30th
International Maritime Lecturers Association Conference
Split Croatia
www.imla30.org

LOOKING OUT FOR FUTURE SEAFARERS: IMPLICATIONS OF REBRANDING 21ST CENTURY SKILLS

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Abstract. ***Introduction:*** In parallel to increasing demands for new technical skills for seafarers to prepare for digitalization, automation and decarbonization, a strong emphasis on soft skills has been observed under the ongoing Comprehensive Review of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) at International Maritime Organization (IMO) meetings. The 10th session of the Human Element, Training and Watchkeeping Sub Committee (HTW 10) agreed to review the Convention and Code to address 21st century skills and interpersonal skills, acknowledging their importance for future seafarers in the rapidly changing maritime workplace. However, discussions during HTW 11 suggested a narrowing of this concept, limiting it to non-technical behavioural skills, and six competency domains: Teamworking; Communication and influencing; Situation awareness; Decision making; Results focus; and Leadership and managerial skills. This rebranding contrasts sharply with the extant body of literature that discusses 21st century skills required by seafarers in light of contemporary maritime trends. ***Aim:*** This study aims to explore the implications of conflating 21st century skills with legacy non-technical behavioural skills in the STCW revision. Particular attention is paid to examining the limitations of this redefinition in addressing the future 21st century skills requirements of seafarers. ***Methods:*** A previous study investigating 21st century skills for officers and ratings identified ten top 21st century skills based on a literature review. These skills are revisited to assess the extent to which they are covered by existing non-technical behavioural skills frameworks. This document-based study is further validated with empirical data obtained through a systematic literature review and interviews with maritime education and training (MET) experts. ***Results:*** Findings highlight a disconnect between the policy discourse with respect to STCW and contemporary research on 21st century skills required by seafarers. Interviews with experts further support the need for a wider conceptualization of 21st century skills in STCW. The study argues for a reframed approach to 21st century skills that builds on, but does not limit itself to, traditional non-technical behavioral skills. It offers practical recommendations for maritime educators.

Keywords: 21st Century Skills; Future Seafarers; Comprehensive Review of STCW Convention and Code; Non-technical Behavioral Skills; Maritime Education and Training; Human Element.

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https://doi.org/10.7225/imla30.35

1. INTRODUCTION

Rapidly changing work environments due to technological advancement and sustainability agenda urge future-proofing of the workforce to be able to adapt to these changes. 21st century skills are recognized as the most important skills in higher education (Karaca-Atik et al., 2023). A similar trend can be observed in the maritime industry where digitalization and decarbonization are shaping the future of maritime education and training (Borromeo, 2025). It was not surprising that "21st century and interpersonal skills" were considered important future skills for seafarers and appeared as one of the 22 areas[1] in the Comprehensive Review of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) during the 10th session of the International Maritime Organization's (IMO) Human Element and Watchkeeping Sub-Committee meeting (HTW 10) in 2024.

However, during the Intersessional Working Group of the Comprehensive Review of STCW Convention and Code (ISWG-STCW) held in October 2024, 21st century skills were rebranded as non-technical behavioural soft skills in the submission (ISWG-STCW 1/2/15) made by INTERTANKO and OCIMF. The proposed non-technical behavioural soft skills originally came from their submission (MSC 101/INF.6) to the Maritime Safety Committee (MSC) in 2019, aiming to address the need to improve safety in the tanker industry in relation to the IMO Model courses 1.22 on Bridge Resource Management and 1.30 on Onboard Assessment. The background of introducing non-technical behavioural soft skills to maritime education and training (MET) lacks a rationale for rebranding 21st century skills as part of the key areas for the Comprehensive Review of STCW.

Further, the document ISWG-STCW 1/2/15 states in its Annex that *new competences are proposed to be added to cover the skills required for non-technical behavioural soft skills needed to operate in the 21st century within the KUPs for officers at the management and operational levels*. This statement does not seem to refer to the same skills, because non-technical behavioural soft skills are those required to operate (tankers) in the 21st century while 21st century skills are defined as *the knowledge, skills and attitudes necessary to be competitive in the twenty-first century workforce, participate appropriately in an increasingly diverse society, use new technologies and cope with rapidly changing workplaces* (Scott, 2015: 3). In addition to the mismatch between non-technical behavioural soft skills and 21st century skills, the statement focuses on *officers at the management and operational levels*. In contrast, research conducted by Pazaver and Kitada (2025) determined that 21st century skills, such as effective communication; information/ICT/digital literacy; collaboration and teamwork; social responsibility/global awareness; cross-cultural skills; and flexibility/adaptability, are relevant to both officers and ratings.

