Catching up with time? Examining the STCW competence framework for autonomous shipping

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Abstract – **The increased automation and digitalization in maritime industry has gradually changed the operational environment of ships and the competences required for seafarers. In the era of autonomy, these developments may dramatically restructure the work processes and require new competences to be acquired by the personnel involved in ship operations. The aim of this study is to explore the suitability of the existing STCW competence framework for Officers in Charge of a Navigational Watch (OICNW) under autonomy degree two as defined by IMO. A total number of n=82 OICNWs participated in a survey designed to evaluate the applicability of 66 Knowledge, Understanding and Proficiency items (KUPs) as listed in STCW Table A-II/1. An Exploratory Factor Analysis resulted in emergence of 9 factors that indicated the relevant competence themes for autonomy degree two operations. The findings are discussed with possible implications towards the training of future OICNW.**

***Keywords*:** Future competencies, STCW, Maritime Autonomous Surface Ships, Autonomy level, MASS

INTRODUCTION

Maritime industry is undergoing radical changes with the ongoing introduction of automation and digitalization (Kitada et al., 2018). Modern ships have bigger dimensions and more advanced support systems, though being manned by fewer specialized crew members than their predecessors. Introduction of autonomous ships is expected to be the next major technological step-change in shipping. The arguments in support of introducing autonomous ships range from economic reasons through increased efficiency to safety considerations (Brandsæter & Knutsen, 2018). They might also result in new modes of ship transportation than present. The era of autonomy, therefore could dramatically restructure the work processes and require new competences to be acquired by the personnel involved in the ship operations (Relling, Lützhöft, Ostnes, & Hildre, 2018).

The International Maritime Organization (IMO) is the global maritime authority for establishing the standards for safety, security and environmental performance of international shipping. To cope with the increasing industrial demands and accelerated technological development, IMO during its MSC 98th initiated a regulatory scoping exercise for the use of Maritime Autonomous Surface Ships (MASS). The intention of this scoping exercise is to consider human element, legal aspect and environmental concerns for the autonomous ships (IMO, 2017). In the context of autonomous ships, the skills and competences that are required for the officers in charge of a navigational watch is relatively unknown territory. There is a need for detailed investigation of the needed competencies in order to correspondingly address the novel training requirements of future OICNW. The Standards of Training, Certification & Watchkeeping convention (STCW 1978 as amended) – as one of the key instruments of IMO in regulating the minimum qualification for seafarers worldwide – provides the global benchmark for training of seafarers. It establishes the internationally accepted qualification standards for officers and ratings serving onboard merchant ships. In this paper, the suitability of the present competence framework as defined by STCW was investigated for autonomy degree two operations. The scope was narrowed down to the competence requirements for navigation officers in the operational level as defined in the STCW code, Part A, Chapter 2, Table A-II/1 (IMO, 2011).

Autonomy framework for maritime domain

In order to test the suitability of STCW regulations, it is important to clarify first the degrees of autonomy. Different organizations have proposed several definitions for autonomous shipping. In this paper, we aimed to use the MASS definitions as proposed during IMO MSC 100th session in 2018 (IMO, 2018)

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due to international profile of the respondents. According to this framework as illustrated in Figure 1, there are four degrees of autonomy wherein the first and the second degree, human operators are still present onboard the ship. OICNW remain onboard to maneuverer and control the shipboard systems in Degree one. Although some systems can be automated, but the control of the ship is performed onboard. However, in Degree two the ship is controlled from a remote location. The OICNW are available onboard to take control of the system if necessary. In Degree three, the ship is remotely controlled without any OICNW onboard. Whereas the Degree four, which refers to the ship that is completely autonomous in which the ship is able to determine the decisions and the actions by itself. Degree three and four, which has no human presence on ship is difficult to be realized in practice in near future due to liability issues (Wróbel, Montewka, & Kujala, 2017). In addition, according to article 3 (Application) of the STCW Convention, it is stipulated that the convention only applies to ships with seafarers on board. The regulatory scoping exercise on Maritime Autonomous Surface Ships (MASS) executed by the IMO Maritime Safety Committee for STCW is currently focusing on autonomy degree two (IMO, 2019). Accordingly, it is more reasonable to evaluate the suitability of STCW regulations under autonomy degree two operations.

