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Have Non-Native English-Speaking Marine Cadet Engineers Been Educated Appropriately?

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Abstract: Freight transport via ships is the cheapest and most effective way to transfer more than 80% of the global cargo volume. Seafarers have always been multinational, and accordingly, non-English-speaking crew members are becoming an increasing presence on board. Although marine engineers comprise half of the crews among all seafarers on board ships, Standard English guides, such as SMCP for navigation officers designed to reduce communication barriers, are unavailable for marine engineers. IMO conventions require marine engineers to possess adequate English skills. However, marine accidents due to inappropriate communication between crew members continue to occur. In this paper, 185 marine engineer cadets enrolled in two universities who had completed 12 months of training on a commercial ship or school training ship were surveyed in terms of the adequacy of English courses for marine engineers in class. This paper investigated whether the marine engineer English subjects are reviewed and analyzed and whether the English examination for the Certificate of Competence is suitable for the content taught in international maritime instruments and for the actual work of engineers. Finally, this paper aimed to establish a need to develop Standard English for engineers.

Keywords: ship; transport; English; engineer; IMO

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1. Introduction

According to the International Marine Organization(IMO), more than 80% of global trade is carried out via ships using international transportation logistics. This delivery method is the cheapest and most efficient and can transport many different types of items at once [1–5]. The United Nations Conference on Trade and Development (UNCTAD) reported that seaborne trade expanded by 2.7% in 2018, which is below the annual average of 3.0%. However, UNCTAD has predicted an annual average growth rate of 3.4% for 2019–2024 [6].

While the shipping industry has been continuously expanding, the leading causes of accidents at sea are human elements [7–10]. Almost 75–96% of marine casualties are caused by human error [11,12]. Human error in maritime accidents is the most important element requiring attention, as Rothblum pointed out [13]. The United States Coast Guard(USCG) studies have shown that human error contributes to 84–88% of tanker accidents, 79% of towing vessel groundings, 89–96% of collisions, 75% of allisions, and 75% of fire and explosions [13]. On merchant ships, 80% of the crew are from different nationalities with different languages [14,15]. Around 66–80% of the world's merchant fleets have multicultural crews [16–18]. According to a report by UNCTAD, Asia is the largest provider

of a seafaring workforce in the world, accounting for four of the top five countries supplying seafarers in 2021: The Philippines, Indonesia, China, India, and Russia [19]. English is not the native language of any of these countries. For those multilingual and non-native-speaking crew members on board ships, the Standard Marine Communication Phrases (SMCP) were compiled to aid communication [20]. The 22nd Assembly of the IMO adopted the SMCP in November 2001 [21]. Despite this, it was noted that the skill of seafarers in using English is questionable [22]. Furthermore, IMO instruments such as the Standards of Training, Certification, and Watchkeeping(STCW), Safety of Life at Sea(SOLAS), and the International Convention for the Prevention of Pollution from Ships(MARPOL) require seafarers to be adequately qualified. Throughout the last decade, many accidents due to human error have been reported and recorded, and in most cases, the main reason was a communication misunderstanding [23–29]. A lack of communication has resulted in major marine accidents, and all discussions about possible measures or solutions have concluded with the general belief that in order to prevent such catastrophes and risks, there must be a common language that all seafarers and trainees have to speak fluently [30,31].

To avoid accidents caused by a lack of communication, the shipping industry has regulations relevant to communication between seafarers. For instance, most oil tankers are chartered from shipping companies outside oil interests. Vetting inspections are performed, and one of the goals of such inspections is to check crew members' maritime English knowledge. Therefore, it is essential to mention that all accidents due to miscommunication or language misconception indicate that the English language is not taught to an adequate degree as far as maritime sector professionals are concerned [31]. In order to educate high-quality seafarers in maritime English, instructors should focus on teaching particular terminology and communication skills that include listening, speaking, reading, and writing as required by IMO conventions and the international shipping industry.

The Korean shipping industry has started to employ foreign seafarers to overcome the shortage of skilled ratings. The number of foreign seafarers increased continuously and reached 25,301 (2503 officers and 22,798 ratings) by the end of 2017 [32]. Foreign seafarers account for approximately 40% of seafarers on Korean flagships, and they have increased by 12% every year, while Korean crew members have decreased by 0.5% annually. Multinational crews' communication difficulties and cultural differences can lead to both significant and minor marine incidents. Therefore, there is an urgent need to train and nurture ships' crews to respond to the trend of globalization in the multilingual shipping industry and to meet the mandatory requirements for maritime communication skills and global cultural capabilities on coastal vessels [33].

The aim of this paper is to determine the nature of the lack of English proficiency recognized by non-native English-speaking marine engineer cadets upon first boarding a ship. Thus, first, this paper starts by examining the kinds of English skills that are required according to International Maritime Organization Provisions for marine engineers, and the kinds of tasks that are required in the Convention for Marine Engineers when cadets become engineers. Next, we review the SMCP and the Maritime English Model Course of IMO's requirements for engineers. Based on an analysis of the international conventions and IMO model courses, we analyze what syllabus is used to teach the Engineer Cadet in Maritime English course at two maritime universities in Korea. In addition, this paper examines what kind of content the Maritime English course of the Certificate of Competency(CoC) consists of in marine engineer examinations. Finally, through a survey of engineer cadets who have practiced on board for more than 12 months, we demonstrate what non-native-speaking Korean marine engineer cadets lack in maritime English and areas that they need to improve in.