INTERTANKO and OCIMF (2024) specify the Knowledge, Understanding and Proficiency (KUP) of non-technical behavioural soft skills based on (1) Team Working; (2) Communications and Influencing; (3) Situation Awareness; (4) Decision Making; (5) Results Focus; and (6) Leadership and Managerial Skills. According to Pazaver and Kitada (2025), the top ten 21st century skills identified through a scoping exercise are Critical thinking; Collaboration and teamwork; Effective communication; Creativity; Problem solving; Digital and ICT literacy; Social responsibility and global awareness; Learning to learn; Cross-cultural skills; Flexibility and adaptability. Overall, the non-technical behavioural soft skills suggested by INTERTANKO and OCIMF appear to be much narrower in application than the originally proposed 21st century skills. Based on the discussion at ISWG-STCW in 2024, HTW 11 identified over 500 gaps to be addressed in the next Phase of the Comprehensive Review of STCW. The term "21st century skills" disappeared to be replaced by non-technical behavioural soft skills. The lack of discussion on 21st century skills for seafarers seems to have resulted in the loss of the term itself in policy-making.

This study aims to explore the implications of conflating 21st century skills with legacy non-technical behavioral skills in the STCW revision. Particular attention is paid to examining the limitations of this redefinition in addressing the future 21st century skills requirements of seafarers. To achieve the research aim, the following research question was developed: 1) How has the concept of 21st century skills been redefined during the STCW revision process and what are the implications of this conceptual narrowing in terms of gaps for the future readiness of seafarers? 2) What policy implications arise from this limited definition of 21st century skills?

The following sections are structured as follows: Section 2 details the methods used in this study; Section 3 presents the results of a systematic literature review and interview analysis to highlight key findings; and Section 4 provides discussions and conclusions, including policy implications and recommendations for future research.

[1] At the point of HTW 10, there were 22 areas but later in the year two more areas were added for the Comprehensive Review of STCW.

2. METHODS

This study is designed to build on a previous study (Pazaver & Kitada, 2025) investigating 21st century skills for officers and ratings. The study identified the top ten 21st century skills. These skills are revisited to assess the extent to which they are covered by existing non-technical behavioral skills frameworks. Additionally, a systematic review of maritime literature was conducted to determine which 21st century skills are deemed to be essential for future seafarers. This document-based study is further validated with empirical data obtained through interviews with MET experts.

The systematic literature review (SLR) was conducted in line with the Preferred Reporting Items for Systematic reviews and Meta-Analysis (PRISMA) guidelines. The literature search focused on studies that discussed future skills for seafarers. The following search strings were entered into the Scopus citation database, ("seafarer" AND "21st century skills") OR ("seafarer" AND "soft skills") OR ("seafarer" AND "non-technical skills") OR ("maritime" AND "21st century skills") OR ("maritime" AND "soft skills") OR ("maritime" AND "non-technical skills"). Since the terms 21st century skills, soft skills and non-technical skills are often used interchangeably in the literature, this strategy ensured that relevant studies would not be overlooked. The search was limited to peer reviewed journal articles, conference papers and book chapters published in English after and including 2020. The results of the search are shown in Figure 1.

The initial search returned 78 items, 73 of which were screened and sought for retrieval. In nine cases, a paywall was encountered and those reports were not retrieved. Sixty-four reports were assessed for eligibility, of which 54 were excluded for the following reasons: 1) they did not focus on 21st century skills and competences for seafarers; 2) they were not future focused. The nine remaining reports were analyzed and six further records were identified from their reference lists. In total, 15 studies were included in the literature review. The 15 reports were analysed to determine which skills are considered essential for future seafarers and for what reasons. The results were compared with the interview results and the six non-technical behavioural skills proposed for inclusion in the STCW revision.

Semi-structured interviews were conducted with 7 MET experts from the Philippines, Thailand, Tukiye,

