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Skills and Competency Framework for Future Autonomous Ship Operators: A Feasibility Study for STCW Code Revision

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Abstract

Recent qualitative research by the authors of this paper revealed a common understanding that future operators of autonomous ships are expected to possess a traditional seafaring licence (deck or engine) as a prerequisite for obtaining a licence to operate the future smart ships. Since the standards of competence for a traditional seafaring licence are dictated by the Standards of Training, Certification, and Watchkeeping (STCW 95) Convention, this paper sets out to investigate if the Convention, in its current form, can serve as a skill and competency-based framework for Maritime Autonomous Surface Ship (MASS) operations. The theoretical and analytical research presented in this paper is based on the analogy drawn between the elements of the STCW with the elements of existing skills and competency frameworks in other industries influenced by increasing automation. The findings of this research paper set out to answer the future dilemma between the need to revise an existing, global standards (STCW 95), the approval of which may find a quick consensus among existing members of the International Maritime Organization (IMO) versus reinventing and building new standards which may become redundant due to possibly delayed regulatory bureaucracy. The recommendations, based on the findings of the analysis, provide a pathway for the STCW Code to continue being relevant with an evolving skills and competency framework due to changing technologies and innovation.

Keywords: Autonomous shipping, STCW Code, maritime education and training, skills and competency framework, future-ready, MASS

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1 Introduction

Research (Streng & Kuipers, 2021; Shahbakhsh, Emad, & Cahoon, 2021; Hogg & Ghosh, 2016) on Maritime Autonomous Surface Ships (MASS) suggested that current seafarers will need to undergo new forms of training to play a key role in operating the ships of the future. They suggested that the future focus should be on issues such as the operation of autonomous systems and human interaction with manned and unmanned ships from shore control centres. A recent study by the authors of this paper (Emad & Ghosh, 2023) involved interviewing 37 persons from various facets of the maritime business (maritime educators, seafarers, maritime regulators, etc.). The research concluded that, during the transition period, future operators of autonomous ships will be expected to possess a traditional seafaring licence (deck or engine) as a prerequisite for obtaining a licence to operate smart ships. The knowledge obtained through a traditional licence may then be supplemented with specific skills (information technology, robotics, systems thinking, communication, software management, etc.) required to manage ships with a reduced human presence on board from a shore control center.

However, although the skills and competency required for a traditional seafaring licence are listed in the Standards of Training, Certification, and Watchkeeping (STCW 95) Convention, the competencies required to operate future ships will not be organized into similar framework. For example, a study by Man et al. (2015) showed that future operators in Shore Control Centres (SCC) will require training in terms of their cognitive skills in order to deal appropriately with all the information displayed on screens but failed to propose any framework for the development of those cognitive skills. Similarly, the need to align maritime training to technological developments in MASS is reinforced by recent research (Bolbot et al., 2022; Ceylani, Kolcak, & Solmaz, 2022; Emad, Enshaei, & Ghosh, 2021) but does not propose a practical, usable framework for developing the future skills. Although the research proposed identifying and ranking the competencies however, there is a need for their translation into a skills and competency framework (Emad and Roth, 2008). Hence, in this paper, the characteristics of a competency framework or model are mapped to the STCW Code to determine the latter's suitability in outlining new behaviours expected from future operators of MASS. The characteristics of the competency framework are drawn from a review of available literature and models developed for the workforce in other industries.

2 Structure of the STCW code

The STCW Code provides global, minimum standards of competence for seafarer training based on the STCW convention of the International Maritime Organization (IMO). However, the Code does not provide a pathway and clear skills and competency framework. The aim of this paper is to simply determine the suitability of the existing version of the STCW Code as a skills and competency framework model which can be used for guidance on development of a curriculum for autonomous ship operation. The maritime community would benefit if the competencies identified for MASS operations can be incorporated into the current STCW Code. This is because currently the Convention mainstreamed the approval process of revision and upgrading of the existing framework whereas seeking approval of a new model is complicated and time consuming due to the lagging governance issues within IMO (Psaraftis & Kontovas, 2020).

