Mersin University Journal of Maritime Faculty

Mersin University Journal of Maritime Faculty (MEUJMAF)
Vol. 5, Issue 1, pp. 7-14, June 2023
e-ISSN 2687-6612, Türkiye
DOI: 10.47512/meujmaf.1297401
Research Article

A LONGITUDINAL STUDY ON KNOWLEDGE, SKILLS AND ATTITUDES OF NEWLY GRADUATED MARINE ENGINEERS[a]

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Received: 15/05/2023 Accepted: 17/06/2023

According to the Organisation for Economic Co-operation and Development (OECD, 2023), maritime transportation, which accounts for approximately 90% of international trade, is the primary mode of transportation for global trade. In order to meet the diverse and essential needs of people around the world (such as oil, food, flour, electronics, textiles, etc.), world maritime trade must continue uninterrupted and without interruption. This continuity is ensured through thousands of ships with various characteristics that are constantly in motion on the world's seas. Marine engineers responsible for the operation, maintenance, upkeep, and repairs of the electrical generation systems, boiler systems, propulsion systems, and the operations of these systems, as well as the ability to make quick and accurate judgments during potential failures in the engine room while the ship is underway, are among the most important actors involved in this mobility. This study aims to examine the knowledge, skills, and attitudes of newly graduated marine engineers and determine whether these attributes have changed within a 15-year period. To achieve this goal, the data collection form (questionnaire) used in the author's master's thesis published in 2008 was revised and data was collected through face-to-face interviews with 33 experts who possess similar qualifications. The data obtained in 2023 and the data obtained from the master's thesis published in 2008 were analyzed using the SPSS 15.0 program, and the findings were compared longitudinally. As a result of the study, it was determined that the averages of the knowledge, skills, and attitudes possessed by newly graduated marine engineers have increased by 0.52% over a 15-year period.

Keywords: *Maritime Education, Marine Engineering, Longitudinal Comparison*

[a] The study was derived using the author's master's thesis.

1. INTRODUCTION

The aim of this study is to examine the knowledge, skills, and attitudes of newly graduated ship machinery operation engineers and to determine whether these aspects have changed over the course of 15 years. In pursuit of this aim, the data collection form (questionnaire) used in the author's 2008 master's thesis was revised and data was collected through face-to-face interviews with 33 experts with similar qualifications. The data obtained in 2023 and from the master's thesis published in 2008 were analyzed using the SPSS 15.0 program, and the findings were longitudinally compared. As a result of the study, it was determined that the averages of the knowledge, skills, and attitudes possessed by newly graduated ship machinery operation engineers increased by 0.52 over a period of 15 years

The sea transportation, which is considered as the main mode of global trade and covers approximately 90% of it (OECD, 2023), is carried out through various actors that coordinate sea and land transportation. It is essential to continue world maritime trade without interruption to meet the various essential needs of people around the world such as oil, food, flour, electronics, textiles, etc. Some of the actors involved in this mobility are marine engineers, long-distance watch officers, shipowners, freight forwarders, and ship agents. Marine engineers, who are responsible for the electricity generation systems, boiler systems, propulsive power systems, the operation, maintenance, attitude, and repairs of these systems, and must make quick and accurate judgments and support them during possible malfunctions in the engine room during navigation, are among the most important actors involved in this mobility. The subject of this study, marine engineering, is among the most important actors in international maritime transportation with their responsibilities for the electricity generation, boiler, propulsive power systems, their operation, maintenance, attitude, and repairs of these systems, as well as their obligation to make quick and accurate judgments and support them during possible malfunctions in the engine room during navigation.

In Turkey, there are institutions and organizations that provide undergraduate and graduate education in marine engineering. The major ones are Dokuz Eylül University, Istanbul Technical University, Piri Reis University, Yıldız Technical University, Bandırma Onyedi Eylül University, İskenderun Technical University, Girne University, and Karadeniz Technical University. In these educational institutions, marine engineering students are aimed to be individuals with total quality, safety, security, and environmental management philosophy, as well as self-confident, self-disciplined, leadership skills, researcher, questioning, lifelong learners, teamwork skills, social responsibility awareness, analytical thinking and practical skills, and have knowledge of maritime customs, traditions, and practices (www.deu.edu.tr, 2023).