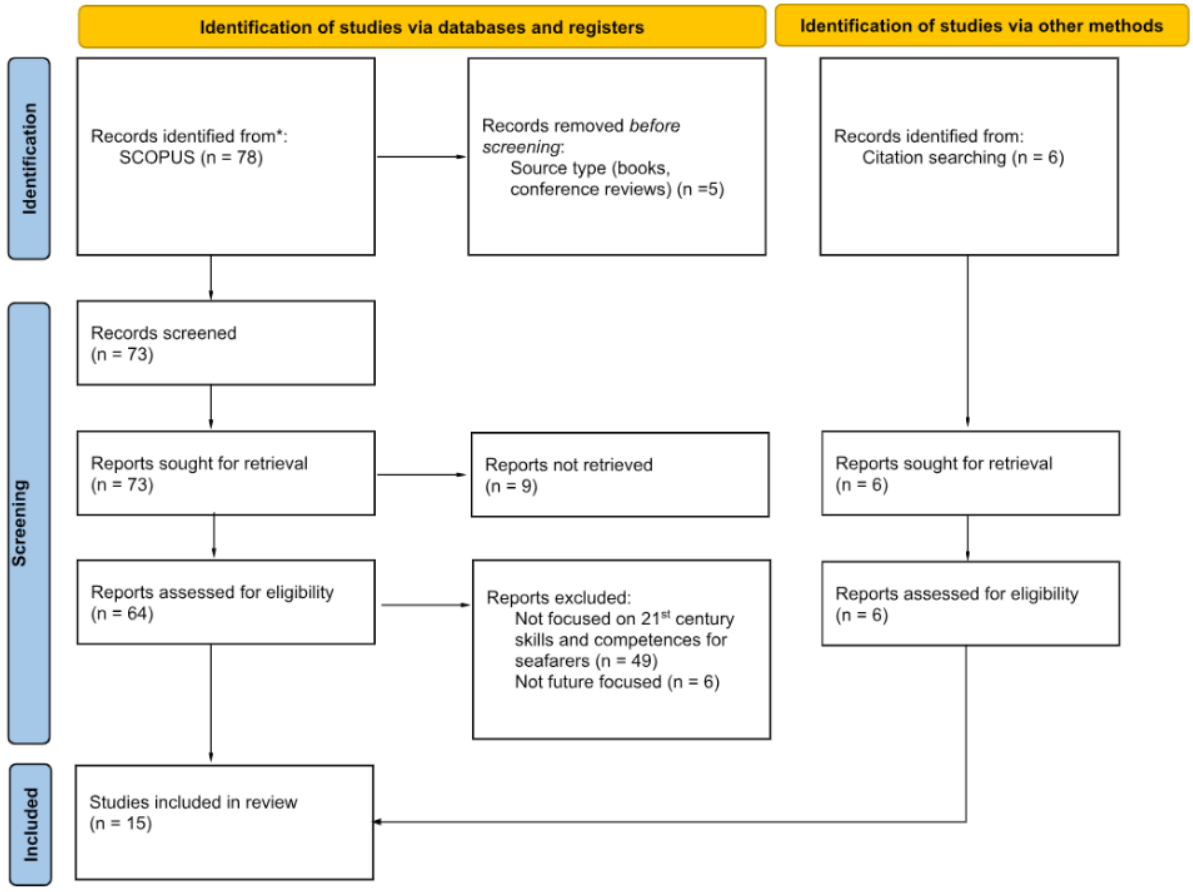

Figure 1. PRISMA flow diagram of search results

Belgium and Republic of Korea in the second quarter of 2025. Most interviews took place in person but some through video calls. Each interview took from 30 to 120 minutes. Before the interview, the focus and objectives of the research were explained to the participants who signed a consent form, approved by the World Maritime University's (WMU) research ethics committee. The audio data were transcribed using the transcription software otter.ai and the transcripts were manually checked before analysis. Researchers employed both inductive and deductive coding methods (Fereday & Muir-Cochrane, 2006). Inductive coding helped to explore themes from the MET experts' narratives around 21st century skills while deductive coding was used to examine whether the most important 21st century skills (Table 1) are mentioned by them during the interviews.

Table 1. Top ten 21st century skills

twenty-first century skills	Officers	Ratings
Critical thinking	X	
Problem-solving and decision-making	X	
Effective communication	X	X
Information/ICT/digital literacy	X	X
Creativity and innovation	X	
Collaboration and teamwork	X	X
Social responsibility/global awareness	X	X
Cross-cultural skills	X	X
Flexibility/adaptability	X	X
Learning how to learn	X	

The results of the systematic literature review and interview study were synthesized according to the guiding research questions. This triangulation methodology (Patton, 2014) increases the validity, reliability and legitimation of findings, which could support the concepts of science-policy interface (Maas et al., 2022) and evidence-informed policy-making (Galluccio, 2021). This paper will make a meaningful contribution to strengthening the collaboration between academia and policymakers through the application of scientific evidence for effective and equitable decision-making.

3. COMPREHENSIVE REVIEW OF 21ST CENTURY SKILLS

3.1. 21st Century Skills, Non-technical Skills and Soft Skills

21st century skills were identified as one of the 22 areas for consideration in the comprehensive review of the STCW Convention and Code. However, the term "21st century skills" is not specifically defined in any related IMO documents, leaving it up to interpretation. The submission (ISWG-STCW 1/2/15) to HTW 11 by INTERTANKO and OCIMF suggests that the identified gap in STCW can be addressed through the incorporation of six non-technical behavioural soft skills, suggesting that non-technical/ soft skills are synonymous with 21st century skills. This study explored, through a systematic literature review and interviews with MET professionals, how these concepts are understood and applied in the maritime context.

