skills gaps* and *D1.1.3 Future skills gaps*. A comparison of the two results is presented to indicate skills gaps, present and future needs. In this report we also used *Future Skills, Future Report, Current Skills* and *Current Report* to reference these reports.
Work Package	WP1. Skills Need Identification
Workflow	To study the skills gaps, present and future needs, we extract the outcomes from above two tasks – D1.1.2 and D1.1.3. We compare and conclude. Gaps that are found in only the *Current skills gaps* report are likely short-term gaps, those that are found in both reports are medium-term gaps and those that are only found in the *Future skills gaps* report is most likely long-term gaps. In addition, document analysis is included in this task in order to triangulate our comparison and conclusion.
Deliverable	Report D1.2.1
Dissemination level	Public / Project Website
Website link	https://www.skillsea.eu/index.php
Lead authors	A. Oksavik, H.P. Hildre, Y. Pan
Reviewers	L. Ockerman, D. Appleton, A. Linington, Susie Bogojevic-Simonsen, Hanne Bonde Jensen, Damir Zec, M. Johns
Photo credits	Adobe Stock
Submission date	M15
Version	V 8.0

VERSION HISTORY			
VERSION	DATE	EDITOR	SUMMARY OF MODIFICATIONS
V1	21. April 2020	Yushan Pan	First version, based on first versions of D1.1.2 and D1.1.3
V2	02. June 2020	Yushan Pan	Revised following feedback from partners. All partner meeting in Aalesund was cancelled due to Covid-19, rendering feedback digital-only.
V3	11. January 2021	Yushan Pan	Revised according to updated 1.1.3 and additional research
V4	30.September 2021	Max Johns	Revised for readability and comprehension. Aligned with other WP1 reports
V5	23. February 2022	Hans Petter Hildre, Arnfinn Oksavik	Revised and slightly restructured aligning findings of current and future reports. Revised after comments from partners.
V6	April 2023	Arnfinn Oksavik	Added scenarios and revised after comments from external reviewer
V7	June 2023	Alco Weeke, Arnfinn Oksavik, Andrew Linington	Final review and touch up of tables, idexes and consistency throughout
V8	June 2023	Alexander Bakker	Final layout check

CONTENT

FIGURES

TABLES

ABBREVIATIONS

AI	Artificial Intelligence
BRM	Bridge Recource Management
BSc	Bachelor of Science
CEDEFOP	European Centre for the Development of Vocational Training
CRM	Crew Resource Management
DNV	Det Norske Veritas - a class society
DP	Dynamic Positioning
EC	European Comission
ECSA	ECSA
ECTS	Study points
ERM	Engine Room Management
ESCO	European Skills and Competence Organisation
ETF	European Transport Workers Federation
EU	European Union
HEI	Heigher Education Institution
IMO	International Maritime Organisation
IT	Information Technology
LLL	Life Long Learning
LNG	Liquid Natural Gas
MARPOL	Maritime Polution Convention
MBA	Master of Business Administration
MEPC	Marine Environment Protection Committee
MET	Maritime Education and Training
MSc	Master of Science
STCW	Standards of Training, Competence and Watchkeeping
VR	Virtual Reality
WP	Work Packages

1 EXECUTIVE SUMMARY

Through our deliverable D1.1.2, based on a survey of 1,149 seagoing and 474 shore-based professionals in the shipping industries across the EU countries, we surveyed and analysed the present skills needs. We found that the Standards of Training Certification & Watchkeeping (STCW) has been successful in defining and establishing a common standard worldwide and that the shipping industry benefits from such a standard. However, in the current shipping environment, the STCW standard is not delivering up to the industry needs and considerable skills gaps are identified. These are mainly in ship operations; maritime economy and law; and transitional and digital skills – practically in areas only marginally included in the STCW Convention and associated Model Courses.

In our deliverable D1.1.3, through a series of interviews with visionary shipping industry leaders, focus groups and a literature review of reports on future developments, we distilled the future skills and competence needs. We found that the gaps between the present level – denoted the "Baseline" – and future skills and competence needs are growing.
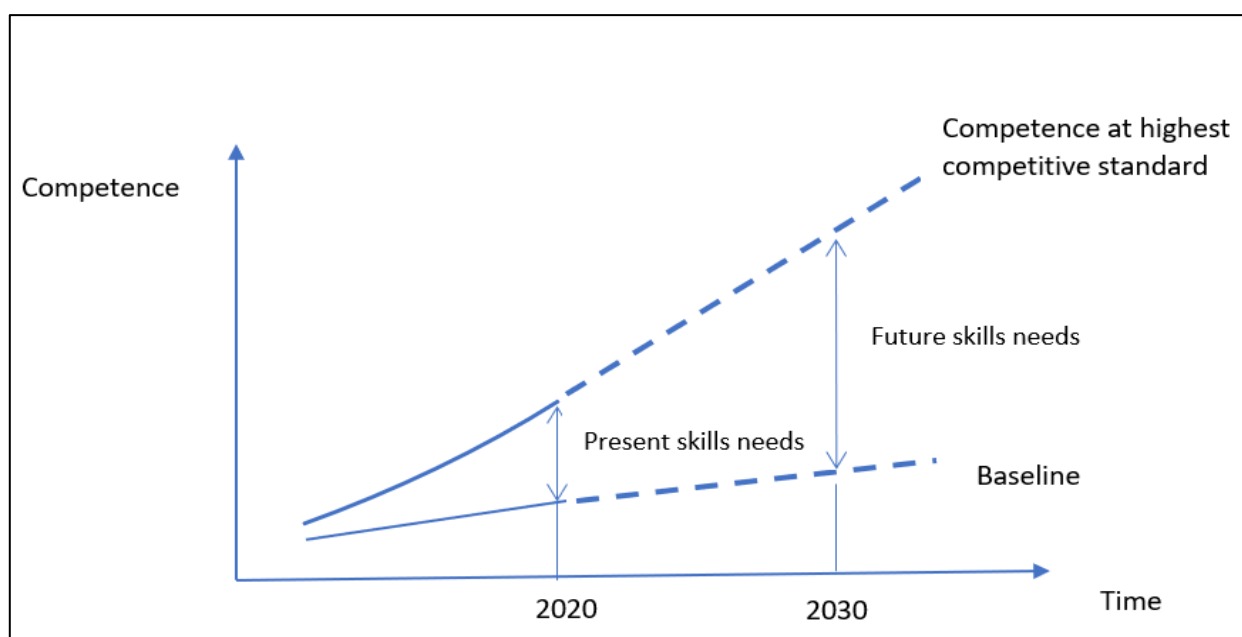

Figure 1: Visualising the gaps found in D1.1.2 Current and D1.1.3 Future skills.

As Figure 1 illustrates, the baseline competence which is the competence requirements established through the STCW Convention, is expected to be under continuing revision[1] and therefore will increase steadily with time. Our findings show a finite gap between this baseline and the present skills needs. This gap is denoted the "Current Skills Gap" or "Present Skills Needs". This is a gap that exists today and is what we have found from our D1.1.2 study.

The competence required to close the **"Present skills need"** gap has been denoted **"On Demand"**, since the need is already being expressed and the competence to close this gap is generally available but is not currently being delivered to this group of shipping industry professionals, for various reasons.

The competence required to close the "Future skills need" gap has been denoted **"Competence at highest competitive standard"** or **"Higher Standard"** and consist of the sum of present and future skills needs, which of course overlap and need to be consolidated.

To arrive at the net skills needs in the shipping industry, we consolidate the outcomes from the reports D1.1.2 and D1.1.3.

The current skills gap has arisen partly since educational requirements (and, thus, **educational programmes**) are slow to change, and have temporarily left seafarers with insufficient competence to handle new technology and new operational modes in the workplace.[2]

The analysis predicts that the gaps will be dynamic due to the rapid digital transformation and technological changes in the shipping industry. On the one hand, such dynamic changes will cause 'gaps' in the maritime training programmes, as experience has shown that the industry is creating new demand through research and innovation faster than regulatory requirements can be adjusted. On the other hand, we have seen that such dynamic changes are treated as opportunities by maritime training providers who are quick to develop training programmes that close the gaps.

In line with this, training courses should be flexible and adaptive, reacting to changes in technology and operation. We conclude that intermediate (short-term) skills needs can be met through additional **On-Demand training,** training that with time may become mandatory minimum in the course of amendments to the STCW Convention.

We conclude that the medium and long-term skills needs can be met through **Higher Standard training, centred around seven key topics:**

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1 Ongoing minor revisions and a possible major amendment which may be expected in 5-10 years is represented in a linear graph for ease of reference.

2 Although the IMO codes and conventions offer an abundance of training requirements and competence goals, only a limited amount are included in the STCW minimum competence requirements
    which METs give during basic education.

- Developing career paths

- Mobility issues

- Communication, culture and language issues

- Core skill sets for ship-to-shore transition: business, economy, law, ship technology

- Skill sets on digital technologies and data analysis

- Transversal skills

- Green skills

1.1 METHODOLOGY

In this report we align and compare the key findings of previous reports D1.1.2 Current Skills Gap and D1.1.3 Future Skills Gap. Skills gaps that are found in both reports are thus confirmed by both the maritime professionals and the shipping industry and as both a need that exists and will persist, perhaps evolving and expanding in the future.

Gaps that are only found in the D1.1.2 Current Skills Gap report may turn out to be temporary and of less importance in the future. Gaps that are only found in the D1.1.3 Future Skills Gap report and do not appear in the Current are the gaps that are not visible yet but will appear due to ongoing trends and developments and will probably need to be solved with a training programme.

