MEUJMAF

Mersin University Journal of Maritime Faculty

e-ISSN 2687-6612

June 2023 Volume: 5 Issue: 1

MERSİN UNIVERSITY JOURNAL OF MARITIME FACULTY (MEUJMAF)

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PUBLICATION FREQUENCY

The MEUJMAF accepts the articles in English and is being published 2 times (December and June) a year.

CORRESPONDENCE ADDRESS

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CONTENTS

Volume 5 – Issue 1

ARTICLES

Mersin University Journal of Maritime Faculty

Mersin University Journal of Maritime Faculty (MEUJMAF)
Vol. 5, Issue 1, pp. 01-06, June 2023
e-ISSN 2687-6612, Türkiye
DOI: 10.47512/meujmaf.1230643
Research Article

MARITIME BORDER DISPUTE BETWEEN KENYA AND SOMALIA IN THE INDIAN OCEAN

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Received: 06/01/2023 Accepted: 10/05/2023

ABSTRACT
Among the recent cases adjudicated before the International Court of Justice (ICJ), the maritime dispute between Kenya and Somalia exhibited in the Indian Ocean is among the forefront one. Though there are several studies dealing with the case at hand, the decision of the aforenamed court has not been comprehensively reviewed. Therefore, having the ICJ's decision, which was rendered on 12 October 2021, this Article exhaustively reviews – not only Somalia's claim and Kenya's submission, – but also ICJ's ruling and decision on major disputed issues. Moreover, the Article provides some scholars critiques attributed to the latter ICJ's decision.

Keywords: *Indian Ocean, International Court of Justice, Law of the sea, Maritime Dispute.*

1. INTRODUCTION

The Republic of Kenya (Kenya) and the Federal Republic of Somalia (Somalia) are the two neighboring countries located in eastern Africa, sharing extends 681 Kilometers (i.e., 423 miles), among which the maritime border that intersects the Indian Ocean to the south-east is the one (Loannides & Yiallourides, 2021; Sovereign Limits, n.d.). During the colonial period, though Italy and Britain, the occupying power of '*Jubaland*', located in the present-day Somalia, and Kenya, agreed to land border delimitation via the 1927 agreement and exchange of notes in 1933, maritime border delimitation has not been set. This scenario has not changed even after both Somalia and Kenya got their independence in 1960 and 1963, respectively. Consequently, the contested coastline area has been a source of conflict between the two countries for many years due to the economic significance of petroleum, marine resources, and maritime transportation services (Gunawan *et al, 2021; Sabala, 2021*).

Both Kenya and Somalia signed the United Nations Convention on the Law of the Sea (UNCLOS) on 10 December 1982, while they ratified it on 2 March 1989 and 24 July 1989, respectively (ICJ, 2021, para 33).

According to part 15 section 1 of the UNCLOS, there were several moments when both Kenya and Somalia attempted to settle their maritime dispute through negotiation, in which the 2009 Memorandum of Understanding (MoU), which was brokered by the United Nations (UN), deserves to be mentioned (Sharmarke, 2009). According to the latter MoU, the two coastal states had agreed to settle their maritime dispute per international laws. Accordingly, as per Article 76 paragraph 8 of the UNCLOS, both states have submitted their matter to the Commission on the Limits of the Continental Shelf (CLCS) and requested a recommendation on the areas that are subject to dispute, particularly on 'the outer limits of their continental shelves beyond 200 nautical miles,' though they later have acted otherwise and withdrawn their request in the course of time (ICJ, 2021, para. 34).

On top of the above, their MoU, unfortunately, could not bear fruit and, as such, was rejected by the Somalia Parliament (Loannides & Yiallourides, 2021). Consequently, the maritime dispute over the shared Indian coastal area continued.

Albeit absence of agreement, "in 2012, Kenya awarded exploration licenses for eight offshore blocks in the Indian Ocean to foreign oil companies, including Italy-based Eni, France-based Total, and US-based Anadarko Petroleum" (Loannides & Yiallourides, 2021). Being alarmed by the action of Kenya, on 28 August 2014, Somalia, finally, filed its maritime case against Kenya before the ICJ, on the subject of establishing a single maritime boundary between the two coastal states in the Indian Ocean.

2. MATERIAL FACTS – BENCHMARK

2.1. Somalia's Application and Claims

In its application, Somalia stated that no maritime boundary exists between the two coastal states (ICJ, 2021, para. 35). Moreover, Somalia submitted that, in the absence of agreement, Kenya, with its unilateral action on the disputed Indian maritime area, notably on exclusive economic zone and continental shelf, acted not only in violation of its sovereign rights but also in contradiction with the principles enshrined in the UNCLOS (ICJ, 2021, para. 199).

Accordingly, per international laws, Somalia requested the ICJ: 1) to determine the full course of the single maritime border separating the whole designated maritime extent of the Indian Ocean to Kenya and Somalia, including in the continental shelf beyond 200 nautical miles; 2) to ascertain the exact topographical location of the single maritime boundary; 3) to adjudge that Kenya acted in violation international laws, particularly sovereign rights and jurisdiction of Somalia, thus, obligated to make full reparation (ICJ, 2021, para. 25).

2.2. Kenya's Defence and Counter Claims

In its counter Memorial, Kenya raised preliminary objections against the case of Somalia, claiming the existence of an accustomed acquiescent line between them that has been put into practice for a long time, as such affirmed the existence of an equitable delimitation (ICJ, 2021, para. 35).

On top of the above, Kenya further argued the inexistence of dispute let alone any form of a challenge until 2014, thus, its activities over the Indian sea were made in good faith and lawful (ICJ, 2021, para. 83). Accordingly, Kenya requested the ICJ to dismiss all of Somalia's claims and affirm the already agreed maritime boundary and long maritime practices between the two coastal states.