The SLR revealed that the maritime literature rarely refers to "21st century skills" when discussing the competency and training needs of future seafarers. Instead, the terms "non-technical skills" and "soft skills" predominate, and are, to a large extent, used interchangeably. The literature distinguishes non-technical skills from technical skills, which are taken to refer to the occupational knowledge directly related to carrying out ship operations, such as navigation, maintenance, communication and cargo handling (Chowdhury et al., 2024; Ghosh et al., 2024; Sharma & Kim, 2021). Technical skills are regulated in STCW (Cicek et al., 2019) and are the measurable outputs of formal training. They are, therefore, considered easier to define and assess (Ghosh et al., 2024). Non-technical skills, in contrast, are seen as complementary, reinforcing and enabling of non-technical skills (Chowdhury et al., 2024; Kennard et al., 2022). Thomas (2012) refers to non-technical skills as *the vehicle through which technical skills and knowledge can be applied [...] the art in contrast to the technical science of performance*. The definition of non-technical skills provided in much of the literature derives from the first introduction of the term in the early 1990s in the context of European civil aviation, where it was defined as *the cognitive, social and personal resource skills that complement technical skills, and contribute to safe and efficient task performance* (Flin et al., 2008, p. 1). It is in connection with this definition that Bridge Resource Management (BRM) courses were developed in the maritime industry in the early 1990s, and later incorporated into STCW (for masters and officers) by way of the Manila amendments (Table A-II/I). Non-technical skills are described by some as less tangible and more difficult to quantify, making their development and evaluation more complex (Ghosh et al., 2024)

When 21st century skills are referred to in maritime literature, they are defined generically or synonymously with soft skills. Zheliaskov et al. (2024) suggest "21st century skills" as one of the possible synonyms of "soft skills", together with "key competencies", "generic competencies" and "core competencies", all of which, according to the authors, refer to *subjective, behaviour-*

al and socio-emotional competencies (p. 144). In contrast, Chowdhury (2024) categorizes crucial 21st century skills for seafarers into two groups: hard skills and soft skills, while Pazaver & Kitada (2025) offer a more generic definition based on Scott (2015), viz *the knowledge, skills and attitudes necessary to be competitive in the twenty-first century workforce, participate appropriately in an increasingly diverse society, use new technologies and cope with rapidly changing workplaces* (p.3). The latter two conceptualizations align best with those offered by the interview participants in this study in relation to the maritime context.

Maritime professionals were asked how they interpret the term 21st century skills in the context of seafarer training and maritime industry requirements. Their responses reflect a shared understanding that 21st century skills encompass a combination of technical and non-technical skills essential for seafarers to operate effectively in the rapidly changing maritime workplace that is being shaped by digitalization, automation and sustainability. One MET professor suggested that *as AI continues to evolve, it will lead many of the major changes in the maritime industry, requiring seafarers to be equipped with competencies to interact effectively with intelligent systems.* Another expressed that 21st century skills should differentiate humans from AI, viz *I also believe that it is not only the soft skills or these technological competencies; I think that the 21st century skills should involve unique cognitive and creative mind, which distinguish human intelligence from artificial intelligence.*

O'Connor and O'Day (2024) note that frontline workers often have a clear understanding of technical and non-technical aspects of their roles, but the boundaries between these domains are increasingly blurred as digital tools become integral to operational tasks. This blurring necessitates a re-examination of what constitutes non-technical skills in the 21st century, especially as seafarers are expected to interact with advanced technologies and diverse and multi-cultural teams.

3.2. 21st Century Skills for Future Seafarers

Skills required by future seafarers have been derived from the SLR and interviews with MET professionals. These are presented in a skills matrix (Table 2) which compares the results of the behavioural non-techni-

Table 2. Comparison of skills requirements for future seafarers

Category	Skill	Literature	Interviews	ISWG-STCW 1/2/15
Cognitive skills	Problem solving	√	√	
	Critical thinking	√	√	
	Decision making	√		√
	Managing complexity	√	√	
	Creativity	√		
	System thinking	√	√	
	Situational awareness			√
	Results focus			√
Social/interpersonal skills	Communication	√	√	√
	Teamwork	√	√	√
	Intercultural competence	√	√	
	Collaboration	√	√	
	Ethical judgement	√		
	Conflict solving	√		
	Emotional intelligence	√	√	
	Negotiation skills	√		
Digital Skills	Digital literacy	√	√	
	Data analysis	√	√	
	Cyber security	√	√	
	AI literacy		√	
Individual attributes	Leadership	√		√
	Flexibility and adaptability	√	√	
	Learning mindset	√	√	
	Stress resistance	√		

cal skills proposed in ISWG-STCW. The bolded checkmarks indicate skills recommended for future seafarers in more than 50% of the articles reviewed for the SLR or by more than 50% of the interview participants. The skills framework adapted from Cicek et al. (2019) and Ceylani et al. (2022) contains four categories of skills, cognitive, social/interpersonal, digital and individual. Two skills, communication and teamwork, mentioned by all three sources are significant in that, along with leadership skills, they have been included in STCW as competences to be developed, since the 2010 Manila amendments (Ghosh & Bowles, 2024).

