Mar. Sci. Tech. Bull. (2022) 11(2): 158-168
e–ISSN: 2147–9666
info@masteb.com

dergipark.org.tr/en/pub/masteb
www.masteb.com
DOI: 10.33714/masteb.1079480

Marine Science and Technology Bulletin

RESEARCH ARTICLE

Analyzing marine engineering curriculum from the perspective of the sustainable development goals

Burak Zincir[1]*

[1] *Istanbul Technical University, Maritime Faculty, Department of Marine Engineering, 34940, Istanbul, Turkey*

ARTICLE INFO

Article History:
Received: 26.02.2022
Received in revised form: 20.03.2022
Accepted: 20.03.2022
Available online: 30.03.2022

Keywords:
Curriculum
Marine engineering
Maritime education and training
Maritime transportation
Sustainable development goals

ABSTRACT

The aim of this study is to answer the questions, what are the relevancies of sustainable development goals (SDGs) and the marine engineering curriculum, and what areas should be improved to achieve a curriculum that supports sustainable marine engineering education. This study is the first study that analyzes all courses at the existing marine engineering curriculum of a university from the perspective of SDGs. Five stepped methodology is applied, which are understanding the content of all SDGs and relevance with maritime transportation, examining the marine engineering curriculum of ITU Maritime Faculty, examining each course catalog and weekly course plan, comparing the content of the SDGs with the content of the courses to determine the relevancy, and find strong and weak sides of the marine engineering curriculum from the aspect of the SDGs. According to the study findings, the top three relevant SDGs to the marine engineering curriculum are SDG4 – Quality education, SDG12 – Responsible consumption and production, and SDG8 – Decent work and economic growth with the percentages of 50%, 18%, and 13%, respectively. On the other hand, the least relevant three SDGs are SDG17 – Partnerships for the goals, SDG2 – Zero hunger, SDG1 – No poverty, and SDG15 – Life on land with the percentages of 1%, 2%, and 3% for the remaining two, respectively. In addition to the curriculum relevancy, IMO Agenda topics are examined and linked with SDGs. According to this examination, the marine engineering curriculum should be improved to achieve sustainable development-based marine engineering education. Moreover, maritime education and training should be changed from the STCW-based structure to the SD-based structure for a modern and sustainable marine engineering curriculum.

Please cite this paper as follows:

Zincir, B. (2022). Analyzing marine engineering curriculum from the perspective of the sustainable development goals. *Marine Science and Technology Bulletin*, *11*(2),158-168. https://doi.org/10.33714/masteb.1079480

* Corresponding author
E-mail address: bzincir@itu.edu.tr (B. Zincir)

Introduction

Sustainable development is a popular term worldwide nowadays, but the basis is formed in the 1980s. The definition of sustainable development is 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs', according to the World Commission on Environment and Development (WECD) (UN, 1987). The main elements of sustainable development are determined as social equity, economic growth, and environmental protection. Figure 1 shows three pillars of sustainable development which are the foundation of the further agendas for sustainable development.

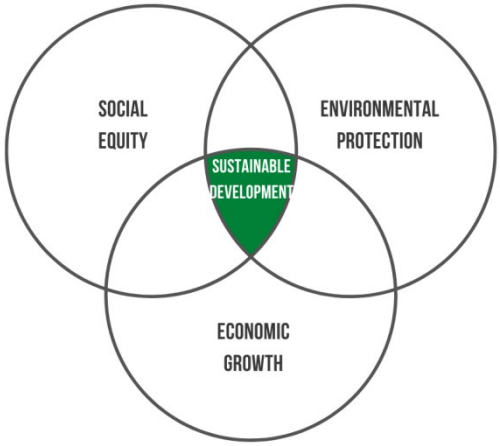

Figure 1. Three pillars of the sustainable development

To achieve and maintain sustainable development, the United Nations (UN) has been working on various declarations and agendas in history. The progress of the studies of the UN for sustainable development is shown in Figure 2. The first milestone of the works of the UN is the adoption of Agenda 21 at the Earth Summit in June 1992 (UN, 2022a). This agenda contains a comprehensive plan to promote and spread global cooperation for sustainable development. The next step is the Millennium Declaration at the Millennium Summit in September 2000. The Millennium Declaration describes 8 Millennium Development Goals (MDGs) with 18 targets under the three pillars of sustainable development (Rowihil & Farag, 2021). The MDGs are for fifteen years between 2000 and 2015. To improve the MDGs, the Johannesburg Declaration on Sustainable Development and the Plan of Implementation was adopted in 2002 at the World Summit on Sustainable Development. In June 2012, the Member States of the UN adopted the Future We Want as the outcome document of the UN Conference on Sustainable Development. This document is the start of the development process of Sustainable Development Goals (SDGs). And the last milestone of the works of the UN is the adoption of the 2030 Agenda for Sustainable Development in September 2015. This agenda includes 17 SDGs and 169 targets for people, the planet, and prosperity (UN, 2022b). The SDGs aim to build on MDGs to improve lacking sides for sustainable development. The 2030 Agenda determines goals and targets to achieve a higher standard of sustainable development by working on poverty, inequality, social, economic, and environmental preservation between 2015 and 2030 (Di Vaio et al., 2021).