Our interviews with visionaries are constituting a "customer discovery" method[3] well suited to identify needs in areas that presently do not exist[4]. Discovery of this type of need is further investigated in WP3: Strategy.

1.2 IDENTIFYING AND RESOLVING THE DIFFERENT GAPS

The purpose of the SkillSea project is to address both the short-term skills gaps and the long-term skills gaps, with emphasis on creating a long-term solution for continuously monitoring and closing the skills gap.

In this report we consolidate the short- and long-term gaps found in the two previous reports.

Future gaps develop mainly due to the demands shaped by changing technology and operational methods, caused by the drivers identified in D1.1.3.

Maritime Education & Training establishments (METs), vocational schools and universities respond to the demands from the shipping industry created by these future gaps, to provide the most appropriate training programmes to reduce the gaps (see Table 1).

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3 The National Science Foundation: Innovation Through Partnerships: Barry W. Johnson https://doi.org/10.1080/08956308.2018.1516929

4 Customer discovery method is a suitable method in developing new products, seeking to target new personas, or entering new markets. In the SkillSea context we are seeking to discover new competence and training programs (products) that the industry will need in the future.

Short-term gap

For example, On-Demand training fills the needs of Dynamic Positioning and Liquefied Natural Gas operational skills. The main purpose is to deliver important competences that the industry demands for safe operations, while simultaneously reducing gaps created by new rules as they become implemented as part of the STCW Convention.

Medium-term gap

There are some skills needs which are not so much tied to safety, but rather more connected to operational and business performance, such as digital, green, and soft management skills. These skills needs, defined as Higher Standard in Table 1, require METs to train maritime professionals to become highly skilled and competent. All generations of active seafarers need to be trained in these skills.

Long-term gap

Finally, the universities need to have a continuous Educational Programme targeting seafarers with vocational education backgrounds, that is seafarers with an education with no ECTS/study credits as per today. These should target traditional educational areas such as management, economics, logistics, mechanical engineering, and computer science, among others. It is of vital importance that transitions from vocational to formal university education programmes leading to a BSc or MSc degree are established if the future needs of the shipping industry is going to be met.

Hence, in this report, we suggest that METs and Higher Education Institutions (HEIs) communicate and collaboratively develop the below gap closing models. The most urgent skills needs are largely identified within the SkillSea project (see Table 1), but not all of these skills can be fulfilled by Higher Standard training. The rest can be delivered by On-Demand courses and through the Educational Programmes.

Model for closing gaps

Below we suggest a model for how gaps can be closed. For columns 3 and partially 2, we anticipate that some form of structured cooperation is necessary to resolve these gaps.

Gap closing models	1) On-demand training (MET)	2) Higher Standard (MET + Higher Education Institutions)	3) Adapted education programmes (Higher Education Institutions)
Type of gap	• Gaps due to new rules & STCW. regulations that are not part of basic education[5] • Customised training required by shipping industry	• Course modules needed to fill shipping industry demand for competent, highly skilled maritime professionals not yet in STCW • Training within shipping professionals' occupation • Transition from ship to shore and between occupational profiles	• Skills needed to enter new careers • Skills needed to change direction of career
Examples of competence	• DP • LNG	Digital, green, and soft management (leadership) skills for the changing maritime labour market	BSc and MSc degrees: • Economics • Business • Law • Technology • Logistics

Table 1: Proposed training model for reducing the gaps between current and future needs.

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5 These gaps were identified by respondents in the D 1.1.2 survey, mainly by seafarers.

2 THE SKILLS GAPS

Through our deliverable D1.1.2, based on a survey of 1,149 seagoing and 474 shore-based professionals in the shipping industries across the EU countries, we surveyed and analysed the present skills needs. We found that STCW has been successful in defining and establishing a common standard worldwide and that the shipping industry benefits from such a standard. In the current shipping environment, the STCW standard is not delivering up to the industry needs and considerable skills gaps are identified. These are mainly in 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.

In our deliverable D1.1.3, through a series of interviews with visionary shipping industry leaders, focus groups and a literature review of reports on future developments, we distilled the future skills and competence needs. We found that the gaps between the present level – denoted the "Baseline" – and future skills and competence needs are growing.

2.1 COMPETENCE VS SKILLS

In the SkillSea application it is indicated that Skills and Competencies are two different capacities for maritime professionals. This is, however, not the case in terms of how the European Skills, Competences, Qualifications and Occupations (ESCO) treats these, and which operates with the following definition[6]:

The ESCO skills pillar distinguishes between i) skill/competence concepts and ii) knowledge concepts by indicating the skill type. There is however no distinction between skills and competences. Each of these concepts comes with one preferred term and a number of non-preferred terms in each of the 27 ESCO languages. Every concept also includes an explanation in the form of description.

In the D1.1.2 Current skills needs report we have adopted a slightly different interpretation where it is stated: "the term *skill* here will be understood as a totality of cognitive, psychomotor and affective abilities required to successfully and within the given time person complete a task. The term *competence* will be understood as defined in the STCW Convention". In other words, the competence term is slightly narrower than the skills term, in which higher-order mental abilities for certain tasks and jobs are included.

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6 https://esco.ec.europa.eu/en/classification/skill_main

2.2 PRESENT SKILLS NEEDS

We have identified seven skill gaps in D1.1.2:

1. Developing career paths

2. Mobility issues

3. Communication, culture and language issues

4. Core skill sets for ship-to-shore transition: business, economy, law, ship technology

5. Skill sets on digital technologies and data analysis

6. Transversal skills

7. Green skills

Below, the measures from D1.1.2 to respond to the identified challenges are proposed for further consideration. These measures are presented in Table 2. In addition, we articulate the measures with possible training models to reduce the gaps.

In line with Table 2, we observed that almost all identified skill gaps could be improved by higher standard training. Below, we articulate the most valuable topics which are expected by the shipping industry.

Developing career paths

Our report *D1.2.2 Identification of mismatches on a structural basis* surveyed study programmes available at European METs and found that 104 study programmes result in a BSc or MSc degree while 260 programmes are vocational and do not result in a degree or earn the student any study points. And here lies the key issue. Traditionally the maritime occupations at sea have been vocational occupations that to a large degree could be trained by on-the-job training. The international minimum requirements for competence (and thus education) were first formalised through the adoption of the IMO STCW Convention in 1978. It has since undergone major updates in 1995 and 2010 and has been hugely successful in establishing a common standard for seafarers worldwide.

With the development of global trades and modern shipping, a large maritime sector and shipping industry have evolved to support seaborne trade and transportation. This industry is increasingly absorbing seafarers into shoreside positions, requiring new competences to be added in the process[7]. The ship-to-shore mobility is necessary to supply the shoreside industry with sufficiently experienced professionals and these professionals need a structured path to make the transition, a transition which they welcome according to our survey.

Mobility issues

Mobility can have a number of interpretations. In our D1.1.2 survey we look at mobility in the context of both the ability to go from sea to land, mobility between different positions and mobility in the context of student exchange.

The sea-to-land mobility is restricted since an estimated three-quarters of the seafarers have a vocational education without European Credit Transfer and Accumulation System (ECTS)/study credits, while the shoreside positions frequently require additional competence and more specialisation which is offered through higher education institutions (leadership, digital, language and communications subjects).

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7 Manuel, M.E. Vocational and academic approaches to maritime education and training (MET): Trends, challenges and opportunities. WMU J Marit Affairs 16, 473–483 (2017)

The need to develop research capacity in addition to specialisation leads to this additional training being conducted at HEIs. This is a key step to be able to hold a higher position such as a manager on the shoreside.

The seagoing leadership culture is inherently a command structure and consists for a large part of giving orders and following up. Ashore, modern leadership has evolved in the direction of coaching, motivation and facilitating to enable people to perform. This transition requires re-skilling.

The same goes for additional cross-functional education, in case a seafarer wants to transition into a different line of occupation ashore, which is almost always the case, since the shoreside occupations are not about sailing itself but about supporting the ships at sea and the related operations.

Communication, culture, and language issues

Shipping is an international industry with a high number of transnational businesses requiring a mix of communication, language and cultural competence among its employees.

Different departments onboard ships – engine, deck and bridge – are often crewed by different cultures, requiring a thorough cultural and language understanding in order to operate safely and efficiently.[8]

To aspire for shore-based positions, good communication skills are key. These are different from shipboard communication. Language skills are a requirement at sea but are dominated by ship operational terms and expressions, specifically to operate the ship safely. Transitioning to land, the language capacity needs to be developed to communicate effectively across departments, cultures and more. Leadership is also different with frequently less hierarchical structures that confuse seafarers.[9]

Maritime economy and business

Skills related to various aspects of the maritime economy and business have been dropped from the regular programmes for educating seafarers, mostly because there is a limited requirement in the STCW Convention. Consequently, numerous MET institutions as well as shipping companies are not considering these subjects as sufficiently important to require inclusion into the programmes. These skills, although highly welcome for onboard positions, are mandatory for positions ashore – particularly for medium and top management in shipping. They represent core professional skills for shore-based management, although the importance of different aspects may vary significantly across different positions.

