

**INVESTIGATION OF NEGATIVE IMPACTS OF INCREASING
SHIP TRAFFIC IN THE GULF OF IZMIT**

by

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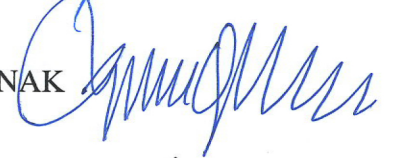
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FOREWORD

Sea transportation while being considered as one of the major means of Turkey's trade as well as the global trade contains many different risks and problems along with its significance. Today, 90% of world trade is carried out via sea transportation. Therefore, continuation of sea transportation in a safe and secure environment has a particular importance.

The Turkish shipping industry and transportation have grown rapidly during the last decade. Turkey's key geographical location contributes extensively to maritime trade. Therefore, ship traffic is increasing in the region each day.

Addition to the unique geographical location of Turkey, our subject region Izmit Bay, hosting numerous factories and refineries, with more than forty terminals, and the Turkish Naval Base in Gölcük with more than 100 navy vessels of every kind bring about a very dense sea traffic in the bay area. Roughly 11,000 ships visit this bay each year. With the presence of increasing traffic of merchant shipping, north-south bound ferry traffic, navy vessels going in and out of the Naval Base and the restrictions stemming from the geographical constraints such as maneuvering area, depths and navigational hazards etc. The bay area is getting congested in every passing year.

The current regulations on maritime traffic and traffic separation in the region would probably not suffice in near future. Therefore, sea traffic in Izmit Bay should be well regulated in the future.

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LIST OF ABBREVIATIONS

AIS	Automatic Identification System
BTK	Baku Tbilisi Kars Train Line
COLREG	International Regulations for Preventing Collisions at Sea
GTHM	Center of Vessel Traffic Service (Turkish Acronym)
GTHS	Vessel Traffic Service (VTS) (Turkish Acronym)
GTYM	Main Center of Vessel Traffic Services (Turkish Acronym)
IMO	International Maritime Organization
IZMITRAP	Izmit Bay Reporting System
ONHO	Office of Navigation, Hydrography and Oceanography of Turkey
PAWSA	Ports and Waterways Safety Assessment
PFI	Port Finance International
TEU	Twenty Foot Equivalent Unit (Used for 20 Feet Standard Container Size)
TGI	Traffic Watching Post (Turkish Acronym)
TSVTS	The Turkish Straits Vessel Traffic Service
TSS	Traffic Separation Scheme
SAR	Search and Rescue
VTS	Vessel Traffic Service
Al	Aluminum
Cu	Copper
CO	Carbon Monoxide
Cr	Chromium
Fe	Iron
Mn	Manganese
Ni	Nickel
Pb	Lead
Zn	Zinc
Ag	Silver
Cd	Cadmium
Hg	Mercury
Mo	Molybdenum
SOLAS	Safety of Life at Sea
SWAN	Simulating Waves Nearshore

ABSTRACT

INVESTIGATION OF NEGATIVE IMPACTS OF INCREASING SHIP TRAFFIC IN THE GULF OF IZMIT

Maritime transportation has a big role in world's trade as well as in Turkey. Turkey's foreign trade depends mainly on maritime transportation. One of the node points that has a huge role in outstanding logistic is Izmit Bay which is located in the Kocaeli Province. Due to its geographical location, the city Kocaeli became one of the leading industrial center of Turkey. As part of the industries such as petroleum, automotive, textile, pharmaceutical, chemical, infrastructure, food, iron and steel, comprising 61 million tons of various types of cargo are handled by 43 port facilities in different sizes in the bay area which corresponds %15,86 of total cargo handled in Turkish ports according to statistics of Turkish Chamber of Shipping which consequently result in significant amount of maritime traffic activities in Izmit Bay. Based on Eurostat statistics 2015, Izmit Port in the region of Izmit Bay, is the 8th largest port in Europe by means of that carried cargo ports, on the basis gross weight of goods handled (in terms of million tons). Since, Izmit Bay is very preferable by a variety of industries for maritime transportation, many regulations on safety of shipping traffic are carried out. However, stemming from shipping traffic is still a major problem and many regulations and solutions must be considered. Here in this study, possible solutions for this major problem related with stemming and congestion caused by shipping traffic in Izmit Bay are discussed.

After discussion, possible solutions to the problems are put forward for further investigations.

Key Words: Gulf of Izmit, Ship Traffic, Marine Pollution, Shipping.

ÖZ

İZMİT KÖRFEZİNDEKİ ARTAN GEMİ TRAFİĞİNİN OLUMSUZ ETKİLERİNİN İNCELENMESİ

Deniz taşımacılığı, dünyada olduğu gibi Türkiye’de de çok büyük bir yere sahiptir. Türkiye’nin dış ticareti büyük çoğunlukla deniz taşımacılığına bağlıdır. Kocaeli ilçesinde yer alan İzmit Körfezi, deniz ticaretinde dünya çapında bir öneme sahiptir. Coğrafi özellikleri sebebiyle, Kocaeli ilçesi Türkiye’nin lider endüstri merkezlerinden biridir. Türkiye Deniz Ticareti Odası’nın istatistiklerine göre, Türk limanlarından sağlanan taşımacılığın %15,86’lık kısmı, İzmit Körfezi üzerinden sağlanmaktadır. Petrol, otomotiv, tekstil, farmasötik, kimyasal, enfastrüktür, demir ve çelik sanayi gibi sektörlerden 61 milyon tonu kapsayan farklı kargo tipleri ve farklı boyutlarda 43 farklı liman tesisi ile İzmit Körfezi, Türk deniz ticaretinde önemli bir yere sahip olması ile birlikte, önemli ölçüde deniz trafiğine sebep olmaktadır. Eurostat 2015 istatistiklerine göre, İzmit Körfezi’nde bulunan İzmit Limanı, işlenen brüt ağırlık (milyon ton) bazında, Avrupa’nın en büyük 8. limanıdır. İzmit Körfezi, deniz taşımacılığı için birçok endüstri tarafından tercih edilmesi sebebiyle, Körfez içerisinde deniz taşımacılığı trafiği emniyeti ile ilgili düzenlemeler yapılmaktadır. Buna rağmen, gemi trafiği sebebiyle oluşan sıkışıklık, körfezdeki en büyük problem olmakla beraber, bu sıkışıklığı önlemek amacıyla birçok düzenlemeler ve çözümler düşünülmelidir. Bu çalışmada, İzmit Körfezi üzerindeki deniz trafiğinden kaynaklı gemilerin sıkışma ve çarpışmalarını önlemek amacıyla muhtemel çözümler tartışılmıştır.

Tartışmalardan sonra daha ileri incelemeler için problemlerle ilgili çözüm önerileri yapılacaktır.

Anahtar Kelimeler: İzmit Körfezi, Gemi Trafiki, Deniz Kirliliği, Gemi Taşımacılığı.

1. INTRODUCTION

1.1. Sea Transportation in Turkey

Turkey has an important geographical location and Turkish Straits provide seaborne trade routes from Black Sea to Mediterranean Sea followed by Suez Canal and Gibraltar Strait then the oceans. Thus, through Turkey's maritime trade routes, significant amount of logistics and shipping operations can be accomplished. Sea transportation is carried out along the international sea routes as well as the lengthy Turkish coasts to meet the not only national transportation requirements but also international transportation requirements. Maritime transportation in the region is increasing with each passing day in terms of integrating transportation modes linking transnational corridors between east and west as well as north and south. Today, projects related with international sea ports and stations have become a huge focus of interest in the sense of major investments. As the international ports and stations are developed more, the share of maritime transportation in foreign trading is getting scaled up. The Turkish shipping industry and transportation have grown rapidly during the last decade. Turkey's key geographical location contributes extensively to maritime trade. Izmit Bay, hosting numerous factories and refineries, with more than forty terminals, and the Turkish Naval Base in Gölcük with more than 100 navy vessels of every kind bring about a very dense sea traffic in the bay area. Roughly 11,000 ships visit this bay each year [1]. Figure 1.1 graphically shows the increasing figures of Turkish Maritime Foreign trade between the years of 2006 and 2016 [2]. This graph shows that the trade will continue to increase in the future. It also implies the increasing ship traffics along with the increasing maritime foreign trade.

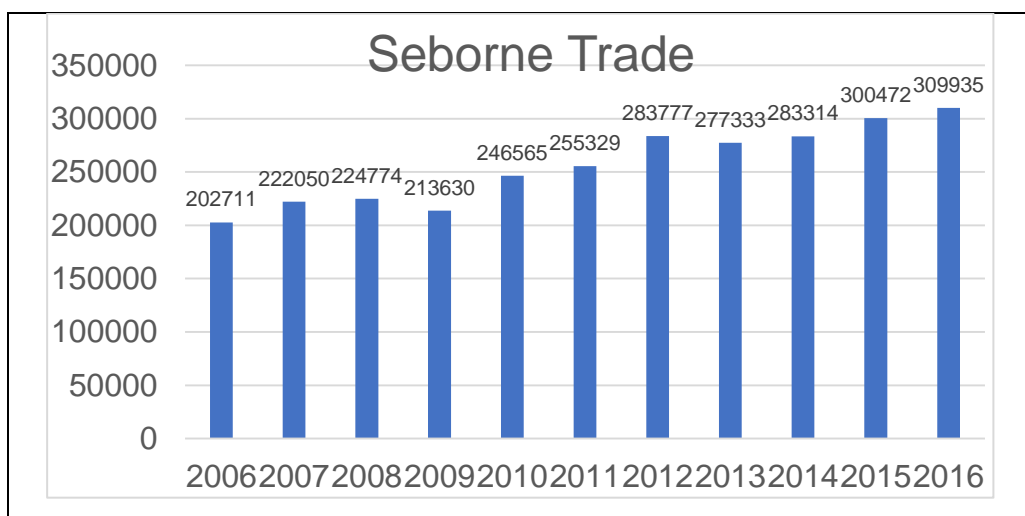


Figure 1.1. Development of the Seaborne Trade (Million Tons) (Source:2017 Report of Republic of Turkey Ministry of Transport, Maritime Affairs and Communications)

1.2. Maritime Trade Statistics

Turkey's maritime fleet (1000 gross ton and above) is listed at the 15th rank in the world fleet as of 2016 [3]. Growing fleet brings an increase in total freight and passenger transportation as well. For the last decade, total passenger and freight seaborne transportation has more than doubled in Turkey [4]. Short Sea Shipping passenger transportation was around 160 million and total freight handled short sea shipping was around 53 thousand tons in 2014. The Volume of maritime transport in total foreign trade reached 283 million tons in 2014. In 2014, seaborne trade held 54,8% of total export revenues and 58,3% of total import revenues [1], [5]. Increasing handled cargo capacities is the evidence of raising ratio of maritime transportation.

Total handled cargo in Turkish ports is shown in the Figure 1.2. This graphics shows that, cargo handling at Turkish ports has been increasing rapidly since 2011. Amount of cargo (including import, export, cabotage and transit) handled in Turkish ports increased from 363 million tons in 2011 to 416 million tons in 2015. Apart from foreign trade statistics, total handled cargo in the ports of Turkey in 2016 (Tab 1.2.) [5]

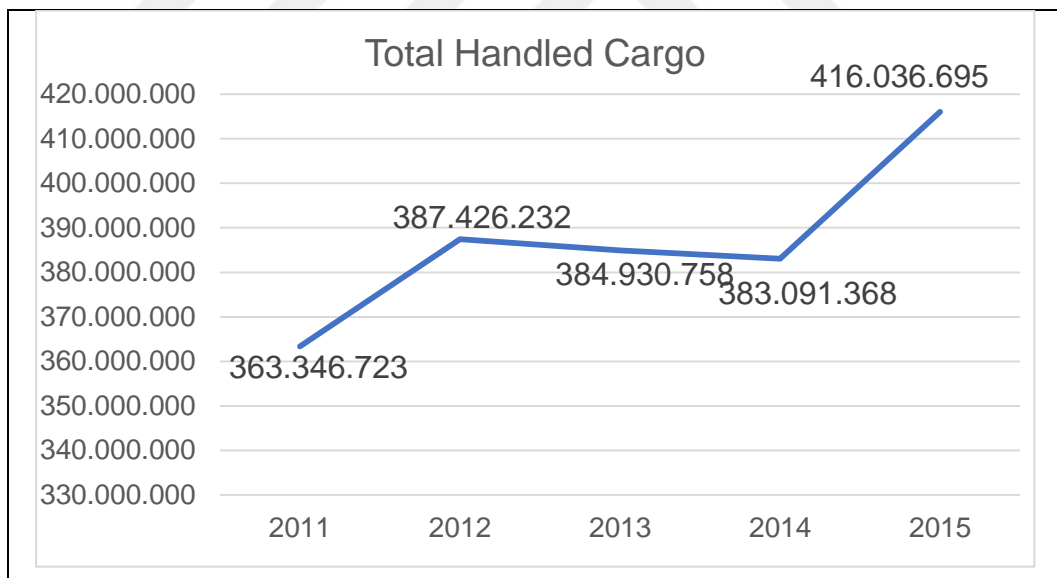


Figure1.2. Cargo Handled Figures at Turkish Ports (Source:2017 Report of Republic of Turkey Ministry of Transport, Maritime Affairs and Communications)

It is easy to understand from Figure 1.3. shows that total handled containers in 2016 were approximately 9 million TEU. Number of containers handled in sea ports and terminals showed a drastic rise in the last 10 years. Trends to increase in total handled containers in the sea ports and in maritime trade imply that the possible increase in the sea traffic to and from Turkish ports in the future.