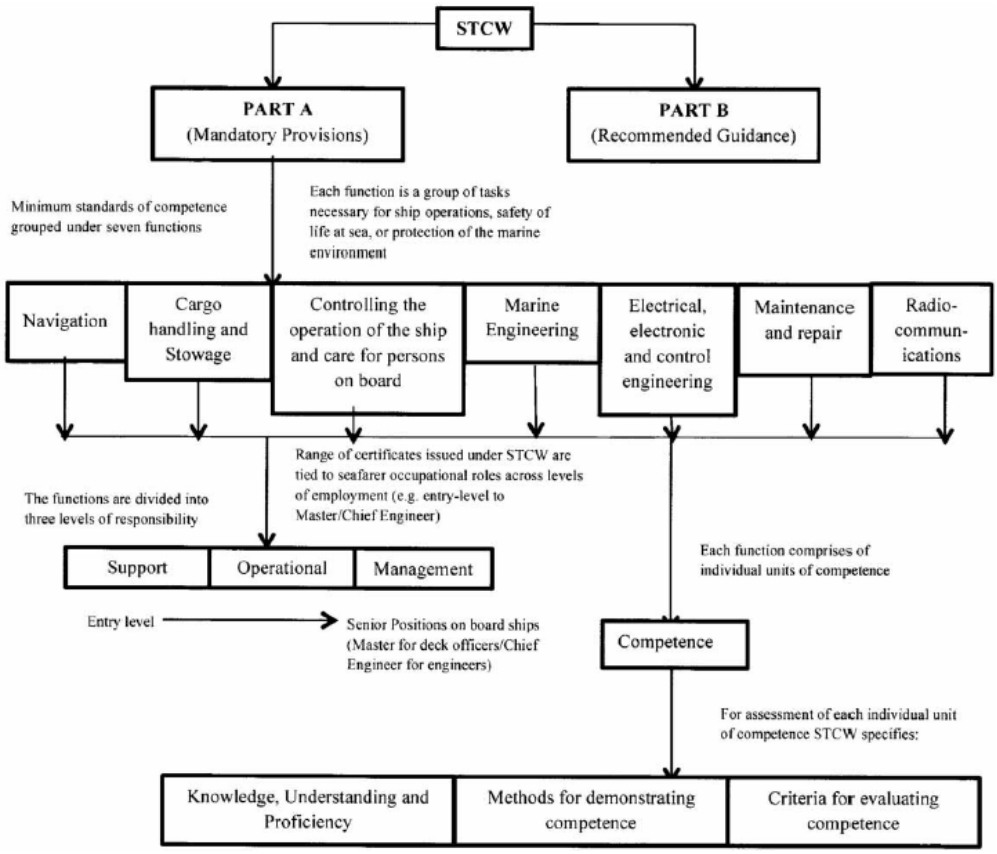

Figure 1: The structure of the STCW Code

Figure 1 (Source; Ghosh et al., 2014) outlines the structure of the latest version of the STCW Code 1995. The STCW Code applies to seafarers who are working or intending to work on commercial vessels on domestic or international voyages but not to those serving on naval vessels, government owned or operated vessels engaged in non-commercial service, fishing vessels, pleasure yachts not engaged in trade and wooden ships of primitive build. It provides guidance about the competence that needs to be developed to safely operate ships, with an aim to create consistent and uniform competence standards in a global industry. The original STCW Convention has been revised in 1995 and amended in 2010) since its conception in 1978 by the IMO. Currently, the revised STCW is referred to as STCW 95 as amended in 2010 Manila.

3 Skills and Competency Framework

In order to assess the suitability of the STCW Code to be categorised as a skills and competency framework, it is important to distinguish between the terms ‘competence’ and ‘competency’. Professional competence requires essential cognitive abilities of recalling information (knowledge) and applying it (skills) based on analytical and critical thinking (Nusche, 2008) while competencies are the knowledge, skills, and behavioural attributes that contribute to an individual’s ability to perform the professional task. In other words, competence is focused on the output, i.e., what people need to do to perform a job whereas competency is focused on input or behaviours that lie behind

competent performance (Emad and Roth 2009, 2016; Johns, 2023). In recent literature, the two terms (competence and competency) have become interchangeable due to a need to create a framework that can accommodate both terms to produce a workforce comprising of graduate employees who can perform in professional settings at expected standards (Johns, 2023).

The common perception is that qualifications, workplace training, and work experience while simultaneously assessing personal values and behavioural attributes are reliable indicators of professional competence. Notwithstanding the importance of the aforementioned parameters of competence measurement, a need to outline and describe an ideal set of behaviours and traits for successful workplace performance is needed. To ensure individuals perform to the expected standards, skills and competency frameworks can be particularly useful (MindTools, 2023).