Maritime transportation with its all stakeholders is one of the important elements of global sustainable development (Wang et al., 2020). Maritime transportation carries 90% of global trade (OECD, 2022) in the most efficient way if cargo ton per mile is considered (Inal & Deniz, 2021). Since maritime transportation is the major actor of global trade, it has links with almost all SDGs. International Maritime Organization (IMO) is also one of the UN organizations that support sustainable development and indicates that global sustainable development is directly connected to the sustainable development of maritime transportation (UNCTAD, 2019). Moreover, IMO worked on a concept is named "a sustainable maritime transport system" in 2013 and under this concept one of the focus areas is "Education and Training in Maritime Professions, and Support for Seafarers" (Rowihil & Farag, 2021). The main element of sustainable maritime transportation is high-quality maritime education and training (MET) which provides safe and effective action to the sea conditions (Ölçer et al., 2017).

Marine engineering education and training is one of essential elements in the MET. There are various engine parts, systems, and operations in the engine room that the marine engineers have to be aware of. Furthermore, new technologies are developed, international maritime regulations are evolved, and the way of thinking is started to change. The marine engineering curriculum should adapt to the new technologies, regulations, and ideas. For instance, the previous studies by Zincir & Deniz (2018) and Inal et al. (2021) focus on a course proposal to the marine engineering curriculum about alternative fuels and hybrid propulsion technologies. Dere et al. (2017) and Kandemir et al. (2018) have studies on effectively including engine room simulators at teaching and assessment methods. Two other studies are focused on distance/online learning courses/curricula (Michaeli, 2016; Balagiu & Sandiuc, 2020).

Sustainable development at maritime transportation is a recent idea that should be considered in the marine engineering curriculum. However, there is only one study as to the best of

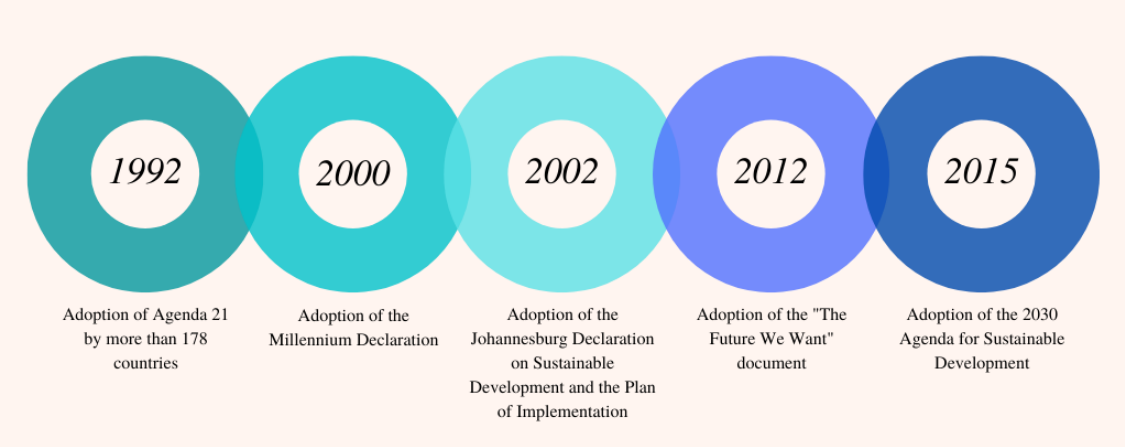

Figure 2. Progress of the studies for the sustainable development

author's knowledge that targeted maritime education and sustainable development topic (Aakre, 2021). The study aims to look at maritime education and sustainable development in Japan from a Norwegian perspective. There is a gap in the maritime education-sustainable development area and the purpose of this study is to fill the gap and contribute to the literature.

The main research question of this paper is what are the relevancy of SDGs and the marine engineering curriculum of Istanbul Technical University Maritime Faculty (ITU MF) and what areas should be improved to achieve a curriculum that supports sustainable marine engineering education. This study is the first study that analyzes all courses at the existing marine engineering curriculum of a university from the perspective of SDGs.

The marine engineering curriculum of ITU MF is used in this study. The relationship between SDGs and curriculum courses is examined and the relevancy percentage of each SDG is found. The discussion was made on the strong and weak sides of the curriculum considering SDGs and how to improve the existing STCW-based marine engineering curriculum to a sustainable development-based modern curriculum. The study shows that the marine engineering curriculum of ITU MF supports some SDGs more and some SDGs less. The findings indicate that some improvements should be made on the existing curriculum for the modernization of the marine engineering curriculum from an STCW-based structure to a more sustainable development-based (SD) structure.