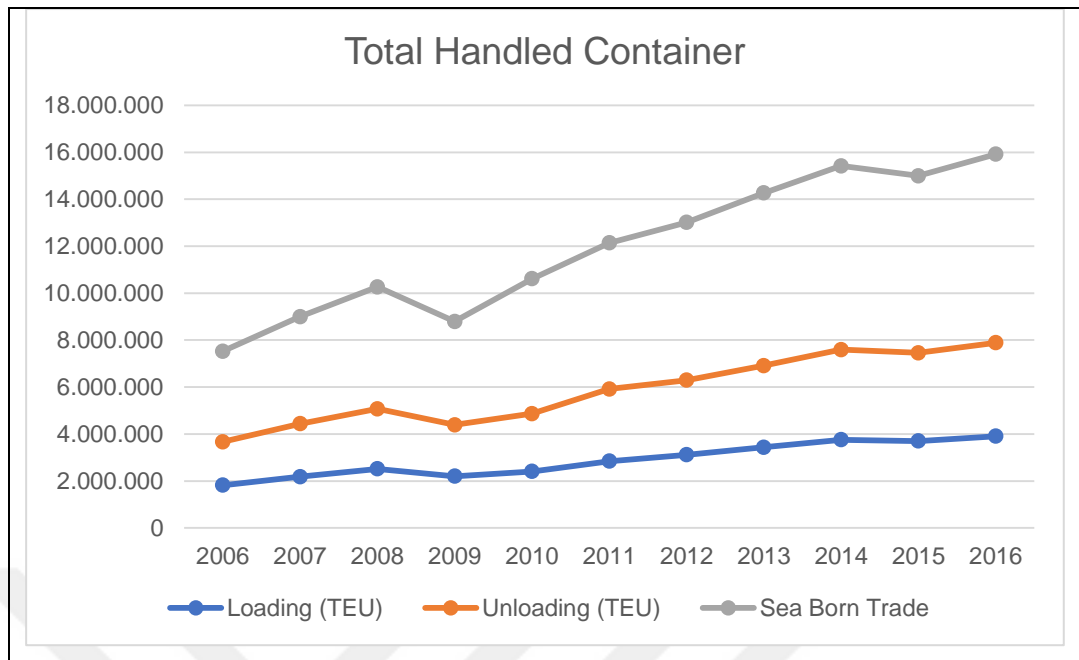


Figure 1.3. Turkish Ports Total Handled Container Statistics (million TEU) (Source:2017 Report of Republic of Turkey Ministry of Transport, Maritime Affairs and Communications)

1.3. Continuing Turkish Port Projects

In the study, not only ports in the Izmit Bay Area but also all the port projects of Turkey are taken into account because the total port capacity which is to be created by all the projects will contribute to the decreasing ship traffic in Izmit Bay.

Major port projects constituted the supreme focus to boost the total handling capacity in the maritime world. In recent years, several projects were given a start at three significant areas; Black Sea, Aegean and Mediterranean.

Petkim Port is considered to be one of the projects that would give a rise to container handling capacity of Turkey. This port is first in Mediterranean and Aegean Sea that 11.000 TEU of container ship could berth. Initial capacity is designed as 1.5 million TEU and total container handling capacity will be up to 4 million TEU. Petkim Port will provide an opportunity to Turkish industry to directly export large amounts of cargo to outer markets, hence decreasing shipping charge [6].

Çandarlı is another port in the Aegean coast, designed to have 11,4 million TEU of container handling capacity. The project still on progress. Çandarlı and Petkim together will be sea trade hubs of the western coast of Turkey, connecting land and railway routes with maritime transport. Moreover, freight transported from Asia along Caspian Transit Corridor and Baku-Tbilisi-Kars railway, would reach these ports to be distributed European and North African markets[2], [7].

Mersin Container Port is another important project, planned to be constructed in the Mediterranean coast of Turkey. It is designed to become container transportation hub in East Mediterranean, Middle East and also Central Asia. Mersin Port is important in a sense to re-export of goods transported from Central Asian countries.

According International Grains Council Market Report, 2016 [8], Kazakhstan is one of the major grain producers of the world. Kazakhstan's grain can be transported to Turkey via Caspian Sea and Baku, Tbilisi, Kars railway and connected to these container ports. Mersin is at a location closer to East Mediterranean and Middle Eastern markets, which have growing demand to import grain. It is strategic to attract cargo from different spots, especially from Central Asian countries, gather in Turkish ports and export these goods to the markets with growing demands. It will provide additional revenue to these countries to flourish their non-oil industry and contribute to Turkey's goal to become a logistic center of the region [2].

Filyos Port is another project, planned to become operation by 2018. Total handling capacity of the port will be 25 million tons. Filyos Port will ensure north-south connectivity, in addition to east-west direction of combined transportation. It is also an important project to enhance industrial activities, bring regional development and welfare and connect Black Sea with other regions [1].

1.4. Increasing Ship Traffic in the Gulf of Izmit

Turkey's sea transportation is increasing each year 87,6% of Turkey's foreign trade is executed by maritime transportation. Total amount of container transportation has increased up to 144% between 2004 and 2013 while the total amount in 2004 was 34.598.747 Tons and 84.656.192 Tons in 2013 [9].

Sea transportation while being considered as the major means of Turkey's trade as well as the global trade contain many different risks and problems along with its significance. In other words, today's boundaries between countries are just lines on the map when it comes to trading, and 90% of this trading is done via sea transportation [9].

Izmit Bay is one of Turkish' ports and has a significant potential in terms of maritime transportation - logistics because of its location. Today, there are many types of cargo are being handled in Izmit Bay such as LPG, chemical tanker, container in 43 ports and the bay have 33 ship yards, 8 fishing vessel shelter and 6 marinas. On the other hands every passing day shipping companies stated in İZMİT BAY being progress new projects to increase their capacity. Derince Port, Evyap Port, Rotaport, Yılport are some of them and that means there will be more ship movements in the future.

Nowadays, roughly 11 thousand ships are passing through Izmit Bay which causes a highly dense environment around the Izmit bay. This increase in local traffic is the main reason that causes unacceptable situations stemming from collision risks and navigational safety risks [10].

On the other hands, annum 11 thousand ships include only merchant ships statistics which trading between İZMİT BAY ports and national/international ports. At the same time there are many sub-reason cause increasing ship traffic. These are listed as below;

- New port project working vessels
- Dredging vessels
- Navy vessels
- Ferries
- Fishing boats
- Sailing boats
- Small boats (private)
- Tugs
- Pilot boats
- Service vessels (barge, fresh water, waste)
- Service boats (shipyards, agency)
- Local regular passenger vessels
- Fast ferry line
- R&D Vessels (measurement, cable)

According Incoming Vessels related the Tonnage Intervals in Kocaeli Harbour Master website outputs, understand the most vessel between 5000 – 20000 GRT as seen Figure 1.4. This issue occurred more congestion due partly cargo/container transportation by different vessels.

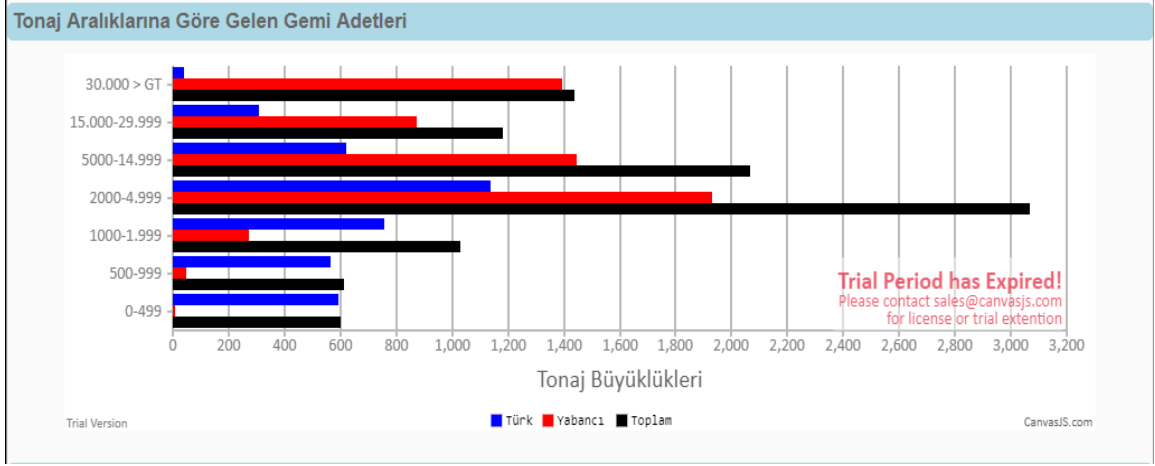


Figure 1.4. Incoming Vessels related the Tonnage Intervals in IZMIT BAY (Source: <http://www.kocaeliliman.gov.tr/istatistik.aspx>)

All above matter has involved serious volume of the part of increasing ship traffic and getting more complicated day by after. It is predicted that ship traffic will continue to increase with the influence of local factors in the region and the seaborne trade, handling cargo/containers statistics in recent years.

Here in this study, general information of sea transportation and about Izmit Bay has been given in the first chapters then current regulations, problems and suggested solutions for the risks stemming from congestion of shipping traffic in Izmit Bay have been provided in the next chapters. Finally, in the study, after investigation of the increasing ship traffic in Izmit Bay, a risk assessment is to be made, then possible solutions to the defined risks are to be discussed.

1.5. Methodology

The concept of the study can be evaluated in two parts, the revealed problems and the solutions and findings as well as discussion of possible solutions and proposals. Therefore, the evaluation of the characteristics (including ports, facilities, limitations, risks etc.) for Izmit Bay, followed by current regulations for the safety of shipping traffic and as being the main concern major problems are presented in detail. Based on these concrete findings and data, possible solutions are discussed in the second and final phase of the study concept. The main findings of the thesis are based on the literature survey including previous researches, articles, papers and thesis of graduate studies. The numerical methods previously employed are referenced to support the findings. The official reports and figures depicted on the web sites of Turkish Maritime Authorities are also mentioned and referenced.

The mainly collecting relevant information by using field study thereafter have been searched from article, paper, researches and internet sources. After investigate all matter related the main and sub problems triggered from increasing shipping traffic, trying the unroll present situation and giving suggestion to reduce arising risks accordingly.

1.5.1. Aim

The aim of this thesis study is to evaluate the risks caused by increasing ship traffic in Izmit Bay and investigate possible solutions of the problems.

Therefore, the study basically focused on the risks caused by the increasing maritime traffic and the evaluation of the congestion due to busy shipping traffic in Izmit Bay and also finding possible solutions to overcome the risks stemming from the risks introduced by the mentioned maritime traffic.

1.5.2. Scope

This thesis study provides a view on the risks caused by the increasing maritime traffic and made an evaluation of the congestion due to busy shipping traffic in Izmit Bay. Furthermore, possible solutions to overcome the risks stemming from the risks by the related maritime traffic have also been discussed in detail.

1.5.3. Problem of the Study

The problem of this study can be phrased as “Potential risks of increasing ship traffic in the Gulf of Izmit and possible preventive solutions”. This is the research question of this study. To sum it up, Izmit Bay with blooming maritime facilities and ports, encouraged by the heavy industrial sites in the bay’s hinterland is one of the major nodes of Maritime Traffic in Turkey. Unfortunately, the shipping traffic in the bay area is getting congested each and every passing day. Risks stemming from this traffic are not only limited to congestion or risks of collision but also environmental issues.

With the help of this study, it is envisioned to present the current and future problems of the increasing shipping traffic in the bay area, while effective solutions and proposals are discussed.

1.5.4. Literature Review

Izmit Bay has a very important potential in the logistics sector due to the location of Izmit which one of the most important industrial cities in terms of its geographical position in Turkey. In the Bay, there are various industries such as oil, automotive, clothing,

pharmaceutical, chemical, cement and steel industry and for this reason the bay is a frequent destination for ships of many different types and sizes [9], [11].

Izmit Bay starts from the Cape of Yelkenkaya in the west and reaches up to City of Izmit in the east of the Bay. It is about 48 km long. The widest part of the Izmit Bay, which has a constricted and expanding structure, is 10 km. The width of the narrowest section falls to 1.5 km. The approximate surface area is 18,300 km², the volume is 308 km³ and the average depth is about 60 m [12].

There are few studies related to environmental pollution on Izmit Bay, especially in Gölcük earthquake and Izmit Bay. One of them is done by Yurtören and others (2014) who make use of the Automatic Identification System (AIS) data and the data through the Environmental Stress (ES) model in the Bay [13], [14].