There is considerable overlap between the results of the SLR and of the interviews. In both cases, critical thinking, problem solving and digital literacy are emphasized among other skills. On the contrary, none of these are included in the non-technical behavioural skills suggested for inclusion in STCW by ISWG-STCW 1/2/15. Detailed analyses of four categories of skills, cognitive, social/interpersonal, digital and individual are presented in the following sub-sections.

3.2.1. Cognitive Skills

The literature consistently identifies cognitive skills as core skills for future seafarers. Ceylani et al (2022) ranked skills required by future seafarers using a fuzzy analytic hierarchy process and identified cognitive skills as most important for seafarers in the digital era. Within the broader category of cognitive skills, critical thinking and complex problem solving are most frequently mentioned in the literature (see Annex 1). The digitalization of shipboard systems and the integration of automation have introduced new layers of complexity to maritime operations, requiring seafarers to process vast amounts of information, evaluate ambiguous situations, and make informed decisions under uncertainty (Ceylani et al., 2022; Pazaver & Kitada, 2025). Moreover, as maritime systems become more interconnected and data-driven, the ability to address ill-defined problems with creative strategies will be essential for safe and efficient vessel management. Future seafarers, according to Sharma and Kim (2021) will be faced with unpredictable situations linked to interactions among various system components, which will require systems thinking and non-routine problem solving skills among others. MET professionals interviewed for this study largely corroborate the results of the SLR, with more than half naming critical thinking and problem-solving as key 21st century skills for seafarers, and several naming systems thinking as a needed skill. One participant described systems thinking as crucial for seafarers as part of the socio-technical environment of the ship in which seafarers are required to interact with other system components, including artificial intelligence.

3.2.2. Social/interpersonal Skills

Communication and teamwork are core social/interpersonal skills according to all three sources consulted for this study, with the literature also emphasizing intercultural competence (Annex 1). According to Ceylani et al. (2022), teamwork is consistently highlighted as a core competency in maritime operations, with multiple studies underscoring its significance for both routine and emergency scenarios. The ability to communicate effectively across cultural boundaries is not only considered essential for operational efficiency but also for ensuring safety, reducing misunderstandings, and promoting a harmonious working atmosphere on board ships (Ceylani et al., 2022; Zheliaskov et al., 2024). Teamwork and communication skills are already incorporated into the STCW Code; nevertheless, a scoping review conducted by Pazaver and Kitada (2025) revealed that the nature of communication and teamwork are changing with the evolution of automation and communication technologies. Teamwork is increasingly taking place across distances, requiring more sophisticated skills to connect, share information and problem-solve. Belabyad et al. (2025) similarly noted that in the context of automation and remote operation, clear communication between ship and shore will be crucial, while Ghosh et al. (2024) suggested examples of communication skills for support, operational and management level MASS operators, including, at support level, *establish[ing] mechanisms to analyse, evaluate and report information across different workplace locations* (p.8). In a similar vein, one interview participant described the *growing emphasis on skills like communication and remote collaboration* that has taken place since the Covid-19 pandemic. The social/interpersonal skills required of future seafarers extend beyond traditional notions of teamwork, encompassing cross-cultural communication, and the ability to use digital tools effectively for collective decision-making.

3.2.3. Digital Skills

The digital skillset identified through the SLR and interviews includes digital literacy, data analysis, cyber security and AI literacy skills, none of which are included in the non-technical behavioural soft skills suggested for inclusion in STCW. Ceylani et al. (2022) ranking of future skills for seafarers, positions operational skills in second position after cognitive skills. In the authors' framework, operational skills include "information and data processing" and "managing cyber security", with emphasis placed on the importance of

seafarers' having a *thorough understanding of digitalization skills in order to manage, process and comprehend increasingly complex data in order to handle and optimize operations* (p. 213). A similar framework developed by Emad and Ghosh (2023) presents technical skills for seafarers to be involved in the operation of autonomous vessels. The authors interviewed 37 maritime professionals in order to identify the needed skills. The literature also cites cyber security awareness as a fundamental component of digital literacy for seafarers as the maritime sector undergoes rapid digital transformation (Ceylani et al., 2022; Ghosh et al., 2024; Stefani & Apicella, 2022). The integration of advanced technologies such as the Internet of Things, Big Data, Artificial Intelligence, and automation has significantly increased the digital footprint of ships and maritime operations, thereby expanding the potential for cyber threats (Ceylani et al., 2022; Sharma & Kim, 2021), necessitating training and skills for seafarers in detecting and responding to cyber incidents. This need was also acknowledged by interview participants who advocated for the integration of cyber security into STCW to prepare seafarers for emerging challenges through cyber security awareness and support of cyber hygiene best practices.