2. Review of Regulations on International Maritime Instruments

2.1. STCW Convention

There are three levels in the STCW: supportive, operational, and management. The operational level indicates mostly officers in charge of a navigational watch (OICNW) and

officers in charge of an engineering watch (OICEW), who are not familiar with on board work compared to those at the management level such as masters and chief mates, chief engineers, and second engineers. As for the STCW convention, the minimum competence for navigational officers on ships of 500 gross tonnage or more at the operational level needs to be qualified for "Use of the IMO Standard Marine Communication Phrases", and they have to use English in written and oral forms in terms of knowledge, understanding, and proficiency. Navigational officers need adequate knowledge of the English language to enable them to use charts and other nautical publications; to understand meteorological information and messages concerning a ship's safety and operation; to communicate with other ships, coast stations, and VTS centers; and to perform their duties with a multilingual crew, including the ability to use and understand the IMO SMCP [20].

Next, chapter III/I, a code of the STCW convention, stipulates requirements about the competence of a marine engineer at the operational level. The minimum competence for officers in charge of an engineer's watch in a manned engine room or a designated duty engineer in a periodically unmanned engine room is that they must be qualified to "use English in written and oral form" to be considered competent. Marine engineers' competence requires adequate knowledge, understanding, and proficiency in English to enable them to use engineering manuals in the written form and to perform their engineering duties in an oral format [34,35].

As stated above, marine engineers at the operational level, such as navigational officers, must be fluent in English in both written and oral forms.

2.2. SOLAS Convention

In accordance with Regulation 8, muster list and emergency instructions of SOLAS chapter III, clear instructions to be followed in the event of an emergency shall be provided for every person on board. In the case of passenger ships, these instructions shall be drawn up in the language or languages required by the ship's flag state and in the English language. Pursuant to Regulation 14, ship's manning of SOLAS chapter V, on ships to which chapter I applies, English shall be used on the bridge as the working language for bridge-to-bridge and bridge-to-shore safety communications as well as for communications on board between the pilot and bridge watchkeeping personnel, unless those directly involved in the communication speak a common language other than English. According to Regulation 30, operational limitations of SOLAS chapter V, this regulation applies to all passenger ships to which chapter I applies. A list of all limitations on the operation of a passenger ship including exemptions from any of these regulations; restrictions in operating areas; weather restrictions; sea state restrictions; restrictions in permissible loads, trim, speed, and any other limitations, whether imposed by the administration or established during the design or the building stages, shall be compiled before the passenger ship is put in service. The list, together with any necessary explanations, shall be documented in a form acceptable to the administration, which shall be kept on board readily available to the master. The list shall be kept updated. If the language used is not English or French, the list shall be provided in one of the two languages. As far as danger messages, Regulation 31 of SOLAS chapter V is concerned, the master of every ship which meets with dangerous ice, a dangerous derelict, or any other direct danger to navigation, or a tropical storm, or encounters sub-freezing air temperatures associated with gale force winds causing severe ice accretion on superstructures, or winds of force 10 or above on the Beaufort scale for which no storm warning has been received, is bound to communicate the information by all means at his disposal to ships in the vicinity, and also to the competent authorities. The form in which the information is sent is not obligatory. It may be transmitted either in plain language (preferably English) or by means of the International Code of Signals. In accordance with Regulation 5, continuous synopsis record of SOLAS chapter XI-1, the continuous synopsis record shall be in the English, French, or Spanish language. Additionally, a translation of the continuous synopsis record into the official language or languages of the administration may be provided [36,37].

2.3. MARPOL Convention

Ships subject to Annex I, Reg. 17 of the MARPOL convention must maintain an engine room oil record book. In this case, in the record book, the contents of receiving fuel oil and lubricants, transporting them on board, outboard discharge through a bilge separator, and maintenance or calibration of the bilge separator must be described in detail in English, French, or Spanish. Annex V, Reg. 10 of the convention also requires a garbage record book to be maintained on vessels. In case of a bunker change between high and low sulfur fuel oil, Annex VI, Reg. 14.6 stipulates strict regulations describing in detail how a fuel oil change should be implemented in the low sulfur limit of the emission control area. Of course, it is also necessary to record, in the engine room logbook, whether the transition to low sulfur took place before entering an Emission Control Area (ECA). Thus, a marine engineer requires English writing skills [38].

2.4. ISM Code

According to Regulation 6 (resource and personnel) of the ISM code, it is necessary to communicate effectively to perform seafarers' duties for the proper implementation of a ship's management system. In this code, ship personnel must be able to communicate with one another in their native language or English to perform their duties. This means that multinational seafarers must possess English reading, writing, speaking, and listening skills [39].

2.5. PSC Procedure

According to Resolution A.1155(32) of the PSC procedure, an engine room logbook is an essential document to be used as official documentary evidence in the case of maritime accidents in court. Information must be recorded accurately and consistently. The Resolution also requires that seafarers on board should have communication skills in their working language and English. In addition, the ship's structural safety evaluation document prepared by the Port State Control Officer (PSCO) must be based on the inspection report conducted for the ship and in their working language and English [40].