According to the survey, the following topics are considered the most valuable to both seafarers and shore-based personnel:

- Maritime business and economy
- Safety and risk management
- Ship operations and crew management
- Maritime regulations and port operations

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[8]https://www.maritime.dot.gov/sites/marad.dot.gov/files/docs/resources/3751/crewingreportinternetversioninword-update-janfinal.pdf

[9] https://www.marineinsight.com/life-at-sea/how-not-to-choke-when-making-the-transition-from-ship-to-shore/?fbclid=IwAR1w_cLCl1-z8nSjXSkDe6U8Hl0hoXIdvE-JzC4Z_pMiS-bEE213GDfPntw

Maritime law

Although not all the skills related to various aspects of the maritime law were left out, as in the case of maritime business skills, the lack of skills in this subject area serves as an obstacle to former seafarers in assuming duties in shore-based maritime industries, particularly at the level of medium- and top-level management. The skills in this group are welcomed onboard but are not a mandatory requirement. Contrary to this, for positions at the management level ashore these skills are frequently compulsory. Since many companies employ legal experts, the full scope of such skills is not required for those with shipboard experience.

In that respect, and because of the size of the subject area, a possible upgrading programme for former seafarers needs to cover the subject area in at least several courses, being individually selectable and focused on the main functions of shipping companies or similar ventures (insurance, claims, etc.). The subject area may be partitioned in different ways to reflect the previous knowledge of former seafarers, their work schedules, and selected modes of delivery.

According to the survey, the following topics are considered the most valuable:

- Rights of seafarers and maritime workers
- Insurance
- Claims

While shore-based respondents and seafarers selected the same three maritime law topics as the most important, they believe the following topics are also valuable:

- Collisions
- Carriage of goods by sea

Ship technology

The skills related to ship technologies (particularly the use of different equipment) are the most frequent skills described in the present STCW Convention. However, these skills mostly refer to technologies common on ships trading in mid-1990s, at the time when the first major revision of the STCW Convention had been prepared. [10] Amendments adopted in later years focused mostly on the human element, leadership and management (HELM), and less on new technologies.

Modern ships are being developed, or have already been developed, under the influence of radically different technologies, many of them with extensive built-in Artificial Intelligence (AI) support. Such advancements significantly reduce the opportunities for on-the-job training (learning by doing), a method extensively used in the past to upgrade skill sets. In addition, a certain number of skills will become obsolete. Consequently, these trends should be considered during the next revision of the STCW Convention.

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[10] The work on the next revision of the STCW Convention was expected to start in 2020.

When new technologies are being introduced, upskilling of seafarers looking for jobs ashore through numerous short courses depends on intra-company training programmes and the vessel type that such a company employs. A more helpful approach would be the development of several more extensive courses containing all the additional competencies for certain classes of ships or technologies, having in mind the positions frequently found in shore-based industry (for example, an upskilling course for superintendents[11]). In this case, it would be possible to extend the scope of the courses beyond safety, security and pollution prevention. According to the survey, the following topics are currently considered the most valuable:

- Dynamic positioning operations
- LNG operations.

Although these are Certificates of Proficiency (CoPs) in the STCW, they are not part of the education as they are not in the minimum curriculum and therefore have to be paid for by the seafarer or the shipping company and are consequently missing from many seafarers' competences.

Digital skills

Digital skills required onboard may be divided into two broad groups: skills required to use dedicated software, and skills connected with general information management. The skills belonging to the first category will be required only for seafarers specialised in maintenance of integrated and complex systems and similar high-tech jobs. The skills required for information management will be required by a much larger group of seafarers, practically for all seafarers executing functions at operational and management levels, as well as for those working ashore.

Presently, digital skills are not part of the STCW Convention. However, the majority of active seafarers today already acquire a minimal set of digital skills (mailing, basic spreadsheet and word processing). The level of acquired digital skills is left to each person, and significantly depends on personal inclinations. To improve digital skills among seafarers, but also to recognise skills they have already acquired, a formally recognised set of digital skills and assessment methods (standard of proficiency) should be developed. It may prescribe several levels of proficiency. To ensure effective implementation, the standard of digital proficiency could be included in the STCW Convention.

According to the survey, the following topics are considered the most valuable to seafarers:

- Using a computer to store, search, find and process information using standard programs, send and receive electronic mail, use word processing, and mange files
- Using a broader range of computer capabilities and options, able to create and modify spreadsheets, to create documents using formatting options, to create original drawings or illustrations.
- Shore-based respondents chose the same digital skill topics as seafarers.

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11 The approach proposed is already implemented by the Lloyds Maritime Academy.

Transversal skills

Transversal skills are the skills that may be used in almost any job. Minimal requirements for transversal skills – i.e. skills mostly used onboard – are listed in the STCW Convention. However, these skills are closely related to the jobs carried out onboard. Therefore, it is highly questionable whether these skills are applicable in other situations, apart from those they are designed for. The very low level of transversal skills required by the STCW Convention and associated Model Courses represent only a minimal requirement. Consequently, it could be likely that these subjects will be significantly extended in scope and depth in the forthcoming revision of the Convention.

If compared with lists of commonly accepted transversal skills, it is easy to identify that the programme seafarers are required to attend deals only with a limited set of skills; the majority of transversal skills are not covered. Finally, the subjects required (as they are represented in the respective Model Courses) assume relatively high levels of cognitive skills, clearly beyond the level assumed in the present revision of the STCW Convention. If compared with the key competencies as recommended by the European Parliament, then almost all transversal skills are missing in the STCW Convention. Therefore, it seems that transversal skills of the presently active European seafarers are much more the outcome of primary and secondary education, company-specific training, culture, tradition and personal inclination.

Regarding the transversal skills required for shore-based jobs in the maritime industry, the standard outlined in the STCW Convention appears below the industry's requirements. Consequently, additional opportunities to acquire these skills should be provided. Since such skills are useful in all situations and in all jobs, development of an appropriate set of training programmes and tools is recommended. The programmes and tools should be developed with the industry needs in mind.

According to the survey, the following topics are considered the most valuable to seafarers:

- Teamwork and leadership

- English language

- Oral communication

- Aural communications

Shore-based personnel chose the same four topics but also have more expectations:

- Ability to use standard office software

- Understanding corporate culture

- Knowledge of internal procedures

- Ability to effectively write technical reports and similar documents

- Entrepreneurship

Green skills. According to **the European Centre for the Development of Vocational Training (**CEDEFOP)[12], "Developing a low-carbon economy depends [more] on improving existing skills rather than specialised green skills."

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12 According to CEDEFOP 2014, Europe, green skills are "Abilities needed to live in, develop and support a society which aims to reduce the negative impact of human activity on the environment."

Terminology of European education and training policy (2014)

As in other industries, green skills in shipping are based much more on attitudes than on knowledge. However, attitudes, especially in case of professionals, can be more easily imparted if argumentation is clearly based on facts and through the understanding of the causes and effects.

In that respect, the present approach used in the STCW Convention is of limited use because for most subject areas only the lower-level knowledge skills are required. Even for the professional subjects, the required knowledge, understanding and proficiency is limited to what is required for safe operations of the ship.

Therefore, the main causes and effects of processes taking place in sea transport and influencing the environment should be clearly explained both to shipboard and shore-based personnel. This can be done through several different activities, ranging from printed materials, videos, and social media up to short courses to be introduced in the next revision of the STCW Convention, either in STCW Code A or B.

It is, however, important that the management level onboard is aware of current environmental legislation, company strategies and their translation into operations. It is a good example of where ship- and shore-based management need to work closely together. Respective training courses are suggested in WP2.

2.3 FUTURE SKILLS NEEDS

In this section, we present a summary of future skills needs based on our previous study D1.1.3. Here, we saw that the future skills needs require creative learning (know-how knowledge). That means seafarers are able to conduct analytical work, including planning, decision-making, information interpretation, and knowledge representation.

In this manner, foreseeing future skills is not the same as manpower planning. However, foreseeing the future requires examination of the ways in which labour markets are developing and consequently, how jobs, skills and learning are changing. We need a flexible, scalable training system, and it is important that maritime training institutions encourage specialisation.

- Establish instructors' capability to be able to update training programmes and to shape a strong interdisciplinary environment.

- Establishing effective transfer schemes between academies and companies to address mobility and culture issues.

- Develop digital skills to extend the value chain in the shipping industry, such as using IoT, blockchain, big data to work on logistics

As a consequence of the changes described in D1.1.3, the following skills and competences and capabilities will then be needed:

1. Environmental skills

   – 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

2. Collaborative skills (cluster)

3. Digitalisation skills

   – Data analytics

   – Human/machine interface

4. Innovation skills

   – Product development

   – Intrapreneurship

5. Sea-land mobility skills

   – Soft skills whereunder for example leadership

The basis for maritime education will remain the minimum requirements of the STCW Convention which have given the maritime industry a uniquely global basis and have allowed seafarers from around the world full access to career opportunities and enabled them to thrive.

We now suggest that a module course package is added in between current training and future developments, such as digital skills, green skills, leadership, etc. For specialisations in present occupations, each country could develop module courses that fit the context of their countries in various formats, such as degree-oriented (i.e., BSc or MSc) and non-degree-oriented training (i.e., certificates).

This would establish an opportunity to build up new knowledge for maritime training without intervening in the STCW Convention but to respect worldwide trends in digitalisation, sustainability, collaboration of clusters, education and training. In such a module course package, we suggest new courses to fulfil the industry's needs, such as digital, language, and social literacy, as well as ship finance, law, insurance and management competence.

In terms of digital skills, we suggest utilising simulator-based practical and hands-on learning as a means to support the development of future skill sets, as this has proved to greatly facilitate effective learning[13], considering the relatively large gap of skills that has to be closed.

For cross-functional skills and soft skills, such training paths beyond STCW can enhance career options for seafarers and keep them within the scope of the maritime industry for longer.

In line with Table 2, we observed that almost all identified skill gaps could be improved by higher standard training. As this is a highly dynamic environment, some of the training courses will become standardised and may even become part of STCW, while others will have a more ephemeral existence.