While they are categorized by some as technical or hard skills (e.g., Ceylani et al., 2019; Cicek et al., 2019; Stefani & Apicella, 2022), a review by Pazaver and Kitada (2025) established that the approach to defining digital skills has shifted to include a wider range of cognitive and socio-emotional skills, including safe, responsible and ethical use of technology. The digital skillset also underpins other skills. Data-driven decision making, for example, relies on the increasing integration of real-time data exchange, advanced monitoring systems, and interconnected digital platforms, demanding that seafarers possess not only technical proficiency but also the ability to critically analyze, process, and utilize complex datasets (Cicek et al., 2019; Chowdhury et al., 2024). The skill of situational awareness is also transformed by the use of intelligent situational awareness systems that use sensors, lasers and other innovative technologies to improve decision making (Karadencheva et al., 2024). The interview participants also highlighted the need for information and digital literacy, data interpretation and artificial intelligence awareness skills, as well as the need for seafarers to understand the *philosophical and ethical dimensions* of the socio-technical system, including the part that they play.

3.2.4. Individual Skills

The individual skills identified in this study are leadership, flexibility and adaptability, readiness to learn and stress resistance. While leadership skills were consistently highlighted in the literature as a critical skill for future seafarers, and is one of the non-technical behavioural skills recommended by INTERTANKO and OCIMF for inclusion in STCW, it was not identified in the interviews. Flexibility and adaptability and readiness to learn were included in both the SLR and interview results. Several authors (Chowdhury et al., 2024; Emad & Ghosh, 2023; Kim & Mallam, XX; Sharma & Kim, 2021) have suggested that as digitalization and automation progress, the concept of leadership will change. Sharma and Kim (2021) argue that effective leadership, rated as extremely important by the majority of their respondents, will become even more critical with higher levels of automation. Kim and Mallam (2020) further argue that, with automation, leadership will shift from hierarchical to horizontal collaboration, including human-machine interaction. In that vein, the authors envision machines as a key part of the leadership structure, taking over routine tasks and decisions. Leadership skills for future seafarers will need to be redefined as traditional leadership competencies become less relevant and more complex skills like complex problem solving and remote collaboration gain importance.

Adaptability and flexibility, and learning mindset are also increasingly recognized as core individual skills for future seafarers, driven by the rapid digitalization and automation of maritime operations. Several studies indicate that adaptability and flexibility are highly valued, as they enable seafarers to respond effectively to evolving technological environments and unforeseen operational challenges. (Ceylani et al., 2022; Pazaver & Kitada, 2025). Karadencheva et al., (2024) identify flexibility as a key attribute for seafarers facing cybersecurity challenges, necessitating the ability to adapt to new protocols, rapidly changing threat landscapes and evolving regulatory requirements. Belabyad et al. (2025) reported similar findings in the context of necessary skills for MASS. The interview analysis revealed similar perspectives on flexibility and adaptability, which were highlighted by three participants. In one MET expert's view, *flexibility and adaptability are particularly critical when changes are rapid but regulations are slow*. On the same basis, having a learning mindset was a key skill revealed in both the SLR and interviews. .

3.3. 21st Century Skills and STCW

Interview participants were asked whether the six non-technical behavioural soft skills suggested for inclusion in STCW are sufficient to prepare future seafarers to operate effectively in the maritime industry. While the participants agreed that the six non-technical skills are strong and essential for sea-

farers, the majority expressed that they do not fully capture the comprehensive nature of 21st century maritime operations. In particular, the absence of digital skills was concerning. One MET professional noted that *the current framework is a strong foundation but needs further expansion*. In particular, he noted that *additional skills such as digital adaptability and cross-cultural communication may be necessary.* Another MET expert similarly noted that *teamwork and decision making and other skills should be [included], but [...] data interpretation and artificial intelligence awareness should be important as a skill from them; maybe we can say digital literacy*. A third interviewee noted that AI integrated systems are an area in which communication errors and operational risks might arise. He therefore considers these as essential issues to be considered in workforce readiness discussions, citing in particular the importance of addressing *the growing need for seafarers to interact effectively with increasingly advanced systems*.