Therefore, when the PSCO conducts an engine room inspection, engineers must have English speaking skills to respond to them, just as they need writing skills concerning engine room logbooks. If fire and ship evacuation drills are performed during the PSCO's inspection, special attention is required for any verbal communication problem between the PSCO and non-English-speaking seafarers. The PSC Resolution states that conducting fire and evacuation drills is a crucial aspect of crew competence. In demonstrating the drills, the key issues are how well crews cope in an emergency and how effectively they communicate. If engineer officers have a problem communicating in English, it is clear grounds for remedial action. If there is a communication problem with other crew members on the ship, it is indicated that this is also clear grounds for remedial action.

Moreover, the PSCO procedure requires crew members to be able to understand the information provided in manuals, instructions, and documents relevant to the safe condition and operation of the ship and its equipment. If they are aware of the requirements for maintenance, periodic testing, training and drills, and recording of logbook entries, they have to record this in the related documents. In other words, marine engineer cadets must possess English reading skills to understand manuals and work instructions provided on the ship and to correctly write in engine room logbooks and related documents in English. For instance, all of the Korean shipbuilders, who are making commercial ocean-going ships, supply the manuals in English.

3. IMO SMCP and Model Course

3.1. IMO SMCP

Resolution A.918(22) IMO SMCP is a Standard English rule governing maritime communication [23]. The main contents of this resolution are designed to support the safe navigation of ships and to standardize the English for navigational communication

required for sea and port, as well as access between multinational crews. Moreover, the SMCP contains engine matters in the AII/2 chapter regarding standard engine order and B1 1.7~1.13 regarding some machinery operations such as the B1/1.7 briefing on special events; the B1/1.8 briefing on temperatures, pressures, and soundings; the B1/1.9 briefing on the operation of the main engine and auxiliary equipment; the B1/1.10 briefing on pumping of fuel and ballast water; the B1/1.11 briefing on special machinery events and repairs; the B1/1.12 briefing on record keeping; and the B1/1.13 briefing on handing and taking over the watch.

It is questionable whether the Standard English provided by the SMCP provides engineers with enough content to perform all of their duties.

Currently, the Standard English related to marine engineers in the SMCP is only two out of 103 pages of SMCP, from B1/1.7 to B1/1.13. To analyze B1/1.7 to B1/1.13, first, there is no mention of the terminology used in the engine room. One of the important things in communication between seafarers is to use the same terms for the same object. The reason is that there is room for future accidents if different terms are used. The equipment installed in the engine room has to use the same terminology, because most equipment on ships is the same, and the components of each piece of equipment also require the same terminology. Marine engineers on board Japanese owners' ships still use a lot of mixed terms in Japanese and Korean, so on Korean fishing vessels, there are words that are neither Korean nor Japanese, especially in the engine room. Furthermore, although there are multinational crews on board Korean ships, the terms used in the engine room are not Korean, Japanese, or English, and are instead nautical neologisms. There are cases where crews from third countries boarding Korean ships have to learn mixed terms separately [41,42]. In addition to this, B1/1.7~B1/1.13 only deal with briefings of engine work on ships, and do not deal with terms related to the engineer work required by the IMO convention, engine duty watch, or paperwork at all. The SMCP does not deal with this, despite the fact that almost the same number of engineers as navigators are aboard a ship. This means that the English of engineers is just as important as the English of navigation officers in preventing accidents. Of course, the main goal of the SMCP is to deal with English communication between ships, but the SMCP lacks knowledge of many aspects of engineer officers' work, and there is no Standard English textbook for engineer officers.

3.2. Maritime English Model Course 3.17

The IMO Maritime English Model Course 3.17 is the International Maritime Organization's linguistic education guideline for the systematic training and education of various English proficiency elements specified in the STCW convention. In 1999, the first model course was developed with the participation of Marlins and a British maritime publishing company. The first revision was made with the support of the International Shipping Federation (ISF) and the International Maritime Training Trust (IMTT).

In the past, the IMO Maritime English Model Course revised and combined the English curriculum of the former group of maritime engineers (sailors, engineers, etc.) into one. Currently, the guideline for the model course is divided into beginner and intermediate courses according to the learner's language level. Sub-themes related to the work on board a ship are set for each class per level with learning elements of English, grammar, vocabulary, phonetics, and communication skills (listening, reading, writing, and speaking) that are essential for seafarers [35].

On the contrary, in the revised 2015 IMO Maritime English Model Course 3.17, the framework of maritime English education is further divided into general maritime English (GME) and specialized maritime English (SME). GME is the first stage of maritime English education divided into beginner and intermediate courses. In this case, the syllabus is presented step by step. It is designed for the study of English pronunciation, intonation, vocabulary, grammar structure, discourse structure, etc., along with maritime-related topics and scenarios before entering the specialized maritime English learning area.