In this study, the variables of the knowledge, skills, and attitudes that marine engineers should have, which were identified by the author in 2002 (Nuran, 2008), will be analyzed, and the extent to which new graduate marine engineers have these knowledge, skills, and attitudes will be determined, and these outputs will be compared with the outputs obtained in 2008, and it will be aimed to reveal whether these knowledge, skills, and attitudes have changed in 15 years. Another important output expected from the study is to determine the expectations and needs of decision-makers working in sectors that will employ marine engineering graduates regarding new graduate marine engineers.

It is anticipated that the outcomes of this study will contribute to the development or revision of training materials and curricula for institutions providing marine engineering education, the evaluation of performance of marine engineering officers employed by maritime companies, the establishment of in-service training strategies as necessary, and the development of new strategies for career planning of both current and prospective graduates and students in the field of marine engineering.

2. LITERATURE

Marine engineering is a field of engineering responsible for the operation, maintenance, attitude, and repair of electric power systems, boiler systems, propulsion systems, and their operations on ships. Marine engineers are also responsible for ensuring that wastewater systems, fuel transfer systems, lighting systems, ventilation, and fresh water systems on ships are functioning properly and maintained regularly (Nuran, 2008).

Although the digitalization process has accelerated in many sectors worldwide, especially since the COVID-19 pandemic that affected the entire world, starting in 2019, the maritime industry has not yet reached the stage of 'fully automated ships' in current world maritime trade processes. Therefore, there is still a need for many seafarers/ship crew members to make international maritime trade possible (Sokolovskaya, 2020; Barnes 2020; Özispa ve Arabelen, 2022). Successful and efficient management of both land and sea organizations is essential for sustainable international maritime trade. Indeed, even with a highly efficient land organization, the efficiency of this land organization will not be sustainable without ship personnel who have the same skills (Şakiroğlu, 2007). Therefore, the training process for all seafarers, including marine engineering operations engineers who actively participate in international maritime trade, is of great importance. Personnel resources and their usage methods of maritime companies show a structure that varies from country to country depending on the macro-environmental factors of the maritime industry. The unique policies of companies, the structure and features of the ship to be equipped, and the flag carried by the ship can be listed as the main reasons for these differences (Şakiroğlu, 2007).

Considering the nature and multidisciplinary structure of the maritime industry, it is evident that minimizing these differences and even eliminating them entirely is essential for the safety of the process. For this purpose, institutions such as Maritime Education and Training (MET) and the International Maritime Organization (IMO) have established specific standards to eliminate these differences from the education process of seafarers, starting with the necessary skills and competencies (STCW, 2010). While Maritime Education and Training (MET) plays a crucial role in imparting the necessary skills and competencies to seafarers to perform efficiently in the workplace (Basak, 2017), the International Convention on Standards of Training,

Certification, and Watchkeeping for Seafarers (STCW 2010), which is compulsory for seafarer education by IMO, sets minimum standards for seafarer education and training worldwide.

The convention, which is mandatory for seafarer education by IMO, clearly defines the expected competency standards, relevant knowledge, understanding and competence, and, more importantly, the methods and evaluation criteria for demonstrating such competence. This is necessary to ensure that seafarers have the knowledge and skills to work on ships safely and efficiently (STCW, 2010)

The contract, which is mandated by IMO for seafarer training, clearly specifies the expected competency standards, the necessary relevant knowledge, understanding and skills, and more importantly, the methods to demonstrate and assess such competency. This is crucial for the STCW Convention, which is a paradigm heavily influenced by competency-based training and requires specific practical and performance-based outcomes (Manuel, 2017).

The STCW Convention, with the 2010 Manila amendments, includes both mandatory standards (Part A) and recommended guidance (Part B) for the education and training of marine engineering officers. The relevant learning objectives and assessment criteria, along with the expected minimum competency standard for operational, management, and support-level marine engineers, are described from Table A-III/1 to Table A-III/5 in STCW Section III. The minimum requirements for the qualifications of watchkeeping engineers/officers at the operational level are presented below as 17 items

1. Maintaining a safe engineering watch
2. Using English language in written and oral communication
3. Using internal communication systems
4. Operating main and auxiliary machinery and related control systems
5. Operating fuel, lubrication, ballast, and other pumping systems and related control systems
6. Operating electrical, electronic, and control systems
7. Dealing with maintenance and repair of electrical and electronic equipment
8. Properly using hand tools, machine tools, and measuring instruments for ship manufacturing and repair
9. Dealing with maintenance and repair of ship machinery and equipment
10. Compliance with pollution prevention requirements
11. Maintaining the seaworthiness of the ship
12. Preventing, controlling, and extinguishing fires on board
13. Operating necessary life-saving equipment
14. Applying medical first aid on board
15. Monitoring compliance with regulatory requirements
16. Applying leadership and teamwork skills
17. Contributing to personnel and ship safety (STCW, 2010).