A well-structured skills and competency framework will benefit the future MASS operators and their employers. With this framework, operators (or seafarers undertaking training to be operators) will have a comprehensive understanding of competencies expected of them. Gaps found in training (as seafarers will transit from conventional ships to MASS) may be found through a competency framework and targeted training can be deployed to address the gaps. The framework may also be used to highlight skills and competencies which will be highly valued across different industries (e.g., information technology or software management) and benchmark standards required for trainees to achieve for future successful performance (Gillis, 2023).

Hence, the competencies for MASS operations will need a structured and organised framework which not only identifies the knowledge and skills but defines the processes of the work to be done or roles to be performed. The framework needs to be set as a useful tool for providing clear descriptions for stakeholders to use as a guidance for developing training and regulatory requirements. Having clear guidance on the required competencies will allow the maritime industry to pair the individuals from the workforce with the required skills and enhance the performance of the employee to achieve organizational outcomes.

4 Mapping Skills and Competency Framework to the STCW Code

4.1 Components of a skills and competency framework

The components of a skills and competency framework differ on the different types of industry for which they are constructed. For example, the UNESCO competency framework includes core values, core competencies, and managerial competencies. However, Later on technical, inter- personal, techno-managerial, and strategic competencies have been added for particular industries (Kansal & Singhal, 2018). This paper expands the characteristics outlined by Gillis (2023) and Johns (2023) who stated that the framework should ideally include:

1. Core set of ethical values related to decision-making
    a. for example, seafarers should avoid oil spills into the sea when pumping out bilges and tanks
2. Core skills and competencies which are essential for the professional role
    a. for example, seafarers should be able to launch and operate a lifeboat or extinguish fires in emergencies
3. Functional competencies which are essential to specific ranks
    a. for example, a chief officer must be able to calculate the stability of the vessel
4. Meta competencies which are relevant to the profession but not directly required for employment

   a. for example, seafarers should ideally possess information technology (IT) skills, but it is not required for finding work on ships
5. Leadership competencies which refer to management skills
   a. for example, ship's master or chief engineer is expected to manage the ship's staff or members of their department.

A review of the STCW Code revealed that the core skills, functional, and leadership competencies are clearly outlined for seafarers intending to find employment on ships at support, operational, and management levels. One might argue that selected core set of ethical values are integrated into other units of competence included in the Code. For example, the unit of competence of 'Use of leadership and managerial skill' requires seafarers to have the knowledge and ability to apply decision-making techniques. The meta competencies were not found to be mentioned directly or as recommendations. However, the next section explains why simply listing the competencies does not automatically translate into a structured skills and competency framework.

4.2 Title, behaviours, and levels

According to Kansal & Singhal (2018), competencies listed in a skills and competencies framework should be observable and measurable as actions an employee from the workforce is expected to demonstrate while performing their role. Hence, every competency should be named, defined by clearly outlining the associated key behaviours. For example, the non-technical skill of 'Communication' for MASS operators may be defined as below in Table 1:

Title	Communication
Definition	MASS operators must evidence the ability to communicate operational breakdowns and technical specifications of machinery and equipment both onboard ships and in the Shore Control Centres. The MASS operators must be able to develop knowledge and information and share within and across locations, functions, or projects.
Key Behaviours	Establish mechanisms to analyse, evaluate, and report information; Coordinate the management and sharing of information and knowledge across departments and across disparate geographical workplaces.

Table 1: Example of how competencies may be defined for MASS operators

Table 1 is a suggestion and cannot be construed as an accepted definition. The review of the STCW Code revealed that although the Code outlined the knowledge, understanding, and proficiency; methods for demonstrating competence; and criteria for evaluating competence, it does not outline the definition of the competencies. For some units of competence, however, the behaviours have been vaguely outlined. For example, for the unit of competence of 'Use of managerial and leadership skill', the criteria for evaluating competence mentions "effective leadership behaviours are demonstrated" or "the crew are allocated duties and informed of expected standards or work…". Such descriptions, if vague, can be misconstrued or interpreted as per an individual's understanding.

Skills and competency framework are also expected to indicate the levels of competencies (for example, novice, practitioner, and proficient) required to succeed in different roles and responsibilities. Table 2 below provides an example of how the levels of proficiency for non-technical skill (Communication) may be outlined for MASS operators.