In terms of instructor qualifications, the IMO Maritime English Model Course 3.17 stipulates the qualifications of the instructors who can implement these model courses in the educational field as follows: "The instructor must be a qualified English instructor trained in the communication approach, content-based teaching method, task-based learning method, etc., and must have a sufficient understanding of the subject of navigation." In other words, as an essential qualification condition, an English instructor must be qualified to effectively convey a wide range of English knowledge such as pronunciation, grammar, intonation, and vocabulary, and knowledge of various teaching methodologies of special-purpose English.

4. Composition and Contents of Marine Engineer English Courses in Maritime Universities in Korea

The basis of the operational level at which engineers should learn English include, at the very least, the STCW convention, the requirements of the SOLAS, MARPOL, ISM Code, PSC procedure, SMCP, and the IMO Model Course 3.17, and practical content necessary for the ship's operation. These rules stipulate that engineers should be equipped with English speaking, listening, writing, and reading skills. This section examines whether students at maritime universities who are completing a course following the STCW convention receive an appropriate education.

Table 1 shows the weekly training contents that students of the Korea Maritime and Ocean University and the Mokpo National Maritime University take in courses related to marine engineer English. These two universities were examined because they produce 500 out of 600 Korean third-class engineers every year. Thus, by examining the institutional English curriculum of these universities, it was judged that the actual condition of English education for engineers in Korea could be confirmed.

Table 1. Training contents of marine engineer English.

Week	Korea Maritime and Ocean University	Mokpo National Maritime University
1	Introduction to the Course Self-Introduction Personal Proposal	Fundamental Marine Engineering Terminology
2	Business Letter General Report General Communication Report	Compositions of English Sentence
3	Engine Logbook, including the officer's duties Abstract Log Accident Report	Diesel Engine
4	Oil Record Book Garbage Record Report Docking Indent Various Accounts	Steam Turbine
5	Main Engine Boiler and Turbine	Boiler
6	Auxiliary Machinery Electric and Electronic Device	Main Propulsion
7	IACS	Mid-Term Examination
8	Mid-Term Examination	Electrical Devices
9	Marine Engineering SMCP	Measurement Devices
10	Marine Engineering SMCP	Auxiliary Machines 1
11	SOLAS	Auxiliary Machines 2
12	MARPOL	Safety
13	STCW	Workshop
14	Other Convention and Codes	Engine Logbook
15	Practical Conversation for Marine Engineers	Navigation
16	Final Examination	Final Examination

4.1. English of the Korea Maritime and Ocean University

The 15-week curriculum consists of a minimum agreement with the conventions or four practical skills in English: 27% (four weeks) for speaking and listening skills; 20% (three weeks) concentrated on preparing various documents necessary for marine engineers during a ship's operation; and 27% (four weeks) for reading ability, with institutional manuals, for example, being allocated. In the case of learning conventions and terminology, four weeks (27%) are allocated. Regarding the three conventions, since students are taught in the subjects of the International Maritime Convention, it can be seen that they overlap in terms of knowledge and terminology.

Moreover, Korea Maritime and Ocean University students are finally assessed on whether they have achieved the sufficient ability required in Model Course 3.17, General English, by receiving a specified minimum score on the Test of English for International Communication (TOEIC), comprising only reading and listening. This work must be principally carried out by acknowledging that learning the entire engineer English content within the 15-week course is impossible.

4.2. English of the Mokpo National Maritime University

The English sentence composition class appears to have been planned using the general education in the English language required in Model Course 3.17. Under the principle that the 15 weeks of lectures should be evenly distributed to develop four English skills, the first and second weeks can be considered to correspond to all four skills in terms of learning general English. A total of 10 weeks are allotted to reading engine room manuals and publications. In other words, 67% of the focus is on reading ability. Only one week is allocated to the recording books prepared in the engine room and general sailing, respectively. Therefore, it is advantageous to allocate time to reading ability for 10 weeks, general English composition (week 2), and basic institutional terminology (week 1). However, there seems to be insufficient time for writing and speaking skills.

Furthermore, the students' English ability achievement is assessed through the TOEIC, as with the Korea Maritime University.

4.3. English of the Marine Engineer Examination for the CoC

The English subjects of the marine engineer examination on the Certificate of Competence (CoC) are marine engineer English and general maritime English. The percentages of these two sub-subjects are 40% and 60%, respectively. General maritime English deals mainly with IMO provisions, not the general issues of ship operation. Marine engineer English covers the principle or theoretical contents of main engine, auxiliary machinery, and electrical and electronic control on board a ship.

The examination of navigation officers for the CoC in Korea also consists of five subjects, one of which is an English test. The English examination consists of two parts, the SMCP and general maritime English, at a ratio of 40% to 60%, respectively. The SMCP component comprises a multiple-choice test (with four options for each question), and general maritime English is related to all aspects of navigation and ship operations necessary for navigators that the SMCP does not cover. It covers general issues necessary for a ship's operation.

Consequently, there is a gap in the meaning of general maritime English between navigators and engineers in the examination for the CoC. The English subject for navigation officers and marine engineers does not fully include the oral form or listening and speaking tests required by each convention. In addition, it does not address the English writing skills required by the above convention.

5. Methodology

5.1. Design of Questionnaire Contents to the Survey

This survey was designed to find out whether non-native English-speaking marine engineers were adequately receiving maritime English education. The questionnaires had

been designed and developed by two ex-2nd class engineers, one university professor, and one doctoral researcher in measurement and evaluation major. The completed questionnaire was delivered to the respondents through the application platform.