Methodology

This section explains each step of the methodology. The details of the steps are shown in Figure 3. The study is done in five steps. The study starts with understanding the content of all SDGs and their relevance with maritime transportation. The next step of the study is to examine the updated marine engineering curriculum of ITU MF in 2021. ITU MF is the oldest maritime university in Turkey and has graduated many students since 1884. The faculty is inspected by European Maritime Safety Agency (EMSA) every five years. One of the roles of EMSA is inspecting maritime education and certification in non-EU countries (EMSA, 2022). After then, course catalog and weekly course plan of each course in the marine engineering curriculum of ITU MF are examined. The comparison of the content of the SDGs with the content of the courses in the marine engineering curriculum is the fourth step of the study. The final step of the study is to find the strong and weak sides of the marine engineering curriculum by considering the SDGs. Which SDGs are supported more and which SDGs are supported less is shown at the end of the study.

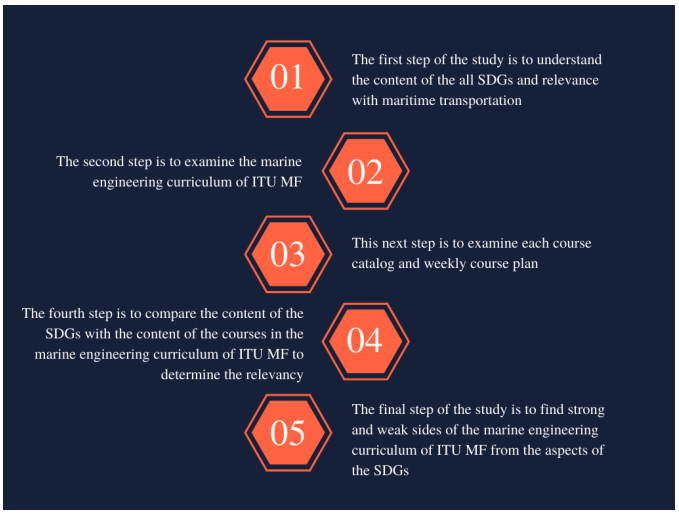

Figure 3. Steps of the study

Examination of the Marine Engineering Curriculum

Examination of the marine engineering curriculum section contains the analysis of the relationship between SDGs and maritime transportation and the relevancy of SDGs and marine engineering education.

Table 1. SDGs and their relevancy with maritime transportation

SDG No	SDGs	Description (UN, 2022a)	Relevancy (Carpenter et al., 2021)
1	No poverty	End poverty in all its forms everywhere	Partially/Directly
2	Zero hunger	End hunger, achieve food security and improved nutrition and promote sustainable agriculture	Partially
3	Good health and well-being	Ensure healthy lives and promote well-being for all at all ages	Partially/Directly
4	Quality education	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all	Directly
5	Gender equality	Achieve gender equality and empower all woman and girls	Partially/Directly
6	Clean water and sanitation	Ensure availability and sustainable management of water and sanitation for all	Directly
7	Affordable and clean energy	Ensure access to affordable, reliable, sustainable and modern energy for all	Directly
8	Decent work and economic growth	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all	Directly
9	Industry, innovation and infrastructure	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	Non
10	Reduced inequalities	Reduce inequality within and among countries	Non
11	Sustainable cities and communities	Make cities and human settlements inclusive, safe, resilient and sustainable	Partially
12	Responsible consumption and production	Ensure sustainable consumption and production patterns	Directly
13	Climate action	Take urgent action to combat climate change and its impacts	Directly
14	Life below water	Conserve and sustainably use the oceans, seas and marine resources for sustainable development	Directly
15	Life on land	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	Partially
16	Peace, justice and strong institutions	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels	Directly
17	Partnerships for the goals	Strengthen the means of implementation and revitalize the global partnership for sustainable development	Directly

Sustainable development goals and maritime transportation

The 2030 Agenda of the UN contains 17 SDGs and 169 various targets under these SDGs. The SDGs are described with different colors and symbols which are shown in Figure 4. The SDGs are included in the main three pillars, social equity, economic growth, and environmental protection.

Table 1 contains the name and description of seventeen SDGs and their relevance with maritime transportation. There are not many studies in the literature that discuss the relevancy of the SDGs with maritime transportation. The study of Carpenter et al. (2021) is the only one as the author's knowledge, and it is used in this study. According to the derived information from the found study, SDG 9 – Industry, innovation and infrastructure and SDG 10 – Reduced inequalities are not relevant to maritime transportation. On the

Table 2. Marine engineering curriculum of ITU MF

Fall	Spring
1st Year	
Physics I	Physics II
Physics I Laboratory	Physics II Laboratory
General Chemistry I	Mathematics II
General Chemistry I Laboratory	Numerical Analysis of Engineering Systems
Mathematics I	Computer Aided Technical Drawing
Material Science and Manufacturing Methods	History of Turkish Revolution II
Introduction to Marine Engineering Ethics	Turkish II
Maritime Safety I	Maritime Safety II
Turkish I	Maritime English I
History of Turkish Revolution I	Academic Advising
2nd Year	
Engineering Mathematics	Probability and Statistics
Introduction to Scientific & Engineering Computing	Thermodynamics
Engineering Mechanics	Hydraulic and Pneumatics
Workshop	Fundamentals of Electronics
Naval Architecture and Stability	Fluid Mechanics
Marine Auxiliary Machinery I	Electrotechnics
Ship Emergency Response	Marine Diesel Engine I
Basic Swimming Skills	Elective Course
Elective Course	Elective Course
3rd Year	
Automatic Control Systems	Long Term Sea Training
Heat Transfer	
Marine Boilers and Operation	
Marine Diesel Engines II	
Ship Machinery Operation and Maintenance	
Engine Room Simulator (ERS) I	
Maritime Rules and Regulations	
Maritime Law	
Elective Course	
4th Year	
Marine Auxiliary Machinery II	Operation of Steam and Gas Turbines
Marine Electrotechnics	Engine Room Simulator (ERS) II
Marine Diesel Engines III	Marine Engineering Design II
Maritime English II	Economics
Elective Course	Elective Course
Elective Course	Elective Course