According to the International Chamber of Shipping, there are nearly 1.7 million certified and qualified seafarers worldwide, and developing countries account for more than half of the global supply with approximately 900,000 seafarers (ICS, 2020). In our country, there are 9578 deck officers with long-term licenses and 3464 engineering officers who undertake the task of ensuring safe navigation by meeting the minimum requirements of the above-mentioned STCW qualifications. However, due to the severity of working conditions at sea, only 50% of them are active in the sea working life. Currently, there are 8 universities in our country, including 6 in Turkey and 2 in the Turkish Republic of Northern Cyprus, offering Marine Engineering programs. In 2022, 402 students were registered in these universities (Pirireis, 2023). The importance of marine engineering education is also reflected in industry demand. According to the Bureau of Labor Statistics, employment in marine engineering and naval architecture is expected to increase by 2% from 2020 to 2030, driven by strong demand for professionals with knowledge and experience in new technologies and sustainable design (BLS, 2021).

As of 2008, there was still a shortage of employment opportunities for marine engineering graduates. The education of marine engineering has been changing in recent years for various reasons, and learning how to learn has become increasingly important thanks to the constantly evolving science and technology. In this context, this study aims to longitudinally examine the knowledge, skills, and attitudes of marine engineering graduates, especially new graduates who are considered to need the ability to work with international personnel and interdisciplinary teams in companies that operate internationally (Vervoort and Cools, 2010). The findings from this study are expected to contribute to the improvement of the education process for marine engineering students.

3.METHOD AND APPROACH

The purpose of this study is to investigate the knowledge, skills, and attitudes of new marine engineering graduates and to determine whether these have changed in the past 15 years. To this end, the data collection form (questionnaire) used in the author's 2008 thesis has been revised for current conditions.

The data collection form used in this study was compiled from employer surveys conducted by ABET (Accreditation Board for Engineering and Technology) and the Yıldız Technical University Faculty of Construction in 2002-2003, and was enriched with some professional and attitudinal questions believed to encompass the internal dynamics of the marine engineering profession. This data collection form was sent to 3 technical managers and 2 personnel managers working in various maritime companies for testing in 2008, and was revised based on the feedback received from this preliminary evaluation to its final version used in 2008. In 2023, the same data collection form was used, but some variables included in the original study had become outdated over the past 15 years and were therefore excluded from the scope. The resulting data collection form consists of 39 questions, including 3 demographic questions, 5 nominal questions (yes/no), and 39 Likert scale questions specifically designed to assess the knowledge, skills, and attitudes of new marine engineering graduates. The 39 variables used to evaluate the knowledge, skills, and attitudes of new marine

engineering graduates are listed below."

1. The ability to apply the fundamental principles of mathematics, natural sciences, social sciences, and engineering to the practice of marine engineering.
2. The ability to identify engineering problems.
3. The ability to define engineering problems.
4. The ability to solve engineering problems.
5. The ability to design engineering systems.
6. Sensitivity to the national and international impacts of engineering solutions on society and the environment.
7. The ability to design experiments, collect data, analyze and interpret results.
8. The ability to use modern engineering techniques and tools as well as information and communication technologies effectively.
9. The ability to work in single and multi-disciplinary teams.
10. The ability to work independently.
11. The effort to constantly renew oneself by following developments in science and technology.
12. The ability to communicate effectively in Turkish both orally and in writing.
13. The ability to communicate effectively in English both orally and in writing.
14. The ability to exhibit professional ethics.
15. The effort to stay informed about current professional issues.
16. Awareness of quality.
17. The knowledge and skills to install marine engineering equipment.
18. The knowledge and skills to operate marine engineering equipment.
19. The knowledge and skills to analyze and solve complex problems in marine engineering.
20. The knowledge and skills to analyze statistical data.
21. The ability to bring original and alternative solutions to problems.
22. The ability to understand and interpret project and report prepared by others.
23. The ability to follow the necessary bureaucratic process for the conduct of work.
24. Efficiency in terms of productivity and timing.
25. Skills to be able to make judgments in solving problems
26. Skills to determine/evaluate economic and technical criteria in material selection
27. Willingness to participate in in-service and/or external continuous training for professional development
28. Knowledge and skills to use current professional computer software
29. Skills to form a team and lead it
30. Skills to understand and implement internal company standards and specifications
31. Knowledge and skills to understand and follow global economic and legal issues related to the profession
32. Willingness to follow professional information sources (magazines, books, etc.)
33. Skills to behave in accordance with maritime customs and traditions
34. Lifelong learning skills
35. Written reporting knowledge and skills
36. Knowledge and skills to take necessary measures related to job safety
37. Analytical thinking knowledge and skills
38. Ability to adapt to marine life
39. Skills to work with multinational personnel