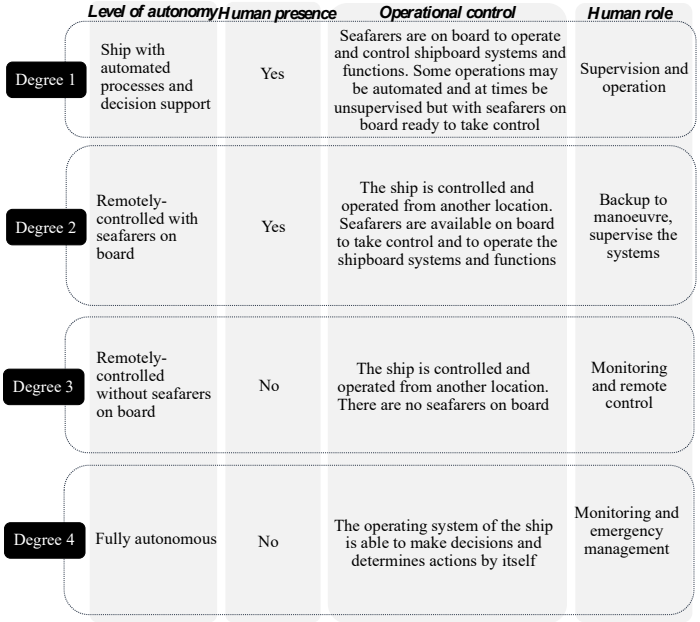

Figure 1. Four degrees of autonomy as defined by IMO (Adapted from Kim, Sharma, Gausdal, & Chae, 2019)

STCW regulations and codes for seafarer competence

Safety and efficiency of ship operations, protection of the marine environment and life at sea depends largely upon competent crew. The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) (IMO, 2011) was the first international convention to establish the minimum standards for navigational officers worldwide. This convention was introduced in the year 1978 and entered into force in 1984. It sets minimum qualification standards for masters, officers and watch personnel on seagoing merchant ships. The convention, after its establishment was revised in 1995 to include Competency Based Training which required concrete outcomes and a set of Knowledge, Understanding and Proficiency (KUPs) items that the qualified officers in charge of a navigational watch should demonstrate (Emad & Roth, 2008). The convention was further amended in 2010 and outlined new definitions for Electro-Technical Officers (ETO) and new training requirements with respect to use of ECDIS and also requiring training in leadership and teamwork, security-related familiarization, security-awareness training etc. In the era of autonomous operations, many of the routine operations are more likely to be automated (Porathe, 2019), and therefore it will be necessary to revise the competence requirements. The current version of STCW 1978 (as amended) has 19 competence themes consisting of 66 Knowledge, Understanding & Proficiency items (KUPs), which specifies the minimum standard of competence for officers in charge of a navigational watch on ships of 500 gross tonnage or more (IMO, 2011).

METHOD

The aforementioned 66 STCW Table A-II/1 KUPs have been used in a survey questionnaire, where respondents were asked to rate the suitability of each KUPs for degree two autonomous operations on a Likert scale from 1 (Extremely important) to 5 (Not at all important). The KUPs were not modified rather, the original text from STCW was followed in order to maintain the originality of the codes. The questionnaire was digitalized using platform Qualtrics™. The questionnaire was designed using "forced responses" function for the listed KUPs, so that there are no missing values and the respondents had to complete all the answers before proceeding further. Only completed responses will be recorded and reported to the researchers. Several demographic questions were also included at the end of the questionnaire to facilitate the understanding of survey responses. The questionnaire was then sent out to OICNW working on international merchant shipping industry through purposive non-random sampling approach using professional contacts. The survey data was collected from March to April 2019 period. A total number of 82 valid responses were registered out of 114 respondents (Response rate – 71.9%). The survey utilized an anonymous link with no personal

information being collected. The majority of respondents were from the tanker sector. The demographics data was collected for all the respondents (except 2 cases of missing values) and the information is summarized in Table 1.