There is generally a demand for specialised technology and equipment in the maritime industry to achieve improved efficiency at sea, as well as to address new operational limitations and ambitious goals due to recent environment regulations. Thus, the need for **environmental skills**. The CO_2 reduction targets cannot be achieved by one single technology. A range of technologies and methods must be improved, such as logistics, hydrodynamics, machinery, fuel, and energy sources, as well as systems for effective harbour operations. The technology shifts with respect to energy systems and operational challenges are more significant than ever before. These challenges are opportunities for seafarers to gain Higher Standard competence. As our interview studies revealed, the industry will also benefit from personnel possessing competencies outside of the current scope.

Isolated ideas will not bring about change and advancement. In D1.1.3 we have shown that collaborative structures such as maritime clusters can enhance developments and benefit the whole value chain. **Collaborative skills** will become essential to bring industry partners together and understand the various pieces of the puzzle.

Digital transformation and distributed technologies are changing our societies and the maritime business. The gap between common practice, competence, and future opportunities is observed to be growing. For example, connectivity, IoT, common broker platforms, and e-commerce will simplify and secure the supply chain and reduce the amount of paperwork in the value chain. Technological advances offer the possibility to make the business process seamless and potentially eliminate transaction costs. **Digitalisation skills** supporting business development taking advantage of technology will be important. The technology will offer the possibility for a high degree of optimisation of operations from ship control centres in the ship owner's office ashore. Work tasks will increasingly be transferred from ship to shore-based control centres. As our interviews revealed, advanced digital competence in analytics and use of data in optimisation of the fleet will be needed.

Seafarers have, for decades, contributed operational maritime experience and knowledge to companies in the maritime sector and have helped to realise much innovation potential. Seafarers can give concrete innovation suggestions to shipping, ship designers and equipment manufacturers, finance and port operations, as well as to researchers who seek to understand the challenges facing specific maritime innovations and become closely intertwined with product and service development or become part of the intrapreneurial process. Close interaction between users and researchers provides a faster and more precise path to new technology and solutions. Establishing a habit and a process for such close cooperation is key to delivering successful innovation in maritime clusters.

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13 Chernikova, O., Heitzmann, N., Stadler, M., Holzberger, D., Seidel, T., & Fischer, F. (2020). Simulation-Based Learning in Higher Education: A Meta-Analysis. Review of Educational Research, 90(4), 499–
541. https://doi.org/10.3102/0034654320933544

Thus, seafarers must also be trained to move from one value chain to another and, thereby, contribute to innovation. Such transversal skills for seagoing positions are also of vital importance to allow smooth transition to other positions in the maritime industry.

Maritime is an equipment-intensive industry, and this equipment needs competent employees during development and use. To support new programmes in seafarers' training, the collaboration between the business community and research-based universities should explore new methods and new technology. Most skills required in the future, as our interviewees forecasted, are beyond the scope of current training courses and cover areas such as: advanced data analysis; operational economics; future onboard power and energy production; developing and using statistics; and risk analysis. It will be essential for seafarers to develop **sea-land mobility skill**s in order to participate in the dynamic developments of the industry. This requires educators to establish suitable lifelong learning programmes that enable seafarers to work across industries and services in the maritime shipping sector and understand various parts of the value chain.

A key factor for the successful career development of seafarers is the implementation of and training of transversal skills such as creative thinking, time management and problem solving, Understanding corporate culture, knowledge of internal procedures, written communication skills (technical reports, et al) and many others. Seafarers onboard ships work in a structured hierarchy in which higher ranks have authority over lower ranks and, for a large part, the ship's crew is confined to staying together 24 hours a day. The ship's voyage and the maritime environment serve as strong common motivators to accomplishing tasks or facing collective wrath. Transitioning to shore means working in looser hierarchies, and leadership competence, such as motivating team members, becomes more prominent, as well as only being available during work hours.

2.4 CONSOLIDATING CURRENT AND FUTURE SKILLS GAPS

We see that the gaps consolidated above are resolved through a 'Higher standard' training programme. The measures arising from the D1.1.3 Future skills needs report should be further elaborated in the process of developing the Higher Standard training programmes

*Table 2: **The identified skills gaps with measures and training models to respond to the identified challenges.***

Challenges	Gaps from the Current skills survey (D1.1.2)	Gaps from Future skills report (D1.1.3)	Measures for future (extracts from D1.1.2 & D1.1.3)	Training model
Developing career paths (shortage of maritime professionals)	Restricted ship-to-shore mobility Educational restrictions Public image of the profession	Lack of qualified maritime professionals Difficulty to attract and educate talents (few highly educated maritime professionals)	• Coordinated action (at EU level) should be initiated by strategy plan WP3, aiming to change public perception of the maritime industry, particularly in respect of seafarers • Study programmes offered by MET institutions should include topics/courses covering subjects beyond and above STCW requirements • MET institutions should be encouraged by strategy plan WP3 and implementation WP5 to increase a number and scope of study programmes aiming to upskill seafarers • Maritime industry should cooperate more closely with maritime administrations and MET institutions to provide trainees with more opportunities for practical training. This should be planned and implemented in WP3 and WP5 • An EU alliance of MET institutions should be proposed to promote harmonised workforce	Higher standard

			education for the EU maritime industry, both onboard and ashore	
Mobility issues	Resistance to relocate Labour competition Inadequate communication	Need seafarers to work in multidisciplinary areas Limitation qualified seafarers Need professionals skilled in digitalisation	• Courses aiming to upgrade or re-skill shore workers associated with the maritime industry should be promoted by strategy plan WP3 and Toolkit WP2 • Student exchange between MET institutions across the EU should be further promoted by strategy plan WP3 to ensure appropriate understanding of different cultures • Academic staff exchange should be further promoted to accelerate update and harmonisation of study programmes among different institutions. They should be encouraged to gain ability in use of new teaching methods to upskill workforce, i.e., e-learning platforms. This should be promoted by WP2, new courses for teachers	Higher standard
Communication, culture and language issues	Inadequate Communication Cultural differences Language	Ship-based leadership skills need to be transferred to shore-based jobs	• Courses aiming to upgrade seafarers' communication and language skills should be promoted by new courses in WP2 • EU-wide standards of proficiency in language skills for people working in the maritime industry should be considered and strategically planned by WP3 • EU-wide programmes of measures aiming to increase cultural awareness should be considered by both WP3 and WP5	Higher standard

			• Courses aiming to upgrade management and leadership skills should be developed and promoted by WP2	

	Deficiency in core competencies and competencies concerning maritime economy, business, law and ship technology	Need people with core competencies concerning maritime economy, law and ship technology	• The maritime industry should cooperate more closely with maritime administrations and MET institutions to provide trainees with more opportunities for practical training • Courses aiming to upgrade knowledge and skills of maritime industry workforce should focus on linking up the interactions between seagoing positions and land-based occupations, covered by WP2. Courses should be modular and flexible in terms of duration, scope and delivery. Degrees awarded should be comparable and based on the ECTS system • Courses aiming to upgrade the management skills of former seafarers and shore-based staff should be developed and promoted • Courses aiming to upskill seafarers in the use of integrated and complex systems should be developed and promoted • Courses aiming to upskill seafarers' analytical skills should be developed and promoted	Higher standard
Skill sets on digital technology and data analysis				

Core skillsets between	**Deficiency in the use of analytical tools**	Seafarers and maritime professionals need to use new	• Courses that upskill seafarers in the use of standard software tools should be developed and promoted **in WP2.** They should be in accordance with the standard	Higher standard

	Deficiency in dedicated software	technologies/methods to support operational modes Need people to use integrated systems with analytical skills, data representation, and computing skills	EU set of skills (DigComp 2.0), as planned by strategy WP3 • Courses aiming to up-skill shore-based personnel using analytical software tools should be developed and promoted • Skills in maritime information and control systems should be developed and promoted in new developed courses by WP2 • Courses aiming to upskill seafarers in remote monitoring, surveillance and control technologies should be developed and promoted in WP2 • Courses aiming to upgrade shore-based employees' skills in maritime information and control systems should be developed and promoted • Courses aiming to upskill seafarers in the use of new technologies/methods to support operational modes should be developed and promoted in new courses delivered by WP2, i.e., VR, simulators, etc • Courses aiming to upskill seafarers in data analysis and computing skills should be developed and promoted by new courses delivered by WP2 for both teachers and students	
Transversal skill	**Inappropriate attitude regarding constant upskilling**	Need maritime professionals to integrate with existing workforce	• Courses aiming to upskill seafarers in human element, leadership and management skills beyond those already outlined in the STCW Convention should be developed and promoted **by WP2**	Higher standard

	Inability to communicate constructively in different environments		• EU-wide measures aiming to promote "learning to learn" attitudes should be promoted **in strategic plan WP3 and implementation WP5** • Courses aiming to widen seafarers' skills in collaboration with land-based personnel **should be developed and promoted by WP2**	
Green skills	Need to protect environment is vaguely part of IMO STCW and concretely part of MARPOL Knowledge of competencies needed to properly use tools and follow procedures ensuring appropriate environment protection is not seen as important	Need maritime professionals to understand why and know how to use high-tech equipment and integrated systems to protect environment	• EU-wide measures aiming to increase environmental awareness and shore-based staff employed in the maritime industry should be considered in strategy plan in WP3 • Courses aiming to upskill seafarers in procedures and proper use of tools to ensure appropriate environmental protection should be developed and promoted in WP2	Higher standard

2.5 FINDINGS IN CURRENT VS FUTURE SKILLS REPORTS

In the Current report, regarding **Developing career paths,** seafarers are pointing at restricted ship-to-shore mobility, and lack of Life-Long Learning (LLL) programmes targeting seafarers. These are not apparent in the same form in the Future report but rather as an effect of this, that the industry is reporting a shortage of qualified seafarers. These are obviously two sides to the same problem and show that the both the supply side and the demand side are aware of the issue and can therefore be prepared to do something about it.