In the original study published in 2008, the sample was limited to individuals working as technical directors, personnel managers, and machinery inspectors in maritime companies engaged in long-distance sea transportation. These individuals were preferred because it was thought that their previous actual ship experience as well as office experience would provide a broader perspective during the analysis. Additionally, it was evaluated as another preference reason that individuals in these positions regularly perform performance evaluations of all ship employees according to company policies. In this study, which aims to make a longitudinal evaluation and comparison, quota sampling method was used to reach a sample with the characteristics of the sample reached in the original study. The data obtained from 33 experts working as technical directors, personnel managers, machinery inspectors, and chief engineers in long-distance sea transportation maritime companies operating in Izmir and Istanbul, which are considered as two major metropolitan cities in Turkey, were analyzed through the SPSS statistical analysis program.

4. FINDINGS

The findings obtained at the end of the study were analyzed under three main headings: demographic findings of the experts participating in the study, nominal findings aimed at accessing summary information regarding the expectations of maritime companies from new graduates, and findings related to the knowledge, skills, and attitudes of new graduate marine engineers.

4.1. Demographic findings of the experts participating in the study

Table 1 shows the demographic characteristics of the experts interviewed in 2008 and 2023 within the scope of the study

Table 1: Findings Regarding the Demographic Data of the Experts Participating in the Research

	2008		2023	
	No	Percent	No	Percent
Ocean Going Chief Engineer/master qualified	9	27,27	10	30,30
Technical Manager	4	12,12	5	15,15
Human Resource Manager	12	36,36	10	30,30
Superintendent Engine Department	8	24,25	8	24,25
Sum	33	100	33	100

Source : Author

In order to achieve similarity in terms of the demographic characteristics of the experts participating in the research, it was aimed that the professional qualifications of the experts interviewed in 2008 and 2023 were similar. In 2008, out of the research participants, 9 were experts with Ocean Going Chief Engineer/Master qualifications, 4 were technical managers, 12 were human resource managers, and 8 were superintendents of engine department. In the research conducted in 2023, the number of experts interviewed with Ocean Going Chief Engineer/Master qualifications was 10, the number of technical managers was 5, the number of human resource managers was 10, and the number of superintendent of engine department 8, ensuring similarity in professional qualifications.

4.2. Nominal findings on accessing summary information on the expectations of maritime companies from new graduates

To access summary information on the adequacy of the research sample and the expectations of maritime companies from new graduates of marine engineering, the questions asked to the participants of the study and the findings obtained from these questions are presented in Table 2

Table 2: Nominal findings on accessing information on maritime companies' expectations from recent graduates

	2008		2023	
	Yes	No	Yes	No
Do you have marine engineers working in your fleet?	32	1	32	1
Is it a cause of preference for your engine officers working in your fleet to be marine engineers?	33	0	31	2
Are you having trouble finding a marine engineer to work in your fleet?	30	3	17	14
Do you believe that the language of education in marine engineering should be English?	30	3	28	5
A training covering STCW minimum requirements is sufficient in marine engineering education.	6	27	8	25
In marine engineering education, a vocational training that covers STCW minimum requirements in more detail and comprehensively is sufficient.	13	20	3	30
In marine engineering education, an education required by the academic requirements at the undergraduate level is sufficient.	14	19	16	17
In engineering education, a graduate level education required by academic requirements is sufficient	0	33	0	33

Source : Author

When the results obtained from Table 2 are examined, it is determined that in general, the expectations of shipping companies from new graduate ship machinery management engineers have not undergone a significant change within 15 years. When the changes between 2008-2023 are examined, it is observed that the biggest difference emerged in the responses to the question "Are you experiencing difficulty in finding ship machinery management engineers to work in your fleet?" The number of experts who stated that they had difficulty finding ship machinery management engineers in 2008 was 30, while this number decreased to 17 experts in 2023. Among the noteworthy results of the study is that qualified personnel graduating from maritime faculties offered a solution to a significant problem that existed in 2008 within the 15-year period, but the market still has not been fully filled.

The findings related to the knowledge, skills, and attitudes of new graduate ship machinery management engineers are presented in Table 3, including expert evaluations of their knowledge, skills, and attitudes in 2008 and 2023, as well as the percentage change between them.