The survey was conducted with the questions in Korean, as shown in Tables 2–4, for Korea Maritime University and Mokpo National Maritime University students entering the fourth year of engineering within the next year. The content and composition of this survey was designed to recognize which English skills marine engineer cadets lack during their 12-month training period on a ship, and to know what English skills need to be supplemented in preparation for boarding as a ship engineer in the future.

Table 2. Questions to assess the background of marine engineers' English skill.

	Questions	1	2	3	4	5
1	Do you know if the maritime engineer English for the examination of marine engineers is currently organized as follows? (1) Engineering English: Read the marine engineering manual; (2) maritime English: IMO Convention	15.4	45.1	25.3	11.5	2.7
2	Do you know if the STCW Convention requires the ability to read and write marine engineering manuals and publications as a marine engineering English subject?	15.9	44	25.3	13.2	1.6
3	Do you know if the STCW Convention requires that the English proficiency of an engineer includes listening and speaking ability necessary for communication while on duty?	18.7	49.5	22	8.2	1.6
4	In connection with communication with foreign seafarers on board a ship, have you experienced many difficulties in communication due to your lack of English skills?	4.4	15.4	44.5	20.9	14.8
5	Have you ever thought that your English expression was a problem in the event of a near-miss while working with foreign seafarers?	2.2	5.5	35.2	32.4	24.7
6	The Republic of Korea has mutual recognition agreements of the CoC with 31 countries, including the UK. Are you willing to board a foreign vessel if you have sufficient English proficiency?	45.1	31.3	18.1	4.4	1.1
7	There is a standard maritime English communication set by the International Maritime Organization (IMO). For navigation officers, except for marine engineers, there is no standardized or customized marine engineering English set by the IMO.Do you think the development of standardized marine engineering English is now necessary?	23.6	46.2	27.5	27.5	0
8	Do you think that the number of accidents related to machinery would be reduced if standardized marine engineering English is provided to the engineers as well?	14.8	37.4	33	12.6	2.2
9	Do you think the marine engineering English subject for the CoC is necessary in the maritime engineer exam?	23.1	50.5	22.5	3.3	0.5
10	Do you think the test method of the marine engineering English subject should be improved in a more practical way?	23.1	48.4	25.3	2.7	0.5
11	Do you think the proportion of marine engineering English of the CoC should be increased over other subjects?	12.6	29.7	41.8	14.3	1.6
12	The marine engineering English subjects of the existing CoC test consist of reading questions and finding answers (reading-oriented). Do you think that the addition of listening and speaking assessments in the marine engineering English subject in accordance with the STCW Convention will help you work with machinery?	18.7	40.7	29.1	7.7	3.8

1 = Strongly Agree; 2 = Agree; 3 = Neutral; 4 = Disagree; 5 = Strongly Disagree.

Table 3. Questions about the minimum necessary English proficiency in ship operation.

	Questions	Very Low	Low	More or Less	High	Very High
1	How much English reading skills are required for ship operation works?	0	2.7	34.1	49.5	13.7
2	How much English writing skills are required for ship operation works?	0	11.5	51.1	31.3	6
3	How much English-speaking skills are required for ship operation works?	0.5	1.6	16.5	47.3	34.1
4	How much English listening skills are required for ship operation works?	0	1.1	19.8	45.6	33.5

Table 4. Questions about what personal English ability is necessary for confident ship operation.

	Questions	Reading	Writing	Speaking	Listening
1	What aspect of speaking English on ship operation works are you most confident about?	48.4	8.8	17	25.8
2	What aspect of your ability to speak English on ship operation works are you least confident about?	4.4	27.5	52.2	15.9
3	In your experience on board a ship, what is the most vital aspect of English proficiency in terms of engine room operation and management?	8.8	4.4	54.9	31.9

5.2. Information on the Respondents

This study analyzed data on 185 students from two marine-specialized universities located in Korea. Among all the respondents, those who did not respond or whose response values were outside the mean of ±3 standard deviations were removed. The personal background characteristics of the respondents are shown in Table 5. All marine engineer cadets completed a 12-month training period, whether on a university training ship and/or commissioned training through a shipping company. The gender distribution of the respondents was 154 men (83.2%) and 31 women (16.8%). The period of school boarding training was 10 (5.4%) at 0 months, 147 (79.5%) at 6 months, and 28 (15.1%) at 12 months. In total, 121 (65.4%) respondents, who have experience with foreign seafarers, were surveyed. The responded number of working with foreign seafarers was 63 (34.1%) of between 10 and 14 foreign seafarers, which was the most; with 31 (16.8%) of less than 10 foreign seafarers; and 27 (14.6%) of 15 or more foreign seafarers. By nationality of the foreign seafarers, the Philippines had the most with 80 (52.3%), followed by Myanmar with 34 (22.2%), Indonesia with 14 (9.2%), India with 10 (6.5%), and Georgia with 7 (4.6%).