Another work about this subject is the Izmit Bay PAWSA Workshop, which was held in 2014, where the sea traffic in the Gulf of Izmit was examined, risky areas were identified and questioned about the validity of security measures taken and new measures could be discussed (data not published) [9], [15].

In Şahin's work (2015) the risks created by intensive maritime traffic and also the regions where these risks are concentrated were identified by the IWRAP model, which has been accepted as a quantitative maritime traffic analysis method by IMO and formed by the International Navigation Assistants and Lantern Authorities Association (IALA) in the Izmit Bay [9].

Other research is , "İzmit Körfezi'nde Çevre Sorunları," Aydın, A., 2002, discusses the ecologic situation and find out the area is the industry residential so arising environmental problems entire of the Izmit Bay coasts [16] .

Another research is "Water quality Assessment of Izmit Bay By to Dimensional Modeling," Dengili, K., 1999, shows us the area has some limitations for water changes causing the pollution in the determined area [17].

Despite these theses speak to various problems related to the same area, we focus especially pollution risks occurred because of increasing shipping traffic in Izmit Bay.

1.5.5. Concept of the Terms [18]

***Arsenic:** A chemical element. Found to be carcinogenic to human by Environmental Protection Agency.

***Collision:** A physics, vessel crash the other vessel or land construction in any situation. Most of collision reason is not obey the maritime rules while underway through the sea.

***Container:** The differentiated box specialized carrying of the dry, liquid or gasses cargoes easier and faster on the vessel by seaway. Kind of box as follow: 20 feet, 40 feet, 45 feet, open box, special dimensions.

***Container Ship:** Vessel designed to transport differentiated containers between the ports. Nowadays there are very large container vessel between the continent in regular line. To feed this vessel small container vessel network on progress from small ports to hub ports.

***Maritime Transportation:** Transporting of goods, passengers and animals by seaway. This matter relevant many kind of sector. Shipbuilding, brokering, agency, ship Chandler, logistic, owner, seafarer, some of them.

***Naval Ship:** The vessel used in army for naval purpose. Equipped different kind of weapons against the enemy powers.

***Sea Pollution:** Water corruption caused by ship. It can occur by vessel crash, crew fails. This issue has major problem for the humanity. So maritime sector trying the develop solutions against the arising pollution. The value of the monetary allowance is very big for the company and country.

***Gulf:** Sea or water enclosed by land.

***Bay:** Water indentation shore, enclosed land but smaller than the gulf.

***Water Change:** Remove of water affected by current, wind or geographical reasons. It causes either current which can affect the vessel movement or ecological circulations.

***Navigation:** The term used for vessel proceed on the water. The term covers many kinds of vessel such as sail boat, fishing boat, merchant vessel, scientific vessel, service vessel, navy vessel and others.

***Visibility:** Relative seen ability in the certain condition. Could be arise dangerous situations for one vessel or each other. Restricted visibility mostly occurred by fog situation.

***Risk:** The probability of exposure the hazard, injure, damage or loss. To avoid this matter organizations and companies established the risk assessment procedures. They aim to be ready in all respect during vessel operations.

***Pilotage:** The assist service specialization for straits or ports, take command of vessel and manage all movements of ship during berthing/departure from port or passing the straits.

***Tug:** Assist the vessel mooring, unmooring, towing and escort operations by pushing, pulling or keeping. Taking order from pilot whom on board with Master to assist him critical operations such as berthing, departure, passing straits/channel/canal or escort service.

***Maneuvering:** The vessel movement by engine power, rudder order or tug assistance. The vessel could use one, two or all of them at the same time.

***Vessel Traffic Service:** The service following the vessel movements, giving advice and arrange schedule for passage or ports



2. ANALYSIS OF IZMIT BAY AREA

2.1. Geographical Layout and Limitations

Gulf of Izmit (Turkish: İzmit Körfezi), also referred to as Izmit Bay, is a bay placed in easternmost border of the Sea of Marmara, in Kocaeli Province, Turkey. The gulf is called Izmit Bay due to city of Izmit placed in it, other cities and towns around the bay being Gebze, Körfez, Gölcük, and Altınova. In the east–west direction, it extends for a length of about 48 kilometers (30 Nm). Meanwhile vertical distance which can vary from 2 to 3 kilometers (1.2 to 1.9 Nm) at the narrowest spots to about 10 kilometers (6.2 Nm) at its widest (Fig 2.1.) [19].

The main traffic of Cargo transportation which is on the east-west direction, while the local traffic is basically in the North-South bound are considerably limited in terms of maneuvering area in İzmit Bay [19].

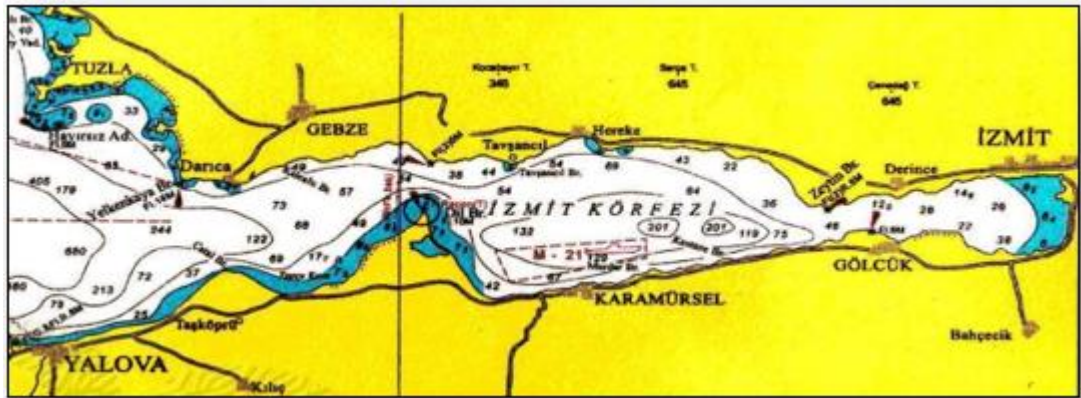


Figure 2.1. Izmit Bay Chart (Source: British Admiralty Chart No 291)

The line connecting Yelkenkaya light house and Çatalburun is assumed to be the furthest limit of the bay in the West bound. The widest part lays between Hereke and Karamürsel. The narrowest part lays between Derince and Gölcük. The bay area is unfortunately lays on the problematic fault line of northern Anatolia, which caused a disaster in Gölcük and surrounding cities in 1999 [20].

The depths in the bay area is less than 200 m isobaths in the West bound. The depth isobaths become 100m in the North between Darıca and Eskihişar. There lays also another spot with 100m depth to the east of these cities and two spots with 200m to the east of Dil Burnu up until Yarımca. These two abysses are to the North of Ulaşlı. The shallowest part of the bay is to the east of Değirmendere with 50m of maximum depth [9].

There are Naval Exercise Areas to the east of Dilburnu which are published on most of the days. Therefore, the traffic is confined in the North of these areas with less

maneuvering capability. The North of Gölcük is reserved for Naval Ships. The Northern coastline of the bay starting from West to east, Darıca, Gebze, Hereke, Yarımca, Derince and İzmit host industrial sites and consequently piers and maritime facilities, the southern coastline is rather residential with the exception of Gölcük, Turkish Main Naval Base. The busiest ferry line (North-South bound) between Eskihisar and Topçular is the only hampering traffic for the commercial traffic in the East-West bound.

Dilburnu, on the other hand, is a critical choke point considering the depths and the turning point.

The area is covered by the Turkish chart number TR291, TR292, TR2911, TR2916, TR2919, TR2923 and British Admiralty chart number BA 497 [1]

2.2. Meteorological Situation

The persistent wind in the Marmara Sea and İzmit Bay is northeasterly. Depending on the winds and temperature, fogs may be quite obstructing for the ship traffic especially during spring and autumn. The worst records for the visibility stand for March, when one out of every six days are subject to fog. July-August is the best period for visibility. As for the records for rain, İzmit and surroundings keep the highest with 706 mm/year [19]. This also has quite an impact on both fog formation and visibility during rain in terms of the safe navigation.

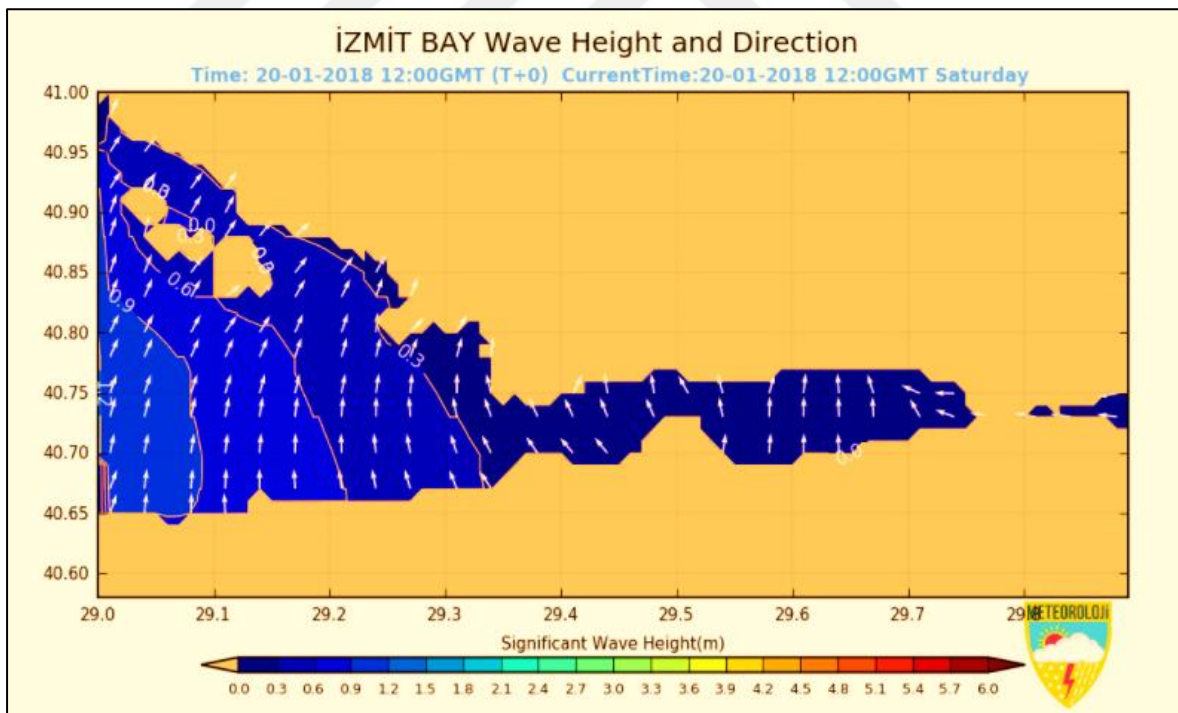
The rainy seasons are winter and spring. Annually only between 7 to 8 days are snowy in total. On the other hand, annual stormy days are between 2 to 11 days. Hazy days are annually between 6 to 18 days. About 21 days in a year, field of sight is restricted due to these bad weather conditions (based on personal communication with State Meteorological Officer).

According to the data of Turkish State Meteorological Services, the maximum and minimum temperature values measured at the region are +45.4 °C and -11 °C [21]. According to the data of Office of Navigation, Hydrography and Oceanography of Turkey (ONHO), the possibility of Beaufort 7-8 force storms to be observed at the region is 11 days per year. The probability of fog to be observed at the regions is 1.5 day/month and this ratio increases to 2.5 day/month at December as according to the data of ONHO[21]. Restricted visibility and adverse weather condition could be influence the vessel maneuvering, traffic or operations so it cause dangerous situation for the certain area.

2.3. Hydrographical Situation

The wave movement estimation model for the bay area is utilized by SWAN (Simulating Waves Nearshore) Model [18] developed by a Dutch university and a company. This high resolution and reliable system indicate annual figures between 0 to 1,2 seconds of wave period and 0 to 2.1m wave height, which means wave is not hampering shipping traffic significantly. The above mentioned model's output for wave period is depicted below (Fig. 2.2.) [21].

The currents in Marmara Sea form up basically in the eastbound and/or west bound. The surface currents are in Black Sea nature while the deeper currents are either local or Aegean, Mediterranean in character, considering the salt ratio, temperature, and oxygen ratio. The southbound surface currents head to the south where the local currents and winds are weaker, then split into two (west and east) in Cape Bozburun. The eastbound current enters in the Izmit Bay and fades down gradually until Cape Yelkenkaya. To the east of Cape Dilburnu, currents move clockwise direction from north to south sweeping southern coastline of the bay. The strength of currents in the bay with exception of both



coastlines and Cape Dilburnu is almost negligible.

Figure 2.2. Sample of SWAN (Simulating Waves Nearshore) Map for Izmit Bay (Source: <https://www.mgm.gov.tr/deniz/swan.aspx>)

According to the data of Office of Navigation, Hydrography and Oceanography of Turkey (ONHO), the prevailing wind is SE varying between 25% and 46% ratio based on the observation of the five years averages of Gölcük. The possibility of Beaufort 7-8 force storms to be observed at the region is 11 days per year as according to the data of ONHO.