Table 1. Demographic characteristics of the respondents

Range		Frequency	Percent
Industrial area	Shipping company	64	80.0
	Others	4	5.0
	Shipping management company	11	13.7
	Maritime training institute/provider	1	1.3
Shipping sectors	Wet Bulk (Tanker sector)	51	63.7
	Dry Bulk	5	6.3
	Cargo Liners and Container Ships	18	22.4
	Passenger Liners/Cruise Ships/Ferries	3	3.8
	Other shipping sectors	3	3.8
Year of experience	0-5 years	57	71.3
	6-10	9	11.2
	11-15	3	3.8
	+ 15 years	11	13.7

To ensure the respondents have a sufficient understanding regarding the definition of autonomy degree two, the questionnaire begins with an introduction of the autonomy framework by IMO. The analysis of data gathered was performed using the software SPSS™ version 25. The responses derived were then analysed using an Exploratory Factor Analysis (EFA). EFA is a multivariate statistical technique to reduce the large number of variables into smaller set of factors that represent the sets of co-related variables (Kilner, 2004; Tabachnick & Fidell, 1984). EFA allows the researchers to undertake parsimonious analysis, generate theory and also evaluate the construct validity of the measurement instrument (Williams, Onsman, & Brown, 2010). There are various guidelines available in the literature regarding the sample size for EFA. While some of the literature suggest a sample to variable ratio of 3:1, 4:1 or as large as 15:1 & 20:1, there are no absolute guidelines. In this regard, obviously the more the sample size is, the better conclusions can be drawn from the data. However, Bryman (1997) argued that at least a sample size equal or greater as the number of items in the measurement instrument should be present, which was possible in this study. The result, derived from the data analysis, is presented in the following section.

RESULTS

A Principal Component Analysis (PCA) was conducted on the 66 questionnaire items with varimax rotation. The Bartlett's test of sphericity was significant ($p<0.001$). KMO value signifying the measure of sampling adequacy was greater than 0.5. The descriptive statistics table is provided in Table 2. It also illustrates the 19 competences as described in Table A-II/1, as well as the range of KUPs i.e. the sequential order in which they cluster to form a specific competence.

Table 2. Descriptive statistics for all KUPs in Table A-II/1

	M	SD
Competence 1: Plan and conduct a passage and determine position		
KUP 1 Ability to determine the ship's position by use of celestial bodies	2.22	1.043
KUP 2 Ability to determine the ship's position by use of 1) landmarks, 2) aids to navigation, including lighthouses, beacons and buoys, 3) dead reckoning, taking into account winds, tides, currents and estimated speed	2.07	.979
KUP 3 Have thorough knowledge of and ability to use nautical charts, and publications, such as sailing directions, tide tables, notices to mariners, radio navigational warnings and ships' routeing information	2.06	.947
KUP 4 Ability to determine the ship's position by use of electronic navigational aids	1.65	.692
KUP 5 Ability to operate the equipment and apply the information correctly	1.77	.742
KUP 6 Have knowledge of the principles of magnetic and gyro-compasses	1.98	.846
KUP 7 Ability to determine errors of the magnetic and gyro-compasses, using celestial and terrestrial means, and to allow for such errors	2.39	1.141
KUP 8 Have knowledge of steering control systems, operational procedures and change-over from manual to automatic control and vice versa. Adjustment of controls for optimum performance	1.91	.864
KUP 9 Ability to use and interpret information obtained from shipborne meteorological instruments	2.50	.892
KUP 10 Have knowledge of the characteristics of the various weather systems, reporting procedures and recording systems	2.22	.956
KUP 11 Ability to apply the meteorological information available	2.34	.864
Competence 2: Maintain a safe navigational watch		
KUP 12 Have thorough knowledge of the content, application and intent of the International Regulations for Preventing Collisions at Sea, 1972, as amended	1.82	.818
KUP 13 Have thorough knowledge of the Principles to be observed in keeping a navigational watch	2.16	1.000
KUP 14 Proficient in use of routeing in accordance with the General Provisions on ships' routeing	2.38	.884
KUP 15 Proficient in use of information from navigational equipment for maintaining a safe navigational watch	1.90	.826
KUP 16 Have knowledge of blind pilotage techniques	2.39	.940
KUP 17 Proficient in use of reporting in accordance with the General Principles for Ship Reporting Systems and with VTS procedures	2.21	.885
KUP 18 Knowledge of bridge resource management principles, including 1) allocation, assignment, and prioritization of resources, 2) effective communication 3) assertiveness and leadership, 4) obtaining and maintaining situational awareness, 5) consideration of team experience	2.17	1.004
Competence 3: Use of radar and ARPA to maintain safety of navigation		
KUP 19 Have knowledge of the fundamentals of radar and automatic radar plotting aids (ARPA)	1.99	.762
KUP 20 Ability to operate and to interpret and analyse information obtained from radar and ARPA performance, including 1) factors affecting performance and accuracy, 2) setting up and maintaining displays, 3) detection of misrepresentation of information, false echoes, sea return, etc., racons and SARTs	1.88	.744