5.3. Analysis

The survey was analyzed through SPSS. The survey tool used self-developed questions to investigate the opinions of using English as a marine engineer, such as whether or not they experienced communication problems due to the inappropriate use of English with crew members from other countries as per Tables 2–4. The questions used in this study were: recognition of the composition and content of the marine engineer English curriculum (3 questions), the ability to use English for work on a ship (2 questions), the necessity to develop standard marine engineer English (2 questions), and engine room work. It consisted of English proficiency most necessary for operation and management (4 questions), the necessity for each area of using English for ship work (4 questions), and the necessity for the marine engineer English subject in the CoC examination (4 questions). The experience of experiencing inconvenience in communicating with foreign crew members, problems with English expression in the event of a near-miss or an accident, and intention to board foreign ships were additionally investigated if English proficiency was

sufficient. All questions excluding qualitative variables were composed of a five-point Likert scale among the total questions. The reliability of each sub-item is shown in Table 6.

Table 5. The respondents' personal background characteristics (n = 185).

Category		Frequency	Percentage
Sex	Male	154	83.2
	Female	31	16.8
Period of experience on board a training ship in school	0 months	10	5.4
	Less than 6 months	147	79.5
	6 months or more	28	5.1
Experience with foreign seafarers	Yes	121	65.4
	No	64	34.6
Number of foreign seafarers	0 persons	64	34.6
	Fewer than 10 persons	31	16.8
	Between 10 and 14 persons	63	34.1
	More than 15 persons	27	14.6
Nationality	Philippines	80	52.3
	Myanmar	34	22.2
	Indonesia	14	9.2
	India	10	6.5
	Georgia	7	4.6
	China	2	1.3
	Latvia	2	1.3
	Russia	1	0.7
	Cambodia	1	0.7
	Vietnam	1	0.7
	Croatia	1	0.7
Total		185	100

Table 6. Cronbach's alpha coefficient.

Sub-Questions	Question Number	Number of Questions	Cronbach's α
Recognition of marine engineer English (Engineer English awareness)	Table 2 (1, 2, 3)	3	0.83
Necessity for the development of standard marine engineer English (Requiring standard English)	Table 2 (7, 8)	2	0.72
Importance of each ability in ship maintenance and operation (Need for business English)	Table 4 (3 questions)	3	0.71
Importance in the marine engineer examination (Need for marine engineer English)	Table 2 (9, 10, 11, 12)	4	0.80
Total		12	0.84

In order to determine what kind of correlation exists between communication discomfort frequency, communication problems in the event of a near-miss or an accident, and intention to board a foreign shipping company, the product moment correlation coefficient of Pearson was calculated, and the statistical significance was tested. The product moment correlation coefficient of Pearson is a measure of the linear relationship between two questions/measures/variables, X and Y. The correlation value can range from +1 to −1. A positive correlation means there is a positive relationship between two questions. A negative correlation means there is a relationship between two questions that moves in the opposite direction. A correlation of 0 means that there is no linear relationship between two questions; although, there could be a non-linear relationship between two questions. The Pearson correlation coefficient is the most common and widely used measure of the degree of linear relationship between two variables. It should be noted that the Pearson moment correlation tells us whether there is a linear relationship between two variables, but it does not tell us anything about causality. For the 121 respondents who had experience on board with foreign seafarers, the part of using English on the ship about which they were most

comfortable was divided into three groups (reading and writing, speaking, and listening), making communication difficult due to a lack of English proficiency. A one-way analysis of variance (ANOVA) was conducted to determine whether there was any difference between the experience of uncomfortable communication with foreign seafarers, the degree of thinking that it was a problem in terms of English expression when a near-miss or an accident occurred during work with foreign seafarers, and the intention to board a foreign ship.

6. Results and Discussion

Correlation between Awareness, Importance, and Necessity for Marine Engineer English and Communication Factors on Board a Ship

Table 7 shows the correlations between awareness, importance, and necessity of marine engineer English communication factors on board a ship. Further, questions 4–6 in Table 2 regarding discomfort communication, accident by miscommunication, and intentions for boarding foreign ships are added for the correlation analysis.

Table 7. Correlation between recognition marine engineer English, necessity for marine English use, communication, etc. (n = 121).

	Engineer English Awareness	Requiring Standard English	Need for Business English	Need for Marine Engineer English	Discomfort for Communication	Accident by Miscommunication	Intentions for Boarding Foreign Ships
Engineer English awareness	1						
Requiring standard English	0.358 **	1					
Need for business English	0.111	0.120	1				
Need for marine engineer English	0.410 **	0.478 **	0.359 **	1			
Discomfort of communication	−0.192 *	−0.051	0.173	−0.097	1		
Accident by miscommunication	0.027	0.204 *	0.069	0.121	0.181 *	1	
Intentions for boarding foreign ships	0.088	0.138	0.030	0.179 *	−0.207 *	−0.201 *	1

* $p < 0.05$, ** $p < 0.01$.