Regarding **mobility issues,** the Future report sees more need for seafaring competence, digital and cultural competence ashore than is available in the maritime labour market. For the seafarers in the Current survey this need is apparently not visible. This could mean that creating programmes to promote this transition and enable upskilling would be welcome among seafarers.

Communication, cultural and language issues are seen as isolated issues by seafarers in the Current survey while in they are seen in the Future investigation literature and by visionaries as a leadership challenge, where the hierarchical nature of the ship's chain of command culture needs to transition to the modern leadership style ashore. An attempt to solve this was made through the IMO STCW 2010 upgrade, where all seafarers had to undergo additional Bridge, Engineroom and Crew Resource Management (BRM/ERM/CRM) training. Clearly it only partially worked, and more is required for the ships' officers to make the transition,

Regarding **Core skill sets between sea to land transition**, Current and Future reports come to the same conclusion that more of everything is needed. More maritime economy, business, law and ship technology is needed. This is not to say that there is a need for seafarers to become lawyers, complete MBAs or engineering degrees. It is more an expression of a frustration of not being capable on a number of areas that are interacting with shipping operations and officers on ships. A good start to solve this could be to include the value chain in basic education instead of keeping it as only a sea-journey. By adding logistics and contractual issues to the training programmes, including simulator training, complete business cases can be trained at basic education and thus become part of seafarer's competence.

Skill sets on digital technologies and data analysis. These skills and competencies are starting to emerge as an inadequacy in the Current survey, not in an advanced form, but rather as basic IT literacy. While in the Future report, in the literature and among the visionaries, it is seen as a clear need that has to be handled and the need will only grow as shipping embraces more technology.

Transversal skills are seen by seafarers in the Current survey related more strongly to furthering their career at sea, as efficient collaboration is essential for both safety and operational performance of the ship. To some degree it is also pointed at in the literature and by the visionaries in the Future report, but more to the effect of achieving good teamwork and seafarers being able to integrate with the shoreside staff.

Green skills are pointed at by the seafarers in the Current report in the form of duties and obligations related to the ship officer role, while the Future report highlight the transition to zero emission that is coming and requiring a lot of new green skills. Here there is quite a distance between what the seafarers see as necessary and what the industry wants.

3 SCENARIOS FOR SKILLS TOWARDS 2035 & 2050

3.1 INTRODUCTION

This chapter uses a scenario planning methodology that is primarily qualitative. By sampling key research reports on the future development of the maritime sector, and in particular the labour market, we construct scenarios about the future.

Scenarios are alternative descriptions of the future. Good scenarios are sufficiently connected to reality and the development paths are justified with demographic data, starting points and developments that are suitably interconnected.

It is not to be expected that any of the scenarios come true. As stated by Lloyds:[14] "They are not predictions, preferences, or forecasts. Rather, the process of developing and using scenarios is intended to help us learn and generate insights, both from exploring each scenario individually and from comparing and contrasting them."

It is likely that scenarios can promote learning and support decision-making for both individuals and organisations. As a supporting method for developing strategies, scenarios can improve understanding of development trends and challenge conventional thinking and business-as-usual planning.

Scenarios also serve to highlight complex mechanisms and reduce uncertainty by understanding better how various changes affect each other. By visualising possible futures, it becomes more possible to accept actions today that seem premature or altogether unnecessary.

We look at scenarios, which in this context, the medium term is 2035, and long term is 2050.

We use the following steps to develop future scenarios [1,15]:

1. Formulating the central questions defining the purpose of the investigation
2. Identifying drivers and hypothesis
3. Determining key uncertainties
4. Constructing scenario frameworks
5. Developing scenario stories
6. Test hypotheses and analyse data

3.2 FORMULATING THE CENTRAL QUESTIONS DEFINING THE PURPOSE OF THE INVESTIGATION

What will be the core/key shipping industry skills and competence needs in 2035 and 2050?

What are the key skills that maritime professionals must have in the future?

Which occupational profiles will there be less demand for, and which will be in higher demand?

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14 Global Marine Trends 2030 - https://www.lr.org/en/insights/global-marine-trends-2030/

15 Scenario Based Strategy; Paul de Ruijter, Tailor & Francis Ltd, ISBN 9781472437174, 2014

3.3 IDENTIFYING DRIVERS AND HYPOTHESES

The future cannot be known with absolute certainty. One general principle is to use multiple reasoning methods to explore different views of the future. We have, in report D1.1.3 Future Skill Needs, combined literature review, technology forecasting, trend studies, case studies, semi-structured interviews, and focus groups to gain better insight. The finding is also summarised earlier in this report.

In the report Future Skills Needs, we have reviewed the outlook in the literature and reports from key shipping businesses and captured insights from visionaries within the industry to establish a solid impression of the future needs of maritime shipping. Through this work, the resulting report places maritime professionals [16] firmly in the 21st century. The results forecast future skills and competence needs originating from the key trends that are shaping the future.

Our major hypothesis is that the following two trends will change the shipping industry and require new skills:

- **Digitalisation and smart shipping**

- **Sustainable shipping, towards zero emissions**

Our second hypothesis is that increased attractiveness is necessary to:

- **Recruit young talents for a career in the shipping industry**

- **Deliver candidates with better education to be attractive for European shipowners**

Sustainability and digitalisation are global trends that are transforming our society. The key question is how they will affect the maritime business, how fast, and what skills are needed to master this future.

The IMO has reached an agreement on a strategy for the reduction of CO_2 emissions from shipping. Its Marine Environment Protection Committee [17] (MEPC) announced that member state delegates have agreed on a target to cut the shipping sector's overall CO_2 output by 50% by 2050, to begin emissions reductions as soon as possible, and to pursue efforts to phase out carbon emissions entirely. The agreement includes a reference to bringing shipping in line with the Paris Climate Agreement's temperature goal, which seeks to limit global warming to below two degrees Celsius.

Many alternative fuel technologies are available for reducing the CO_2 emissions of shipping. For alternative fuels and power sources, the technical applicability and commercial viability will vary greatly for different ship types and trades, where deepsea vessels have fewer options compared with the shortsea segment. It is important to find technically feasible and cost-effective solutions for the deepsea segment, accounting for more than 80% of world fleet CO_2 emissions. Currently, the only technically applicable alternatives for this are liquefied natural gas (LNG) and sustainable advanced biofuels. Key sources have also defined scenarios within both digitalisation and sustainability. For example, DNV made 30 future scenarios of the energy transition in the report Maritime Forecast to 2050[18].

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16 We mix use of the terms maritime professional and seafarer with the purpose of clarifying the scoped occupational profiles in this report, including both sea and land. Unless otherwise noted, maritime professionals refer to both seagoing and shore-based jobs.

17 http://www.imo.org/en/KnowledgeCentre/IndexofIMOResolutions/Marine-Environment-Protection-Committee-%28MEPC%29/Pages/default.aspx

18 MARITIME FORECAST TO 2050 Energy Transition Outlook 2020

Seafaring is an age-old employment generating sector, and as international trade has grown it has evolved into globalisation and this has favoured collaboration in the form of clusters. The clusters enabled increased recruitment of professionals and semi-skilled resources from different countries around the world. Maritime clusters with a variety of job opportunities and career paths to new occupations are a key to talent attractiveness. A key finding from the expert group, see D1.1.3 Future Skill Needs, is the importance of transversal skills within future maritime competences. These skills are vital to move from one value chain to another. Lifelong learning programmes are needed to enable seafarers to work across industries and services in the maritime shipping sector. Mobility and possibilities to enter a variety of occupations are needed to attract young talents.

Attractiveness is also a key for European shipowners and the industrial cluster. We must educate highly skilled maritime professionals and offer continuous education programmes.

3.4 DETERMINING KEY UNCERTAINTIES

Digitalisation and smart shipping

The major uncertainties are how fast the maritime industry adopts to advanced digital solutions and the consequence of such implementations.

- Development and implementation of autonomous functions is particularly hard to predict.

- Increased connectivity opens the potential for increased use of remote support. The consequence is uncertainties in manning, roles, and occupational profiles.

Sustainable shipping, towards zero emissions

The major uncertainty is the rate of change in shipping with respect to new fuels. How fast must the shipping industry adapt to zero emissions? Will it be acceptable to not reach the IMO emission target of 50%? Is the IMO emission target acceptable or do we need stricter requirements?

Attractiveness

Are we able to attract young talent into the shipping industry career based on the suggestions of the SkillSea project?

Will the industry hire European talent with improved/higher education, as suggested in the SkillSea project, in favour of professionals with minimum certificate competence?

3.5 CONSTRUCTING SCENARIO FRAMEWORKS

Our major hypotheses were that the trends 1) Digitalisation and smart shipping and 2) Sustainable shipping toward zero emissions will change the shipping industry and require new skills. We will therefore set up scenarios for each of these trends.

Our second hypothesis was the need for increased attractiveness. Attractiveness is necessary to recruit talent into shipping industry careers and improved education is necessary for candidates to be attractive for European shipowners. We will therefore set up scenarios for attractiveness.