KUP 21 Ability to operate and to interpret and analyse information obtained from radar and ARPA use, including 1) range and bearing; course and speed of other ships; time and distance of closest approach of crossing, meeting overtaking ships, 2) identification of critical echoes; detecting course and speed changes of other ships; effect of changes in own ship's course or speed or both, 3) application of the International Regulations for Preventing Collisions at Sea, 1972, as amended, 4) plotting techniques and relative- and true-motion concepts, 5) parallel indexing	1.91	.789
KUP 22 Awareness of principal types of ARPA, their display characteristics, performance standards and the dangers of over-reliance on ARPA	2.12	.760
KUP 23 Ability to operate and to interpret and analyse information obtained from ARPA, including 1) system performance and accuracy, tracking capabilities and limitations, and processing delays, 2) use of operational warnings and system tests, 3) methods of target acquisition and their limitations, 4) true and relative vectors, graphic representation of target information and danger areas, 5) deriving and analysing information, critical echoes, exclusion areas and trial manoeuvres	1.94	.759
Competence 4: Use of ECDIS to maintain the safety of navigation		
KUP 24 Have knowledge of the capability and limitations of ECDIS operations, including 1) a thorough understanding of Electronic Navigational Chart (ENC) data, data accuracy, presentation rules, display options and other chart data formats, 2) the dangers of over-reliance, 3) familiarity with the functions of ECDIS required by performance standards in force	1.76	.779
KUP 25 Proficient in operation, interpretation, and analysis of information obtained from ECDIS, including 1) use of functions that are integrated with other navigation systems in various installations, including proper functioning and adjustment to desired settings, 2) safe monitoring and adjustment of information, including own position, sea area display, mode and orientation, chart data displayed, route monitoring, user-created information layers, contacts (when interfaced with AIS and/or radar tracking) and radar overlay functions (when interfaced), 3) confirmation of vessel position by alternative means, 4) efficient use of settings to ensure conformance to operational procedures, including alarm parameters for anti-grounding, proximity to contacts and special areas, completeness of chart data and chart update status, and backup arrangements, 5) adjustment of settings and values to suit the present conditions	1.80	.793
Competence 5: Respond to emergencies		
KUP 26 Ability to take precautions for the protection and safety of passengers in emergency situations	1.46	.632
KUP 27 Ability to take initial actions following a collision or a grounding; and ability to assess initial damage and perform control	1.40	.626
KUP 28 Appreciate the procedures to be followed for rescuing persons from the sea, assisting a ship in distress, responding to emergencies which arise in port	1.54	.706
Competence 6: Respond to a distress signal at sea		
KUP 29 Have knowledge of the contents of the International Aeronautical and Maritime Search and Rescue (IAMSAR) Manual	1.84	.853
Competence 7: Use the IMO Standard Marine Communication Phrases and use English in written and Oral form		
KUP 30 Have adequate knowledge of the English language to enable the officer to use charts and other nautical publications, to understand meteorological information and messages concerning ship's safety and operation, to communicate with other ships, coast stations and VTS centres and to perform the officer's duties also with a multilingual crew, including the ability to use and understand the IMO Standard Marine Communication Phrases (IMO SMCP)	1.71	.762
Competence 8: Transmit and receive information by visual signalling		
KUP 31 Ability to use the International Code of Signals	2.04	.949
KUP 32 Ability to transmit and receive, by Morse light, distress signal SOS as specified in Annex IV of the International Regulations for Preventing Collisions at Sea, 1972, as amended, and appendix 1 of the International Code of Signals, and visual signalling of single-letter signals as also specified in the International Code of Signals	2.23	1.169
Competence 9: Manoeuvre the ship		
KUP 33 Have knowledge of ship manoeuvring and handling, including knowledge of 1) the effects of deadweight, draught, trim, speed and under-keel clearance on turning circles and stopping distances, 2) the effects of wind and current on ship handling, 3) manoeuvres and procedures for the rescue of person overboard, 4) squat, shallow-water and similar effects, 5) proper procedures for anchoring and mooring	2.09	.905
Competence 10: Monitor the loading, stowage, securing, care during the voyage and the unloading of cargoes		
KUP 34 Have knowledge of the effect of cargo, including heavy lifts, on the seaworthiness and stability of the ship	2.02	.981
KUP 35 Have knowledge of safe handling, stowage and securing of cargoes, including dangerous, hazardous and harmful cargoes, and their effect on the safety of life and of the ship	1.76	.840
KUP 36 Ability to establish and maintain effective communications during loading and unloading	2.10	1.001
Competence 11: Inspect and report defects and damage to cargo spaces, hatch covers and ballast tanks		
KUP 37 Have knowledge and ability to explain where to look for damage and defects most commonly encountered due to 1) loading and unloading operations, 2) corrosion, 3) severe weather conditions	1.93	.886
KUP 38 Ability to state which parts of the ship shall be inspected each time in order to cover all parts within a given period of time	2.27	.802
KUP 39 Ability to identify those elements of the ship structure which are critical to the safety of the ship	1.91	.773
KUP 40 Ability to state the causes of corrosion in cargo spaces and ballast tanks and how corrosion can be identified and prevented	1.98	.875
KUP 41 Have knowledge of procedures on how the inspections shall be carried out	2.20	.999
KUP 42 Ability to explain how to ensure reliable detection of defects and damages	1.99	.778
KUP 43 Have understanding of the purpose of the "enhanced survey programme"	2.45	.996
Competence 12: Ensure compliance with pollution prevention requirements		
KUP 44 Have knowledge of the precautions to be taken to prevent pollution of the marine environment	1.68	.887
KUP 45 Awareness of anti-pollution procedures and all associated equipment	1.91	.892
KUP 46 Awareness of importance of proactive measures to protect the marine environment	1.84	.923
Competence 13: Maintain seaworthiness of the ship		
KUP 47 Have working knowledge and application of stability, trim and stress tables, diagrams and stress-calculating equipment	2.10	.883
KUP 48 Have understanding of fundamental actions to be taken in the event of partial loss of intact buoyancy	2.27	.917
KUP 49 Have understanding of the fundamentals of watertight integrity	2.24	.910
KUP 50 Have general knowledge of the principal structural members of a ship and the proper names for the various parts	2.30	.965
Competence 14: Prevent, control and fight fires onboard		
KUP 51 Ability to organize fire drills	1.85	.970
KUP 52 Have knowledge of classes and chemistry of fire	1.85	.970
KUP 53 Have knowledge of fire-fighting systems	1.66	.773
KUP 54 Have knowledge of action to be taken in the event of fire, including fires involving oil systems	1.71	.824