3. PRELIMINARY ISSUES

3.1. Kenya's Preliminary Objection

As provided above, Kenya asserted its preliminary objection arguing that there is an accustomed maritime line already in place, amplifying the existence long practiced maritime boundary in the Indian Ocean. Per Kenya's submission, though Somalia knew about Kenya's conduct in the shared coast maritime sea, the former failed to react and respond to the latter state's conduct within a reasonable time (ICJ, 2021, para. 37). Kenya added that Somalia's first objection was recorded on the 4th of February 2014 when it submitted its letter to the UN, which shows the consistent practice exhibited in the Indian Ocean. Thus, Kenya claimed that Somalia's request to negotiate on the maritime delimitation should not create a wrong impression, as if an acquiesced maritime boundary did not exist, underlining its otherwise argument (ICJ, 2021, para. 38).

3.2. Somalia's Counter-Defence

Somalia submitted its counter-defense against Kenya's preliminary objection. Accordingly, per Articles 15, 74, and 83 of the UNCLOS, Somalia argued the primary condition of an express agreement, written or unwritten, to assume the existence of a maritime boundary delimitation between coastal states. Somalia refuted Kenya's assumption of acquiescence arguing that failing to object to Kenya's unilateral act doesn't constitute affirmation, negating silence amounts to acceptance (ICJ, 2021, para. 44). Somalia also added the timing when the unilateral act of Kenya took place, in which Somalia was at war with itself and no effective government that could actively oversight the situation of maritime boundaries of Indian Ocean, thus, was not in a position to assert its objection (ICJ, 2021, para. 47).

3.3. ICJ's Ruling

Upon evaluating Articles 15, 74, and 83 of the UNCLOS, the ICJ highlighted the usual track of expressing agreement is in a written format. Though the court didn't rule out the possibility of having an unwritten agreement, it underlined the crucial elements of having a 'shared understanding,' which shall be ascertained through 'acquiescence or tacit agreement' (ICJ, 2021, para. 50, 52).

Examining the case at hand per the forgoing baseline, the court uncovered the absence of 'shared understanding' between the two Parties. Moreover, the court also observed Kenya's affirmation as to the inexistence of indorsed agreement in its preliminary objection hearing and 'Note Verbales' to the UN (ICJ, 2021, para. 70).

Aside from the above, the ICJ took into consideration the situation of Somalia's internal civil war, where there was no effective governance structure in place, which Kenya did not deny. Thus, considering Somalia's inability to protest in the year between 1979 to 2014, the court ruled out the scenario of entailing Somalia's action as an acquiescence, reasoning the absence of 'clear and consistence' adherence to the maritime practice (ICJ, 2021, para. 80).

Finally, the ICJ adjudged the absence of compelling evidence as to the existence of acquiesced practice in the Indian Ocean, therefore, dismiss Kenya's preliminary objection (ICJ, 2021, para. 89).

4. MARITIME DELIMITATION ISSUES

After deciding the inexistence of maritime boundary accords, considering Somalia's request to ascertain the respective states' equitable maritime boundary, the ICJ proceeded to delimit the maritime demarcation of Somalia and Kenya in the Indian Ocean (ICJ, 2021, para. 90-91).

Recalling the adherence of the two coastal states to the UNCLOS, the ICJ maintained the application of the provisions of the aforesaid Convention in demarcating the equitable maritime line between Somalia and Kenya (ICJ, 2021, para. 92).

The ICJ noted the starting point which both Kenya and Somalis have already agreed on, which was deduced 'by connecting PB 29 to a point on the low-water line by a straight line that runs in a south-easterly direction and that is perpendicular to the general trend of the coastline at Dar Es Salam' per the 1927 and 1933 UK-Italy land border treaty arrangement (ICJ, 2021, para. 95).

However, unlike the starting point, both Kenya and Somalia submitted different stands on the demarcation of the territorial maritime sea (ICJ, 2021, para. 99).

4.1. Somalia's Claim

In demarcating the territorial maritime sea, Somalia argued a 'median line' need to be considered between the two coastal states (ICJ, 2021, para. 101).

4.2. Kenya's Claim

On the other hand, Kenya asserted its stand arguing the territorial sea should go after the 'parallel of latitude', as it has already remained in place between the Parties (ICJ, 2021, para. 105).

4.3. ICJ's Ruling

However, the ICJ has already concluded, in its preliminary adjudication, that no maritime boundary with 'shared understanding' exists between the two coastal states, thus, it disregarded Kenya's argument from the get-go. Consequently, per Article 15 of the UNCLOS, the Court stick with Somalia's claim and ruled the viability of following the 'median line' of the coastal line and underlined the 1927 and 1933 UK-Italy land border treaty regime to objectively draw a line that run into the territorial maritime sea (ICJ, 2021, para. 118).

5. DELIMITATION OF THE EXCLUSIVE ECONOMIC ZONE AND THE CONTINENTAL SHELF WITHIN 200 NAUTICAL MILES

5.1. Maritime Delimitation Methodology

To have a clear take-off, it is crucial to set the pattern of ICJ in demarcating an exclusive economic zone and the continental shelf. As provided in the case of Romania vs. Ukraine Maritime Delimitation, since the UNCLOS was enforced, the court, to ease its task of maintaining equitable delimitation, has developed three stages of maritime territorial demarcation methodology in its jurisprudence (ICJ, 2021, para. 122, 128).

In its first stage, having a 'strict geometrical' qualification on the basis of objective data derived from the coasts of the Parties, the ICJ intends to create a 'provisional equidistance line from the most appropriate base points' (ICJ, 2021, para. 123).

In its next stage, to attain equitable maritime demarcation, the ICJ articulates if there are compelling circumstances, like geographical and other relevant factors, which need to be considered to modify or alter the 'provisional equidistance' established in the first stage (ICJ, 2021, para. 124).

Finally, to delimit a maritime boundary equitably, the ICJ, in its third stage, proceeds with the 'equidistance' or 'adjusted line', and, accordingly, demarcates a disputed territorial sea area (ICJ, 2021, para. 125).

5.1.1. Somalia's Claim

Somalia, maintaining its argument in line with the above ICJ pattern, asserted the appropriateness of employing the three-stage methodology and requested the court to follow its usual track in delimiting the maritime boundaries between the coastal states (ICJ, 2021, para. 126).