Recognition of the composition and content of marine engineer English subjects was distinctly positive, correlated with the necessity for the marine engineer English subject of the maritime engineer examination for the CoC, with r = +0.41. The necessity for engineer standard English development was r = +0.36 with a distinctly positive correlation. However, there was a negative correlation of r = −0.19 in the case of experiencing discomfort in communication with foreign seafarers. It can be seen that the higher the awareness of the composition and contents of the marine engineer English subject, the less frequent the inconvenience of communication with foreign seafarers. The necessity for the development of standard marine engineer English was distinct positive correlated with the need to improve English for the maritime engineer examination for the CoC, with r = +0.48, and the accident frequency caused by communication problems with foreign seafarers, with r = +0.20. It is possible that the higher the frequency of communication problems with foreign seafarers in the event of an accident, the greater the need to develop a standard marine engineer English. The importance of using English in ship maintenance and operation showed a distinct positive correlation with the necessity for improving the English subject of the maritime engineer examination for the CoC, with r = +0.36. The necessity for improving the English subject of the maritime engineer examination for the CoC showed a weak positive correlation with embarking on a foreign vessel, with r = +0.18. It can be seen that the more the respondents were willing to board a foreign vessel, the greater the need to improve the marine engineer English subject and increase the proportion of marine engineer English subjects. There was a weak positive correlation between the frequency of communication problems with foreign seafarers and the frequency

of communication problems with foreign seafarers in the event of a near-miss or an accident, with r = +0.18. This means that the higher the frequency of uncomfortable communication with foreign seafarers in English, the higher the frequency of communication in English expressions in the case of an accident. As a result, differences in communication with foreign seafarers by English proficiency in engine room work are shown in Table 8; the group with confidence in listening had the highest communication discomfort (M = 3.17, SD = 1.12). The group with confidence in speaking had the lowest frequency (M = 2.24, SD = 0.95) of communication discomfort. There was a significant difference in the degree of communication discomfort due to a lack of English proficiency in the four groups (F = 6.99, $p < 0.01$). When a near-miss or an accident occurred while working with foreign seafarers, the average student of the reading and writing groups thought that English expression was the greatest problem (M = 2.26, SD = 0.90). The group with confidence in listening was the lowest (M = 2.03, SD = 1.1). However, there was no significant difference between the three groups. If English proficiency was sufficient, the average of the speaking group was the highest in terms of whether they were willing to board a foreign ship (M = 4.34, SD = 0.81). Nevertheless, there was no statistically significant difference between the three groups.

Table 8. Differences in communication by proficiency in English.

Category	Group			F
	Reading and Writing (n = 62)	Speaking (n = 29)	Listening (n = 30)	
Communication discomfort with foreign seafarers	2.94 (0.97)	2.24 (0.95)	3.17 (1.12)	6.99 **
An accident due to insufficient/inadequate communication in English	2.26 (0.90)	2.07 (0.99)	2.03 (1.1)	0.68
Intention to board a foreign ship	4.15 (0.90)	4.34 (0.81)	4.03 (0.96)	0.92

** $p < 0.01$.

As a result of the need for the development of standard marine engineer English according to the experience of boarding with foreign seafarers, Table 9 shows the results of analyzing the differences in the awareness in terms of composition and content of the marine engineer English courses, the necessity for developing standard marine engineer English, the necessity for improving the English subject of the maritime engineer examination for the CoC, and the importance of using English in the engine room work, depending on whether they had experience on board with foreign seafarers.

The group (n = 121) with experience on board with foreign seafarers showed a higher average than the group with no experience (n = 64) in terms of the three categories, i.e., the composition and content of the marine engineer English subject, the need to develop standard marine engineer English, and the necessity for improving the English subject of the maritime engineer examination. In particular, there was a statistically significant difference between the two groups in the necessity for improving the English subject of the marine Engineer examination (t = 1.94, $p < 0.05$). The group with no experience on board with foreign seafarers thought that the use of English for reading and writing is essential for working in the engine room. However, the other group thought that speaking and listening in English are essential. The average of the group with experience on board with foreign seafarers was higher than the other. On the importance of speaking, the group with experience on board with foreign seafarers (M = 4.22, SD = 0.65) was statistically more significant than the other group (M = 3.95, SD = 0.95) and significantly higher (t = 2.04, $p < 0.05$). On the necessity and importance of listening ability, the group with experience on board with foreign seafarers (M = 4.23, SD = 0.69) was more statistically significant than the other group (M = 3.91, SD = 0.81) and significantly higher (t = 2.86, $p < 0.01$). With respect to the importance of marine engineer English according to the number of foreign seafarers on board together, Table 10 shows the results of analyzing the differences in seven categories.

The group that experienced 11 or more foreign seafarers on board together (n = 62) showed a higher average than the group with fewer than 11 foreign seafarers (n = 59). The average number of crew members on the ship the students boarded was about 20 persons, so we used 11 persons as the standard when the number of foreign crews was 50% of the total number of crew members.

Table 9. Differences in the necessity for developing marine engineer English according to the presence or absence of experience boarding with foreign seafarers.

Category	Experience on Board with Foreign Seafarers		t
	Presence (n = 121)	Absence (n = 64)	
Awareness of the composition and content of marine engineer English courses	3.66 (0.79)	3.62 (0.88)	0.28
The necessity for developing standard marine engineer English	3.73 (0.80)	3.69 (0.74)	0.36
Need to improve the English subject of maritime engineer examination	3.78 (0.68)	3.57 (0.73)	1.94 *
Reading proficiency for engine room work	3.69 (0.73)	3.81 (0.71)	–1.06
Writing proficiency for engine room work	3.30 (0.81)	3.38 (0.63)	–0.72
Speaking proficiency for engine room work	4.22 (0.65)	3.95 (0.95)	2.04 *
Listening proficiency for engine room work	4.23 (0.69)	3.91 (0.81)	2.86 **

* $p < 0.05$, ** $p < 0.01$.