Competence 15: Operate life-saving appliances		
KUP 55 Ability to organize abandon ship drills and knowledge of the operation of survival craft and rescue boats, their launching appliances and arrangements, and their equipment, including radio life-saving appliances, satellite EPIRBs, SARTs, immersion suits and thermal protective aids	1.76	.869
Competence 16: Apply medical first onboard ship		
KUP 56 Awareness of the practical application of medical guides and advice by radio, including the ability to take effective action based on such knowledge in the case of accidents or illnesses that are likely to occur on board ship	1.96	.793
Competence 17: Monitor compliance with legislative requirements		
KUP 57 Have basic working knowledge of the relevant IMO conventions concerning safety of life at sea, security and protection of the marine environment	1.96	.867
Competence 18: Application of leadership and teamworking skills		
KUP 58 Have working knowledge of shipboard personnel management and training	2.34	.919
KUP 59 Have knowledge of related international maritime conventions and recommendations, and national legislation	2.09	.919
KUP 60 Ability to apply task and workload management, including 1) planning and co-ordination, 2) personnel assignment, 3) time and resource constraints, 4) prioritization	2.44	.876
KUP 61 Have knowledge and ability to apply effective resource management, including 1) allocation, assignment, and prioritization of resources, 2) effective communication onboard and ashore, 3) decisions reflect consideration of team experiences, 4) assertiveness and leadership, including motivation, 5) obtaining and maintaining situational awareness	2.24	.924
KUP 62 Have knowledge and ability to apply decision-making techniques, including 1) situation and risk assessment, 2) identify and consider generated options, 3) selecting course of action, 4) evaluation of outcome effectiveness	2.12	.852
Competence 19: Contribute to the safety of personnel and ship		
KUP 63 Have knowledge of personal survival techniques	1.70	.781
KUP 64 Have knowledge of fire prevention and ability to fight and extinguish fires	1.61	.662
KUP 65 Have knowledge of elementary first aid	1.74	.814
KUP 66 Have knowledge of personal safety and social responsibilities	1.68	.718