5.1.2. Kenya's Claim

On the other hand, Kenya, although affirmed the relevance of the three-stage methodology in maintaining equitable delimitation in several instances, argued otherwise in the present case. Instead, basing itself on regional practice and geographical context, it stated that the parallel of latitude is the appropriate methodology in order to establish equitable maritime demarcation (ICJ, 2021, para. 127).

5.1.3. ICJ's Ruling

Though the ICJ normally adopts a three-stage delimitation methodology, it normally won't consider using those abovenamed methodologies – if parallel of latitude, as suggested by Kenya, is a relevant methodology to establish equitable delimitation, and – if there are other appropriate factors entailing the equidistance methodology irrelevant (ICJ, 2021, para. 129-130).

However, the ICJ didn't find any compelling reason to deviate from its usual jurisprudence, thus, ruled the application of the three-stage methodology in determining the territorial maritime border of the two coastal states (ICJ, 2021, para. 131).

Therefore, the Court, while ascertaining its appropriateness, proceed with the three-stage methodology to delimit the territorial maritime demarcation between the two coastal states.

5.2. Provisional Equidistance Line

Though Somalia at first suggested CARIS-LOTS software of US NGA Nautical Chart 61220, later compromised its stand and hesitantly accepted Kenya's suggestion of British Admiralty Chart 3362, and signaled the ICJ to choose an appropriate and reliable one. Accordingly, the court ruled to use the British Admiralty Chart 3362 and pursued drawing a provisional equidistance line (ICJ, 2021, para. 143-146).

While setting the equidistance line per the British Admiralty Chart 3362, the ICJ evaluated the existence of pushing factors compelling the adjustment or shifting of the provisional equidistance line. In this regard, the Court observed that Kenya and Somalia have an opposing stand (ICJ, 2021, para. 147).

5.2.1. Somalia's Claim

Somalia argued the inexistence of compelling factors requiring the adjustment or shifting of the provisional equidistance line, other than geographical factors (ICJ, 2021, para. 148).

5.2.2. Kenya's Claim

On the other hand, Kenya submitted five factors as compelling circumstances, requiring the shift/adjustment of the provisional equidistance line. These circumstances are: 1) the substantial 'cut-off' due to territorial sea demarcation between Kenya and Tanzania; 2) the usage of 'parallel latitude' as the regional modus operandi in determining the maritime delimitation of East Africa 3) the security issues, notably terrorism and piracy, of the region; 4) the accustomed longstanding coastal states economic activities, such as oil concessions, naval patrols, and fishing among others; 5) the access route for fisherfolk and/or other natural resources (ICJ, 2021, para. 149-153).

5.2.3. ICJ's Ruling

Taking into account the relevant provisions of the UNCLOS, Articles 74 and 83 in particular, the ICJ evaluated the viability of those factors asserted by Kenya as follows (ICJ, 2021, para. 157).

With respect to Kenya's argument in terms of substantial 'cut-off' due to territorial sea demarcation between Kenya and Tanzania, the ICJ ruled out its significance reasoning that any cut-off effect due to the aforesaid bilateral *inter alios acta* maritime accord is irrelevant, thus, cannot impact the contemporary maritime delimitation case of the two coastal states (ICJ, 2021, para. 163).

Concerning Kenya's claim of using 'parallel latitude' as the regional modus operandi, the ICJ, while affirming Somalia's geographical consideration, opt to consider the concavity of the broader geographical context of the coastline, which is congruous with its precedent and other international tribunal/s, like Arbitral Tribunal in the *Guinea/Guinea-Bissau* case (ICJ, 2021, para. 165, 167).

In relation to Kenya's security threat assertion, the ICJ, underlining its awareness about how serious terrorism and/or piracy menace is, negated its relevance in the present case, reasoning that the sway over the maritime sea is not typically related to security situations, thus, doesn't impact the coastal state/s right of navigation (ICJ, 2021, para. 158).

As to Kenya's submission in the context of the longstanding accustomed coastal states' economic activities, the ICJ automatically rejected the claim, as the decision had already been made as to the non-existence of territorial maritime accord between Kenya and Somalia (ICJ, 2021, para. 160).

Concerning Kenya's claim to access route for fisherfolk and/or other natural resources, the ICJ remarks the probability of considering it as an important factor exceptionally, only if the equidistance line would probably result in 'catastrophic repercussions for the livelihood and economic well-being of the population' of a given coastal state/s. Within the foregoing context, the court, however, is not satisfied with Kenya's claim, providing its weak premises as to the actual implication and repercussion of the equidistance line on its wider population, thus, rejected it (ICJ, 2021, para. 159).

At the backdrop of the above, the ICJ, after evaluating the significance of geographical configuration in the coastal area of Kenya and Somalia in the Indian Ocean, has underlined and ruled on the need to adjust a provisional equidistance line to attain the ultimate objective of equitable maritime delimitation (ICJ, 2021, para. 172-173).

As a result, considering the geographical configuration of the coastal area, the ICJ technically pursued to adjust the provisional equidistance line toward the north, which go after 'a geodetic line with an initial azimuth of 114º' (ICJ, 2021, para. 174).

According to the above adjustment, Somalia and Kenya are awarded 733 km and 511 km coastline long respectively, which favour the former state with its 1:1.43

ratio. In the case of a territorial sea demarcation, about 120,455 sq. km. and 92,387 sq. km. were assigned to Kenya and Somalia respectively, which favour the former state with its 1:1.30 ratio. Comparatively, the court underscored the aforenamed two ratios don't entail 'any significant or marked disproportionality' (ICJ, 2021, para. 176).

Therefore, per paragraph 1 of Article 74 and 83 of the UNCLOS qualification in maintaining equitability, the ICJ remained satisfied with the above territorial maritime seacoast and its outskirt delimitation for the exclusive economic zones and continental shelves of the two coastal states (ICJ, 2021, para. 177).