Table 10. Differences in the necessity for developing institutional English according to the number of foreign seafarers on board together.

Category	Number of Foreign Seafarers on Board Together		t
	Fewer Than 11 People (n = 59)	11 or More People (n = 62)	
Awareness of the composition and content of the marine engineer English courses	3.49 (0.77)	3.82 (0.78)	−2.34 *
The necessity for developing standard marine engineer English	3.65 (0.83)	3.81 (0.78)	−1.06
Need to improve the English subject of the maritime engineer examination	3.77 (0.69)	3.79 (0.67)	−0.19
Reading proficiency for engine room work	3.61 (0.67)	3.77 (0.78)	−1.24
Writing proficiency for engine room work	3.32 (0.78)	3.27 (0.85)	0.32
Speaking proficiency for engine room work	4.12 (0.65)	4.32 (0.65)	−1.74
Listening proficiency for engine room work	4.20 (0.64)	4.26 (0.75)	−0.43

* $p < 0.05$.

In particular, for the group with experience of 11 or more foreign seafarers (M = 3.82, SD = 0.78), the awareness of the marine engineer English subject was statistically significantly different (t = –2.34, $p < 0.05$) to that of the other group (M = 3.49, SD = 0.77). On the importance of writing ability for working in the engine room, the group with experience of fewer than 10 foreign seafarers (M = 3.32, SD = 0.78) was not significantly different from the other group (M = 3.27, SD = 0.85). In addition, on the necessity for the three abilities of reading, speaking, and listening, the average of the group with experience with more

than 10 foreign seafarers was higher than that of the other group. However, there was no statistically significant difference.

7. Conclusions and Recommendations

In this study, while global cargo volume is transported between continents by ships, crews operating on the ships play a very important role. Ships' crews are becoming multinational, and the ship accidents that occur might be fatal due to communication problems between engineers or with other departments on board. Ship personnel can be divided into two groups: navigators and engineers. In the case of navigation officers, standard maritime English (called the SMCP) is applied, and efforts are being made to reduce accidents caused by human factors. However, the Standard English relating to engine officers in the SMCP covers only a small portion and deals with only general English skills, not the specific terminology used in the engine room, as described in other IMO model courses. IMO conventions such as the STCW, SOLAS, MARPOL, ISM Code, and PSC procedure require a lot of special-purpose English for engineers. However, there is no textbook that can be treated as a standard for engineers in IMO, such as the SMCP for navigation officers, in terms of its content.

Furthermore, there is no English textbook for engineers that covers listening, speaking, writing, and reading skills, which are important in English proficiency. Therefore, in this research, the contents of the institutional English of two representative maritime universities in Korea, which is a non-English-speaking country, were examined. This analysis was also meaningful as only the principles and operation of the IMO conventions and engine room machinery were dealt with in the English course for marine engineers, and only reading-oriented content was taught. IMO regulations or the contents required in the actual engine room were not covered in the universities' lectures, but IMO conventions and engine room machinery were dealt with; only the above two English subjects were dealt with in the Korean naval officer exam. In fact, IMO conventions and engine room machinery are sufficiently dealt with in other subjects for engineers, and the engineers' English course is learned by translating the content of other subjects into English only. It is duplicated with other subjects. In order to prove the validity of this study, a survey was conducted with 185 students who had completed a 12-month boarding at the two universities to see if the engineer's English course they had undertaken at the university was appropriate. The students experienced inconvenience in communication due to a lack of speaking and listening during boarding practice. In addition, the students on board with 10 or more foreigners felt the need for the development of Standard English for engineers.

As a result of this research, the following suggestions are made.

First, an international standard of marine engineer English, suitable for engineers, should be developed in the future. This standard should include the stipulations of the SOLAS, STCW, MARPOL, ISM Code, etc., and the guidance used by actual engineers on ships.

Second, in the Korean engineer's examination system, the definition of general English should be consistent with both navigation and engineer officers. The general English content for engineers is currently dealt with as IMO conventions, but it will have to be converted to English as necessary for vessel operation.

Third, it is necessary to reorganize the exam system for the CoC for Korean engineers, so that listening, speaking, writing, and reading contents are modified altogether.

Fourth, the curriculum of the English subject should be revised so that lectures at Korean universities can test students' abilities as competent engineers in the field.

Lastly, it will be necessary to create an institutional English instructor or designer course so that the engineer's English course can be established and recognized internationally.

This paper has some limitations. First, this paper conducted a survey on non-native speakers who were marine engineers, but the subject was only Korean. If possible, in the future, we think that more valid results can be obtained by conducting a survey targeting multinational non-native speakers, including those from China, Indonesia, etc. Second, the

survey was not conducted with the fourth, third, second, and chief engineers working on ships. If these engineers were targeted, more effective results could have been obtained.

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