The key trends are mostly independent of each other, and we therefore set up scenarios for each trend and combine trends as a part of the analyses (step 6). The trends are global and generic. The key uncertainty is to what degree these trends will affect the maritime industry, when, and what new skills and occupations are needed to be competitive. We will then make three scenario stories for each trend to define and visualise the level of impact on the maritime industry and skills needed.
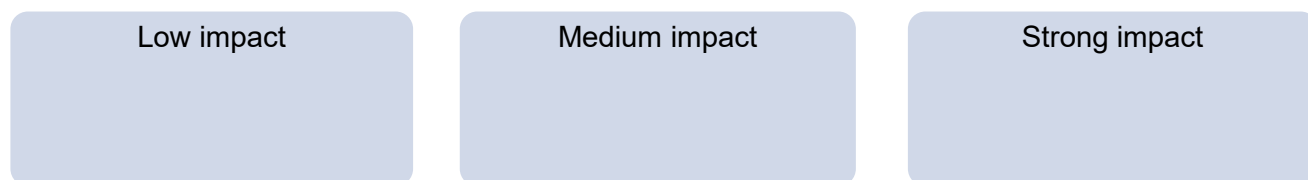
Low impact	Medium impact	Strong impact

Figure 2: Three scenarios with increasing impact for a trend

Each scenario is written with respect to views, the level of the trend impact and implication for skills.

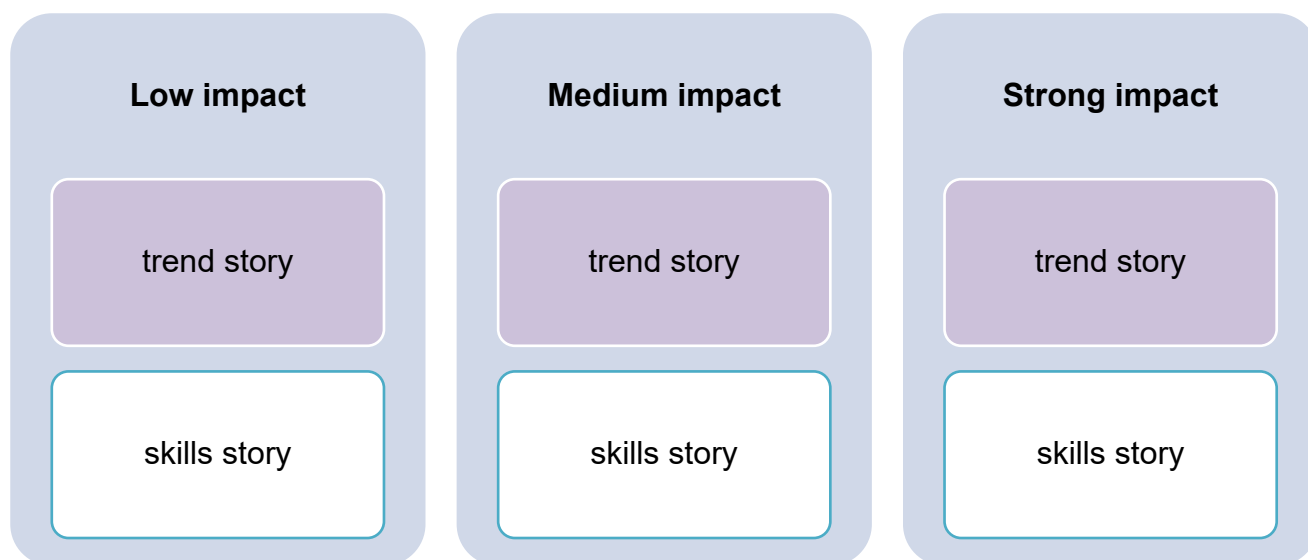| Low impact	Medium impact	Strong impact
trend story	trend story	trend story
skills story	skills story	skills story

Figure 3: Scenarios with increasing trend impact described as a trend story and impact on skills

We will then test the hypotheses with respect of impact in 2030 and 2050.

3.6 DEVELOPING SCENARIO STORIES

3.6.1 Three scenarios for the trends of digitalisation and smart shipping

Low impact	Medium impact	Strong impact
The digital systems onboard will not change significantly. Communication with ship owner and other organisations will remain as at present.	**Ships will be smarter, data driven, connected to the rest of world.** Autonomy will not play an important role.	**Remote support and autonomy will transform the maritime business.**
The IMO minimum requirement is sufficient.	Seafarers become system managers. In-depth skills to understand complex systems, onboard and onshore, are needed to be able to serve the necessary redundancy of all systems. In-depth skills to understand complex systems, onboard and onshore, are needed to be able to serve the required redundancy of all systems. Skills to update, service and repair digital systems are also needed. Seafarers should know how to interact with the computer systems to respond to challenges in the operation of automatic systems, such as when routes are changed, or ships are in hazardous waters.	Distributed maritime capabilities where knowledge and competence increasingly rely on technology, procedures and regulations will change the role of the individual seafarers. Fleet managers analyse this data, enabling them to advise the captain and crew on navigation, weather patterns, fuel consumption and port arrival. The fixing of faults onboard are handled with aid of outside expertise from the shoreside suppliers. Common broker platforms and e-commerce will simplify and secure the supply chain and reduce the amount of paperwork in the value chain under the heading of blockchain technology. These advances enable integration of the business process and reduce transaction costs. Digital twins enable real-time data analytics by use of AI and machine learning tools to support a rich management and operational view of the entire supply chain.

3.6.2 Three scenarios for the sustainable shipping trends

Low impact

MEETING IMO 50% EMISSIONS REDUCTION TARGET by 2050

We will see major use of heavy fuel oil in 2030, but a transition to fuel with lower emission towards 2050.

The IMO 2050 targets for emissions can be met by LNG in combination with bio-LNG as a drop in fuel for the deepsea fleet.

We will see a mix of technologies for the shortsea fleet.

The IMO minimum requirement is sufficient.

Medium impact

MEETING EU TARGETS = by 2050

LNG and LPG will be a common fuel in deepsea shipping. Shortsea shipping will be zero emission by 2035, deepsea by 2050. *We will see a variety of solutions within the shortsea shipping segment, such as use of biofuel, methanol, ethane, hydrogen, and batteries.*

LNG is currently not a complete answer to the marine fuels problem but a stepping stone to meet emission targets. Retro-fit and updates will then be common in the years to come.

A lot of upskilling to handle pilot technologies.

Alternative fuels such as LNG, LPG, biofuel, methanol, ethane, hydrogen, and ammonia will have different risk factors and require specialised training.

In addition, there is the need for improved seafarer training which has been made apparent in the areas of low-sulphur fuel switchovers, the correct use of scrubbers, additional wear and tear on machinery, and the safe operation of ballast water management equipment.

Seafarers must be able to gain knowledge on the safe use and storage of carbon and variety of fuels as well as battery packages. All these are beyond current IMO conventions and require new thinking in maritime education and training.

Strong impact

SHIPPING INDUSTRY LEADS – ZERO BY 2040

The 2050 goal must be achieved from 2035 and we will have stricter demands from 2050.We will see a mix of fuels such as LNG including bio-LNG and e-LNG, MGO, bio MGO and e-MGO, bio methanol and e-methanol, HFO, e-ammonia, batteries, and nuclear power.

The mix depends on cost of electricity.

A few technologies win and are implemented in basic education, e.g., batteries, hydrogen and nuclear.

Alternative fuels such as LNG, LPG, biofuel, methanol, ethane, hydrogen, and ammonia will have different risk factors and require specialised training.

In addition, there is the need for improved seafarer training which has been made apparent in the areas of low-sulphur fuel switchovers, the correct use of scrubbers, additional wear and tear on machinery, and the safe operation of ballast water management equipment.

Seafarers must be able to gain knowledge on the safe use and storage of carbon and variety of fuels as well as battery packages. All these are beyond current IMO conventions and require new thinking in maritime education and training.

3.6.3   Three scenarios for attractiveness

Low impact

STCW minimum as a standard:

Management is hierarchical and talent is recognised mainly from STCW certification and with extensive experience in many roles, on a multitude of ships and with proven performance.

Europe continuing to lose competitiveness.

Hard to attract young talent.

Shipowners continue to hire low-cost employees.

Medium impact

Skills at higher standard:

Transversal skills needed to move from one value chain to another

Lifelong learning programmes that enable seafarers to work across industries and services in the maritime shipping sector are available. Maritime clusters with a variety of job opportunities and career paths are a key to talent attractiveness.

Improved interface between seagoing and shore-based jobs building up transversal competences and skills in the maritime sectors, such as for remote control centres.

Hard to attract young talent.

Shipowners continue to hire low-cost employees.

Risk of shortage of seafarers, rising demand for upskilling and specialisation.

Attract former seafarers to return to shipping.

Motivate current seafarers to stay active beyond normal retirement age.

Strong impact

Skills at higher standard:

Transversal skills to move from one value chain to another are common.

Lifelong learning programmes that enable seafarers to work across industries and services in the maritime shipping sector are established.

Maritime clusters with a variety of job opportunities and career paths are the norm.

Seagoing and shore-based jobs share a range of common transversal competences and skills in the maritime sectors to facilitate autonomous ship operation.

We are attracting young talent for maritime careers.

European shipowners and related industries prefer and value European talent due to excellent education.

Disruption by geopolitical change, EU regulations going above and beyond IMO regulations. Impact on MET is to implement new curriculums.

3.7 TEST HYPOTHESES AND ANALYSE DATA

The three scenarios for each trend are given scores. 9 is given for the most likely scenario and 0 or 3 for the two others. Scores are given for what we believe in 2035 and 2050.