6. DELIMITATION OF THE CONTINENTAL SHELF BEYOND 200 NAUTICAL MILES

With respect to the limits of the continental shelf beyond 200 nautical miles, though both Kenya and Somalia had made submissions to the Commission per Article 76 of the UNCLOS in May 2009 and July 2015 respectively, both coastal states still requested the ICJ to delimitate it. As a result, the court considered the matter from two aspects and concluded that – the territorial maritime sea 'beyond 200 nautical miles continues along the same geodetic line as the adjusted line within 200 nautical miles until it reaches the outer limits of the coastal states' continental shelves,' – while the remaining delimitation of the continental shelf beyond 200 nautical miles should be delineated based on the recommendations to be made by the Commission (ICJ, 2021, para. 178-181).

7. SOMALIA'S ALLEGED VIOLATIONS BY KENYA OF ITS INTERNATIONAL MARITIME OBLIGATIONS

7.1. Somalia's Claim

According to Somalia, Kenya unilaterally engaged in various economic activities, such as exploration and exploitation, in a contested coastal maritime area, which is contrary to the UNCLOS principles and Article 77 in particular. Somalia added that Kenya's activity not only amounts to its territorial sea violation but also against its exclusive economic zone and the continental shelf jurisdiction. Moreover, Somalia claims that the moment it became aware of Kenya's activity, it protested against them (ICJ, 2021, para. 199).

Therefore, Somalia demanded the ICJ to pronounce Kenya's action as contrary to its international obligations and adjudge the latter state to be liable to 'make full reparation' to the former state per international law (ICJ, 2021, para. 198).

7.2. Kenya's Claim

Kenya, on the other hand, denied the existence of antagonism over the practice of using maritime activities, thus, argued otherwise that it had been freely engaging in economic activities within its maritime boundary where it had assumed and held its undisputed territorial seacoast. Kenya also asserted that, even though the provided coastal areas had been subjected to dispute, its activities cannot be said to be unlawful for two main arguments: 1) arguing its activities did not 'lead to permanent physical change'; 2) claiming paragraph 3 of both Article 74 and 83 of the UNCLOS is not relevant to their case at hand, arguing its 'activities commenced prior to a dispute.'

Therefore, Kenya underlined Somalia's inability to substantiate its claim, in terms of sanctioning its illicit economic activities in the contested coastal area, thus, requested the court to reject Somalia's asserted claim (ICJ, 2021, para. 201-202).

7.3. ICJ's Ruling

After evaluating the abovementioned issues, the ICJ marked that Kenya exercised its economic activities assuming its maritime boundary but suspended its activities in 2016 until an agreement is reached between the two coastal states, thus, learned Kenya was acting in good faith. Moreover, the Court was not convinced that Kenya's economic activities would hinder the process of attaining a final accord on the territorial sea delimitation between the two coastal states. Consequently, the Court was unable to draw a conclusion as to whether Kenya's action amounted to violating paragraph 3 of Articles 74 and 83 of the UNCLOS (ICJ, 2021, para. 210-211).

Therefore, the ICJ ruled against Somalia, underscoring that Kenya, while conducting its maritime economic activities in the contested coastal area, has not acted against its international duty, thus, rejected Somalia's full reparation claim (ICJ, 2021, para. 212).

8. CONCLUSION

All in one, the International Court of Justice, after examining both Kenya and Somalia's claim and counterclaim: decided there is no agreed maritime boundary between Somalia and Kenya that follows the parallel of latitude; delimited single maritime boundary which follows the geodetic line between Kenya and Somalia in the Indian Ocean; Kenya has not violated its international obligations through its maritime economic activities in the disputed area.

Aside from the aforementioned, in this maritime dispute adjudication between Kenya and Somalia, there are criticisms attributed to the ICJ decision.

The first criticism stems from an equal participation perspective. According to Article 287 (1) (b) of UNCLOS and Article 35 (2) of the ICJ Statute, all disputing parties need to be duly represented and have the same access to all information and be allowed to refute as well as produce their side of arguments so that they all have confidence in the overall proceedings and final adjudication of the case. Although Kenya participated in the preliminary hearing, it did not participate in the merit hearing phase due to – the Covid-19 pandemic, – unwillingness to participate via online video trial proceedings, and – other trust issues with the court itself (Bryant, 2021; ICJ, 2021, para. 16, 28). Bearing in mind these aforesaid arguments, the impartiality of the court decision has been criticized (Africanews, 2021; Anna & Barise, 2021; Wasike & Mukami, 2021). Here, it has to be recalled that the court decided the case believing that it has all it needs to give judgment on the case (ICJ, 2021, para. 29).

The other criticism arises from the technical content of the ruling that the Court had some access to technical input. According to scholars like Bekker *et al.* (2022) and Schofield *et al.* (2021), it is unclear precisely who provides such technical expert support, as such question the impartiality of the court in its non-legal, but technical, decision.

Apart from the above, the Author has observed many scholars attest to the legality of the ICJ's decision, affirming that it is in line with the principle of the UNCLOS and its precedents. Moreover, even those scholars that criticize the decision do not rule out the validity of the overall court's adjudication, signaling its legitimacy in a general context. Saving the abovementioned concerns, this Author also believes the ICJ's decision on the territorial sea dispute between Somalia and Kenya in the Indian Ocean is legitimate per international laws.

ACKNOWLEDGEMENTS

The Author would like to acknowledge and extends his gratitude to Prof. Dr. Elif UZUN for her critical feedback and comments while developing this decision review.