other hand, SDG 2 – Zero hunger, SDG 11 – Sustainable cities and communities, and SDG 15 – Life on land have partial relevancy with maritime transportation. SDG 1 – No poverty, SDG 3 – Good health and well-being, and SDG 5 – Gender equality have partial or direct relevancy with maritime transportation according to the targets included in these SDGs. The remaining SDGs have direct relevance with maritime transportation. This shows that 52.94% of the SDGs are directly relevant to maritime transportation, 17.64% are partially/directly relevant, 17.64% are partially relevant and 11.76% are non-relevant. It is obvious that maritime transportation is essential for the SDGs.

Sustainable development goals and marine engineering education

In this section, marine engineering courses of ITU MF are examined and which courses meet with the topics and targets of which SDGs are determined. Each course catalog and weekly course plan are checked to determine the relevancy with the SDGs. Table 2 shows the marine engineering curriculum of ITU

MF. This curriculum is the newest curriculum which was updated in 2021. In the first year, marine engineering students get courses on basic sciences and some introductory courses to engineering. In the second year of the curriculum, besides basic science courses, there are fundamental engineering courses such as "Thermodynamics" and "Fluid Mechanics". There are also vocational courses in the second year of the curriculum for instance "Marine Auxiliary Machinery I" and "Marine Diesel Engine I". Moreover, there are "Elective Courses" that the students can choose according to their interests. The fall semester of the third year contains one fundamental engineering course, "Heat Transfer", vocational courses on marine engineering and maritime, and "Elective Courses". The spring semester of the third year is the "Long Term Sea Training". The marine engineering students do intern for six months on commercial ships worldwide. The students get intensive vocational courses and some "Elective Courses" at the last year of the curriculum and become marine engineers after the completion of the program.

Table 3. Keywords for each SDG

SDGs	Keywords
SDG1	Economy, social security, disasters
SDG2	Social security, disasters
SDG3	Safety, physical education, health, disaster
SDG4	Practical skill, manual skill, language skill, academic skill
SDG5	Rules, regulations, law, ethics
SDG6	Water, sea, sanitation, ecology, environment, disasters
SDG7	Energy, energy generation, energy efficiency
SDG8	Ethics, safety, advising, rules, regulations, law, economy, finance, human resource
SDG9	-
SDG10	-
SDG11	Law, environment, society, safety, quality
SDG12	Energy efficiency, consumption theory, design
SDG13	Environment, disasters, innovative technologies, clean energy
SDG14	Disasters, rules, regulations, environment, ecology
SDG15	Environment, disasters
SDG16	Advising, rules, regulations, law, economy, ethics, disasters
SDG17	Advising

The next step of the study is to match the marine engineering courses with the relevant SDGs. The matching of the courses with SDGs is determined according to the related keywords with each SDG. A similar approach was used at the study of Aleixo et al. (2020). The keywords are shown in Table 3 and the matching is shown in Table 4. The marine engineering course number in the curriculum is 112 which is the sum of compulsory given courses at maritime faculty (53) and allowed elective courses from other faculties (59) for marine engineering students.

Figure 4. Sustainable development goals (UN, 2022c)

Figure 5 shows the percentages of the relevant courses with SDGs. The courses, "Economics" and two elective courses "Social Security Law" and "Disaster Awareness" are related to SDG1 – No poverty. 3% of the total courses in the curriculum are related to this SDG. The elective courses, "Social Security Law" and "Disaster Awareness", are in line with SDG2 – Zero hunger, which is only 2% of the total courses in the curriculum. SDG3 – Good health and well-being is supported by three courses of the department and four elective courses which correspond to 6% of the total courses in the curriculum. The targets of SDG4 – Quality education is in line with twenty-two courses of the department and thirty-four elective courses that equal 50% of the total courses in the curriculum. SDG4 is the most relevant goal with the courses of the marine engineering curriculum. Quality education is given by such as laboratories, workshop courses, swimming pool, etc. that include exercises and applications. SDG5 – Gender equality, SDG6 – Clean water and sanitation, and SDG7 – Affordable and clean energy are relevant with four, nine, and nine courses which are 4%, 9%, and 9%, respectively. SDG8 – Decent work and economic growth is the third most relevant SDG with the curriculum courses. It is linked with fourteen courses, seven of them are courses of the department and seven of them are elective courses which correspond to 13% of the total courses.