Hydrographical Properties is not being affected for vessel maneuvering and the traffic for related area.

2.4. Technical Navigation Aids, Communication and Infra Structure

The Turkish Straits Vessel Traffic Service (TSVTS) became operational in 2003. The VTS in general, provides information, navigational assistance and other services such as rescue and salvage services.

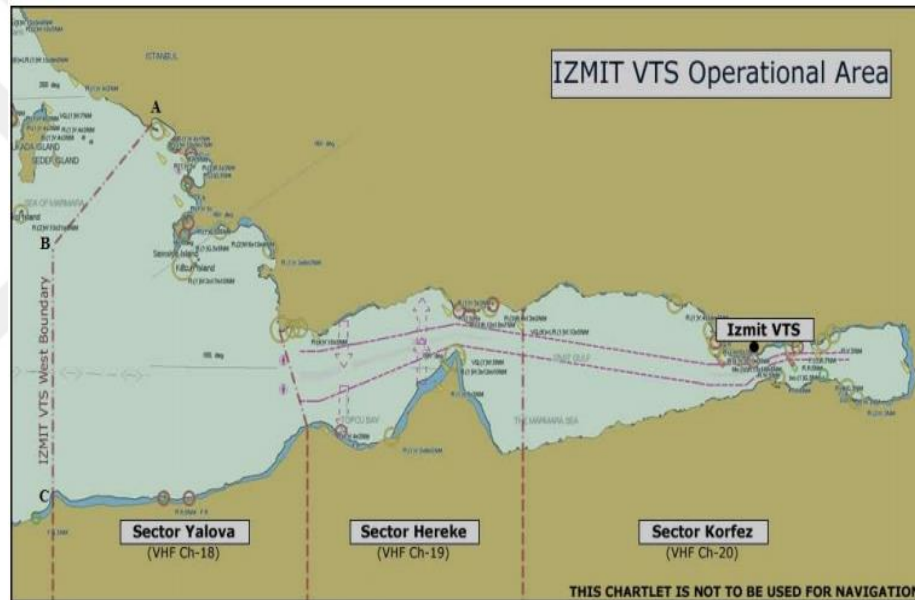


Figure 2.3. Current VTS for Izmit Bay (Source: www.vts.org.tr)

A new obligatory ship reporting system in the Izmit Bay (IZMITRAP) will also contribute to the shipping industry in regards to safe navigation, SAR, pollution prevention and exchange of information.

Izmit Bay, as being a blooming industrial region both nationally and internationally attracts great deal of maritime traffic. Therefore, regulating the vessel traffic in the bay area has a vital significance in terms of risk assessments and environmental impact studies targeted for the region by Ports and Waterways Safety Assessment (PAWSA) tool [9]. The entire area is covered by an automatic identification system (AIS) base stations which monitor the traffic in the bay. Pilot stations operate both in the bay and in some ports, such

as EVYAP, POLIPOINT, ALEMDAR, YILPOINT, ROTAPORT etc. The pilotage is mandatory for the vessels according to the national regulations [13], [22].

The structure of Turkish Vessel Traffic Services has been founded in 2009. The Project is still partly under construction but mostly under evaluation. The center of the Turkish VTS system (GTYM) is envisaged to be located in Ankara. Geographically dispersed 5 different local VTS centers (GTHS) are connected to the system. The overall VTS system will be available for users other than these 5 sub VTSs. The system will be fed with AIS data, and all other data originated from other related Turkish Government Services and Institutions and also international VTS info with updated AIS data [1].

The purpose of GTHSs is to watch the ships in their area of responsibility, communicate with them, relay them adequate info that may be needed and consequently to control the traffic. In order to achieve this task, GTHSs will deploy their own radar sites, AIS system, electro-optical systems, VHF and other means of communication, internet originated meteorological data to locate, recognize the vessels in their area of responsibility.

Among these 5 local VTS centers, Izmit VTS center is composed of a GTHS center and 4 Traffic Watch Posts (in other words “sector”) these posts are located in Çınarcık, Topçular, Kaytazdere and Izmit [6], [23].

The VTS system is very helpful to create solutions for increasing ship traffic in İZMİT BAY after the system started VTS operator can manage the vessel traffic according rules and display all vessel movement/information such as speed, course, destination easily.

2.5. Ports, Piers, and Shipyards of Izmit Bay

Izmit Bay and its nearby are critical for Turkish industry. Among lots of significant industrial companies, Turkey’s biggest refinery, namely Tüpraş and complementing petrochemical companies are located in this region. Port Derince on the other hand is an important gateway for import and exports in this area. With the subvention and encouragement of the government by privatization policy, large scale port facilities are established. Besides, the biggest military shipyard of Turkey is located in Gölcük in this area.

There are 43 port facilities and 33 shipyards (10 of them in the Kocaeli Free Trade Zone, and 23 of them along the coast of Yalova-Altınova Shipyard Zone. The port facilities and their dispersal are depicted in the following figures (Figure 2.4 and 2.5).

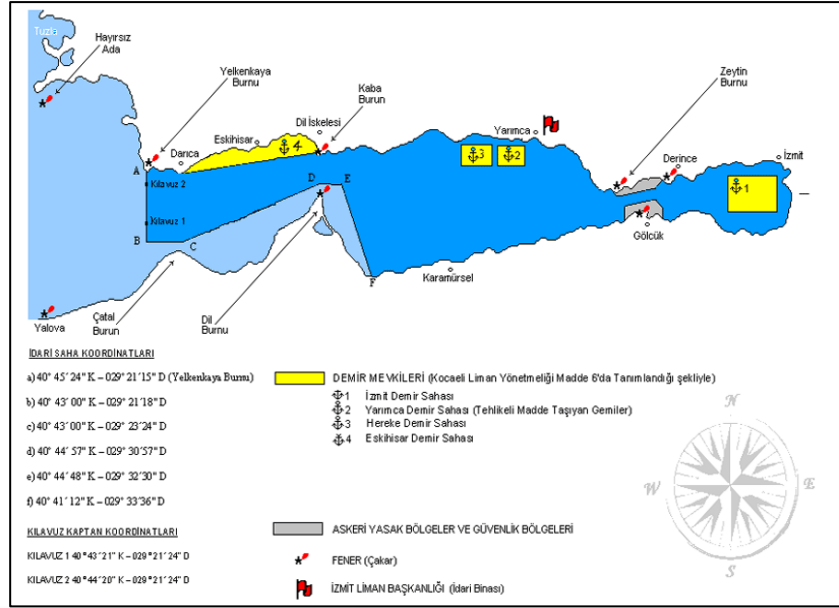


Figure 2.5 Area of Responsibility for Izmit Port Authority (Source: <http://www.kocaeliliman.gov.tr/idarisaha.aspx>)

Here in below are the shipyards that operate in Kocaeli Free Trade Zone. There are 10 shipyards operating in Kocaeli Free Trade Zone. These are as follows [10], [11]:

- ADMARİN Gemi Yapım San.ve Tic. A.Ş
- ÇELİKİYAT İnşaa San.ve Tic.A.Ş
- EDGEMAR Yatçılık San.ve Tic.Ltd.Şti
- North-Star Tekne Üretim A.Ş.
- SOLİ Gemi İnşaa Sanayi ve Tic. A. Ş
- UZMAR Gemi İnşaa San.Tic.A.Ş
- TVK Gemi Yapım Sanayi ve Tic. A.Ş
- YAY Gemi Yapım San. ve Tic. A.Ş.
- Tuna KOÇYİĞİT Deniz Araçları ve Malzemeleri İmalat A.Ş.
- ÖZATA Yat İnşaa Çekek Bakım Onarım Sanayi ve Ticaret Ltd.Şti.

There are 23 shipyards along the coast of Yalova-Altınova shipyard zone. The name of these shipyards is as shown as follows (Table 2.1.) [10], [11]:

Table 2.1. Shipyards Along the Coast of Yalova-Altınova Shipyard Zone.

No	Shipyards	No	Shipyards
1	Admarin Gemi Yapım San.ve Tic.A.Ş	13	Kocatepe Denizcilik ve Gemi İnşaa Sanayi Ticaret Ltd.Şti.
2	Çelikiyat İnşaa San.ve Tic.A.Ş	14	Aykın Tersanecilik ve Taş. İnş.

			San.A.Ş
<u>3</u>	Edgemar Yatçılık San.ve Tic.Ltd.Ş	<u>15</u>	Arif Kalkavan Oğulları Gemicilik
<u>4</u>	North-Star Tekne Üretim A.Ş.	<u>16</u>	Beşiktaş Gemi İnşaa A. Ş
<u>5</u>	Özata Yat İnşa Çekek Bakım Onarım Sanayi ve Ticaret Ltd.Şti.	<u>17</u>	Naci Selimoğlu Deniz İşletmeciliği ve Tic. A. Ş
<u>6</u>	Soli Gemi İnşa Sanayi ve Tic. A. Ş	<u>18</u>	Türkoğlu Gemi İnşa San.Tic.Ltd.Şti
<u>7</u>	Tuna Koçyiğit Deniz Araçları ve Malzemeleri İmalat A.Ş.	<u>19</u>	Yaşarsan Gemi İnşaa Sanayi ve Tic. Ltd.Şti
<u>8</u>	Tvk Gemi Yapım San. ve Tic.A.Ş	<u>20</u>	Sefine Den. Ters.Tur.San.ve Tic.A.Ş
<u>9</u>	Uzmar Gemi İnşaa San. Tic. A. Ş	<u>21</u>	Boğaziçi Tersanecilik Gemi İnşaa
<u>10</u>	Yay Gemi Yapım San. ve Tic. A.Ş.	<u>22</u>	Bayrak Den.Taş.Tem.A.Ş
<u>11</u>	Kurban Gemi İnşaa İnş.Taah.Nak.Tur.Orman Ür. San.ve Tic.Ltd. Şti	<u>23</u>	Altınova Tersane Girişimcileri San.ve Tic.A.Ş.
<u>12</u>	Altıntaş Mermer ve Tersanecilik San. Tic. A.Ş,		

The table below (Table 2.2.) shows the port facilities within the area of responsibility of İzmit Port authority. The table contains the names of 43 port facilities [10], [11].

Table 2.2. Port Facilities Within the Area of Responsibility of İzmit Port Authority.

No	PORTS	No	PORTS	No	PORTS	No	PORTS
<u>1</u>	Aslan Çimento	<u>13</u>	Diler	<u>25</u>	Aygaz	<u>37</u>	Autoport
<u>2</u>	Bayramoğlu Kum İskelesi	<u>14</u>	Nuh Çimento	<u>26</u>	İgsaş	<u>38</u>	UM Tersanesi
<u>3</u>	Ahmet Sarı Kum İskelesi	<u>15</u>	Evyap	<u>27</u>	Tüpraş İzmit	<u>39</u>	Limaş
<u>4</u>	Poloport	<u>16</u>	Gübretaş	<u>28</u>	Petline (Camar)	<u>40</u>	Akçansa
<u>5</u>	Çolakoğlu	<u>17</u>	Turkuaz (Melas)	<u>29</u>	Habaş	<u>41</u>	Tersaneler Böl
<u>6</u>	Yılport	<u>18</u>	Marmara Tersanesi (Kırlangıç İskelesi)	<u>30</u>	Opay	<u>42</u>	Yalova Elyaf
<u>7</u>	Altınel	<u>19</u>	Körfez Belediye İskelesi	<u>31</u>	TCDD Derince	<u>43</u>	Aksa
<u>8</u>	Solvertaş	<u>20</u>	Rota	<u>32</u>	Petrol Ofisi		
<u>9</u>	Efesanport	<u>21</u>	Milangaz	<u>33</u>	Shell Derince		
<u>10</u>	Total	<u>22</u>	Tüpraş Körfez	<u>34</u>	Tarım Koruma		

11	Karayolları	23	Ford Otosan	35	Aktaş
12	Kromançelik	24	Serbest Bölge	36	Setapark

The table below (Table 2.3.) shows the port facilities based on the cargo type. Cargo types are categorized into liquid and dry cargo. Also, liquid cargoes are divided into different categories such as LPG, LNG, petrol and products and chemical, while dry cargoes are divided into categories such as general cargo, dry bulk, container and RO-RO.

Table 2.3. Port Facilities by Cargo Type.

Liquid Cargo			Dry Cargo		
LPG/LNG Port Facilities	Petrol & Products Port Facilities	Chemical Port Facilities	General Cargo, Dry Bulk Cargo Port Facilities	Container Port Facilities	RO-RO Port Facilities
Aygaz	YILPORT	AKSA	YILPORT	LİMAŞ	Ford OTOSAN
Milangaz	Solventaş	Solventaş	LİMAŞ	EVYAP	EfesanaPORT
HABAŞ	TCDD Derince	LİMAŞ	AkçanSA	TCDD	TCDD Derince
	Petline	Altıntel	AutoPORT	Derince	AutoPORT
	Karayolları	Marmara	EfesanaPORT	YILPORT	EVYAP
	Petrol Ofisi	Transport	GUBRETAŞ		
	Opay	Klor Alkali	Altıntel		
	Altıntel	Poliport	KROMAN		
	Shell	EVYAP	Çolakoğlu		
	TOTAL	GUBRETAŞ	DİLER		
	Turquaz	AKTAŞ	PoliPORT		
	TUPRAŞ		Nuh Çimento		
			ROTA		

			Aslan Çimento TCDD Derince		
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Because of many port, piers and shipyards stated in the IZMIT GULF area the traffic congestion getting complicated and some of major port project still on progress. Therefore, the ship traffic congestion gradually increases in the future and becomes real serious problem as well.