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Mersin University Journal of Maritime Faculty

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

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

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

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

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

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

1. INTRODUCTION

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

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

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

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

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

2. LITERATURE

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

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

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

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

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

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

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

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

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

3.METHOD AND APPROACH

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

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

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

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

4. FINDINGS

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

4.1. Demographic findings of the experts participating in the study

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

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

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

Source : Author

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

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

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

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

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

Source : Author

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

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

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

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

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

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

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

Source: Author

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

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

5. RESULTS & DISCUSSION

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

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

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

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Mersin University
Journal of Maritime Faculty

Mersin University Journal of Maritime Faculty (MEUJMAF)
Vol. 5, Issue 1, pp. 15-21, June 2023
e-ISSN 2687-6612, Türkiye
DOI: 10.47512/meujmaf.1294234
Review Article

GEOGRAPHICAL INFORMATION SYSTEMS FOR MARINE APPLICATIONS

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Received: 08/05/2023 Accepted: 20/06/2023

ABSTRACT
Geographical Information Systems (GIS) are special class of information systems which combine spatial and non-spatial information systems within a single system. It is a type of information system that collects, stores, retrieves, analyzes and displays geographically referenced and attribute data simultaneously. GIS is a decision tool that helps decision makers and facilitate decision making process. The usage of GIS for land problems began about 1960s, but application of it to sea problem was in the 1980s. Marine GIS gained a substantial significance in the 1990s with the emergence and popularity of Earth System Science.The aim of this study is to examine the usage of GIS in marine areas and to highlight the importance of GIS technology for marine applications. All of these concepts were examined in a theoretical framework in the study. So the method of the study is a literature review. With the literature review, the concept of GIS and its application in marine areas were tried to be explained. After reviewing literature it is concluded that marine GIS can give different perspectives to marine scientists for solving marine-related problems and facilitating decision making process.

Keywords: *Geographical Information Systems, Marine GIS, Marine spatial planning, GIS for coastline management, GIS for fishery.*

1. INTRODUCTION

Information systems (IS) are special systems designed to collect, store, analyze and present information in a systematic way. These systems improve information management of an organization by applying computer to data processing. So, IS can be defined as a set of interrelated components that support decision making in an organization by collecting, processing, storing and distributing information (Avison&Elliot, 2005; Laudon&Laudon, 2005). These systems are categorized as spatial and nonspatial information systems. In nonspatial information systems,such as student information system and library information system are nonspatial information systems in which data arenot linked to any coordinate information. In spatial information systems data are referenced to any position geographically with coordinate information named as spatial data (Aronoff, 1995; Lo&Yeung, 2002; Laurini&Thompson, 1992). As stated by Gilfoyle&Thorpe (2004), handling and analyzing spatial data have an important role because of the spatial aspects of many problems encountered in the organizations. Spatial data means geographic data which is obtained from measurement or observation of earth. But this data becomes information and can solve the problems only when it is asked who, what, when, where and how many questions. As a result of the need for combinatiorial usage of spatialand non-spatial (non-graphical or attribute) data with digital maps, computer-based systems known as Geographical Information Systems (GIS) emerged.

GIS relates spatial data to attribute data. Its main duty is to store spatial and non-spatial (attribute) data and dijital maps within the same database and to update, manipulate, analyze and display them simultaneously. As depicted by Shamsi (2005), GIS technology develops effective solutions in the management of natural resources by using the integrated power of both geography and information systems. GIS is very helpful for gathering, analyzing and visualizing spatial and non-spatialdata simultaneously. GIS can be used as a decision tool by facilitating decision making process in terrestrial and marine areas.This technology is used to capture, store and analyze terrestrial and marine-related data. Hardware, software, people and dataarecomponents that make up asuccessful GIS.

Hardware component of GIS is, computer and any other equipment (such as digitizers, scanners, printers and plotters, etc…) needed to store, organize, analyze and display spatial and non-spatial (attribute) data. (Heywood, Cornelius, & Carver, 2002).

For GIS to be successful it is important to use the most current version of the software. But as stated by Nasirin, Birks, & Jones (2003), GIS should not be thought of as a just software installed on a computer.People who will use GIS should know what to do with the data, how to benefit from the software package, which analyzes they will do and for what, and should be able to interpret the results of analyzes correctly.

In order to be successful in terrestrial and marine GIS, the selection of true GIS packages is very important. Software selection process must be considered in terms of ease of use, amounts and formats of data they can process. The selected GIS packages should have the ability to interchange data with other packages (Valavanis, 2005: 22).

People component of GIS consists of viewers, general users, and GIS specialists. Viewers are the people who want to browse a geographic database and access to information when they need. General users use GIS for managing businesses and making decisions. They have direct effect on the successful use of GIS in the organizations. GIS specialists are the people who actually perform GIS work. The designation of database and the supplying technical support to viewers and general users are among the main duties of GIS specialists. The system will not work with the absence of specialists who operate and support GIS. (Lo & Yeung, 2002).

As mentioned by (Gilfoyle & Thorpe, 2004; Lo & Yeung, 2002) GIS database can either be in a vector or in a raster format. Points, lines and polygons are representations of spatial data in vector formats, while pixels or voxels are representations of spatial data in a raster format. Points represent anything that can be described as an x, y coordinate such as port, dock and hatchery. Lines are the data that composed of combination of several point data, such as road, railway and stream. Polygons are data that start with a particular point and ends with the same point and are represented by a closed set of lines, such as lagoon, mangroves and lakes. Wind direction or wind force measurements for sediment type are examples of point data format, coastline and bathymetry are examples of line data format, statistical sampling areas or commercial catches are examples of polygon data format, sea surface temperature and sea surface salinity are examples of raster data format. GIS can manipulate these data by converting them to another format (conversion of images to grids), creating new data format and preparing data for analysis. Classification, proximity analysis, optimum path analysis, statistical analysis are some of the techniques that are included in spatial analysis tool of GIS (Valavanis, 2005: 14; Meaden & Do Chi, 1996).

Non-graphical data is the other type of data that must be mentioned in the context of GIS data. These data can either be compiled in the tabular form or hold the attibute information concerning to special graphical database. The database designed for fish landing at a specific port, which includes data about, dates, name and type of vessel, species of landed fishes,is an example of non-graphical GIS database (Meaden & Do Chi, 1996).

Data is very important factor in GIS applications and setting database management system is the heart of any GIS. Cost of data input is high in terms of purchasing digital data or setting up and maintaining data gathering system. So at an early stage of GIS establishment, costs can be very high. The legal situation regarding the means and degree of access to data sources may sometimes be poorly defined or unnecessarily restrictive (Nath et al., 2020: 11).