Table 4. Marine engineering courses relevant with the SDGs

SDGs	Marine Engineering Courses
SDG1	Economics / Elective Course
SDG2	Elective Course
SDG3	Maritime Safety I / Maritime Safety II / Basic Swimming Skills / Elective Course
SDG4	Physics I Lab. / General Chemistry I Lab. / Material Science and Manufacturing Methods / Maritime Safety I / Physics II Lab. / Maritime Safety II / Maritime English I / Academic Advising / Introduction to Scientific & Engineering Computing / Workshop / Ship Emergency Response / Basic Swimming Skills / Fundamentals of Electronics / Automatic Control Systems / Ship Machinery Operation and Maintenance / Engine Room Simulator I / Long Term Sea Training / Marine Electrotechnics / Marine Engineering Design I / Maritime English II / Engine Room Simulator II / Marine Engineering Design II / Elective Course
SDG5	Academic Advising / Maritime Rules and Regulations / Elective Course
SDG6	Marine Auxiliary Machinery I / Long Term Sea Training / Marine Auxiliary Machinery II / Elective Course
SDG7	Thermodynamics / Marine Diesel Engines I / Heat Transfer / Marine Diesel Engines II / Marine Diesel Engines III / Operation of Steam and Gas Turbines / Elective Course
SDG8	Introduction to Marine Engineering and Ethics / Maritime Safety I / Maritime Safety II / Academic Advising / Maritime Rules and Regulations / Maritime Law / Economics / Elective Course
SDG9	-
SDG10	-
SDG11	Elective Course
SDG12	Marine Auxiliary Machinery I / Thermodynamics / Fluid Mechanics / Marine Diesel Engines I / Heat Transfer / Marine Diesel Engines II / Engine Room Simulator I / Long Term Sea Training / Marine Auxiliary Machinery II / Marine Diesel Engines III / Marine Engineering Design I / Operation of Steam and Gas Turbines / Engine Room Simulator II / Marine Engineering Design II / Elective Course
SDG13	Maritime Rules and Regulations / Long Term Sea Training / Elective Course
SDG14	Ship Emergency Response / Engine Room Simulator I / Maritime Rules and Regulations / Long Term Sea Training / Engine Room Simulator II / Elective Course
SDG15	Elective Course
SDG16	Introduction to Marine Engineering and Ethics / Academic Advising / Maritime Rules and Regulations / Maritime Law / Economics / Elective Course
SDG17	Elective Course

Table 5. IMO Agenda topics between 2020-2022 and covering SDGs

IMO Topics	Covering SDGs
Safety of navigation, communication and search and rescue	SDG11, SDG14, SDG17
Ship design and construction	SDG12, SDG17
Pollution prevention and response	SDG6, SDG13, SDG14, SDG15, SDG17
Ship systems and equipment	SDG12, SDG17
Human element, training and watchkeeping	SDG3, SDG4, SDG17
Carriage of cargoes and containers	SDG8, SDG17
Reduction of greenhouse gas emissions from ships	SDG7, SDG13, SDG15, SDG17
Implementation of IMO instruments	SDG16, SDG17

Table 6. STCW-based and SD-based MET (Rowihil & Farag, 2021)

STCW-based MET	SD-based MET
Curriculum content with minimum requirements for the competence	Aim to reach higher standards at the education
Related to shipboard skills and knowledge	Related to interaction with ship, society, and environment
Aim to improve skills and knowledge (psychomotor and cognitive areas)	Aim to improve skills, knowledge, and values (psychomotor, cognitive, and affective areas)
Reactive (focus on respond to situation on ships)	Proactive (focus on anticipation and acting)
Trainee centered education	Institutional centered education
Vocational education	Academic and critical
Career shift of the individual is disregarded	Career shift of the individual is regarded