2.6. Navigational Constraints

2.6.1. Local Traffic

In the Izmit Bay where regular passenger transport and ferry lines, shipyards and yacht berths, passenger skyscrapers, fishing lodges, marinas, sailing, dredging vessel and water sports clubs are located, along with approximately 40 port operations facilities in which oil and petroleum products are handled, thus intensive marine traffic and passenger transport are occurring simultaneously [23].

30 million people a year and about 4 million vehicles are transported by sea in İzmit Bay where approximately 62 million tons of shore is handled annually according to the data of the year 2013 [10].

The busiest ferry traffic in the bay area runs between Topçular / Tavşanlı and Eskişehir in the North-south bound which cuts east-west bound RO-RO, Cargo and tanker vessels traffic. Ferries depart from each pier in every 20 minutes on 24 hours' basis. Although the construction of the Osman Gazi Bridge help reduces the workload of ferries between Topçular / Tavşanlı and Eskişehir, consequently the local scheduled North-south bound ferry traffic. Meantime east-west transit vessel traffic gradually increases as regional developments [23].

Due to some of dredging vessels are not carried AIS equipment it is very dangerous the follow this vessel movement especially in the night and adverse weather condition.



Figure 2.6. A Radar Screen Display Showing Congestion at Ferry Line (Source: M/F Selimiye Car Ferry Radar Screen)

As seen Figure 2.6. N-S and E-W ship traffic has very complex situations. Two fixed ferry line has many vessel departures simultaneously from opposite side while transit traffic is continuing.

2.6.2 Passages and Exercises of Naval Vessels in The Bay

Gölcük is the main naval base for Turkish Fleet starting from the foundation of Turkish Republic. Despite the wounds of earthquake in 1999, the base remained to be of vital importance. Currently, more than 100 naval vessels of all kinds, shipyard, training facilities, shipyard and housing for naval personnel play significant role in the development of the bay area. On the other hand, the need for these naval assets go back and forth from the Gölcük Naval Base in order to reach blue waters, Aegean, Mediterranean and Black Sea, puts quite a big load on the traffic in the bay, not to mention the exercise areas especially for submarines to the east of Cape Dilburnu and to the south of current TSS [1], [19], [24].

To the east of suspension bridge and to the south of shipping route, there is Naval Exercise Areas (M-21) which are published by TURKISH ANNUAL TO MARINERS basically every day. The geographical limits of M-21 naval exercise area as follow;

40° 44'.11N, 029 34'.04E

40° 43'.30N, 029 39'.57E

40° 42'.48N, 029 39'.57E

40° 41'.59N, 029 34'.24E

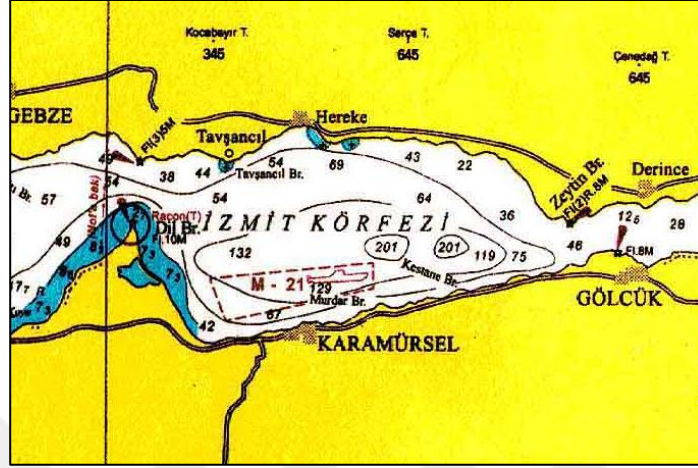


Figure 2.7. Naval exercise area in İZMİT BAY (Source: İzmit Bay Chart No 291)

Although there is quite a reasonable passage to the North of these areas, it is still a restriction for the maneuvering of the ships in the Bay [1], [10].

Nowadays İZMİT BAY ship traffic involve high risk. However, İZMİT BAY using as naval exercise area by TURKISH NAVAL FORCE. For this matter the ship traffic getting more complicated.

3. CURRENT SITUATION ON THE SAFETY OF SHIP TRAFFIC IN İZMİT BAY

3.1. Legal Issues

3.1.1. Montreux Convention

1923 Lausanne Convention, the very first internationally recognized document on Straits was in force only for 13 years and replaced by the Montreux Convention on Straits in 1936. Montreux Convention. Regarding the Regime of the Turkish Straits, which interconnect Aegean Sea and Black Sea via Marmara Sea constitutes the key for the basis of legal aspect of Republic of Turkey's monitor naval purpose vessel which proceed to straits while guaranteeing the merchant vessel passing through to straits in ordinary days. In this context, Izmit Bay, as part of the Marmara Sea, is subject to the regime of internal waters as a consequence of Montreux Convention (1936) [25].

All ships (including warships) possess right of free passages under some restrictions underlined in the Montreux Convention Agreement [25], [26].

Despite this convention involve all of the world İZMİT BAY is out of the transit corridor so this convention does not bind the ship traffic in the bay.

3.1.2. Turkish Straits Maritime Traffic Regulation

The Turkish Straits, which have been the concern of many states, due to their strategic, military and commercial interests encounter significant safety at sea and environmental stress. In fact, the 1936 Montreux Convention falls short in responding the current environmental challenge and safety issues stemming from high volume shipping traffic. In order to ensure navigation safety and to eliminate environmental risks to some extent, Turkish government enacted the “Maritime Traffic Regulation for the Turkish Straits and the Marmara Region” in 1994 and subsequently the 1998 “Maritime Traffic Regulation for the Turkish Straits” which replaced the 1994 Regulation [25], [27].

İZMİT BAY is the special area and the placed out of the straits road.

3.1.3. Other Regulations Imposed by Turkish Authorities

Regulations such as preventing environmental pollution such as control of water, solid waste and air pollution are enforced by Turkish authorities by increased Coast Guard Watch. Other internationally recognized regulation, namely Port State Control (PSC) is another issue with lots of legal aspects [11], [28].

3.1.4. Related IMO Regulations

The International Maritime Organization or simply IMO, was established in 1958, is one of specialized agencies in United Nations which is mainly responsible for safety and security in marine transportation and for prohibiting marine pollution caused by vessels. IMO considers safety, security and environmental performance inside international shipping. The main purpose of IMO is to generate a regulatory model for marine industry which is performed under equitable and effective conditions. IMO regulations are universally adopted and implemented. Today, IMO have 172 Member States and three Associate Members [5], [29].

3.1.5. IMO Conventions Adopted and Enforced by Turkish Authorities

Turkey has adopted almost more than 60 conventions of IMO in due course since 1958. The consequences of these conventions have been considered as the skeleton of the national regulations. Therefore, Turkish Authorities promulgated National Laws and directives in line with these conventions to enforce them in real world applications. Conventions such as preventing pollution, collision at sea, SOLAS (safety of life at sea) are of major concern. All the IMO conventions listed IMO web site: www.imo.org/listofconventions.

3.2. Navigational Safety Regulations

3.2.1. Vessel Traffic Separation Regime

Through Vessel Traffic Separation (VTS), safety of navigation, human life, assets and marine environment is ensured by managing the safeness of vessel traffic within the sea borders. Thus, applying these regulations properly should be obligated for all vessels entering or leaving or navigating inside Turkish Waters. The details of this regime can be referred to the official site [30].

Turkish Straits and Approaches has been verified in compliance with COLREGS 72 Reg. (10) and followed by IMO [10], [31], [32] .

For Turkish industrial point of view, Izmit Bay, the ports and its surroundings have significant point. There are many industrial companies and foundations are placed in Izmit Bay and the ports such as TÜPRAŞ which is the largest refinery in Turkey. Moreover, many important petro-chemical related foundations are located here as well. The largest iron and steel company which is owned by Turkish private sector is also placed in Izmit Bay. Besides Derince Port in Izmit Bay also have a big place in import and export, owning a role as a trading gate.

In latest years, government encourages private sector by providing increased privatization policy, thus private sector has been taking an action on building new port complexes in Izmit Bay, especially in Dilovası region. Turkish naval base and Turkish military shipyard is also found in Gölcük where is located at the easternmost part of Izmit Bay. Consequently, ports located in Izmit Bay have big roles in supplying raw material which is the basis of industry, and Izmit Bay acts as a gate for import and export trading. Because of these condensed activity, maritime traffic which causes big crashes and damages to human life, properties and marine environment, is unavoidable [9], [11], [24] . As for the Izmit Bay as being the east boundaries of the Marmara Sea, there is officially enforced control regime despite the volume of the shipping traffic in and out of the bay area. Vessels navigate in Izmit Bay in a mutually advisory by İZMİT VTS which has already started control/advise of the vessels in the area.

For the ships transiting the bay in the west-east direction, there is no assigned traffic line or canal that vessels are obliged to use. However, for the ships sailing on the way to Izmit Bay passing through Istanbul Straits should move within the traffic line which has the coordination provided below, to the traffic distribution regions.

40° 52'.90N, 028 55'.92E

40° 51'.50N, 028 56'.57E

Moreover, a traffic line is created within the traffic circulation area for the vessels to move through Istanbul Strait followed by South and East Marmara Sea then, Izmit Bay. And the coordination is as following:

40° 52'.00N, 029 01'.73E

40° 55'.00N, 029 00'.06E

İZMİT VTS must be well coordinate with the TURKISH STRAITS VTS system and planned ship traffic just entrance of the bay.

3.2.2. North-South Bound Traffic

It will be wise to evaluate this commercial traffic in two geographically divided areas (by Cape Dilburnu where the new suspension bridge, namely Osmangazi Bridge) in the gulf. To the east of the bridge, fast ferry boats, ferries run by the Municipality of Kocaeli and other small private ferries operate between north and south coast of the gulf. These scheduled ferries are destined in the route Izmit Port-Gölcük-Derince-Değirmendere-Tütünçiftlik and Yarımca and vice versa. This line does not hamper the shipping traffic other than the ones anchored in the far east of the gulf nearby Izmit Port (Fig 3.1.) [33], [34].

Another ferry line runs between Karamürsel and Hereke, which intersects the shipping traffic and especially hampers the maneuvering ships around Hereke trying to get alongside the northern piers. Risks are avoided by ships' mutual advisory precautions.

The volume of the scheduled traffic is around 136 runs per day [10], [35].

To the west of Osman Gazi Bridge, the main concern is the busiest ferry line between Eskihisar and Topçular/Tavsanlı. Every 30 minutes on 7/24 basis, a ferry leaves these ports which result in at least four ferries sailing in the north-south direction and eventually intersect and most of the time hamper the east-west shipping traffic. Risks are avoided by ships' mutual advisory precautions [35], [36].

To reduce ship traffic in the entrance of the area Osmangazi Bridge should be following reachable toll price for the vehicles/drivers.



Figure 3.1. A Satellite Image Showing Important Areas of Izmit Bay and their Connections
(Source: www.kocaeli.bel.tr/vapursaatleri.aspx and www.ido.com.tr)

3.2.3. East-West Bound Traffic

East-West bound traffic is basically based on commercial ships and ferries (container ships, cargo ships, tankers, dredging vessels etc.) and Turkish Naval Forces Ships. This traffic is the main core and also the concern of the congestion and related problems in the gulf. Despite the fact of not being a scheduled traffic, the blooming attraction of the Gulf ports/piers result in many ships of all kinds gathering in front of the ports/piers in the assigned anchorage areas [1], [10].

As for the naval ships, depending on the tasks or exercises, frigates, fast patrol boats, submarines, auxiliary ships utilize this passage very often. The question with the navy ships arises with their need to sail in close formation [10].

By using linked system with the VTS ship traffic can well operate and arranged the vessel movement as per identified schedule. Naval vessel exercise can be carried out at any suitable place except İZMİT BAY.

3.3. Pilotage and Tug Services

3.3.1. Pilotage Service

Pilotage is required for the vessels which are entering or leaving the ports inside Izmit Bay. Pilot Access Area is Lat. 40 degree 44' 89" N and Long. 029 degree 22' 66" E. Except TCDD Derince Port and TÜPRAŞ Refinery, pilotage and tugging services in Izmit Bay are supplied by Derince Kılavuzluk Private Pilotage & Tugging Service or shortly

DEKAS. DEKAŞ provides piloting to vessels in order to their arrival to ports in Izmit Bay. Two pilot stations are found in Izmit Bay and those are DEKAŞ and Derince Pilot which are available on VHF channels of 12 and 16, respectively. Vessels are warned and informed, three hours before their arrival at Darica. [37].