This study emphasizes both the importance of GIS and its application in marine areas. The research problem of the study is to present how GIS can be used to solve marine related problems? So with this study it is tried to show the importance of GIS for solving sea problem and how it can be used for solving marine area problems. The method of the study is a literature review. By doing literature review it was tried to show importance and several usages of GIS for marine areas. Because marine GIS is in its infancy stage, it is tried to draw attention to the importance of the subject by examining marine GIS applications that reveals the significance of the study.

2. GIS FOR MARINE APPLICATIONS

The usage of GIS for land problems began by the late 1960s, but application of it to sea problem was in the 1980s. Marine GIS gained importancein the 1990s with the emergence and popularity of Earth System Science. Other factors that expands the usage of marine GIS include increasingglobal ecological understanding and concerns,increased awareness of marine life.Marine researches began with the United Nations Convention onthe Law of the Sea in 1994, and the designation ofthe International Year of the Ocean in 1998. In the literature there are studies which showed the usage of GIS to determine high productive marine areas and potential fishery location areas. Marine productivity hotspots are crucial areas for fish aggregation for mating, spawning, and feeding. GIS and satellite data based model allows the spatiotemporal mapping of combined anomaly in below average temperature values and above average chlorophyll levels (Valavanis et al., 2004).

When the literature is reviewed it was seen that there are a lot of studies concerning GIS applications in marine areas ranging from oceanography to fisheries. In the literature studies about GIS and Oceanography can be categorized as Marine Geology, Flood Assessment, Coastal and Ocean Management, Coastal Zone Dynamics, Marine Oil Spills, Sea-Level Rise, Wetlands and Watersheds. In the literature some of the studies about the GIS and Fisheries are subdivided as Marine Fisheries, Aquaculture, Inland Fisheries. GIS can contribute to the Inland Fisheries area by mapping of spawning grounds, mapping migration corridors, mapping essential habitats, etc. (Valavanis, 2005).

In the literature there are a lot of studies that emphasıze versatile GIS applications in marine areas. GIS applications are very useful for monitoring, conservation and management of marine areas. Many authors studied spatial awareness in geographical environments. The understanding of various GIS data models and evaluation of spatial analysis in GIS are the basic steps for developing spatial thinking (Kaymaz&Yabanlı, 2017:189). Some of the uses of GIS in marine areas include maritime transport, fisheries, disposal of waste, conservation and managing coastal areas (Kaymaz&Yabanlı, 2017: 189, 195; Jayasankar, George, Ambrose, Manjeesh, 2013: 438).

The importance of GIS comes from its ability to combine different data types, to do spatial analyses and statistical queries with increased speed and accuracy. These feauture of GIS are very important in managing dynamic nature of marine habitats and coastal resources. But in order to manage this process marine data must be accurate and updated regularly. By combining different layers, doing statistical queries and performing buffering operations, such as determining fishing locations in water depths greater than 100 m.,or displaying marine areas having water temperature mean greater than 15 degrees Celcius with the water depth smaller than 100 meters can be performed with GIS. GIS allows decision makers to evaluate different management scenarios with increased speed and accuracy and then enables them to make more comprehensive decision. GIS is an important tool for analyzing time related changes in coastal areas (Paiman and Asmawi, 2017:160; Stanbury&Starr, 1999: 700; Meaden&Do Chi, 1996: 136).

2.1. GIS For Coastal Management

GIS can combine different data set from different resource and enable the coastal manager to see the picture of the problem as a whole. In this process coastal manager's ability to accept and understand complexity of coastal process is important in managing coastal area successfully. Managing coastal resources requires to integrate spatial and non-spatial data from different database. GIS can integrate these databases and allow managers to make decision quickly and accurately. By performing GIS practises coastal erosion vulnerability, sea-level rise and other threats can be modelled by coastal managers (Paiman and Asmawi, 2017:160).

Because coastlines are enduring quick development, dynamic nature of these areas requires strict management policies. To be effective in this coastal management process all decisions must be based on appropriate, reliable and timely data and manager of this process must have full access toall related database. GIS can contibute this process by managing large database, encouraging use of standards for coastal data definition, collection and storage of coastal data.GIS applications are very helpful for planning, managing and monitoring natural and human-sourced changes in coastline areas.The decisons tools of GIS such as simulation modelling and what if scenarios help keeping track ofthese changes regularly and making decision.Results of the analayzes are very important especially for GIS users whose works are related to the coastal areas, such as town planners, land managers etc. Measuring distances and areas, performing buffering operations around lines or determined areas are only some of the functions of GIS that can be used for coastal management and marine-related applications. Thus, a well-designed coastal area information system can serve as an important decision toolin the development of integrated coastal resource management strategies (Paiman and Asmawi, 2017:160,161).

Paiman and Asmawi, (2017:162) cited some GIS applications used in coastal management. GII (Geographic Information Infrastructure) for monitoring the Netherlands' coastal zone, COSMO (Coastal Zone Simulation Model) for risk management, SHO-MAN (the SHOreline MANagement tool) for coastline management are some of the applications mentioned in this study.

In order to maximize effectiveness of GIS in marine applications firstly data needs must be identified to manage coastal areas and marine resources. In marine applications different data sources can be obtained from different GIS data layers, satellite images, aerial photographs and database information Spatially and timely dynamic nature of coastal resources and marine haibats, combination of dissimilar data types is very important in decision making process. GIS can combine or overlaydifferent layers, manage spatial analysis and do querieswithin one layer or among objects in two or more layers (Stanbury&Starr, 1999: 700).

2.2. GIS For Fishery

One of the important application areas of GIS in marine is fishery. In the past the usage of GIS was not practical because of the difficulty of obtaining spatial data about organisms/habitats in underwater environments, When GIS is combined with other technologies (such as remote sensing), analytical tools and models, it allowed for spatial monitoring and analyzes. GIS can serve as an important decision tool in planning and management of fisheries because of the spatial component of this process. Spatial components include, movements and migrations of resources, the description of fishing spots, transportation networks, habitat loss and etc,.GIS is a technology that can elucidate the problems and produce solutions with the help of spatial components. Aquaculture studies used GIS for the past 15 years in the field of evaluation of suitability of coastal areas for farming activities. GIS is a helpful tool for studies seraching for water quality on sellfish aquaculture, various uses of estuarine waters and, etc (Nath, Chutia, sarmash, Bora, Chutia, Kuotsu, Dutta, Yashwanth, 2020: 7).