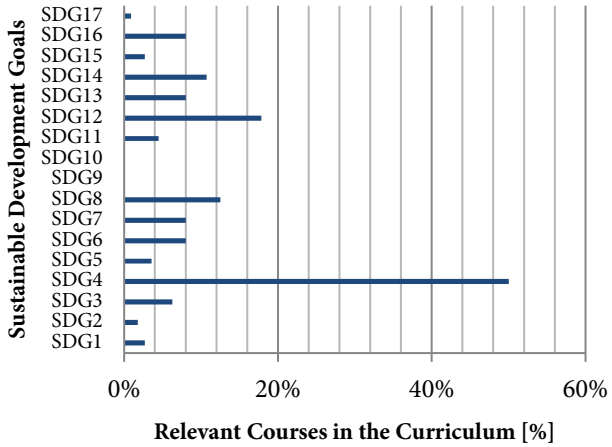

Figure 5. Relevant SDGs-courses in the marine engineering curriculum

SDG9 – Industry, innovation and infrastructure and SDG10 – Reduced inequality are not relevant with the curriculum courses. SDG11 – Sustainable cities and communities is in line with five elective courses which are "Occupational Safety and Health Law", "Environment and Society", "Quality and Safety Management Systems", "Marine Insurance", and "Occupational Health and Safety". The courses correspond to 4% of the total courses in the curriculum. The second most relevant SDG with the courses in the curriculum is SDG12 – Responsible consumption and production. This SDG is relevant with twenty courses which equal 18% of the curriculum. SDG13 – Climate action is one of the important SDGs, but it is only relevant with nine courses, two compulsory and seven elective courses, that corresponds to 8% of the curriculum. SDG14 – Life below water, SDG15 – Life on land, and SDG16 – Peace, justice and strong institutions relevant with twelve, three, and nine courses that equal to 11%, 3%, and 8% of the courses in the curriculum, respectively. The least relevant SDG is SDG17 – Partnerships for the goals is relevant to one elective course, "International Relations and Globalization", which equals approximately 1% of the total curriculum. Lastly, it is observed that twenty-four courses, equal to 21% of the courses at the curriculum, are not related to any SDGs.

Results

This section discusses the strong and weak sides of the marine engineering curriculum of ITU MF. The previous steps of the study show that the curriculum is strong at SDG4 – Quality education, SDG12 – Responsible consumption and production, and SDG8 – Decent work and economic growth with the relevancy of 50%, 18%, and 13%, respectively. After these SDGs, the curriculum is relevant to SDG14 – Life below water by 11%. The remaining SDGs are covered below 10% of the curriculum courses. The least covered SDGs by the curriculum courses are SDG17 – Partnerships for the goals, SDG2 – Zero hunger, SDG1 – No poverty, and SDG15 – Life on land with 1%, 2%, 3%, and 3%, respectively. The findings showed that 1 course is relevant to nine SDGs, 5 courses are relevant to 6 SDGs, 2 courses contain topics from 5 SDGs and another 2 courses include topics from 4 SDGs. 12 courses are relevant to 3 SDGs and 18 courses are pertinent to 2 SDGs. 24 courses are not relevant to any SDGs, and the remaining 49 courses include topics from 1 SDG. The analysis showed that the marine engineering curriculum should be improved by updating the content of the courses with the related topics which are in line with the targets of SDGs.

Discussion

IMO is one of the agencies of the United Nations and determines the minimum standards for international maritime transportation. There are Maritime Safety Committee (MSC) and Marine Environment Protection Committee (MEPC) under IMO. Under these main committees, there are sub-

committees that are working groups on different focus areas. IMO prepares its yearly agenda and what topics are discussed at that year. Table 5 shows IMO Agenda between 2020 and 2022 that sub-committees discussed or will discuss on these topics (IMO, 2022). The Agenda shows the focus areas of IMO and the marine engineering education has to be in parallel with IMO focus areas. The topics are linked with related SDGs to understand the status of the marine engineering curriculum of ITU MF. All topics are covered by SDG17 – Partnerships for the goals since the reason for arranging working group meetings is to establish strong partnerships to achieve the targets.

Safety of navigation, communication and search and rescue is one of the IMO topics that are covered by SDG11, SDG14, and SDG17. These SDGs are related to 4%, 11%, and 1%, respectively, at the marine engineering curriculum. SDG14 is moderately met by the curriculum. On the other hand, SDG11 and SDG17 are weakly met and the curriculum should be updated to increase the number of courses related to these SDGs. Since SDG17 covers all topics, no comments will be made on the remaining topics.

Ship design and construction topic is covered by SDG12 and SDG17 which correspond to 18% and 1%, respectively, of the curriculum. SDG12 is almost strongly met by the curriculum. Because responsible consumption is required on ships, therefore this is supported by given courses at the curriculum.

Pollution prevention and response topic is related to SDG6, SDG13, SDG14, SDG15, and SDG17 which correspond to 8%, 8%, 11%, 3%, and 1%, respectively, of the curriculum. SDG6, SDG13, and SDG14 are moderately met by the curriculum, but the percentage of SDG15 has to be improved by adding new courses to the curriculum on life on land.

The fourth topic is ship systems and equipment that is covered by SDG12 and SDG17. This topic has the same SDGs to ship design and construction topic. This topic is almost strongly met by the marine engineering curriculum.

The human element, training and watchkeeping topic is related to SDG3, SDG4, and SDG17 with the curriculum percentages of 6%, 50%, and 1%, respectively. SDG4 is supported strongly by the marine engineering curriculum. Nevertheless, SDG3 – Good health and well-being should be supported by new course additions to the curriculum.

Carriage of cargoes and containers is covered by SDG8 and SDG17 which correspond to 13% and 1%, respectively, of the curriculum. SDG8 – Decent work and economic growth is moderately supported by the curriculum courses.

The seventh topic is the reduction of greenhouse gas emissions from ships, which is one of the important topics for IMO, which is covered by SDG7, SDG13, SDG15, and SDG17. These SDGs are 8%, 8%, 3%, and 1% relevant respectively to the courses at the marine engineering curriculum. The curriculum has to be improved to adequately meet with the SDG7 – Affordable and clean energy, SDG13 – Climate action, SDG15 – Life on land, and SDG17 – Partnerships for the goals.