3.3.2. Tug Services

Tug services are supplied by the Medmarine, TCDD and TÜPRAŞ. Based on uncertain weather conditions and safety concerns, additional tug services such as anchoring vessel piloting are provided as it is requested [1], [10].

- **Darica DEKAS Pilot Station:**

Call Name: DEKAS

Pilot Position: Lat. 40°45' 20" N., Long. 29°23' 18" E

Phone: (90- 262) 745 43 12 - 745 06 00/ Fax: (90-262) 745 42 03

VHF Band: Ch. 16, 12

Working Hours: 24 hours

- **Yarımca DEKAS Pilot Station:**

Call Name: DEKAS

Pilot Position: Lat. 40°46' 26" N., Long. 29°44' 00" E

Phone: (90- 262) 528 33 00 - 528 79 03 Fax:(90-262) 528 53 72

VHF Band: Ch. 16, 12

Working Hours: 24 hours

- **Derince TCDD Pilot Station:**

Call Name: Derince

Phone: (90- 262) 223 15 40

Fax: (90-262) 223 42 78

VHF Band: Ch. 16, 12

Working Hours: 24 hours

3.4. Search and Rescue Capability

Turkish Coast Guard Regional Command in Istanbul is responsible to initiate and coordinate any efforts regarding a distress and Search and Rescue Operation (SAR).

Existence of Gölcük Naval Base in Izmit Gulf is another guarantee for a successful SAR operation, with the help of fast patrol boats, helicopters and scuba divers. Other than governmental capabilities, non-governmental organizations (NGOs) are quite active and conduct routine operations to be ready for emergencies especially right after the experiences and loss endured during the earthquake in Izmit Gulf in 1999 [9], [31].

3.5. Pollution Prevention

Izmit Bay is placed in the southeastern part of the Sea of Marmara and the Bay has a total area of 279 km² and a length of 26.8 miles. The bay is divided into three pieces of area. Depth of related area as following 200 m, 180 m and 35 m. The bay involves three parts which are linked to each other by narrow openings and channels. Inside the bay, there are two water stratification layers, the flow systems are separated as halocline and thermocline layers. The lower sea layer is composed of about 35-38% of Mediterranean origin and the upper layer consists of about 22-28% of Black Sea origin. The thickness level of those layers shifts seasonally, based on the weather conditions of the region. The main flows are coming from the northern part of the Izmit Bay [34].

Along the coast of Izmit Bay have dense human community and many kinds of industry such as cellulose and paper, chloral-alkali, sulfuric acid, antibiotics, metals, rubber, ammonia, pesticides, detergents, formaldehyde, dyes, solvents, polyvinyl and dung [38].

Amount of the incoming petroleum products for the Izmit refinery around 10 million ton/year. Approximately 3600 tanker/year used for petroleum products transportation. Thus, tanker operations caused a pollution source of petroleum hydrocarbons in the Izmit Bay seawater. Unfortunately, there is no sufficient research carried out related sea water pollution because of ship.[39].

Dilideresi River and Eastern Channel are the main freshwater flows through Izmit Bay, however their main problem is carrying polluted and contaminated water due to industrial wastes and habitat of surroundings. Dilideresi is about 12 km long and 70x10⁶ m³ /year of water is carried through Dilideresi River. Household and industrial wastes, traffic caused by heavy vessels, air pollution due to carbon-gas emission, limited water circulation and natural disasters such as earthquake. These problems cause serious oxygen deficiencies in deep waters, eutrophication which is the increase in nitrogen and phosphorous amount, habitat destruction such as toxic algal blooms and loss in biodiversity of water population [40] [41].

Until 1980's, domestic and industrial wastes were drained off without any environmental treatment, thus causing huge damages to the environment. However, these acts contributed to detrimental effects and threatened both human life and habitat of environment. For this reason, those inadequate policies related with environmental pollution were renewed and upgraded. New regulations and laws were settled related to prevention of water, air pollution and solid waste control. Although these obligations, there is still uncontrollable and unauthorized acts about polluting the water and Bay surroundings, and eutrophication problems are still present. Nowadays, because of algal bloom, red-tide planktons still occur and the depth level of water is decreasing. Moreover, industrial toxic wastes are still draining of without any permission and illegally [33], [42], [43].

Marine pollution is one of the major problem for environment. İZMİT BAY has some disadvantage due to its place. Due to geographic limitation, sea water not circulation as well. On the other hand, to many industrial factories stated around the area. Government should prepare some rules to establish waste water treatment plants for entire industry.

4. STEMMING PROBLEMS and POSSIBLE SOLUTIONS

4.1. Navigational Safety (Collision Risk)

Trading, importing and exporting take place under complicated, and highly-risky operating circumstances. Even though there is a lead of route with advanced and sophisticated technological navigation systems, it is highly possible to come with casualties and vessel accidents [44], [45].

Vessels differ in terms of size and type. They also show differences in terms of navigation. Vessels follow customary routes and courses on their way to destinations. Their primary objectives are [45], [46]:

- Keeping the shortest putative distance
- Avoiding navigational risks
- Avoiding collisions

Furthermore, because of increase in shipping traffic, associated shipping risks are also raised. Black point is a term that is used for determining possible risky regions, thus analyzing those regions where accidents are most likely to happen in terms of accident number/ratio and number/ratio methods can be done in order. Since black points refer to intensive risky areas, it gives a positive effect on deciding necessary steps in order to reduce accidents and collisions [19].

Collision risks involves collision or a near-miss situation can be categorized as following [22]:

- tolerable risk (more than three nautical miles),
- apparent risk (less than three nautical miles),
- increased risk (1 to 2 nautical miles),
- imminent risk (possible damage) (less than one nautical mile),
- high level risk.

If distances between two vessels located in a collision route less than 1 nautical mile, the collision risk is referred to as imminent risk. Within imminent risk conditions, the collision danger exists. Authorized people should evaluate and prevent the collision risks by making assessment of the conditions and situations. So, authorized people should be warned to evaluate well in hard conditions and should act quickly when there is a possible need for sudden action. [22].

For close quarter situation the stages are as follows [46] :

- Between 2-3 miles of outer limits in restricted vision, but less than 1 mile for those vessels where they are in sight of vision
- about 3 miles
- about 3 miles in fog on radar and with unrestricted maneuvering room
- consideration of distances with miles rather than yards based on the type and speed of vessel

A ship can take any action it wants to do until it reaches the point where a collision risk is to be seen. It is important to take precautions to comply with a COLREG situation as soon as the ship's officer is aware of any possible collision. Any wrong action at this stage can increase the risk of collision and ultimately cause an undesired close quadrant.

The knowledge of seafarers is very important to avoid collision and transport of marine vessels from the complexity of the ship's equipment and situation. Statistical analyzes of major causal trends clearly show that human error continues to be the main cause of all transport accidents with marginal decline and is shown in nearly 80 percent of accidents. As a result, it plays an important role in almost every accident of seafarers' actions or jumps [46].

Besides, the distance required for ships with a length of 50 meters or more while approaching each other to observe the same and lateral sides (s) of each other shall be 3 nautical miles. In this context, the distance to the approaching vessels is the outer boundary of the area where the collision risk exists and is clearly visible which is normally 3 nautical miles as the minimum range even though this depends on the longless of approaching vessels. This minimum range is considered to a large extent in the sense of the sea (or maritime common sense) based on sea and ship experience [22], [46].

Due to geographical specification of the area Izmit Bay involve many restrictions to maneuvering and sailing such as naval exercise area, traffic separation, cross line etc. The concentration of ship traffic, especially at two points, first one just entrance of the bay south of the Yelkenkaya and second one is the IZMIT BAY by naval base and trade center of the bay north of the Gölcük.

Üsküdar ferry accident was the deadliest ship accident recorded in Turkish Government. In the date of 1 st March 1958 the ferry called ÜSKÜDAR trip between İzmit and Gölcük, after departure from İzmit pier, near the Derince coast has been sang due adverse weather condition. Despite there was no believable information according some resource 200-300 or 400-500 person died [47].

Due to traffic congestion and geographical limitations in the Gulf of IZMIT, collision risk is always exist especially in two node points of the bay.

4.2. Unexpected Delays in Transportation

As it is often stated in this thesis study, the Izmit Bay has an important role on maritime transportation because of many aspects like its logistical role, sub-components at the bay, and even geographical location of Turkey. Because one of the most common events occurred in the sea environment is transportation done via ships, timing of such operations is also a remarkable issue. Timing is a key factor because it is clear that it has been an important point to Travel, merchandise and information sharing around the world as a requirement of the globalized economy [48]. Trade done with the ships in a regular timing has been a necessary way for the companies to keep the globalized economy alive. As we know that, it has been an efficient approach to perform transportation of large quantities of goods between especially long-distance points [49].

Before discussing about suggestions to solve unpredictable delays in transportation, it is important to firstly indicate the foremost factors causing unpredictable delays in transportation. These factors are graphically listed in the Figure 4.1.

- Dynamic nature of unloading times,
- Dynamic nature of loading times,
- Accidents occurred during unloading and loading processes,
- Delays caused before by other ships,
- Problems caused by people / staff,

*Dynamic nature of unloading times: Unloading times of goods from each ship arrived at the bay may change because of many factors like total amount of goods received, working time(s), total number of staff / machines / components working for unloading. So, because unloading times has a dynamic nature, this can be a key actor to cause unpredictable delays in transportation.

*Dynamic nature of loading times: As similar to unloading, loading of goods has also a dynamic nature because of factors working on loading operations. Delays / problems in such loading processes can cause unpredictable delays in transportation at the final.

*Accidents occurred during unloading and loading processes: As it is similar in every working environment, there can be some accidents occurred during unloading and loading processes. Such situations are unpredictable issues, which cause also unpredictable delays in transportation as a butterfly effect.

*Delays caused before by other ships: Any possible delay that may occur at the start of transportation processes done with other ships can cause delays to also other operations coming from after them.

*Problems caused by people / staff: Human factor is a key element for all operations / works in the modern life. Because any mistake by a person may cause bigger problems. As similar, problems caused by people's / staff's mistakes at the bay may cause delays in transportation operations.

The mentioned factors can be examined in detail in order to have more idea about what type of things may cause the problem in the bigger picture. But suggestions can be discussed directly by focusing on these factors.

Because the delays that start at first may cause more delays in next transportation processes, it is a vital approach to design a good working – organization plan at the bay. Designing a flexible (because of unpredictable sub-problems) and efficient plan will make everything better for the bay and eventually for transportation (trade) flow. In detail, design of such plan can include training people / staff and in this way, problems caused by people / staff can be also lowered (Of course, it is important to ensure as small as percentage of problems caused by human factor).



Figure 4.1. Factors Causing Ship Delays

The mentioned factors can be examined in detail in order to have more idea about what type of things may cause the problem in the bigger picture. But suggestions can be discussed directly by focusing on these factors.

Delay is the major problem for the maritime recently. Maritime has the term as “time is money” to all relevant parties. Not only agent and port manager but also master of ship, VTS system, owner and charterer have to be well coordination to avoid any unexpected situations. after İZMİT VTS has been started it is very helpful to solve this problem.

4.3. Sea Pollution

Izmit Gulf is a small pond located in the northeastern part of the Marmara Sea, moving in the east-west direction. Naturally, there are three physiographic compartments which are inner bay, middle bay and outer bay. The shallower (<20 m) inner bay is discriminated from the larger and deeper (<150 m) central bay through a 15 km-wide structure between the town of Gölcük and TÜPRAŞ Refinery. The middle bay is divided by a narrowing of 3 km wide and ~ 50 m depth between Dilburnu and Diliskelesi from west-flare and deepening outer bay (Fig 4.3.) [45].

About 2 million people are living on Izmit Bay surroundings, and basically there are three large centers which are Izmit, Yalova and Tuzla, and there are several single-industry villages such as Darıca, Gölcük, Hereke and so on. Nearby of Izmit Bay is one of the most heavy-industrialized regions of northwestern Turkey. There are many different industrial areas are found in this region. Petro-chemical and chemical plant industry, heavy steel industries, automotive industries, leather processing facilities are located in Izmit and Yalova and private-sector and military shipyards are located at Tuzla and Gölcük, respectively. Textile related facilities are located in Hereke and Karamürsel. In the last 100 years, the wastewater from these industries was flowing into the coastal waters of the Gulf of Izmit [19].

Seas always face with the risk of pollution. Urbanization and industrialization are two important facts that cause sea pollution. In the last 20 years, a series of studies on the effects of industrialization and urbanization have been made in the coastal marine sediments of the Marmara Sea, where the evaluation of anthropogenic pollution has been done using only a limited number of total concentrations of elements (Al, Cu, Cr, Fe, Mn, Ni, Pb, Zn). Yet, total sedimentary concentrations of many toxic heavy metals such as As, Ag, Cd, Hg, Mo and Sb have not been researched in these studies; thus, the critical value

for the full evaluation of marine environmental pollution in these buried areas is limited [39], [42].