With the advances in radio telemetry, hydroacoustic telemetry, and side-scan sonar, biologists have been able to track fish species and create databases.These technologies can beintegrated with a GIS program to form a geographical representation. Some of the applications of Remote Sensing and GIS in fisheries are site selection for aquaculture or mariculture, modeling fish activity and movement, matching fish distributions with the environmental parameter such as, water temperatures, water depth, bottom sediment type and salinity, analyzing fisheries catches (where is the fish caught and how much is caught) and effort, setting regional and national fisheries database, mapping and monitoring seagrass, seaweed and coral reef, mapping of habitat and change detection.(Nath et al., 2020: 7).

3. AN OVERVIEW OF MARINE GIS

Some of the benefits of GIS can be summarized as: By creating digital maps through GIS, it is possible to update them, to change or merge them with other maps. diverse graphic representations are possible with the analyzes offered by GIS. The other benefits are, integraton of other large data sets, display of easily understandable spatially related data, regular flow of spatial data in a standardized form (Nath et al., 2020: 11) There are some points that need attention and to be careful when using GIS. Firstly, in order to use GIS, organizational change will be mandatory because GIS implementation will change the way organization works (Nath et al., 2020: 11).

As mentioned by Wright and Goodchild (1997), despite the static characteristic of terrestrial-based GIS problems, marine GIS problems have fuzzy boundary, dynamic nature and three dimensional characteristics. Marine area is a dynamic environment where almost eveything moves or changes due to physical processes such as current, upwelling. Marine GIS requires defining relations between wind and sea currents and displaying effects of these relations on oceanographic process and behaviour of marine organisms. Marine GIS has a wide range of applications such as coastal, oceanographic and fisheries GIS. A coastal fisheries GIS deals with,for example, how oceanographic processes, like upwelling, affect fish population and production. This is an example of overlapping of marine disciplines in marine GIS applications. Generating decision-aid tools is one of the main objective of marine GIS. In generating decision-aid tool process GIS technology is incorporated into other technologies, such as Global Positioning System (GPS), Remote Sensing (RS), modelling, image processing, spatial statistics and Internet. Involvement of marine scientists, such as oceanographers, marine biologists and GIS experts is required for marine GIS development. During this procedure, the first task of a marine GIS developer is to collobrate with other marine scientists for fixing and defining the spatial problem and the creating a list of spatiotemporal questions. The nature of these questions will greatly affect the whole design of the marine GIS tool because such tools contain specialised GIS tasks. Marine GIS tools can be categorized as cartography tools, data distribution tools, monitoring tools and decision support tools. These tools contain the main goals for a marine GIS development (Valavanis, 2005: 1-3).

Cartography tools provide visualization of spatiotemporal distribution of data set distribution, such as mapping of bathymetry, mapping of fisheries production, mapping of the distribution of sea surface temperature. Data distribution tools provide raw data in a GIS ready format, thereby enhance the use of the raw data, particularly of satellite data. Time series analyses of GIS datasets can be used for the monitoring of oceanographic phenomena like the start and the end of a cyclonic upwelling event. In order to know current state of the marine resources, seasonal or annual oceanographic phenomena monitoring tools are very important in marine GIS. Marine GIS decision support tools are precious for the development of marine resource management scenarios. They provide a detailed analytical results for species' population dynamics, their life cycles in relation to marine environment and their fisheries production status (Valavanis, 2005: 10).

The questions that marine GIS answer can be categorized as questions dealing with location and extent; distribution, pattern and shape; spatial association; spatial intereaction and spatial change Followings are some of the marine spatial questions that marine GIS can answer (Valavanis, 2005: 12,13):

- Where is the location of an upwelling?
- What is the topography of the upwelling area?
- Why upwelling does not ocur in all coastal areas?
- Why does upwelling happen in a particular area?
- What are the wind patterns of an upwelling area?
- Why do trawlers consistently fish in a particular area?
- What is the distribution of sea surface temperature, chlorophyll, and salinity before, during, and after an upwelling event?
- Is there a particular area where a specific marine species is consistently caught?
- How have productivity levels changed in a particular area?
- Why are particular species found in a particular area?

GIS can serve as a decision tool in finding answer to spatial questions by doing analyzes and then displaying and visualizing results of analyzes on a digital map. Generating true and up to date GIS database is very important before doing analyzes. Because correct answers to these analyzes depend on the creation of the correct GIS database through which questions like what characteristic of an object is, where and how it is located can be answered. Geographic data and attribute data are very important for doing analyzes in a GIS. The center of a GIS is the designing of true and up to date database. GIS is not simply a map making computer system. It also shows spatial relationships between map features.

Doing analyzes over several datasets with GIS provides valuable information for marine areas. GIS allows for representation of analyzed data in the forms of maps, graphs, lists and summary statistic. By marine GIS relationships between wind and sea currents and their effects on oceanographic processes, behaviours of marine organisms can be explained. Defining fish habitat and organizing living marine resources, tracing marine mammals, analyzing their hunting and migrant lines are marine problems that GIS can answer. For detecting changes in marine processes and visualization of these processes multidisciplinary data are used in GIS. GIS analyses give synoptic situation of marine environment that shows marine pollution, quality of seafoodand special ecosystems like mangroves and corals (Kaymaz&Yabanlı, 2017:191).

Marine problems have spatiotemporal characteristics. GIS allows for collecting and using different environmental parameters to understand their effects on marine environment. For example oceanographic GIS is used for doing analyzes about coastal zone management, marine habitat assesment, marine pollution, deep ocean mapping, sea level rise and visualing results on a digital map (Kaymaz&Yabanlı, 2017).