The last agenda topic is the implementation of IMO instruments that is covered by SDG16 and SDG17. SDG16 – Peace, justice and strong institutions relevant to the 8% of the curriculum. New courses have to be added to the curriculum to increase the percentage of relevancy.

The curriculums at the MET are prepared according to the Standards of Training Certification and Watchkeeping (STCW) Convention to comply with the minimum requirements of competencies for marine engineers or marine officers. Therefore, the MET at the maritime universities is STCW-based. The world is changing and maritime universities have to keep up with the change. If sustainable development (SD) is considered at the MET, some updates should be made on the MET curriculum for improvement. Differences between STCW-based and SD-based MET are shown in Table 6. The curriculum should include higher standards rather than minimum requirements of the competencies of STCW. The content of the curriculum should focus on link and interaction with ship, society, and environment and should aim to improve psychomotor, cognitive, and affective areas of the individuals. The courses at the curriculum should improve the anticipation and acting skills of the individuals and should care about the possibility of career shift of the graduated persons. The MET should be more academic and critical, and rather than individual-centered it should be institutional-centered. In addition to these, the MET should include knowledge and understanding of environmental protection, social and economic wellbeing not only in the present but also at the future generations (Mkpandiok & Ukpai, 2017). These properties of SD-based MET have to be considered to improve the marine engineering curriculum of ITU MF and to make the curriculum more supportive of the SDGs.

On contrary, despite SD-based MET will improve maritime higher education, there are still challenges to be applied. Although the importance of SD is well-known, not only MET but also all higher education has not adapted SD into the education system (Aleixo et al., 2018). The positive thing is there are some case applications in the higher education curriculum, but it has not spread to higher education

institutions yet (Barth & Rieckmann, 2012). This study reveals that the marine engineering curriculum of ITU MF is not completely in line with SDGs. This finding is similar to the finding of the study of Mkpandiok & Ukpai (2017) which was done for MET in Nigeria. Some courses contain SDG or SDGs in their content, however more clear and integrated course contents are required to meet SDGs which is also stated in the study of Aleixo et al. (2020). With the Covid-19 pandemic, the education system has been in transition from conventional face-to-face education to more online education. New online education programs and systems can speed up the integration of SDGs to MET as is also discussed in a previous study (Dyagileva et al., 2020).

Conclusion

This paper aims to answer the question, what are the relevancy of SDGs and the marine engineering curriculum of ITU MF, and what areas should be improved to achieve a curriculum that supports sustainable marine engineering education. This study is the first study that analyzes all courses at the existing marine engineering curriculum of a university from the perspective of SDGs. Five stepped methodology is applied, which are understanding the content of all SDGs and relevance with maritime transportation, examining the marine engineering curriculum of ITU MF, examining each course catalog and weekly course plan, comparing the content of the SDGs with the content of the courses to determine the relevancy, and find strong and weak sides of the marine engineering curriculum from the aspect of the SDGs.

According to the study findings, the top three relevant SDGs to the marine engineering curriculum are SDG4 – Quality education, SDG12 – Responsible consumption and production, and SDG8 – Decent work and economic growth with the percentages of 50%, 18%, and 13%, respectively. On the other hand, the least relevant three SDGs are SDG17 – Partnerships for the goals, SDG2 – Zero hunger, SDG1 – No poverty, and SDG15 – Life on land with the percentages of 1%, 2%, and 3% for the remaining two, respectively. In addition to the curriculum relevancy, IMO Agenda topics are examined and linked with SDGs. According to this examination, the marine engineering curriculum should be improved for met a higher percentage with SDG3, SDG7, SDG11, SDG13, SDG15, SDG16, and SDG17. Moreover, the MET should be changed from the STCW-based structure to the SD-based structure for a modern and sustainable marine engineering curriculum.

This study sheds light on future studies about the modernization of the marine engineering curriculum for including a more SD-based structure. Course proposals can be done to improve the curriculum for further studies. Also, the study can be adapted for the maritime transportation engineering curriculum of ITU MF for future study.

Compliance With Ethical Standards

Conflict of Interest

The author declares that there is no conflict of interest.

Ethical Approval

For this type of study, formal consent is not required.

References

Aakre, B. M. (2021). Maritime education and sustainable development in Japan, a Norwegian perspective. *Quest for Technical Pedagogy*, *23*, 1-24.

Aleixo, A. M., Azeiteiro, U. M., & Leal, S. (2018). The implementation of sustainability practices in Portuguese higher education institutions. *International Journal of Sustainability in Higher Education*, *19*(1), 146-178, https://doi.org/10.1108/IJSHE-02-2017-0016

Aleixo, A. M., Azeiteiro, U. M., & Leal, S. (2020). Are the sustainable development goals being implemented in the Portuguese higher education formative offer? *International Journal of Sustainability in Higher Education*, *21*(2), 336-352. https://doi.org/10.1108/IJSHE-04-2019-0150

Balagiu, A., & Sandiuc, C. (2020). Developing an online course for marine engineering. *Scientific Bulletin of Naval Academy*, *XXIII*, 282-286. https://doi.org/10.21279/1454-864X-20-I1-040