Three scenarios for the trend digitalisation and smart shipping:

Low impact	Medium impact	Strong impact
score 2035; X	score 2035; X	score 2035; X
score 2050; X	score 2050; X	score 2050; X

Three scenarios for the sustainable shipping tends:

Low impact	Medium impact	Strong impact
score 2035; X	score 2035; X	score 2035; X
score 2050; X	score 2050; X	score 2050; X

Three scenarios for the attractiveness:

Low impact	Medium impact	Strong impact
score 2035; X	score 2035; X	score 2035; X
score 2050; X	score 2050; X	score 2050; X

3.8 RESULTS

The questionnaire was distributed among 18 SkillSea partners and 25 responses were collected.

3.8.1 Digital and smart shipping – 2035 trends

The results for **"Digital and smart shipping"** clearly favour the medium impact scenario in the perspective until 2035. Looking towards 2050, the majority is very clear that the high impact scenario is most likely, where remote support and autonomous shipping will have a big impact on seafarers' skills, competence, and roles.
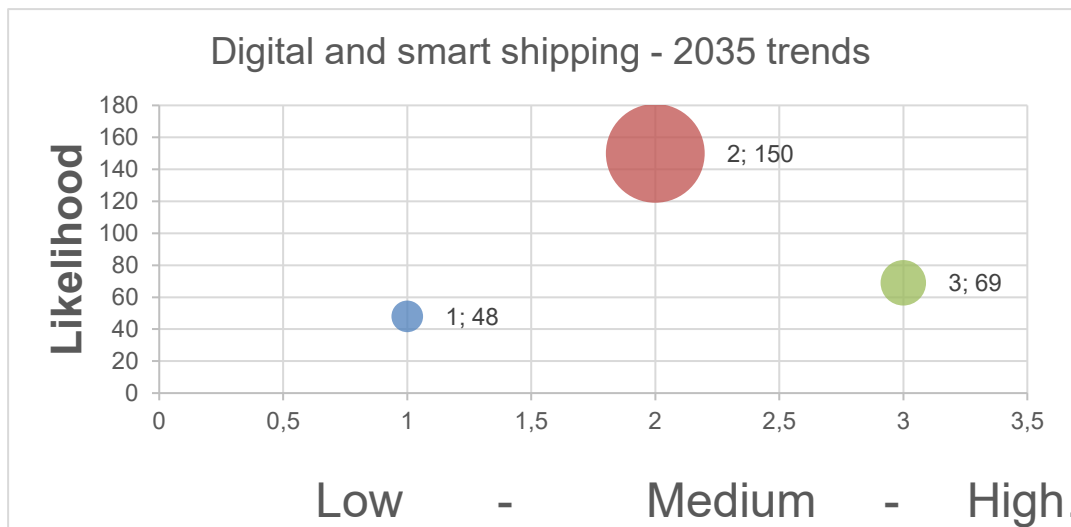

Figure 4: Digital and smart shipping – 2035 trends

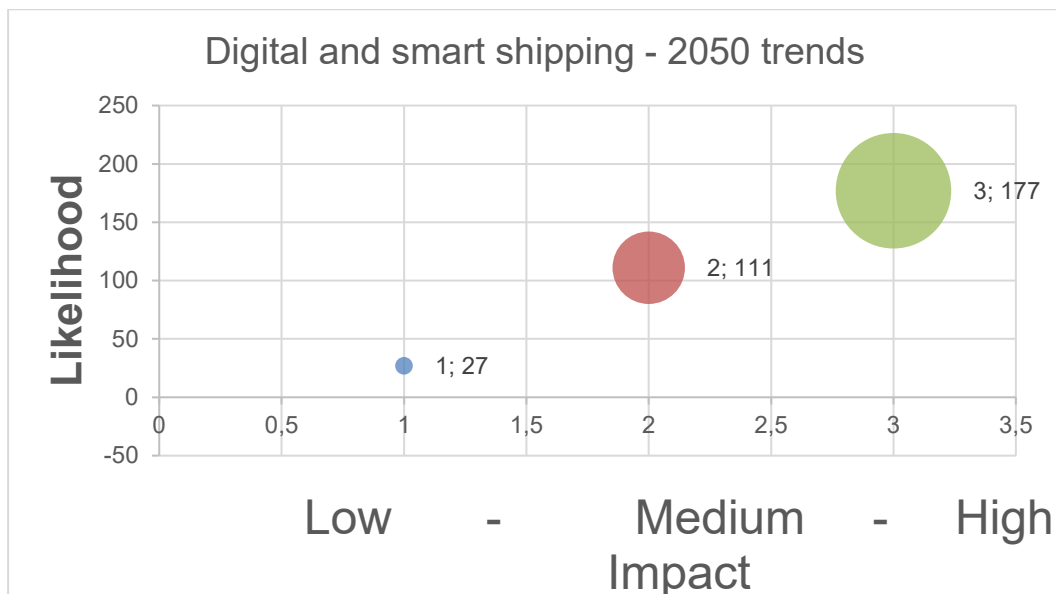### 3.8.2 Digital and smart shipping – 2050 trends

Figure 5: Digital and smart shipping – 2050 trends

3.8.3 Three scenarios for sustainable shipping trends – 2035 trends

Here we find similar result as in the previous chapter. On the perspective until 2035 the medium impact scenarios scores the most but the high impact scenario is close behind, pushing the response towards this outcome. For the 2050 perspective the High Impact scenario is an uncontested number one.
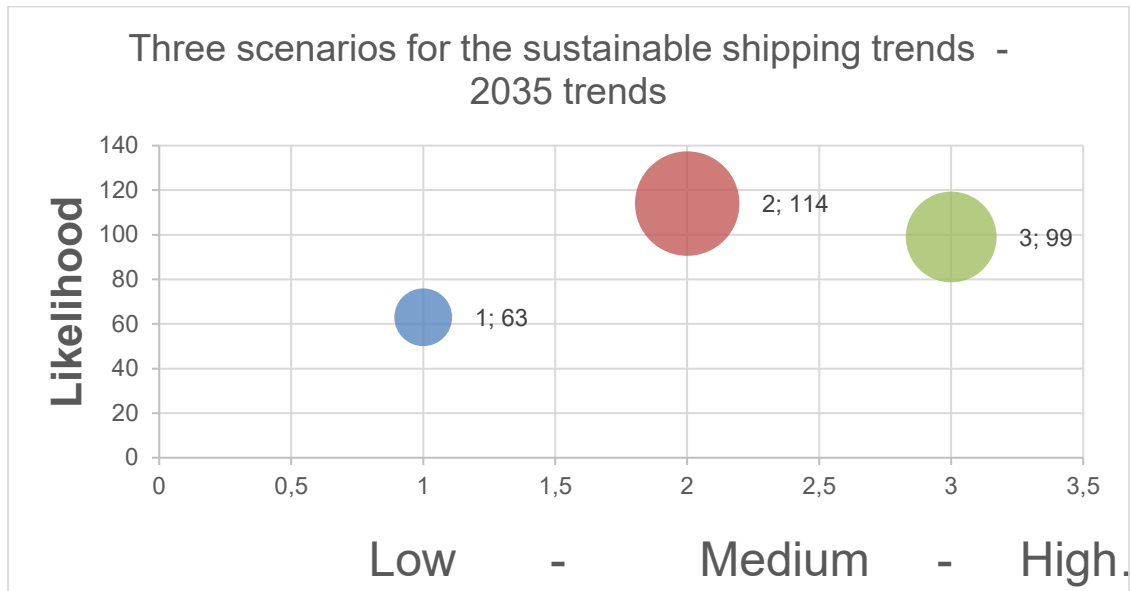

Figure 6: Three scenarios for sustainable shipping trends – 2035 trends

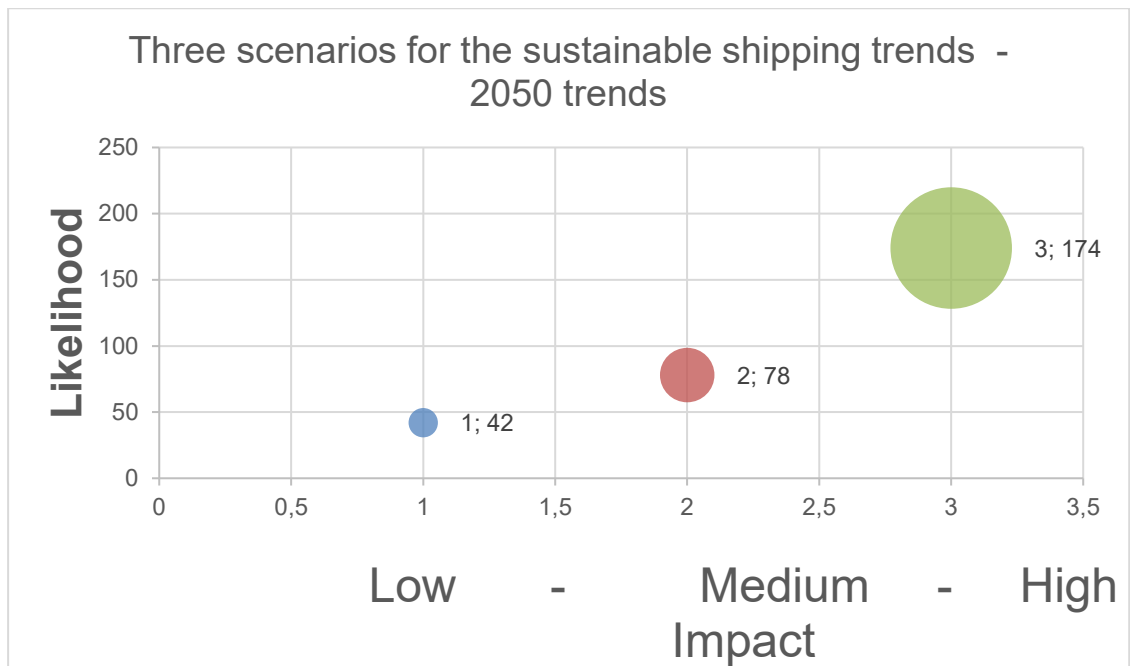### 3.8.4 Three scenarios for sustainable shipping trends – 2050 trends