Consequently, thinking spatially and doing GIS analysis in the marine areaare very important for comprehending the dynamics of marine processes and their effects on the behaviour of species populations.Marine GIS requires multifaceted thinking. For example, the explanationof why a particular species exist in a particular areaat a certain times of their life cycles will require the data about their migration habits, wind and current patterns with GIS experts who integrate all the related data. From a GIS perspective, the main goal is to combine all the data necessary to develop a model of the marine environment to understand what and where objects are and how and why they are there. (Valavanis, 2005: 16).

In the process of building marine GIS, marine GIS developers have to cooperate with marine scientists, such as oceanographers, marine biologists, fisheries and etc., for defining spatiotemporal problems and finding solutions to these problems. In this process marine GIS requires forming spatiotemporal multidisciplinary database, manipulating different data formats (raster and vector) and setting system user interface. The integration of GIS methodolgies with visualization, statistics, spatial analysis, modelling and Remote Sensing is very important part of decision support process for studying the marine environmental problems and development of marine GIS (Valavanis, 2005: 24).

4. SAMPLES OF GIS APPLICATIONS IN MARINE AREAS

GIS applications in marine areas are in their early stages. Because there are some obstacles that hinder quick development of GIS in marine area, like massive marine data sets, the need for three-dimensional data processing, difficulty of getting ocean data, mapping or analyzing moving or changing sea environment, the need for marine scientists that specialize in marine GIS, etc. Despite these challenges, there are successful marine GIS applications in the literature. Habitat mapping, species distribution, fisheries oceanographic modeling, fisheries management are some of the areas that make use of GIS in fisheries.

Li and Saxena (1993), presented the results of the development of Marine Geographic Information System (MGIS) for the development of the Exclusive Economic Zone (EEZ) in the U.S. Pacific Islands region. Some of the applications performed in the study are spatial marine data processing, integration of GIS and mapping systems, simulation of marine operations. In the study MGIS has been used for selecting a potential deep-water research site off the Hawaii island and for generating three-dimensional database and using it for the navigation.

Lucas (1996), handled the issues and implications for coastal GIS, integration of ocean data within a coastal GIS for the Baltic Sea. In the study it is stated that the problems regarding the use of ocean data in coastal area are related to the spatial and temporal variability of coastal ocean data.

Meaden (2000), discussed GIS applications in fisheries management. The main focus of the study is to examine problems and challenges encountered in using GIS in marine fisheries. In addition the study discussed importance of GIS in fisheries management. Meaden mentioned the authors who studied fisheries and GIS, such as marine mapping, habitat mapping, marine productivity mapping, fisheries management, aquaculture location and activities from 1991 to 1997 period in the study.

Jayasankar et al., (2013) mentioned the case studies about GIS applications to fishery both internationally and in India. Some of the examples using GIS in India are thematic mapping of tuna and tuna like resources, monitoring change in the average sea surface temperature, etc.

Triana and Wahyudi (2019), examined GIS development for Marine Spatial Planning and they tried to predict challenges faced in this process in Indonesia. In the study it is stated that GIS is used to store, analyze and display collected data in the process of developing Marine Spatial Planning.

Nath et. al. (2020), highlighted the importance of GIS in fisheries and usage of GIS as a management tool in fisheries. The application of RS and GIS in fisheries in site selection for aquaculture, modeling fish activity and movement, matching fish distribution to environmental parameters, establishing regional and national fisheries database, identification of potential fishing zones were also discussed in the study.

5. CONCLUSION

Terrestrial-based GIS data has more static characteristic than that of marine GIS data. In this context marine data is fuzzier than terrestrial data in terms of locations and boundaries.

Once the aims are determined, then GIS user can list main types of required data and after that can determine additional optional data. For example, for coastal zone management, the GIS user will need data about existing land use, proposed land use changes, transport route, etc. Then the GIS user may want additional data about elevation and slope of the land, locations of harbours, etc. For monitoring fish yields basic data requirement can be listed as, boundaries of fishing zones, rate of catch per species, bathymetric data for particular area, etc. Then GIS user can make additions to the mentioned basic data.

Marine applications of GIS have been slow due to difficulties of mapping marine species distributions, constant change of marine environment, high cost of getting marine data, cooperation problems in data collection, difficulty of defining boundaries because of the fuzzy nature of marine resource distributions and the problems of storing huge amonts of data (Meaden and Do Chi, 1996).

The abilities of GIS in data integration, visualization, statistical analyses and queries help marine scientists to deal with uncertainities of deep (Wright & Goodchild, 1997). The very high costs of acquiring, integrating and interpretating marine data justify the use of marine GIS which provides all of these capabilities within a single system. Visualization of marine problem helps the decision makers to develop spatial thinking. The combined use of GIS and other disciplines, such as visualization, statistics, spatial analysis and Remote Sensing, is very important part of establishing decision support system for marine related problems and marine resource management.

As mentioned by Lucas (1996), in the case of the lack or deficiency of data about marine processes the role of GIS as a decision support tool will be limited. Accurate coastal ocean data must be made accessible and usable so that decison makers can integrate needed information into their task.

Versatile marine scientists such as fisheries and marine biologists, oceanographers, GIS specialists, analysts, etc. are necessary for building full-fledged marine GIS. The marine GIS should display marine data, support contouring, overlaying, incorporate links to GIS external software, support an interactive graphical user interface, enable data downloading and dissemination of the results through the Internet (Valavanis 2005).

Geographical interpretation of marine area using GIS is at the early stage but continue to develop. GIS helps marine scientists to develop comprehensive plans in the fields of fisheries, coastal areas and marine policy making.

Thanks to GIS for providing tools for making decision accurately and in time, creating, changing and updating digital maps easily, producing several what if scenarios, allowing for integration of large data sets, integration with other technologies such as remote sensing and satellite images.

GIS is not only a system of hardware and software. Successful GIS implementation requires having staffs who have high GIS knowledge, speciality, technical competence and skills and having organizations that have innovative environment. In addition, data needs of organizations must be identified. High cost of getting data and designing database, data manipulation and conversion of data to and from diffferent formats must be taken into account prior to establishing GIS.

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CONTENTS

Volume 5 – Issue 1

ARTICLES

June 2023 Volume: 5 Issue: 1