The authors examined the factor loading of all the KUPs and removed the KUPs that did not load on any of the major components, with a score of more than 0.4. An initial analysis was run to obtain the eigenvalues greater than 1 for the components in the data. 18 components (factors) had eigenvalues over 1 and together explained 77.2% of the variance. However, there were 9 components that were having loading from only single item and therefore were not retained as factors. The remaining factors that were extracted composed of at least 2 items. The combination explained 58.2% of the variance present in the data. Table 3 shows the factor loading after rotation.

Out of the 9 factors extracted in the analysis, factors 1, 2, 3, 5, & 6 represented existing competence themes as presented in Table 1. However, the factors 4, 7, 8 & 9 did not include all the KUPs from specific competence themes and therefore were assigned new labels. Factor 1 represents the KUPs from 51-54 that have perfectly overlapped with the competence 14 outlined in Table A-II/1. Thus, this factor retains the original name as "*Prevent, control and fight fires onboard*", which indicated that this competence theme would still be relevant under autonomy level two operation.

Table 3. Rotated component matrix for the extracted factors

	Component								
	1	2	3	4	5	6	7	8	9
KUP 53	.840								
KUP 52	.804								
KUP 54	.787								
KUP 51	.658								
KUP 20		.782							
KUP 19		.745							
KUP 22		.705							
KUP 61			.848						
KUP 60			.718						
KUP 58			.677						
KUP 62			.630						
KUP 15				.706					
KUP 6				.671					
KUP 13				.635					
KUP 25				.616					
KUP 63					.751				
KUP 66					.705				
KUP 65					.691				
KUP 64					.611				
KUP 44						.822			
KUP 46						.820			
KUP 45						.782			
KUP 35							.743		
KUP 28							.612		
KUP 2								.827	
KUP 1								.804	
KUP 17									.800
KUP 31									.760

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 59 iterations.

Factor 2 represents the KUP 19, 20 and 22. It also largely represented the competence 3 "*Use of radar and ARPA to maintain the safety of navigation*". The KUP 23 was dropped due to low factor loading (<0.4). Having the abilities to analyze and interpret information obtained from radar and ARPA is still being considered as a dominant competence. KUP 58, 60, 61 and 62 falls under competence 18 "*Application of leadership and teamworking skills*". KUP 59 was excluded due to low factor loading (<0.4). Factor 4 included KUP 6, 13, 15, 25, which was assigned a new label as "*Watchkeeping with the aid of navigational equipment*". Factor 5 included KUP 63, 64, 65 and 66, which perfectly corresponded to competence 19 of STCW Table A-II/1 and therefore the original label "*Contribute to the safety of ship and the personnel*" was kept. Factor 6 contained KUP 44, 45 and 46 which perfectly overlapped with competence 12 titled "*Ensure compliance with pollution prevention requirements*". Factor 7 had KUPs 28 and 35. These 2 KUP were – "*Appreciate the procedures to be followed for rescuing persons from the sea, assisting a ship in distress, responding to emergencies which arise in port*" and "*Have knowledge of safe handling, stowage and securing of cargoes, including dangerous, hazardous and harmful cargoes, and their effect on the safety of life and of the ship*". We labelled this

factor as "*Abilities to respond in emergencies and cargo management skills*". Factor 8 included the KUPs 1 and 2 which were labelled as competences "*Celestial & Terrestrial navigation skills*" on the account it constitutes KUPs 1 and 2. Finally, the factor 9 was labelled as "*Maintain safe navigation based on understanding of visual signal*".