In contrast to those advocating for the expansion of 21st century skills to be included in STCW, two interviewees support the current proposal by OCIMF and INTERTANKO. One justified the narrowing of 21st century skills to six non-technical skills by arguing that the six skills represent achievable goals that can be standardized to avoid misunderstanding or misinterpretation. Nevertheless, the participant suggested revising the 21st century skills framework every five years and *then later adding other soft skills, which will be relevant*. This aligns with views expressed in the literature by Ghosh and Bowles (2024), who advocated for the integration of the Human Capabilities Framework (HCF) in STCW, including a review and revision of the framework every four years to keep up with the future demand of skills. Another interviewee found the six non-technical skills to be sufficient but noted that those skills *are already incorporated in the [STCW] Code* and do not represent anything new. He stressed, however, that *they must be elaborated more when it comes to KUPs [...] and "should be put in the context of the new technologies that are available and with a view to increasingly autonomous shipping.* This view is shared by Ghosh et al. (2024) who identified vague descriptions of non-technical competencies in the STCW Code, and by Kim and Mallam (2020), who argue that existing KUPs related to leadership may no longer be relevant when higher degrees of automation are implemented.

Interview participants were asked to speculate on why the concept of 21st century skills was narrowed to the six non-technical skills in the context of the STCW comprehensive revision. A number of them mentioned the difficulty of defining and assessing non-technical skills, noting that there are *problems or challenges* in how non-technical skills are addressed and that, in light of this, *regulatory bodies often prioritize measurable technical skills, which makes inclusion of broad behavioural competencies more complex*. This view aligns with the conceptualization of non-technical skills offered by Ghosh et al. (2024) and discussed in section 3.1 of this paper. Another participant went further to imply that the suggested non-technical behavioural skills were a way to avoid this complexity, highlighting that *we already have this sort of, um, you know, checklists for these, so it's not something like, we need to reinvent the wheel [...] the assessment part is already devised*. Challenges related to making the STCW Code too cumbersome and requiring both additional training/assessment time (Ghosh & Bowles, 2024) and modification of existing course structure (Belabyad et al., 2025) were also mentioned by several interview participants. Finally, one interviewee speculated that the decision has *an economic side*, mentioning the affordability of upgrading training to integrate new skills. Belabyad et al. (2025) similarly argue that training costs present a critical challenge to the provision of training in new skills and competencies, particularly in the context of automation.

4. DISCUSSION AND CONCLUSION

The study was motivated by the ongoing Comprehensive Review of STCW at the HTW Sub-Committee which addressed 21st century skills and interpersonal skills as a new area for STCW revision; however, policy-making processes seemed to lack evidence for rebranding 21st century skills as non-technical behavioural soft skills in the submission (ISWG-STCW 1/2/15) made by INTERTANKO and OCIMF. Building on previous research on 21st century skills for seafarers from scoping exercise, seafarers survey and workshop, this study contributes to a better understanding of 21st century skills for seafarers. Our SLR considers academic literature that discusses future skills for seafarers. In addition, interviews with MET experts provided valuable inputs from their observations and perspectives on future seafarers' needs for 21st century skills. A synthesized analysis was presented in the form of a matrix showing the gaps between the non-technical behavioural soft skills proposed at HTW 11 and the results of the SLR and interviews.

These gaps were further analyzed in detail under the four categories of skills, cognitive, social/interpersonal, digital and individual. It is evident that STCW prioritizes technical skills which are measurable whereas soft skills are undermined yet increasingly important in the era of digitalization, automation and sustainability. The absence of digital skills in the non-technical behavioural soft skills proposed by

INTERTANKO and OCIMF was identified as a major drawback for conceptualizing 21st century skills for seafarers. The original proposal of non-technical behavioural soft skills was made through their submission of MSC 101/INF.6) in 2019, long before the Comprehensive Review of STCW addressing 21st century skills was initiated. The gaps identified in this study were also explained by the fact that their proposal was initially aimed at addressing the need to improve safety in the tanker industry and this specific interest by the observers of IMO meetings has potentially rebranded 21st century skills without acknowledging a wide body of knowledge in this field of research.

Our study showcases how academia can participate in policy making at IMO and provide evidence-based inputs to ongoing policy development and revision. It is also important to empower maritime lecturers who are facing contemporary challenges in MET and directly affected by new regulations and policies. The role of International Maritime Lecturers' Association (IMLA) which represents maritime lecturers around the world has the potential to play an important part in science diplomacy and active participation in policy-making at IMO is expected. This will strengthen the collaboration between academia and policymakers through the application of scientific evidence for effective and equitable decision-making as an opinion leader in MET.

Acknowledgements: Authors appreciate the valuable insights shared by the participants who agreed to take part of this research.

Conflict of interest: Authors have no conflict of interest to declare.