Figure 7: Three scenarios for sustainable shipping trends – 2050 trends

3.8.5　Three scenarios for attractiveness – 2035 trends

For the **attractiveness** of the sector, we see the same pattern. Here the perspective until 2035 is leaning a little towards slower adoption and aligning slightly with IMO minimum targets, while the perspective towards 2050 is very much in line with the findings above insofar as the clear majority favours the high impact scenario. The high impact scenario is industry-driven while the medium impact is aligned with EU goals.
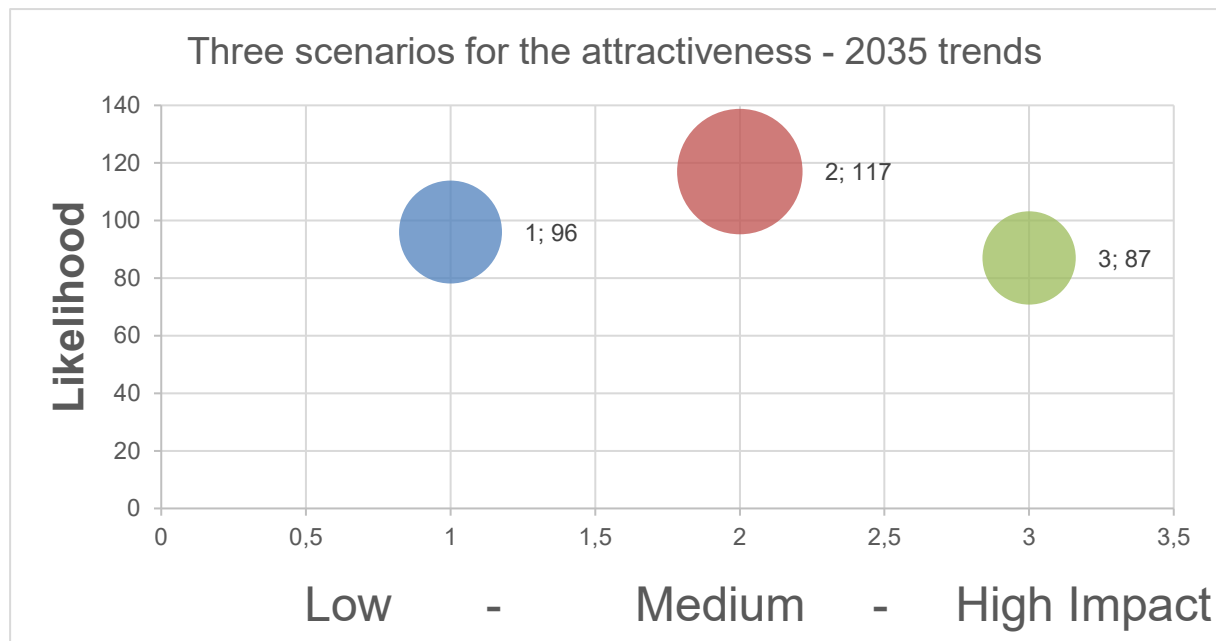

Figure 8: Three scenarios for attractiveness – 2035 trends

3.8.6　Three scenarios for the attractiveness – 2050 trends
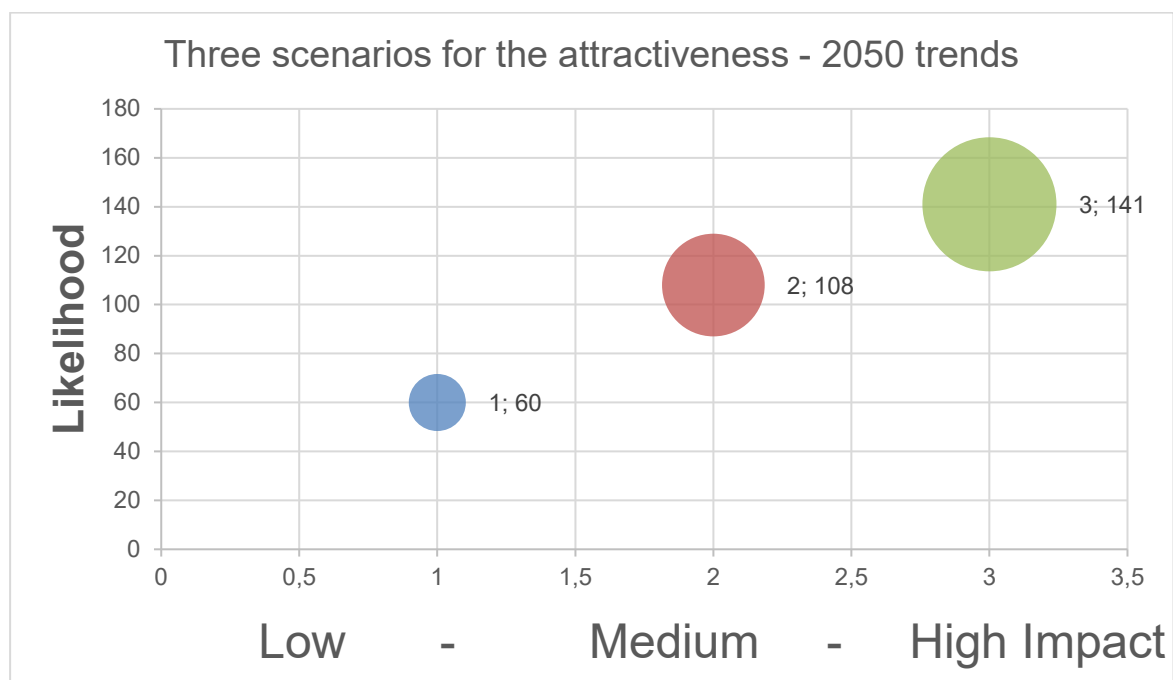

Figure 9: Three scenarios for the attractiveness – 2050 trends

3.9 SCENARIO CONCLUSIONS

We have explored three scenarios for digital and smart, sustainable shipping and attractiveness until 2035 and 2050.

1. In the "Digital and smart shipping" scenario, the medium impact scenario is favored until 2035, while the high impact scenario is favored for 2050, with remote support and autonomous shipping having a significant impact on seafarer skills and roles.

2. In the "Three scenarios for sustainable shipping trends", the medium impact scenario scores the most until 2035, with the high impact scenario close behind. The high impact scenario is the uncontested number one for the perspective towards 2050.

3. In the "Three Scenarios for the attractiveness", until 2035 the perspective leans towards slower adoption and aligns with IMO minimum targets. Towards 2050, the clear majority favors the high impact scenario, which is industry-driven, while the medium impact scenario aligns with EU goals.

This can thus be summarised such that in the perspective to 2035, government/EU goals dominate until industry gains momentum and speeds up the process – perhaps due to favourable effects from public and government support. It is also likely that the industry will see operational efficiencies in implementing digital and smart shipping sooner rather than later. Sustainable fuels will take some time to develop, in terms of both supply chain and technology, but once these are in place, adaptation will likely be quick.

4   CONCLUSIONS & RECOMMENDATIONS

The IMO STCW Convention is established as the worldwide minimum standards of qualification, training, certification and watchkeeping for officers and crew on seagoing vessels of all types and classes. We have observed a gap between the STCW level of competence required to operate ships today and the competences requested by maritime professionals and required by the shipping industry as being necessary to cope with rapidly changing technology and new operational modes, today and in the future.

Through our analysis of identified skills needs within the SkillSea project, we found that some METs are already delivering additional training that responds to requirements for **On-Demand** skills. Competence that responds to new technology and operational modes, termed **Higher Standard,** will be needed in the future. There is currently no systematic process that turns these future competence requirements into training programmes, except for the adoption of new competence in STCW, which is much slower than what industry requires. We see that educational requirements and, thus, **Educational Programmes** are slow to change, and this may leave seafarers with competence gaps when handling new technology and new operational modes in the workplace.

The analysis predicts that the gaps will be dynamic due to the rapid digital and sustainability transformation in the shipping industry. We conclude that short-term skills needs can be met through **On-Demand training, and** those training courses may become included in the revised STCW minimum standard due to the ongoing revisions. We conclude that medium-term skills needs will require to be met through **Higher Standard training.** With time, those training courses could become **On-Demand** training when training modules are ready. **Work Package 2** could assist with the development of new course curricula to fulfil the skills needs.

We propose that the long-term skills gap must be resolved through an **Educational Programme.** Here maritime professionals, both vocational and bachelor graduates of the future, should be offered more opportunities. The programme should cover new technologies and operational procedures, as well as developing specialisations and transversal skills in management, economics, logistics, mechanical engineering and computer science. Such an **Educational Programme** will ensure that European seafarers can employ their competencies and contribute to innovation, development and prosperity of the industry. The scope of such an **Educational Programme** will enhance employment opportunities, attractiveness and mobility in a competitive environment.

To realise the above educational programmes, a strategy for structural cooperation between METs would be appropriate. Further collaboration with industry and METs could contribute to identifying competence areas for the educational programmes.