Barth, M., & Rieckmann, M. (2012). Academic staff development as a catalyst of curriculum change towards education for sustainable development: An output perspective. *Journal of Cleaner Production*, *26*, 28-36, https://doi.org/10.1016/j.jclepro.2011.12.011

Carpenter, A., Skinner, J. A., & Johansson, T. M. (2021). Conclusions: Connecting sustainable development goals to the maritime domain. In Carpenter, A., Johansson, T. M., & Skinner, J. A. (Eds.), *Sustainability in the Maritime Domain* (pp. 489-507). Springer. https://doi.org/10.1007/978-3-030-69325-1_22

Dere, C., Zincir, B., & Deniz, C. (2017). Usage of simulator as an energy efficient operation of main engine practice. *Proceedings of the 13th International Conference on Engine Room Simulators,* Ukraine, pp. 202-208.

Di Vaio, A., Varriale, L., Lekakou, M., & Stefanidaki, E. (2021). Cruise and container shipping companies: a comparative analysis of sustainable development goals through environmental sustainability disclosure. *Maritime Policy & Management*, *48*(2), 184-212. https://doi.org/10.1080/03088839.2020.1754480

European Maritime Safety Agency (EMSA). (2022). *Overview*. Retrieved on December 12, 2021, from https://european-union.europa.eu/institutions-law-budget/institutions-and-bodies/institutions-and-bodies-profiles/emsa_en

Inal, O. B., & Deniz, C. (2021). Emission analysis of LNG fuelled molten carbonate fuel cell system for a chemical tanker ship: a case study. *Marine Science Technology Bulletin, 10*(2), 118-133. https://doi.org/10.33714/masteb.827195

Inal, O. B., Dere, C., Zincir, B., & Deniz, C. (2021). Hybrid propulsion and alternative fuels education in the course of decarbonised shipping. *Australian Journal of Maritime & Ocean Affairs, In press.* https://doi.org/10.1080/18366503.2021.1940475

International Maritime Organization (IMO). (2022). *Meeting Summaries and Schedule*. Retrieved on January 8, 2022, from https://www.imo.org/en/MediaCentre/MeetingSummaries/Pages/default.aspx

Kandemir, C., Soner, O., & Celik, M. (2018). Proposing a practical training assessment technique to adopt simulators into marine engineering education. *WMU Journal of Maritime Affairs, 17*(1), 1-15. https://doi.org/10.1007/s13437-018-0137-4

Michaeli, J. G. (2016). Developing a distance learning curriculum for marine engineering education. *Proceedings of the 2016 ASEE Annual Conference & Exposition,* Louisiana, USA, 9p. https://doi.org/10.18260/p.26722

Mkpandiok, A., & Ukpai, U. E. (2017). Managing maritime education and training for the attainment of sustainable development goals in Nigeria. *World Educators Forum*, *9*(1), 1-15.

OECD. (2022). *Ocean Shipping and Shipbuilding*. Retrieved on March 18, 2022, from https://www.oecd.org/ocean/topics/ocean-shipping/#:~:text=The%20main%20transport%20mode%20for,transport%20arteries%20for%20global%20trade

Ölçer, A. I., Ballini, F., Kitada, M., & Dalaklis, D. (2017). Development of a holistic maritime energy management programme at the postgraduate level: the case of WMU. *Proceedings of the 11th annual International Technology, Education and Development (INTED 2017) Conference*, Spain, pp. 1426-1432.

Rowihil, M. S., & Farag, Y. B. A. (2021). Sustainable development in maritime education and training; trends, challenges and the way forward. Strathprints, *Preprint*. https://strathprints.strath.ac.uk/77215/

United Nations (UN). (2022a). *The 17 Goals*. Retrieved on December 10, 2021, from https://sdgs.un.org/goals

United Nations (UN). (2022b). *Transforming our world: the 2030 Agenda for Sustainable Development*. Retrieved on December 10, 2021, from https://sdgs.un.org/2030agenda

United Nations (UN). (2022c). *Communication materials*. Retrieved on December 10, 2021, from https://www.un.org/sustainabledevelopment/news/communications-material/

United Nations Conference on Trade and Development (UNCTAD). (2019). *Review of Maritime Transport 2019*. Retrieved on December 11, 2021, from https://unctad.org/

United Nations General Assembly (UN). (1987). *Development and international economic co-operation: environment. Report of the world commission on environment and development: our common future*. Retrieved on December 10, 2021, from https://sswm.info/sites/default/files/reference_attachments/UN%20WCED%201987%20Brundtland%20Report.pdf

Wang, X., Yuen, K. F., Wong, Y. D., & Li, K. X. (2020). How can the maritime industry meet sustainable development goals? An analysis of sustainability reports from the social entrepreneurship perspective. *Transportation Research Part D: Transport and Environment*, *78*, 102173. https://doi.org/10.1016/j.trd.2019.11.002

Zincir, B., & Deniz, C. (2018). A course proposal for the training of marine engineering students about alternative fuels, related systems, and operation. *Proceedings of the 19th Annual General Assembly (IAMU AGA 2018)*, Spain, pp. 37-45.