Competence	Support	Operational	Management
Communication	Establishes mechanisms to analyse, evaluate, and report information across different workplace locations. Coordinates the management and sharing of information and knowledge across departments & locations	Makes decisions based on research, analysis, and review of information and knowledge gathered across locations and time. Disseminates information to team members across locations.	Develops communication plans to engage internal and external stakeholders Represents themselves and the employer with authority and credibility in public forums and at events

Table 2: Example of different levels of proficiency for competencies required by MASS operators

One may argue that the STCW Code lays out the competencies for seafarers under the categories of support, operational, and management however, the behavioural attributes need to be expanded in detail for easy distinguishing and understanding of what is expected. For example, a unit of competence at operational level (Application of leadership and team working skills) and management level (Use of leadership and managerial skill) expect the seafaring students to demonstrate the "Effective leadership behaviours" but does not clearly state the attributes.

4.3 Explicit guidelines for outcome development

As mentioned in Section 3, competence is focused on the output, i.e., what people need to do to perform a job. However, a review of the STCW Code provided examples of how at times it provides standards of seafaring students' knowledge with suggested indicators of competence rather than providing 'standards' of demonstrated performance. This makes the STCW an input-based standard (Ghosh et al. 2014), which is in direct contradiction to the 'outcome-based' objective of a skills and competency framework. This is evident in this exemplary excerpt from the STCW Code, as depicted in Figure 2. Although it shows that the word 'respond' represents an action word that provides some indication of what the students should be able to do however, it is not indicating a definite 'standard' of how well it must be done.

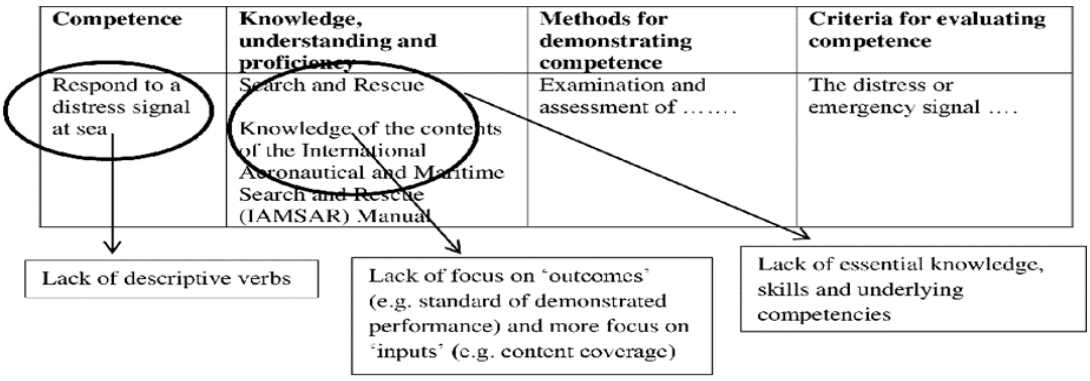

Figure 2: Extract from the STCW Code depicting it as an input-based system

5 Conclusion

Recent and ongoing research on MASS has focused on identifying and listing competencies which may be required for ship operations in the future. However, efforts must be put in organizing the identified competencies into a structured framework which may be used by the maritime stakeholders for training and recruitment of skilled marine workforce. The STCW Code, although not described as a skills and competency framework, has been doing a similar job by providing standards of competence for non-autonomous ship operators. This paper conducted a review of exemplary sections of the STCW Code to determine if it may be revised, restructured, or amended to include the competencies of the future ships and repurposed as a skills and competency framework. The review showed that the STCW Code does address certain elements of a competency framework but needs to modify its current structure and descriptions to define the competencies, describe the levels of proficiency, and outline the expected behavioural attributes explicitly. Doing so will ensure the framework is interpreted in a consistent manner by all stakeholders and result in seafarer or trainee graduates with high, expected standards of competence. Modifying the existing STCW Code may also find approval among its current users (IMO members) in comparison to introducing a new skills and competency framework which may be scrutinized, and thus result in delays in acceptance and implementation.

References

Bolbot, V., Methlouthi, O., Chaal, M., Banda, OV., et. al. (2022). Identification and analysis of educational needs for naval architects and marine engineers in relation to the foreseen context of Maritime Autonomous Surface Ships (MASS). Aalto University, School of Engineering (Mechanical Engineering), 2/2022, Helsinki, Finland. http://urn.fi/URN:ISBN:978-952-64-0826-2.