Furthermore, heavy metals have a negative influence on polluting the sea. Heavy metals are toxic, detrimental and harmful for the environment because of the fact that they pollute the environment with toxic materials [35], [48]. Arsenic (As) and Chromium (Cr) are verified as priority pollutants by United States Environmental Protection Agency (US EPA) since they are carcinogenic to humans and classified in class A carcinogens, whereas Cadmium (Cd) and lead (Pb) are class B carcinogens which is equal to probable human carcinogens [51].

The rapid industrialization in cities has caused heavy metals to be drained into the world rivers and estuaries over the past century. This has accelerated the pollution of seas . [39].

Additionally, sediment contamination is one of the biggest issue that cause environmental pollution to marine ecosystem. Sediments are tools that showing and monitoring the concentration levels of contaminants and their magnitude rates. Sediment analysis have an important role in evaluating pollution status of marine environment [52].

Izmit Bay have a shape of east–west elongated on Marmara region, and latitude 40410 –40470 N, longitudes 29210 –29570 E. Izmit Bay is semi-enclosed embayment which makes the region important, and as a big city, Izmit has been negatively influenced by the increasing population and negative effects of industrialization [33].

Around Izmit Bay area, approximately two million people is living. This is a significant reason that triggers pollution around the area. In addition to the solid and liquid wastes, the origin of pollution in the area is caused by untreated domestic wastes of two million residents living around the bay area [38]. Furthermore, it is significant to note that the solid and liquid wastes in the area are not treated properly. Also, there are around 300 large industrial factories around the bay. Besides, bay sea welcomes heavy ship traffic [38]. All of these are considered as significant sources of pollution around Izmit Bay area.

Additionally, Dilderesi stream located in the western part of Izmit Bay has also been contaminated with industrial solid and liquid wastes due to presence of paint and metal facilities around the stream's area. Those contaminants cause serious danger in Dilderesi stream. This is another important factor that causes pollution in Izmit Bay. Figure 4.5. shows the pollution in Dil Deresi. The pollution in Dil Deresi is a crucial threat for sea pollution because of the fact that Dil Deresi flows into the sea.

Factors explained in detail under previous paragraphs require immediate preventions to be realized in order to overcome that sea pollution problem affecting the Izmit Bay negatively. In this manner, we can discuss about many different solution aspects trying to overcome problem of sea pollution. But by removing details, we can consider three different solution ways into consideration to overcome sea pollution factor at Izmit Bay. Those factors are listed in the figure Figure 4.2.

- Solutions against industrialization,
- Solutions against people population,
- Solutions against natural factors,
- Solutions against ships.

***Solutions against industrialization:** Because there is a rapidly growing, active industrialization around Izmit city and so Izmit Bay, solution mechanisms against lowering pollutions caused by industrial factors should be employed immediately. Such solution mechanisms may include giving training to the representatives of industrial companies to be aware of sea pollution, activating some regulations against industrial operations based sea pollutions, and developing some plans for operations of the industry side of Izmit to have better, regular flow of industrial operations not causing sea pollution directly or indirectly.

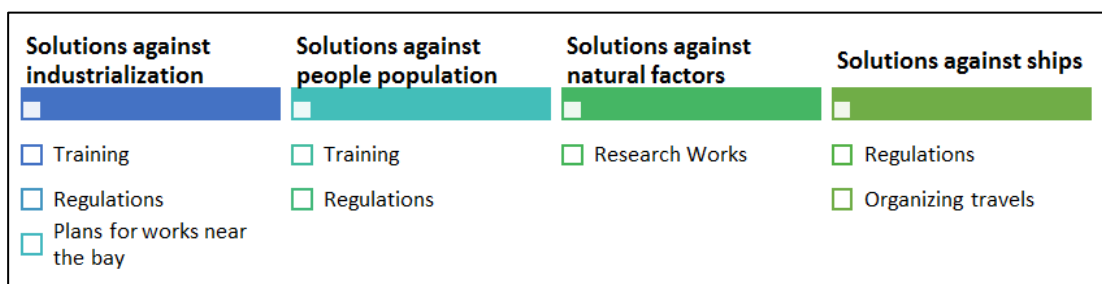


Figure 4.2. Simple Test to Check Solutions and Significant Factors.

***Solutions against people population:** It is clear that the population near to bay area (sea) trigger the pollution. In the literature, event recent studies find connection with changing feature of plastics according to distance to the land [53]. So, it is a vital approach to consider people population in the sense of sea pollution. At this point, pollution risk by people population can be lowered by taking some solution alternatives into consideration. For example, training people about pollution and improving their awareness will be a good way to prevent from sea pollution caused by people. On the other hand, some regulations

suggested for industrialization may be made to direct people for keeping themselves away from polluting the sea.

***Solutions against natural factors:** Natural factors considered here are pollution sources like Dil Deresi stream. Pollution caused by Dil Deresi or similar natural factors can be solved by performing additional research works to have idea about biological features of them and employing appropriate approaches to lower (or completely remove) the pollution.

***Solutions against ships:** As essential factors of maritime transportation, operations of ships can cause sea pollution. Sea pollution with heavy sea traffic and active operations of ships can be solved with some additional regulations improving awareness and also ensuring efficient organization of ship travels near to Izmit Bay. In the literature, there are also some works focusing on that sea pollution problem by ships [54], [55].

Although there are many reasons to increase pollution, there is no water stream in the region to help clean the sea water and pollution remains in the bay. This leads to the continuing increase in the problem of crime in the region. It is possible that there will be considerable pollution and material damages in the possible ship accidents that may occur due to intensive ship traffic.

4.4. Limitations of Naval Ships Movements

Because of its location, Izmit Bay is related to also traffic caused by naval ships, as it was mentioned before under this thesis study. Briefly, naval ships are some kind of ships, which are designed to be used by naval forces. In this sense, such ships are different from civilian and merchant ships with their design, construction and use. So, movements of naval ships are associated with specifically arranged plans and the whole ship traffic is generally arranged by taking movements of these ships into consideration [10], [35], [56].

Movements caused by naval ships are not very often seen but planned processes. Because of that and special state of naval ships, there may be possible blockages, which can cause delays in operations by other ships associated with especially bays. From this perspective, this issue should be accepted as a major problem related to shipping traffic. Possible blockages caused by naval ships may be not too unpredictable events occurred but it is a factor causing problems for general shipping traffic, which is important for bays like Izmit Bay [57].

As a suggestion, management to schedule of naval ships and other remaining type of ships can be realized in order to try lowering the problem of possible blockages caused by naval ships as much as possible. Sometimes, it may not be possible to arrange an optimum traffic schedule by hand without support from any technological components. So, it is necessary to employ computer oriented solutions to overcome this problem of having optimum ship traffic schedule.

By focusing on the last paragraph, scheduling passing of ships may be seen as a simple task. But in detail, such scheduling optimization has many sub-components that should be considered. These sub-components can include arrival time of ships, movement details of naval ships, and even timing details regarding to unloading – loading operations. In this way, an effective schedule optimization can solve not only problem of blockages by naval ships but also other delays related to i.e. transportation, natural factors.

4.5. Sample of Ship Traffic Optimization

The literature has some typical scheduling optimization works related to different transportation ways [58]. As one of the nearest example of ship traffic optimization for the Izmit Bay can be inspired from [57]. In the related research work, the authors have achieved a ship traffic optimization plan for the Kiel Canal and developed some interactive tools (diagrams, simulations as shown below) to show their solutions (Figure 4.3.) [20], [57]. Left figure of the display screen related to way-time diagram in the canal and the right one is vessels movement picture at a time.

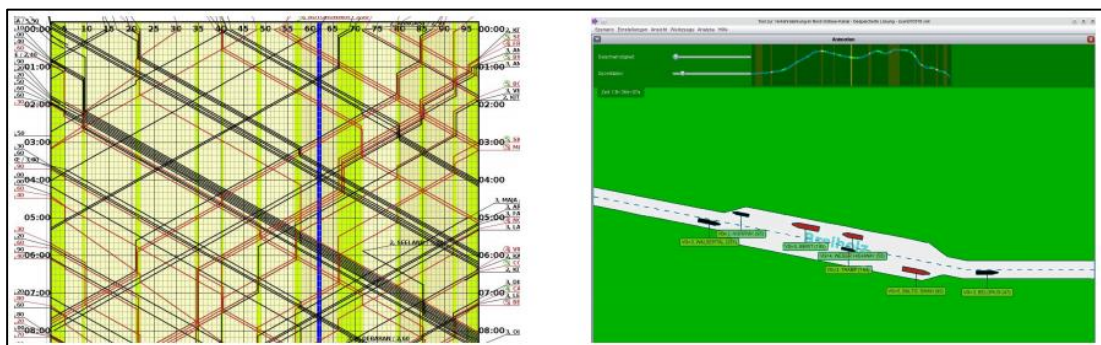


Figure 4.3. Ship Traffic Optimization Diagram Display for Kiel Canal [57] (Source G. Elisabeth, E. L. Marco, and H. M. Rolf, Berlin, 2014)

4.6. The Comparison for Vessel Passage Between İZMİT BAY and KIEL CANAL

There are some node points in the maritime around the world. KIEL CANAL is one of them and contribute short way to BALTIC SEA ports. We can easy understand the

comparison between the KIEL CANAL and İZMİT BAY from Table 4.1 the vessel passages still have high dense in their region.

Table 4.1. Vessel Passage for İZMİT BAY and KIEL CANAL (Source: Online, Available, https://atlantis.udhb.gov.tr/istatistik/istatistik_gemi.aspx Accessed 23.12.2017 / Facts and Figures on Germany's Maritime Dependence Annual Report 2016 Summary

YEAR	VESSEL PASSAGE	
	İZMİT BAY	KIEL CANAL
2011	11273	33100
2012	11455	34879
2013	11553	31097
2014	11339	32589
2015	11182	32091
2016	11574	-

4.7. Assessment on Contribution of Osmangazi Bridge on Shipping Traffic

The Osmangazi Bay Bridge is the biggest part of the Gebze-Orhangazi-İzmir Highway Project which makes the distance shortened between Istanbul and İzmir by roughly 140 kilometers, bypassing the long-stretching Gulf of Izmit. Constructed under the build-operate-transfer model, the Gebze-Orhangazi-İzmir Highway (including the İzmit Bay Bridge) is 433 kilometers long and includes 384 kilometers of highway and 49 kilometers of access road. The project includes an interchange of 2x5 lanes that was constructed 2.5 km after the Gebze Interchange on the Anadolu Highway, and ending at the Otogar Intersection on the Izmir Highway. The bridge is elongated about 252 m, and the deck of bridge is 25.93 m long having a main span length of 1.550 m. Thus, as totally having 2.682 m long, Izmit Bay Bridge became the fourth largest main span in the world [23].

Contribution of the Osmangazi Bay Bridge for the prevention of congestion of shipping traffic is a remarkable subject that should be discussed. Briefly, the bridge has an importance on connecting two points and eliminating disadvantages of long-stretching Gulf of Izmit. If we evaluate the location of the bridge from this perspective, we can

clearly see that there is a remarkable contribution on increasing the road traffic, which may include transportation of goods that can be done via ships. Because of that, there may be a remarkable contribution on lowering the density of ships transporting through the sea and achieving a balance between sea and road – bridge traffic causing to possible indirect preventions regarding to congestion of shipping traffic.

Possible advantages having the Osmangazi Bay Bridge can be listed briefly as follows:

- Better organization regarding to shipping traffic against the Izmit Bay.
- Better use of services with a lowered shipping traffic with more use of the bridge.
- Better control of the shipping traffic by accepting only some quality ships for transportation services and directing other companies to benefit from the Osmangazi Bay Bridge.
- A better model of optimization with lowered number of variables through the shipping organization, after activation of the Osmangazi Bay Bridge.

The bridge benefit for the reduce car traffic transport by ferry which is connecting North and the South. But today, bridge crossing prices are not enough to attract vehicle traffic in the region to the bridge crossing. As a result, ferry traffic on the north and south line create serious risk for entrance of the bay.

4.8. Assessments on Nodes Congestion

Nodes congestion appeared at the bay is another issue that should be taken into consideration. As it can be understood, shipping traffic can easily cause to nodes congestion because of many factors affecting the way of shipping through the Izmit Bay. As a typical issue for especially bays, importance of nodes congestion may change according to structure of the bay considered. It is observed that frequent ship tails are formed and sometimes it is necessary to wait longer before the vessels approach. This can be attributed primarily to the mobilization of existing port facilities to match increasing global trade and, secondly, to some disgusting government policies and regulations. This constant congestion in our ports caused the vessels intended for the Izmit Bay to be directed to other country shipping points. Regarding to the issue considered here, it can be a good way to employ an optimization oriented approach as it is indicated for the blockage caused by ships. But in addition, it will be better to focus on different alternative solution approaches to have another way of solution discussed through this thesis study. In this context, the Queuing Theory can be one option to overcome that issue of nodes congestion.