The findings obtained from the evaluation of 39 criteria aimed at measuring the knowledge, skills, and attitudes of newly graduated marine engineers are shown in Table 3. When the changes in the knowledge, skills, and attitudes of newly graduated marine engineers between 2008 and 2023 were examined, it was found that the rates of change of three criteria were more than 1%. The variable that showed the most change among the specified years was the ability of newly graduated marine engineers to operate marine engineering equipment, with an average of 3.48 and a change of 1.18. The ability to exhibit behavior in accordance with maritime customs and traditions showed a change of 1.06 with an average of 3.48, while the ability to adapt to marine life showed a change of 1.05 with an average of 3.57. These three variables have been the most changing criteria over the past 15 years.

18 criteria with a change rate ranging from 0.50 to 1 followed these three criteria. According to these findings, the ability to understand and apply in-house standards and specifications showed a change of 0.98 with an average of 3.54, the knowledge and skills to take necessary measures regarding occupational safety showed a change of 0.97 with an average of 3.54, the ability to communicate verbally and in writing in Turkish showed a change of 0.97 with an average of 3.54, the knowledge and skills to use current professional computer software showed a change of 0.91 with an average of 3.66, the ability to exhibit ethical behaviors showed a change of 0.79 with an average of 3.24, the ability to solve engineering problems showed a change of 0.76 with an average of 3.36, the ability to conduct single and multi-disciplinary teamwork showed a change of 0.73 with an average of 3.21, the ability to make judgments in solving problems showed a change of 0.71 with an average of 3.30, the variable of analytical thinking showed a change of 0.68 with an average of 3.45, the knowledge and skills to understand and interpret project and report prepared by others showed a change of 0.61 with an average of 3.36, the ability to report in writing showed a change of 0.61 with an average of 3.27, the knowledge and skills to use the basic principles of mathematics, science, social sciences, and engineering in marine engineering applications showed a change of 0.58 with an average of 3.39, the ability to communicate verbally and in writing in English showed a change of 0.58 with an average of

3.24, the ability to identify engineering problems showed a change of 0.58 with an average of 3.36, the ability to effectively use modern engineering techniques and tools and information technologies showed a change of 0.58 with an average of 3.30, the ability to work individually showed a change of 0.58 with an average of 3.21, the effectiveness in terms of productivity and timing showed a change of 0.55 with an average of 3.36, sensitivity to national and international effects of engineering solutions on society and the environment showed a change of 0.55 with an average of 3.33.

Table 3: Findings related to the knowledge, skills, and attitudes of new graduate ship machinery management engineers

N	Variables related to the knowledge, skills and attitudes of recently graduated marine engineers	2008	2023	Difference
1	The ability to apply the fundamental principles of mathematics, natural sciences, social sciences, and engineering to the practice of marine engineering.	2,81	3,39	0,58
2	The ability to identify engineering problems.	2,78	3,36	0,58
3	The ability to define engineering problems	2,81	3,24	0,43
4	The ability to solve engineering problems.	2,60	3,36	0,76
5	The ability to design engineering systems.	3,06	3,00	-0,06
6	Sensitivity to the national and international impacts of engineering solutions on society and the environment	2,78	3,33	0,55
7	The ability to design experiments, collect data, analyze and interpret results	3	3,03	0,03
8	The ability to use modern engineering techniques and tools as well as information and communication technologies effectively.	2,72	3,30	0,58
9	The ability to work in single and multi-disciplinary teams	2,48	3,21	0,73
10	The ability to work independently	2,63	3,21	0,58
11	The effort to constantly renew oneself by following developments in science and technology.	2,96	3,18	0,22
12	The ability to communicate effectively in Turkish both orally and in writing	2,57	3,54	0,97
13	The ability to communicate effectively in English both orally and in writing	2,93	3,24	0,31
14	The ability to exhibit professional ethics.	2,45	3,24	0,79
15	The effort to stay informed about current professional issues	2,84	3,15	0,31
16	Awareness of quality	2,96	3,27	0,31
17	The knowledge and skills to install marine engineering equipment.	2,72	3,27	0,55
18	The knowledge and skills to operate marine engineering equipment	2,30	3,48	1,18
19	The knowledge and skills to analyze and solve complex problems in marine engineering.	2,75	3,18	0,43
20	The knowledge and skills to analyze statistical data.	2,87	3,18	0,31
21	The ability to bring original and alternative solutions to problems.	2,78	3,12	0,34
22	The ability to understand and interpret project and report prepared by 3rd parties	2,75	3,36	0,61
23	The ability to follow the necessary bureaucratic process for the conduct of work	3,09	3,18	0,09
24	Efficiency in terms of productivity and timing.	2,81	3,36	0,55
25	Skills to be able to make judgments in solving problems	2,59	3,30	0,71
26	Skills to determine/evaluate economic and technical criteria in material selection	2,90	3,09	0,19
27	Willingness to participate in in-service and/or external continuous training for professional development	3,30	3,36	0,06
28	Knowledge and skills to use current professional computer software	2,75	3,66	0,91
29	Skills to form a team and lead it	2,96	3,33	0,37
30	Skills to understand and implement internal company standards and specifications	2,56	3,54	0,98
31	Knowledge and skills to understand and follow global economic and legal issues related to the profession	3,21	3,33	0,12
32	Willingness to follow professional information sources (magazines, books, etc.)	3,21	2,93	-0,28
33	Skills to behave in accordance with maritime customs and traditions	2,42	3,48	1,06
34	Lifelong learning skills	2,90	3,33	0,43
35	Written reporting knowledge and skills	2,66	3,27	0,61
36	Knowledge and skills to take necessary measures related to job safety	2,57	3,54	0,97
37	Analytical thinking knowledge and skills	2,77	3,45	0,68
38	Ability to adapt to marine life	2,52	3,57	1,05
39	Skills to work with multinational crew	3	3,48	0,48