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Annex 1: Results of Systematic Literature Review

Cognitive Skills	
• Problem solving	Ceylani et al. (2022); Cicek et al. (2019); de Agua et al. (2020); Ghosh et al. (2024); Ghosh & Bowles (2024); Kennard et al. (2022); Kim & Mallam (2020); Pazaver & Kitada (2025); Stefani & Apicella (2022); Sharma & Kim (2022)
• Critical thinking	Belabyad et al. (2025); Ceylani et al. (2022); Cicek et al. (2019); Chowdhury et al. (2024); de Agua et al. (2020); Emad & Ghosh (2023); Ghosh et al. (2024); Ghosh & Bowles (2024); Karadencheva et al. (2024); Kennard et al. (2022); Kim & Mallam (2020); Pazaver & Kitada (2025); Stefani & Apicella (2022); Sharma & Kim (2022)
• Decision making	Belabyad et al. (2025); Ceylani et al. (2022); Chowdhury et al. (2024); de Agua et al. (2020); Emad & Ghosh (2023); Ghosh & Bowles (2024); Karadencheva et al. (2024); Sharma & Kim (2022)
• Managing complexity	Ceylani et al. (2022); Cicek et al. (2019); Ghosh et al. (2024); Kennard et al. (2022)
• Creativity	de Agua et al. (2020); Cicek et al. (2019); Ghosh & Bowles (2024); Pazaver & Kitada (2025); Sharma & Kim (2022)
• System thinking	Kennard et al. (2022); Kim & Mallam (2020); Sharma & Kim (2022)
Social and interpersonal skills	
• Communication	Ceylani et al. (2022); Chowdhury et al (2024); Cicek et al. (2019); de Agua et al. (2020); Emad & Ghosh (2023); Ghosh et al. (2024); Ghosh & Bowles (2024); Karadencheva et al. (2024); Pazaver & Kitada (2025); Sharma & Kim (2022); Stefani & Apicella (2022)
• Teamwork	Ceylani et al. (2022); Cicek et al. (2019); Karadencheva et al. (2024); Sharma & Kim (2022); Stefani & Apicella (2022); Zheliaskov et al. (2024)
• Collaboration	Belabyad et al. (2025); Cicek et al. (2019); Ghosh et al. (2024); Ghosh & Bowles (2024); Pazaver & Kitada (2025)
• Intercultural competence	Chowdhury et al. (2024); Cicek et al. (2019); de Agua et al. (2020); Karadencheva et al. (2024); Pazaver & Kitada (2025); Sharma & Kim (2022); Zheliaskov et al. (2024)
• Conflict solving	Ceylani et al. (2022); Cicek et al. (2019); Ghosh et al. (2024)
• Social and ethical values	de Agua et al. (2020); Ghosh & Bowles (2024); Karadencheva et al. (2024); Pazaver & Kitada (2025)
• Negotiation skills	Cicek et al. (2019); Sharma & Kim (2022)
• Emotional intelligence	Cicek et al. (2019); Karadencheva et al. (2024)
Digital and information literacy	
• Digital literacy and IT competence	Belabyad et al. (2023); Chowdhury et al. (2024); Cicek et al. (2019); Emad & Ghosh, 2023; Ghosh et al. (2024); Karadencheva et al. (2024); Kennard et al. (2022); Pazaver & Kitada (2025); Stefani & Apicella (2022)
• Information and data analysis	Ceylani et al. (2022); Chowdhury et al. (2024); Ghosh et al. (2024); Kennard et al. (2022); Stefani & Apicella (2022)
• Cybersecurity skills	Ceylani et al. (2022); Ghosh et al. (2024); Stefani & Apicella (2022)
Individual attributes	
• Leadership	Belabyad et al. (2023); Ceylani et al. (2022); Chowdhury et al. (2024); Cicek et al. (2019); de Agua et al. (2020); Ghosh et al. (2024); Ghosh & Bowles (2024); Karadencheva et al. (2024); Kim & Mallam (2020); Pazaver & Kitada (2025); Sharma & Kim (2022); Stefani & Apicella (2022); Zheliaskov et al. (2024)
• Flexibility/ adaptability	Belabyad et al. (2023); Ceylani et al. (2022); Chowdhury et al. (2024); Cicek et al. (2019); de Agua et al. (2020);Ghosh & Bowles (2024); Karadencheva et al. (2024); Pazaver & Kitada (2025); Sharma & Kim (2022); Zheliaskov et al. (2024)
• Learning mindset	Ceylani et al. (2022); Cicek et al. (2019); de Agua et al. (2020); Pazaver & Kitada (2025); Zheliaskov et al. (2024)
• Stress resistance	Ceylani et al. (2022); Cicek et al. (2019); Sharma & Kim (2022); Zheliaskov et al. (2024)