Adedayo et al. suggested that Many situations in life require queuing or queuing before one joins [59]. According to them, the served capacity comes to the queue when the service request is insufficient. Queuing theory is also known as a combination of analytical techniques considered as a valuable tool for solving congestion problems. In short, the primary inputs to the models are the arrival and service patterns. These models are usually identified by a suitable random distribution. Adedayo found that the arrival rates of the ships follow the exponential distribution while observing the Erlang or Poisson distribution of service time. Adedayo concluded that queuing theory could be used to estimate some important parameters close to real parameters such as average waiting time of vessels, average queue length, average number of vessels in the port, and average berth usage factor. [44], [59].

Eventually, all of these variables can be employed for the issue of nodes congestion. One essential thing to do here is accepting the points evaluated within the application of the theory as the nodes in the context of the congestion problem.

All of the information should get one center and decide the best way to avoiding vessel delay and ship traffic congestion in the bay. From first contact to operation time in the port/shipyard have to well planning and realize it in the shortest time.

5. CONCLUSIONS

There is currently a remarkable problem of risks stemming from the increasing shipping traffic at the Izmit Bay and in order to overcome the problem and any other sub-problems triggered by increase ship traffic. Those risks are;

- a) Safety of life, environment and vessel
- b) Collision
- c) Sea water and environmental pollution
- d) Delay loading/unloading operation
- e) Commercial loss

Current regulations are insufficient to solve the problems of that increasing shipping traffic. This problem is not only related to the regulations, naval force, location or including many port and shipyard of the Izmit Bay, but also caused by environmental factors having active roles on directing the shipping traffic around the Izmit Bay. So, we have focused more on possible solution approaches by discussing about major problems related to the environmental factors and suggested solutions, which are associated more with additional efforts for regulations, training of people (improving awareness) and even research works associated with optimization of the factors causing problems by shipping traffic. In this manner, each environmental factor has been evaluated and alternative solutions for these factors have been discussed. Additionally, possible supportive elements (like Osman Gazi Bay Bridge) to have effective on solving the problem have been taken into consideration.

Suggestions are essential outputs of this thesis work to meet with the objective of solving the problem of risks stemming from the increasing shipping traffic at the Izmit Bay. To sum it up we can be listed our suggestion as below;

- Naval exercise area should be moved out of the bay region. So, the naval vessel occupying the area could be minimized.
- Bridge price level could gradually reduction as possible as to getting attractive passing alternative cross the bay. Thus, it could be creating alternative ways to ferry traffic between vertical line in the bay.

- İZMİT VTS has already established in İZMİT BAY. However, the system must be more effectively operated to adjust the vessel schedules in the İZMİT BAY. This issue can be make collaboration between all related parties navigation in the gulf of İZMİT.
- In case of adverse weather condition Vessel Traffic Service, vessel and shore facilities should be well organized to avoid accident or incident could be occurred.
- The competent authority can be published new enforceable rules and dissuasive punishment for prevention of the pollution caused by intensive industrialization and urbanization. It can be able to reduce environmental pollution.
- Instead of private management for each ports/pier should be planning the area more efficiently to reduce vessels maneuvering or delay. It can provide safe navigation while reducing the vessels maneuvering near the ports/piers.



REFERENCES

- [1] Maritime Sector Report, (2017). Draft Report, Turkish Chamber of Shipping.
- [2] United Nations Conference on Trade and Development World Investment Report, (2015). UNCTAD.
- [3] World Shipping Report, (2016). UNCTAD, p. 37.
- [4] Deniz Ticareti Bilgi Sistemi İstatistik Bilgi Sistemi, [Online] Available: www.atlantis.udhb.gov.tr, Retrieved from 21.10.2017.
- [5] Review of Maritime Transport Report, (2007). New York & Geneva, UNCTAD.
- [6] The Logistics Industry in Turkey Report, (2013). Republic of Turkey Prime Ministry Investment Support and Promotion Agency, Ankara.
- [7] International Investment Rule-Making: Stocktaking, Challenges and the Way Forward Report, (2008). UNCTAD, New York & Geneva.
- [8] International Grains Council Market Report, (2016). Retrieved From 09.09.2017.
- [9] Şahin, O. A., (2015). İzmit Körfezi Deniz Trafiğinin IWRAP Model Kullanılarak İncelenmesi, Unpublished Graduate Thesis, İstanbul Teknik Üniversitesi.
- [10] Ulaştırma Denizcilik ve Haberleşme Bakanlığı, “Kocaeli Liman Başkanlığı, [Online] Available: <http://www.kocaeliliman.gov.tr/baskanligimiz.aspx#limantesisleri>, Retrieved From 12.12.2016.
- [11] Altan, T., (2014). Marmara Denizi Trafik Akışı ve Trafik Düzeninin Analizi, Unpublished Graduate Thesis, İstanbul Teknik Üniversitesi.
- [12] Elgin, B. S., (2015). İzmit Körfezi Pikofitoplankton Yoğunluğunun Mevsimsel Değişiminin İncelenmesi, Unpublished PhD Thesis, İstanbul Üniversitesi,
- [13] Yurtoren, C., Aydogdu, Y. V., Seta, H., and Atasoy, C., (2014). İzmit Körfezi Deniz Trafik Akışının Analizi, 1. Ulusal Gemi Trafik Hizmetleri Kongresi Raporu, pp. 145–150.

- [14] Aydogdu, Y. V., Yurtoren, C., Park, J., and Park, Y., (2012). A Study on Local Traffic Management to Improve Marine Traffic Safety in the Istanbul Strait, *Journal of Navigation*, Dokuz Eylül Üniversitesi, Vol. 65, pp. 99–112.
- [15] Deniz Ticareti Raporu, (2016). İMEAK DTO, İstanbul, Türkiye, p. 58.
- [16] Aydın, A., (2002). İzmit Körfezi'nde Çevre Sorunları, Unpublished Graduated Thesis, Ankara University.
- [17] Dengili, K., (1999). Water quality Assessment of İzmit Bay by to Dimensional Modeling, Unpublished Graduated Thesis, Boğaziçi University.
- [18] Encyclopedia Britannica, (2016). [Online]. Available: <https://global.britannica.com>. Retrieved From 01.12.2016.
- [19] Uzun, S. M., (2013). İzmit Körfezi Kıyılarının Jeomorfolojisi ve Kıyı Alanı Kullanımı, Unpublished Graduated Thesis, Marmara Üniversitesi.
- [20] Ceylan, M., (2012). Uzaktan Algılama ve CBS ile Kıyı Çizgisi Değişiminin Belirlenmesi: İzmit Körfezi Örneği, Unpublished Graduated Thesis, Hava Harp Okulu Havacılık ve Uzay Teknolojileri Enstitüsü.
- [21] Orman ve Su İşleri Müdürlüğü, [Online] Available: <https://www.mgm.gov.tr>, Retrieved From 01-Dec-2016.
- [22] Koldemir, B., Esnaf, Ş., and Akten, N., (2008). Enhancing the Collision Risks in The Risk Management Era, *International Maritime Lecturers 16th Conference*, İstanbul Üniversitesi, pp. 429–436.
- [23] Karşlıoğlu, M., (2016). Sismik Zemin Büyütmelerinin İzmit Körfez Geçişi Osmangazi Asma Köprüsü'nün Dinamik Davranışına Etkilerinin Araştırılması, Unpublished Graduated Thesis, Yıldız Teknik Üniversitesi.
- [24] Koçar, Ö., (2015). İzmit Körfezinde Yer Alan İş Yerlerinin İş Güvenliğinin Deprem Riski Açısından Harita Bilgisi Kullanılarak İncelenmesi, Unpublished Graduated Thesis, Üsküdar Üniversitesi.
- [25] De Luca, A. R., (1973). A Diplomatic Study of Anglo-Soviet Rivalry at the Turkish Straits, *The Montreux Conference of 1936*, Stanford University.
- [26] Güçlü, Y., (2001). Regulation of the Passage Through the Turkish Straits, *Journal of International Affairs*, Vol. VI, no. 1.

- [27] Hystad, S. W., Olaniyan, O. S., and Eid, J., (2016). Safe Travel: Passenger assessment of trust and safety during seafaring, *Transportation Research, Part F Traffic Psychol. Behav.*, Vol. 38, pp. 29–36.
- [28] Pehlivançocuk, B., (2012). Integrated Coastal Zone Management: Case Study İzmit Gulf Integrated Plan, Msc Thesis, Middle East Technical University.
- [29] Review of Maritime Transport, (2015). UNCTAD, Retrieved From 10.10.2017.
- [30] International Maritime Organisation (IMO), IMO Conventions, [Online]. Available: <http://www.imo.org>, Retrieved From 09.10.2017.
- [31] Oral, N. and Öztürk, B., (2006). The Turkish Straits, Maritime Safety, Legal and Environmental Aspects, Turkish Marine Research Foundation Report, Istanbul.
- [32] Demirel, E., & Bayer, D., (2015). Further Studies on the COLREGs (Collision Regulations), *TRANSNAV The International Journal on Marine Navigation and Safety of Sea Transportation*, Vol. 9, Number 1, 17-23. Doi: 10.12716/1001.09.01.02.
- [33] Balkıs, N., (2003). The effect of Marmara (İzmit) Earthquake on The Chemical Oceanography of İzmit Bay, Turkey, *Maritime Pollution Bulletin*, Vol. 46, no. 7, pp. 865–878.
- [34] Tolun, L., (2011). İzmit Bay, SPICOSA, Marmara Research Center Report, TUBITAK.
- [35] Ferry Schedule of Kocaeli (2016). Kocaeli Büyükşehir Belediyesi, [Online] Available: kocaeli.bel.tr/vapursaatleri.aspx, Retrieved From 05.03.2017.
- [36] IDO Ferry Schedules, Istanbul Deniz Otobusleri. [Online] Available: <http://www.ido.com.tr/en/interaktif-haritalar>, Retrieved From 01.02.2017.
- [37] North Maritime, Port of Derince. [Online]. Available: <http://northmaritime.com/ports-info/marma-region/55-port-of-derince-tcdd.html>. Retrieved 01.02.2017.
- [38] Telli-Karakoç, F., Tolun, L., Henkelmann, B., Klimm, C., Okay, O., and Schramm, K.-W., (2002). Polycyclic Aromatic Hydrocarbons (PAHs) and Polychlorinated Biphenyls (PCBs) Distributions in The Bay of Marmara Sea: İzmit Bay, *Environ. Pollut.*, Vol. 119, no. 3, pp. 383–397.

- [39] Yaşar, D., Aksu, A., and Uslu, E., (2001). Anthropogenic Pollution in İzmit Bay: Heavy Metal Concentrations in Surface Sediments, Turk J. Engin Env. Sci, TUBITAK, Vol. 25, pp. 299–313.
- [40] Tolun, L. G., Okay, O. S., Gaines, Tolay, Tüfekçi, A. F., M., H., and Kıratlı, N., (2001). “The Pollution Status and The Toxicity of Surface Sediments in İzmit Bay (Marmara Sea), TUBITAK, Environ. Int., Vol. 26, no. 3, pp. 163–168.
- [41] Güven, K. and Günday, H., (1997). Oil Pollution of İzmit Bay, Turkish Journal Mar Sci, TUBITAK, Vol. 3, pp. 1–10.
- [42] Öksüz, İ., (2016). İzmit Körfezindeki 238U, 232Th, 40K ve 137Cs Spesifik Aktivitelerinin Ölçülmesi, Unpublished Graduate Thesis, Kocaeli Üniversitesi.
- [43] Koralay T., (2010). İzmit Körfezi Kirletici Kaynak ve Yüklerinin Belirlenmesi, Unpublished Graduate Thesis, Sakarya Üniversitesi.
- [44] Collisions - Why Do They Occur?, Gard News (2004). [Online]. Available: <http://www.gard.no/web/updates/content/52482/collisions-why-do-they-occur>, Retrieved From 01.03.2017.
- [45] Blokus-Roszkowska, A., and Smolarek, L., (2012). Collision Risk Estimation for Motorways of The Sea, Reliab. Theory Appl., Published Book, Vol. 7, no. 2, pp. 58–68.
- [46] Akten, N., (2005). Risk of Collision: How Far Are the Rules Satisfactory?, European Journal of Navigation, Thomas Reed Publication, Vol. 3, no. 1, pp. 1–5.
- [47] Internet News, [Online]. Available: <http://tarihinzinde.com/uskudar-vapurubatti-olu-sayisi-belirsiz/>, Retrieved From 20.04.2017.
- [48] Kaluza, P., Kölzsch, A., Gastner, M. T., and Blasius, B., (2010). The Complex Network of Global Cargo Ship Movements, Article, Journal of The Royal Society Interface.
- [49] Rodrigue, Comtois, J.P., C., and Slack, B., (2006). The Geography of Transport Systems, Published Book, Taylor&Francis e-Library.
- [50] Tolun, L., Okay, O.S., Gaines, A.F., Tolay, M., Tüfekçi, H, Kıratlı, N., (1998). The Toxicity of Surface Marine Sediments in İzmit Bay (Marmara Sea). International Conference on Ecotoxicology and Environmental Safety, SECOTOX 98, October 1998, Antalya, Turkey.

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