A reliability analysis of the extracted factors was performed resulting in the following scores for each factor as illustrated in the Table 4 below.

Table 4. Reliability measures of the extracted factors

Component	No. of items	Cronbach' s α
1	4	0.852
2	3	0.819
3	4	0.810
4	4	0.759
5	4	0.792
6	3	0.852
7	2	0.555
8	2	0.769
9	2	0.657

DISCUSSION

The 66 KUPs of the Table A-II/1 were rated on a Likert scale from 1 (Extremely important) to 5 (Not at all important). The most relevant KUP score was achieved by the KUP no. 27 "*Ability to take initial actions following a collision or grounding; and ability to assess initial damage and perform control*", followed by no. 26 "*Ability to take precautions for the safety of passengers in emergency situations*". This highlights the relative importance placed by the respondents on emergency management procedures in the autonomy degree two operations. The least relevant KUP score was achieved by no. 9 "*The ability to use and interpret the information obtained from shipborne meteorological instrument*", followed by no. 43 "*Have understanding of the purpose of the "enhanced survey programme*". The new set of competences derived through EFA are illustrated in Table 5 below.

Table 5. Competences derived through EFA for navigation officers for Degree 2 autonomous operations

No.	Competences
1	Prevent, control and fight fires onboard
2	Use of radar and ARPA to maintain the safety of navigation
3	Application of leadership and teamworking skills
4	Watchkeeping with the aid of navigational equipment
5	Contribute to the safety of ship and the personnel
6	Ensure compliance with pollution prevention requirements
7	Abilities to respond in emergencies & cargo management skills
8	Celestial & Terrestrial navigation skills
9	Maintain safe navigation based on understanding of visual signal

The results demonstrate that only some of the KUPs were rated relevant by the respondents, which implies that with the altered work characteristics with increased automation in Degree two autonomous operations may mean that some of the present KUPs required by the navigators will become obsolete and require new and more specific competence themes to be acquired. Appropriate re-skilling of the navigators will therefore be required to adequately cater to new operational demands.

Safety and efficiency of ship operations, protection of the marine environment and life at sea largely depends upon competent crews. This study was a step towards investigating the suitability of present STCW 1978 framework for the future competencies of the OICNW. The aim was to examine the relevance of competences and evaluate the individual KUP items to contribute in the discussion with respect to training and education of future navigators. However, several limitations of the study need to be mentioned. First of all, comprehensive understanding regarding the technical aspect of autonomous shipping should be prerequisite when considering the future competencies of the navigators. Future studies should explore the technological advancements jointly with the required competences. Secondly, the majority of the respondents had relatively less experience in merchant shipping industry. Thirdly, the method utilized i.e. EFA has also certain inherent limitations. The KMO measure was relatively low, indicating the need for larger sample size. Future studies should be directed in collection of more samples to ensure better generalizability of the results and in examining the suitability of other competence requirements stipulated in STCW 1978 as amended (e.g. Table A-II/2), as well as for roles within other departments in merchant shipping sector such as marine engineer officers. Such investigation carried out by different stakeholders could aid the revision and integration of changes that will be required for the STCW regulations to prepare competent seafarers for the dynamically evolving nature of autonomous shipping. This research aims to pave the way for academic community to delve deeper in to understanding the requirement of competence for seafarers to achieve appropriate training solutions.

CONCLUSION

Maritime industry is undergoing radical changes with the technological advancement and fast introduction of automation technologies. To cope with increasing industrial demand and accelerated technological development, the global standard of maritime training and certification will also require revision and adaption. This paper had initiated a preliminary exploration regarding the suitability of existing STCW framework for the OICNW under the MASS

autonomy degree two. The results have highlighted that several competences remain significant for future OICNW. However, some competences reviewed to come across as less important when some functions are taken over by automation technologies. Future research directions should look more closely into the necessary competences for the OICNW across different levels of autonomy and ensure that future OICNW are equipped with sufficient levels of competence to excel in the era of autonomous shipping.

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