Ceylani, E., Kolcak, IC., & Solmaz, MS. (2022). A ranking of critical competencies for future seafarers in the scope of digital transformation. Proceedings of the International Association of Maritime Universities Conference, The 22nd IAMUC, Batumi, 20-21 Oct 2022

Emad, G., R. & Roth, W.-M. (2008). Contradictions in the Practices of Training for and Assessment of Competency: A Case Study from the Maritime Domain, Education + Training 50(3), 260–272.

Emad, G. R., & Roth, W.-M. (2009). Policy as Boundary Object: A New Way to Look at Educational Policy Design and Implementation, Vocations and Learning 2(1), 19–35.

Emad, G. R., & Roth, W.-M. (2016). Quasi-Communities: Rethinking Learning in the Adult and Vocational Formal Education, Instructional Science 44(6), 583—600.

Emad, G. R., Enshaei, H., & Ghosh, S. (2021). Identifying seafarer training needs for operating future autonomous ships: a systematic literature review. Australian Journal of Maritime and Ocean Affairs, 14(2): 114-135. Doi: 10.1080/18366503.2021.1941725.

Emad, G. R., & Ghosh, S. (2023). Identifying essential skills and competencies towards building a training framework for future operators of autonomous ships: a qualitative study. WMU Journal of Maritime Affairs. Doi: 10.1007/s13437-023-00310-9.

Ghosh, S., Bowles, M., Ranmuthugala, D., & Brooks, B. (2014). Reviewing seafarer assessment methods to determine the need for authentic assessment. Australian Journal of Maritime & Ocean Affairs, 6(1): 49-63. doi: 10.1080/18366503.2014.888133.

Ghosh, S., Bowles, M., Ranmuthugala, D., & Brooks, B. (2014). On a lookout beyond STCW: Seeking standards and context for the authentic assessment of seafarers. In Ranmuthugala, D. & Lewarn, B. (Ed). IAMU AGA 15 Looking Ahead: Innovation in Maritime Education, Training and Research, 27-30 October 2014, Launceston, Tasmania. Australian Maritime College, 77-86.

Gillis, AS. (2023). Competency Framework. TechTarget: HR Software.
https://www.techtarget.com/searchhrsoftware/definition/competency-framework.

Hogg, T., & Ghosh, S. (2016). Autonomous merchant vessels: Examination of factors that impact the effective implementation of unmanned ships. Australian Journal of Maritime & Ocean Affairs, 8(3), 206-222. doi: 10.1080/18366503.2016.1229244.

Johns, M. (2023). Competency Frameworks. Thomas. https://www.thomas.co/resources/type/hr-guides/competency-frameworks.

Kansal, J., & Singhal, S. (2018). Development of a competency model for enhancing the organisational effectiveness in a knowledge-based organisation. International Journal Indian Culture and Business Management. 16)3), 287-299.

Man, Y., Lundh, M., Porathe, T., & MacKinnon, S. (2015). From desk to field-human factor issues in remote monitoring and controlling of autonomous unmanned vessels. Procedia Manufacturing, 3, 2674-2681.

MindTools. (2023). Developing a competency framework. MindTools. https://www.mindtools.com/ad66dk2/developing-a-competency-framework.

Psaraftis, HN., & Kontovas, CA. (2020). Influence and transparency at the IMO: the name
of the game. Maritime Economics & Logistics, 22, 151-172.Doi: 1057/s41278-020-00149-4.

Nusche, D. (2008). Assessment of Learning Outcomes in Higher Education: A Comparative Review of Selected Practices OECD Education Working paper No.15. France: OECD Directorate of Education, pp.9-10

Shahbakhsh, M., Emad, G., & Cahoon, S. (2021). Industrial revolutions and transition of the maritime industry: The case of Seafarer's role in autonomous shipping. Asian Journal of Shipping and Logistics. https://doi.org/10.1016/j.ajsl.2021.11.004

Streng, M., & Kuipers, B. (2020). Chapter 7 - Economic, social, and environmental impacts of autonomous shipping strategies in T Vanelslander & C Sys (Ed), Maritime Supply Chains, Elsevier, 135-145.

UNESCO. (2023). UNESCO Competency Framework. United Nations Educational, Scientific, and Cultural Organization. https://en.unesco.org/sites/default/files/competency_framework_e.pdf.