Source: Author

The number of criteria showing a small positive change has been determined as 16. The rate of change in these variables ranges from 0 to 0.5. Among these criteria, the ability to work with multinational personnel has an average of 3.48 with a change of 0.48, the ability to identify engineering problems has an average of 3.24 with a change of 0.43, the knowledge and skills to analyze and solve complex problems in ship machinery operation engineering has an average of 3.18 with a change of 0.43, the ability to sustain lifelong learning has an average of 3.33 with a change of 0.43, the skills to build teams and lead have an average of 3.33 with a change of 0.37, the knowledge and skills to bring specific and alternative solutions to problems have an average of 3.12 with a change of 0.34, the knowledge and skills to analyze statistical data have an average of 3.18 with a change of 0.31, the efforts to have knowledge about current professional topics have an average of 3.15 with a change of 0.31, the awareness of quality has an average of 3.27 with a change of 0.31, the efforts to constantly renew oneself by following developments in science and technology have an average of 3.18 with a change of 0.22, the ability to determine/evaluate economic and technical criteria in material selection has an average of 3.09 with a change of 0.19, the knowledge and skills to understand and follow global economic and legal issues related to the profession have an average of 3.33 with a change of 0.12, the ability to follow bureaucratic processes necessary for the job has an average of 3.18 with a change of 0.09, the willingness to participate in in-service and/or external continuous education for professional development has an average of 3.36 with a change of 0.06, and the skills to design experiments, collect data, analyze and interpret them have an average of 3.03 with a change of 0.03.

Two criteria, on the other hand, have undergone negative changes between 2008 and 2023. These criteria are the desire to follow professional knowledge sources (journals, books, etc.) with an average of 2.93 and a change of -0.2, and the variable of engineering system design skills with an average of 3.0 and a change of -0.06.

5. RESULTS & DISCUSSION

The changes in the knowledge, skills and attitudes possessed by newly graduated marine engineers over a period of 15 years are shown in Tables 2 and 3. The survey, which consisted of 39 questions, revealed an average increase of 0.52 points. The survey results show an increase of 0.58, 0.58, 0.43 and 0.76 in the ability to master the basic principles of engineering, identify and define engineering problems, and develop problem-solving skills, respectively. This increase indicates that there has been an increase in the level of knowledge and skills that an engineer must possess according to ABET criteria. Questions 5 and 7, which relate to system and experiment design skills, had the lowest average scores of 2 and 3, respectively, and no significant change was observed compared to 2018. Although design skills are one of the fundamental requirements of engineering, there is no specific course in the curriculum that focuses on teaching design skills to students, although they are imparted through project-based courses throughout their educational experience.

The ability to determine the economic and technical criteria for material selection had the lowest average score of 3.09, indicating a limited increase of 0.19 points compared to the 2008 survey, which suggests that graduates' material knowledge is still not at a sufficient level.

There was a slight increase of 0.31 points in English speaking and writing skills, but this limited increase was not considered sufficient to indicate an improvement in graduates' English proficiency

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